High Speed 2 - 1MC06 - Stage One C2 - MWCC –

North Portal of Chiltern Tunnels to Brackley

Twyford Embankment GDR

1MC06-CEK-GT-REP-CS06_CL10-000002

Rev	Date	Author	Checked by	Approved by	Revision Details	EKFB Reviewer
C04	07/07/2022	P.Dorado	R.Jones	R.Platt	Updated in line with comments	Georgios KATSIGIANNIS
C03	08/04/2022	P.Dorado	R.Jones	R.Platt	Updated in line with comments	Georgios KATSIGIANNIS
P04	20/07/2021	A.Berenguer	R.Jones	R.Platt	Updated for detailed design	Moustapha Diagne
P03	23/05/2020	R. Masrat	R. Blackmore	R. Platt	Issue for EK comment	Moustapha Diagne
C02	13/05/2020	R. Elandaloussi	R. Jones	R. Platt	Revised in line with comments	Moustapha Diagne
C01	23/08/2019	R. Elandaloussi	R. Jones	R. Platt	Update for optimised scheme design	Moustapha Diagne

Stakeholder review required (SRR)	Purpose of SRR
☐ County / District / London Borough Council	☐ Acceptance
☐ LOV	☐ Approval
☐ LUL	☐ No Objection
☐ NRL	☐ Consent
☐ TFL	
☐ Utilities Company	
☐ Other (please specify)	

Contents

FIGURES

TABLES

1 Glossary of Terms

Acronym	Description	Acronym	Description
ACEC	Aggressive Chemical Environment for Concrete	**ENV**	Environmental
ACSW	Advanced Continuous Surface Wave	**ERD**	Data Modelling Software
AGS	Association of Geotechnical and Geoenvironmental Specialists	**E_u**	Elastic Modulus (undrained)
AIP	Approval In Principle	**EV2**	Modulus of Deformation
ALARP	As Low As Reasonably Practicable	**EW**	Earthworks
AONB	Area of Outstanding Natural Beauty	**EWC**	Early Works Contractor
ATS	Autotransformer Stations	**FOC**	Fraction Organic Carbon
BGS	British Geological Survey	**FPD**	Final Preliminary Design
BRE	Building Research Establishment	**GBR**	Geotechnical Baseline Report
BTEX	Benzene; Toluene; Ethylbenzene; and *o*-, *m*-, and P-xylenes	**GC**	Geotechnical Category
c'_{cv}	Critical Value Effective Cohesion	**GDMS**	Geotechnical Data Management System
CBM	Cement bound material	**GDR**	Geotechnical Design Report
CBR	California Bearing Ratio	**GI**	Ground Investigation
CC	Concrete Core	**GIR**	Ground Investigation Report
CIRIA	Construction Industry Research and Information Association	**GIS**	Geographical Information System
CO	Cable Percussion borehole with Rotary Open Hole follow on	**GRR**	Geotechnical Risk Register
CP	Cable Percussion borehole	**HP**	Hand Dug Pit
c'_{peak}	Peak Effective Cohesion	**HS2**	High Speed 2 Limited
CPT	Cone Penetration Test	**HSV**	Vane Test
CR	Cable Percussion borehole with Rotary Cored follow on	**INNS**	Invasive Non Native Species
CSO	Combined Service Overflow	**IP**	Inspection Pit
CSW	Continuous Surface Wave	**ISRM**	International Society for Rock Mechanics
CT	Cone Penetration Testing	**LCA**	Local Character Area
c_u	Undrained Shear Strength	**LCRM**	Land Contamination Risk Management
c_v	Coefficient of Consolidation	**LEL**	Lower Explosive Limit
DA1 C1	Eurocode 7 Design Approach 1, Combination 1	**LIDAR**	Light Imaging Detection and Ranging
DA1 C2	Eurocode 7 Design Approach 1, Combination 2	**LL**	Liquid Limit
DCP	Dynamic Cone Penetration	**LLAU**	Limits of Land to be Acquired or Used
DGN	CAD drawing	**LOCA**	Location ID
DJV	Design Joint Venture	**mAOD**	metres Above Ordnance Datum
DLS	Design Limit State	**MASW**	Multiple Channel Analysis of Surface Wave
DoU	Degree of Utilization	**mbFL**	Metres Below Foundation Level
DP	Dynamic Probing	**mbgl**	Metres Below Ground Level
E'	Elastic Modulus (drained)	**MCV**	Moisture Condition Value
EIA	Environmental Impact Assessment	**MDD**	Maximum Dry Density
EK	Eiffage Kier	**SP**	Self-boring Pressuremeter Testing

Acronym	Description	Acronym	Description
MOD	Ministry Of Defence	**SPT**	Standard Penetration Test
MPATS	Mid Point Auto Transformer Site	**SPZ**	Source Protection Zone
m_v	Coefficient of Volume Compressibility	**SRR**	Stakeholder Review Required
MWCC	Main Works Civils Contract	**SSSI**	Site of Special Scientific Interest
N	SPT ‘N’ blow count	**TFL**	Transport for London
NCA	National Character Areas	**TP**	Trial Pit (mechanically dug)
NCA	National Character Area	**TPH**	Total Petroleum Hydrocarbons
NCR	No Core Recovery	**TPS**	Total Potential Sulphate
NMC	Natural Moisture Content	**TSA**	Thaumasite Sulphate Attack
OLE	Overhead Line Electrification	**TT**	Trial Trench
OMC	Optimum Moisture Content	**UCS**	Unconfined Compressive Strength
OP	Observation pit (shored)	**ULS**	Ultimate Limit State
OSMM	Ordnance Survey Master Map	**UXB**	Unexploded Bomb
OT	Observation trench (shored)	**UXO**	Unexploded Ordnance
OXC	Oxford Clay Formation	**v'**	Drained Poisson’s Ratio
PBT	Plate Bearing Test	**v_u**	Undrained Poisson’s Ratio
PC	Pavement Core	**WLS**	Windowless Sampling
PCB	Phenol and Gasoline Range Organics	**WS**	Windowless Sampling (also Windowless sampling + Dynamic probing)
PGA	Peak Ground Acceleration	**WWI**	World War 1
PI	Plasticity Index	**WWII**	World War 2
PSD	Particle Size Distribution	**γ_b or γ_{bulk}**	Bulk Density
RAG	Red-Amber-Green	**φ'_{cv}**	Critical Value Effective Angle of Friction
RC	Rotary Coring	**φ'_{peak}**	Peak Effective Angle of Friction
RO	Open Hole Rotary Drilling		
RQD	Rock Quality Designation		
Ru	Pore Pressure Ratio		
SB	Sonic Resonance Borehole		
SCEW	HS2 Specification for Civil Engineering Works (Series 600 Earthworks)		
SCPT	Seismic Cone Penetration Test		
SHC	Subsidence Hazard Category		
SHCN	Hazard Rating for Ground Dissolution		
SHRN	Subsidence Hazard Rating Value		
SMC	Saturated Moisture Content		
SMUG	Strategy for Management of Uncertainty in Ground Conditions		

2 Executive Summary

This revision of the Detailed Design GDR (DD-GDR) presents the technical output of Detailed Design for Twyford Embankment Reference (080-L1) for L3 submission.

It incorporates the GI Impact Assessment undertaken on the outstanding GI data received post-IDR submission.

Twyford Embankment is a low embankment (maximum height is 5.9m at Ch 81+600), 1427m long situated between the HS2 earthwork assets of Calvert Cutting to the south and Twyford Viaduct to the north between Ch_{HS2}. 80+862 and Ch_{HS2}. 82+289.

The landform comprises open, gently sloping shallow valley of the east flowing Padbury Brook main channel and tributary within the Twyford Vale LCA.

The land use is predominantly farmland. Twyford village is located 200m to the west and includes St Mary's Church (Grade I listed) located beyond the northern end of the asset. Portway Farm is located on the Down side at the southern end of the asset. It is situated between the HS2 earthwork assets of Calvert Cutting to the south and Twyford Viaduct to the north.

On Twyford Embankment the HS2 mainline tracks share the earthworks platform with

- Electrified Loop from Ch.80+862 to Ch. 82+257
- IMD Chord 1 from Ch. 80+862 to Ch. 81+657
- IMD Chord 2 from Ch. 80+862 to Ch.81+565

The Chord lines are ballasted. The Electrified loop line is slab track between Ch. 82+074 and Ch. 82+224 to join HS2 mainline.

There are several S&C units. In compliance with HS2 technical standard for earthworks, the total acceptable residual settlement shall be less than 15 mm along 150m pre and post S&C location.

The ground conditions comprise the Ancholme Group composed of the Oxford Clay Formation (OXC) and Kellaways Formation (KLB) at depth overlain by superficial deposits Alluvium (ALV) and River Terrace Deposits (RTD).

The groundwater level is assumed to be at 0.2 bGL, perched in the superficial deposits.

The key ground risks associated with design of the asset are:

- Soft ground and consolidation under embankment loading
- Soft ground and slope instability
- Rayleigh Waves, especially in the southern part of the asset on low embankment
- Perched groundwater in superficial deposits
- Flooding related to Padbury Brook and tributary crossing HS2 respectively around 82+300 and Ch.81+715;
- Potential relic slip surfaces
- Potentially contaminated ground associated with the Made Ground at the location of the Dismantled Rugby to Quainton Great Central Railway (LQ 13.07) and the Sewage Works (LQ 13.06)

  Contamination screening of groundwater samples has highlighted some exceedances against Drinking Water screening criteria for TPHs, Manganese and Sodium. Other metals exceedances were noted but these were against the least stringent environmental guidelines (and likely to be caused by background concentrations).
- Chemically aggressive ground

The mainline earthwork slope gradients are confirmed to be 1V:2H.

Earthwork mitigation measures include (bottom-up):

- E&R 3m bFL to mitigate inadequate subgrade support due to the presence of soft materials in the low embankment from Ch. 80+862 to Ch. 80+920, from Ch.81+000 to Ch. 81+140 and from Ch.81+320 to Ch. 81+470
- E&R 2m bGL to remove soft soils and ensure acceptable post-construction settlements in the high embankment of less than 15 mm from Ch. 80+920 to Ch. 81+000 and from Ch. 81+140 to Ch. 81+320
- E&R 1m bGL or ensure a minimum value of c_u=50kPa beneath the base of the embankment from Ch. 81+620 to Ch. 81+269
- Starter layer (300mm thick) is recommended at the base of the embankment to act as a capillary break from Ch.81+470 to Ch.82+269
- Flood protection on the approach to Twyford Viaduct East Culvert (Padbury Brook main channel) :
  - On the Up side of the embankment from Ch. 82+180 to viaduct
  - On the Down side of the embankment from Ch. 82+252 (end of landscape bund) to the Viaduct
- Anticipation of rail load (additional 1.5m of fill) to achieve post-construction settlement of less than 15 mm in S&C area from Ch. 81+470 to Ch. 81+620
- Settlement hold period of minimum 6 months with I&M at specific locations

Construction stage management to control risk will include:

- a minimum undrained shear strength of 50 kPa shall be proven by sufficient control testing at the base of excavations (on top of the natural subgrade) prior to placing the fill materials.
- the inspection of sub-excavations to confirm the absence of relic slip surfaces will need to be undertaken from Ch. 80+862 to Ch. 81+220 near to Perry Hill Road Alignment and West Street realignment.

A Landscape bund (H=5.5 m above rail level in embankment at 81+660; slope 1V/4H) is planned on Down side facing HS2 mainline between Ch. 80+862 to Ch. 82+200. In compliance with the EKFB construction sequence the landscape will be built at the same time as HS2 mainline embankment to avoid excessive post-construction and differential settlements.

3 Introduction

3.1 Purpose of report

The purpose of this Geotechnical Design Report (GDR) is to present the geotechnical design of the earthworks associated with the HS2 line and Infrastructure Maintenance Depot (IMD), which forms part of the EKFB works in the Calvert Area, at Twyford Embankment location between Ch. 80+862 to Ch. 82+289 at Stage 2 detailed design.

This revision C03 of the DD-GDR for OXD line has been updated to incorporate the results of the GI impact assessment Ref. [86].

This DD-GDR is the full and final revision for L3 acceptance.

All key modifications made to this revision of the DD-GDR are highlighted in blue writing to make them easily identifiable compared to the previous version of the DD-GDR.

3.2 Background

In January 2012, the UK Government announced its intention to proceed with a new high-speed railway line (HS2) and announced the preferred line of the route from London to the West Midlands as the first phase (Phase 1) of a national high-speed rail network which is illustrated in Figure 3-1 – HS2 Phase 1 Route. Phase 1 will involve construction of a new railway line of approximately 230 kilometres (km) -142.9 miles - between London and the West Midlands with stations at Euston, Old Oak Common, Birmingham Interchange and Birmingham Curzon Street.

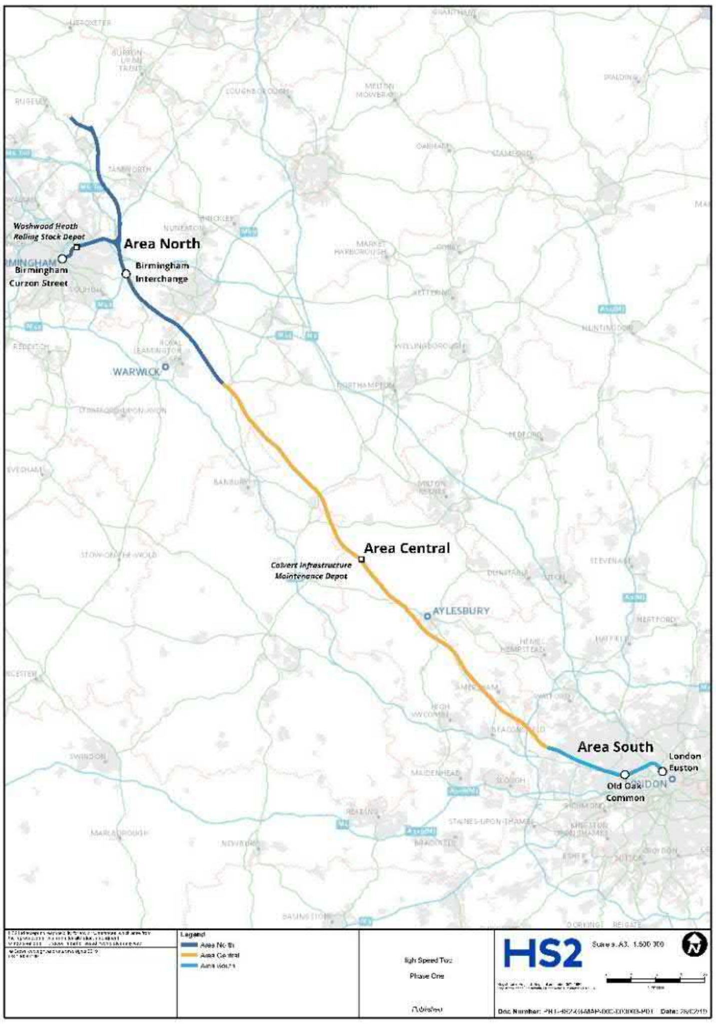


Figure 3-1 – HS2 Phase 1 Route

For design and construction purposes, the overall route has been divided into three Delivery Areas as illustrated in Figure 3-1 – HS2 Phase 1 Route and Table 3-1 below.

Table 3-1 – HS2 Delivery Areas

Area	Comment
Southern	The former London Metropolitan and London Euston Station
Central	The former Country South, with part of Country North
Northern	The remainder of Country North and Birmingham Metropolitan

The delivery areas have been further sub-divided into Contracts, each of which represent a Main Works Civils Contract (MWCC). The Arcadis, Setec, COWI Design Joint Venture (ASC) has been appointed by Eiffage, Kier, Ferrovial Construction, and BAM Nutall Contracting Joint Venture (EKFB) to provide detailed design services for the civil engineering assets within HS2 Contract C23 (Formally Central Area 2 and Central Area 3), which have been further subdivided into the five delivery packages with the approximate extents provide in Figure 3-2 – Calvert Junction – schematic plantbelow.

Table 3-2 – Approximate Extents of HS2 Contract C23 Delivery Packages

DELIVERY PACKAGE TITLE	EXTENTS (Snake Grid)
North Chilterns Area (NCA)	47+750 to 57+850
Aylesbury Area (AA)	57+850 to 71+850
Calvert Area (CA)	71+850 to 81+450
Twyford to Greatworth (T2G)	81+450 to 101+620
Greatworth to Southam (G2S)	The detailed design for Calvert Area 101+620 to 126+540

The Detailed Design of critical assets in the Calvert Area started in July 2019. At this time, the detailed design was being progressed in advance of the remainder of the delivery package areas.

The Twyford Embankment design is one of these critical assets.

3.3 Description of the Works – Calvert Area

3.3.1 General layout

A simplified general layout at the proposed Calvert Junction is provided in Figure 3-2.

3.3.2 HS2 limits / EWR Upgrade Interface

The HS2 trace in the vicinity of Calvert Area interfaces with three existing Network Rail railway lines. These are:

- OXD line – This is the Bicester to Bletchley line (OXD) and it crosses the HS2 trace almost perpendicularly at approximate Ch.$_{HS2}$ 80+100.
- MCJ3 line – This is the Marylebone to Claydon line which runs parallel to the HS2 trace alignment for an approximate length of 8km from Quainton to Calvert. Approximate Ch.$_{HS2}$ 71+800 – 80+120.
- MCJ4 line – This is the chord line that connects MCJ3 to the OXD line between Ch. $_{MCJ}$ 20+600 and Ch. $_{MCJ}$ 19+852.

The start of the Twyford Embankment within Calvert Junction at Ch. 80+862 is illustrated in the below figure. The HS2 asset to the south is Calvert Cutting.

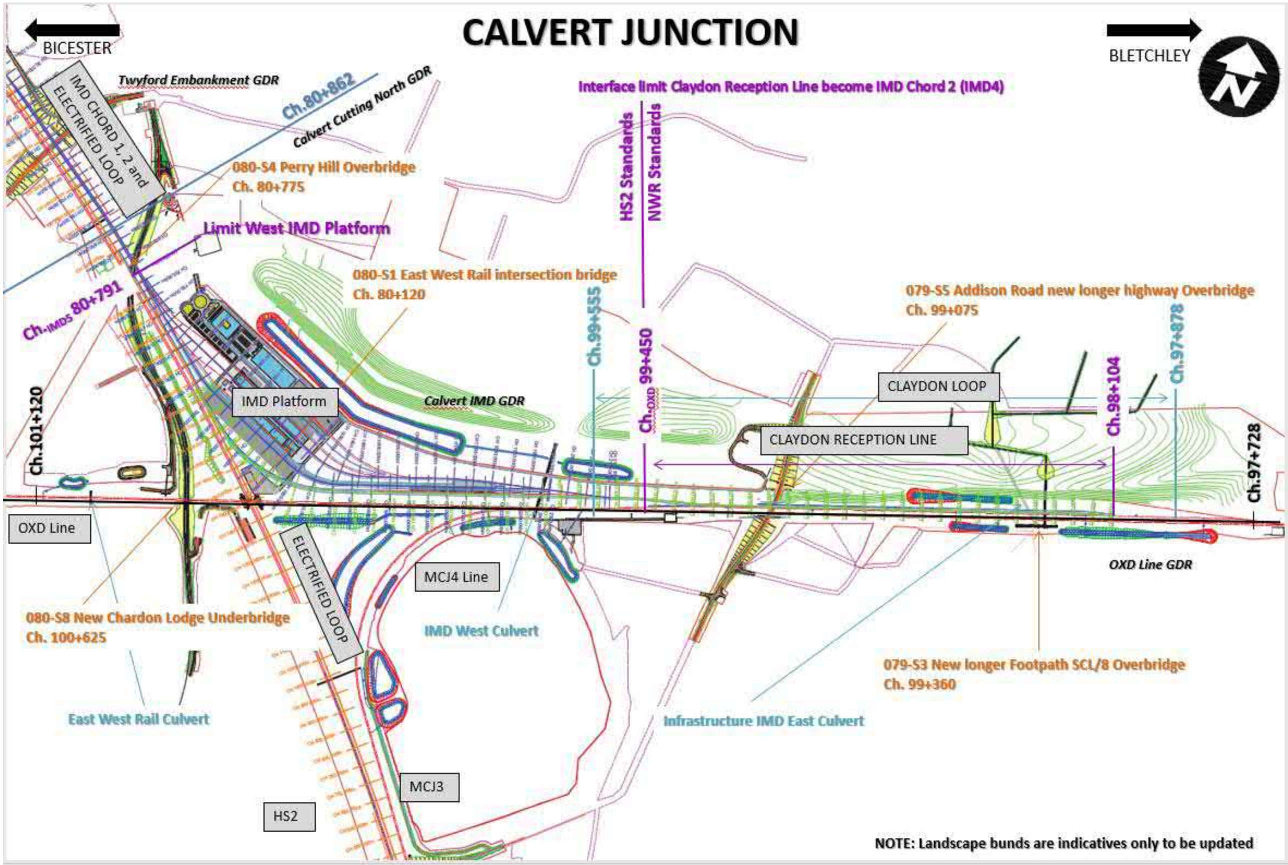


Figure 3-2 – Calvert Junction – schematic plant

The new OXD line is located to the south of Twyford Embankment and crosses over HS2 Calvert Cutting. The OXD line will follow its existing horizontal alignment but require the construction of a new embankment in order to cross over the proposed HS2 route. The existing OXD embankment will be demolished as part of the EKFB works.

The IMD platform is located to the South of Twyford Embankment and will be accessed from two directions as follows:

- The North connection via the HS2 IMD Chord lines (S&C) leading of HS2 mainlines located on Twyford Embankment.
- The East connection leading off the proposed OXD line via the proposed Claydon Loop line and finally transferred via the Reception line.

3.3.3 Design Line speeds:

- IMD Electrified Loop: 80kph (Including connections to the HS2 Mainline),
- IMD Chord 1: 60kph (note, the rail alignment design can accommodate 60kph from JCA14 to JCA17),
- IMD Chord 2: 60kph (note, the rail alignment design can accommodate 80kph from JCA19 to JCA36, HS2 Mainline Connection),
- The adjoining crossovers between the Electrified Loop and IMD Chords 1 & 2: JCA41/42 is 50kph, JCA43/44 is 60kph and JCA13/14 is 50kph,

- A blanket line speed across the IMD Sidings area of 25kph.

3.3.4 EKFB design interfaces

3.3.4.1 IMD interfaces

The interfaces between EKFB and HS2 are outlined in the Interface Control Document for Calvert IMD Ref [63];

EK will provide IMD detailed Earthworks and track formation design based on several parameters:

- All loop lines (1, 2 and 3) (now referred to as Chord Lines 1 and 2 and Electrified Loop (refer to Section 4 Site Description) and tracks within the IMD are to be ballasted, except at turnouts from HS2 mainlines.
- IMD Chord lines and the IMD having a depth to formation from top of rail of 700mm,
- Formation to support ballast track construction having an EV2 of 40 MPa minimum,
- Formation provided with a water-resistant protection treatment,
- Settlement limit overall for the platform of 100mm over 20 years Rail Systems will design and install all depot infrastructure within this footprint e.g. drainage, track, hard standing, finished surfacing, profiling the depot for their needs.

3.3.4.2 EWR interfaces

The interfaces between EKFB and EWR are outlined in the Interface Control Document for Calvert IMD Ref [63].

3.4 Scope and objective of the Report

In accordance with the HS2 Main Works Civil Contract (MWCC) Works Information WI 300 Contractors Design Ref [1], and the HS2 Technical Standard – Earthworks Ref [2], EKFB is required to prepare a GDR as part of the geotechnical design process.

The design within this report satisfies the requirements of the HS2 Technical Standard – Earthworks Ref [2] and where relevant, cross-references the Geo-environmental and Remediation Strategy Reports as required by HS2 Technical Standard – Land Quality Ref [3].

This GDR presents the technical output of the stage 2 detailed design for the HS2 **Twyford Embankment** occupying the northern part of Calvert Junction and extending to Twyford Viaduct. It presents the design and outputs, taking into account the available information which includes supporting geotechnical data and ground investigation (GI) data. The report focuses on the key performance considerations for the particular assets and defines the geometry and the construction measures together with the risks and opportunities associated with the earthworks and geotechnical design.

This revision C03 of the DD-GDR for OXD line has been updated to include the results of the GI impact assessment report Ref. [86] on the new Stage 2 Ground Investigation data received post IDR submission.

This report does not include the Earthwork transition to Twyford Viaduct, which is included in the Twyford Viaduct Structures GDR Ref. [81].

3.5 Report structure

The general site context and asset description is presented in Section 4

The Scheme GIR Ref [7] provides a summary of the baseline GI data and the section-wide geotechnical data by geological formation at the start of detailed design.

The detailed design development of the project knowledge, including updates to the existing information and the factual data from desk study information presented in the Scheme GIR, and the summary of the Ground Investigation data available at detailed design is provided in Sections 5 and 6 respectively of this GDR.

The ground conditions and geotechnical hazards are presented in Section 7.

The geotechnical model, geotechnical design calculations and mitigation measures are presented in Sections 8 and 9.

The onward management of uncertainty in ground conditions after mitigation are detailed in Section 15 and further developed in Sections 16 to 20.

3.6 Management of Uncertainty in ground conditions and new ground investigation data

The Configuration Report Detailed Design for – Calvert Area Works Ref [4] outlines the framework for the assurance of the detailed design including the strategy for management of new GI data.

As part of this strategy, ASC has developed a project specific framework for assessing the level of uncertainty in ground conditions that is linked with the ability to develop the scheme design into a detailed design ready for construction. The framework is set out in detail within the Ground Engineering Design Basis Statement – Management of Uncertainty in Ground Conditions (MUGC) Ref [5]. It introduces 5 classes that are used to communicate the level of uncertainty in ground conditions with Class 2 representing a position where the Scheme Design can successfully be developed into a detailed design with the ground related risks managed to an acceptable level. A dynamic assessment that will evolve through design and construction must be considered as additional information becomes available.

An uncertainty class of 4 was attributed to Twyford Embankment at the start of detailed design due mainly to the lack of GI, the presence of soft ground and a suspected geological fault.

The design presented in this report has been completed using the available supplementary GI data, comprising borehole logs with SPT tests. The few available supplementary data requires implementing a reasonably cautious estimate of characteristic design parameters. The available data considered in this GDR is detailed in Section 6.3 of this report.

Stage 2 GI information was received and analysed between December 2020 (Data drop 6) and April 2021 (Data drop10) in the previous revision of the DD-GDR Rev. P04.

Additional GI was received post DD-GDR Rev P04 submission between June 2021 and December 2021 including Data Drop 11 to 17. This data was assessed and included in Twyford Embankment - New Ground Engineering Data - Impact Assessment Report, Ref. [86].

The MUGC classification at the end of detailed design is Class 2.

3.6.1 Limitations

Data used to undertake virtual walkovers and details of the physical walkovers is presented within the Scheme Design GIR Ref [7] and discussed further in Section 5.1 of this GDR.

The Geotechnical Risk Register GRR Ref. [89] is a multi-discipline register that may be updated for other Level 2 assets after submission of the ground risks for mainline earthworks included in this DD-GDR. .

PMI 52 (dated 28th August 2020) relating to the change of track form for the Loop 1 line to Slab Track from ballasted track has been incorporated into this DD-GDR.

Schedule 17 was being undertaken in parallel with the detailed design of Twyford Embankment. Any changes to the position or height of landscape areas, swales or ponds after submission of this DD-GDR may require changes to the design and mitigation measures recommended in this DD-GDR.

3.7 Design Changes and Updates

The following design updates have been incorporated into this DD-GDR:

- The PMI 52 (dated 28th August 2020) relating to the change of track form for the Electrified Loop 1 line to Slab Track from ballasted track has been incorporated into this DD-GDR.

The following table indicates the optimisations / updates considered in the detailed design of Twyford Embankment and the revision of this DD-GDR where the update was incorporated into the design.

Table 3-3 – Opportunities and updates on the Twyford Embankment at Stage 2 detailed design

Updates	Incorporated	DD-GDR revision
Updated settlement analysis to HS2 standards	Yes	P04
Updated settlement analysis for culverts	Yes	P04
Updated Rayleigh Waves mitigations considering the new ASC methodology outlined in the C23 Dynamic Performance Basis of Design Report – Earthworks Working Group – 03 December 2021 Rev P01	Yes	This current update (post-IDR change in line with GC-7137)
Updated calculation method for slope stability: – Seismic design has been reviewed in accordance with the updated ASC settlement guidance, – Groundwater level impact on slope stability calculation has been updated.	Yes	P04
Applied long term/differential settlement criteria (≤ 15 mm) between closely spaced structures and in areas of S&C	Yes	P04
Detailed Analysis of construction sequence and timing of the placement of landscape materials abutting the mainline earthworks and its impact on settlements	Yes	This current update
Updated analysis and mitigation measures based on the findings of the GI Impact Assessment Report Ref. [86]	Yes	This current update
Updated I&M	Yes	Revised in this current update
Updated Ground Movement Impact Assessment (GMIA) MIA – third party assets assessment	Yes	Revised in this current update

4 Asset Description

4.1 Site Location

The Twyford Embankment (080-L1) will be located between Ch 80+862 and 82+289 (Snake grid) at the northwest of the junction of the HS2 and the OXD lines, centred at approximate National Grid Reference E: 444439 N: 255931 (OSGB). Adjacent HS2 mainline assets include Twyford Viaduct to the north and Calvert Cutting (077-L1) to the south and directly adjacent to Calvert IMD.

The section of embankment corresponding to the transition to Twyford Viaduct falls within the remit of the HS2 section T2G and is not therefore included in this DD-GDR (refer to Section 3.4).

The village of Twyford, which includes St Mary's Church (Grade I listed), is located approximately 200 m to the west. Portway Farm buildings are located 300 m to the south-west of the asset.

The HS2 alignment is set above the existing ground level on embankment and comprises two mainline tracks. The horizontal alignment is straight, and the vertical alignment raises slightly with a uniform gentle grade to the north, from 86.5 m to 88.0 m AOD.

Three loops run parallel to HS2 mainline on Twyford Embankment namely Electrified Loop, IMD Chords 1 and 2.

The S&C of the Electrified Loop is located at Ch. 82+257 as shown Figure 4-3.

The S&C of the IMD Chords 1 and 2 are located respectively at around 81+657 and 81+565.

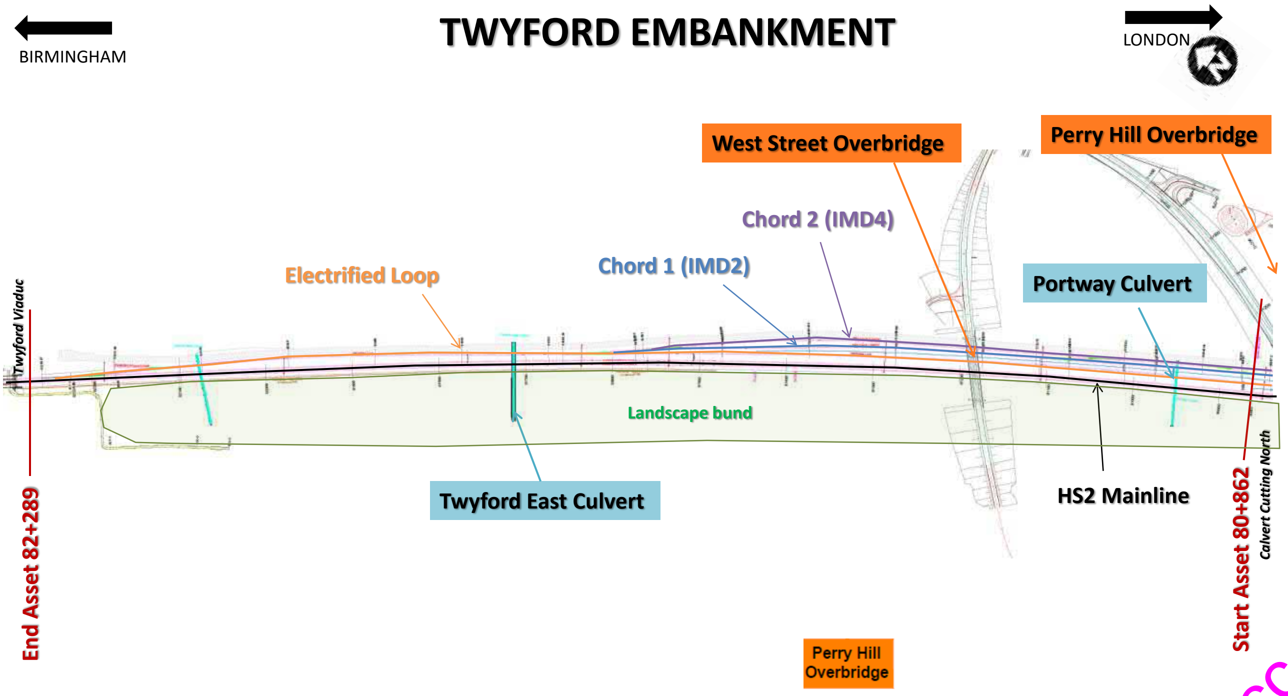


Figure 4-3 – Twyford Embankment Layout

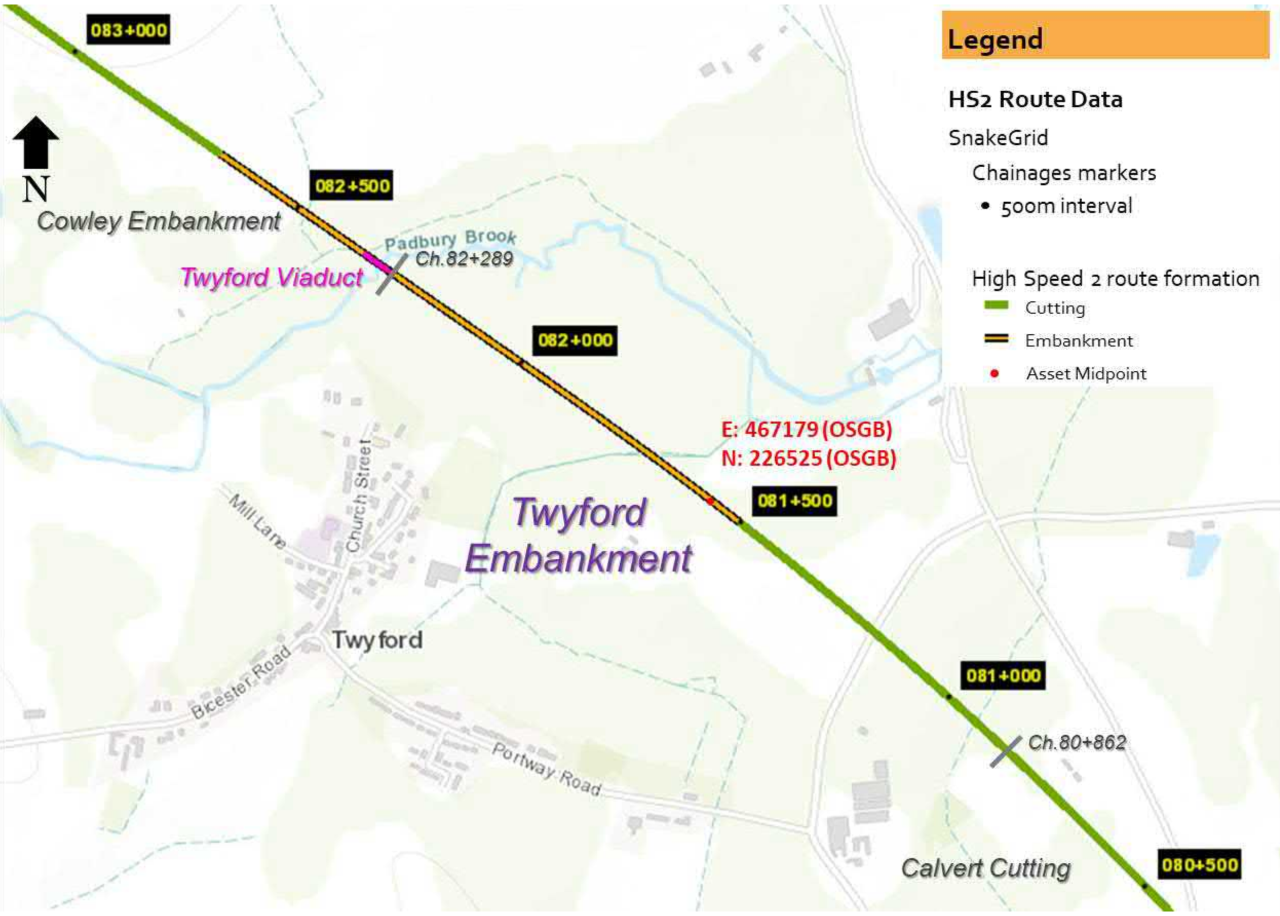


Figure 4-4 – Site location plan (Twyford Embankment)

4.2 General Landscape Setting

Twyford Embankment alignment passes through the “Clay Vale”, characterised by flat open valley floors and gentle hills in Jurassic Clays (Oxford Clays and Kellaways Formations).

A tributary of Padbury Brook crosses beneath Twyford Embankment at about Ch.81+687. The watercourse will flow through HS2 Twyford East Culvert.

Padbury Brook main channel is located immediately to the North of Twyford Embankment and will be crossed by Twyford Viaduct.

The land use is rural characterised by small to medium sized hedged fields. The agricultural land is Grade 3b, according to the Agricultural Land Classification (ALC) system.

The historic village of Twyford is located to the southwest and Portway Farm is located to the south

Other existing land uses in the vicinity of the Twyford Embankment include:

- Dismantled railway parallel to the new HS2 mainline on the Down side to the north of Twyford village and Portway Farm.
- West Street Bridge crosses over the dismantled railway at approximately Ch_{HS2} 81+200 and will be demolished as part of the HS2 works. A new West Street overbridge will be built and will cross the HS2 mainline at Ch_{HS2} 81+186
- Sewage work on the Down side between the dismantled railway and the new HS2 mainline at approximately $Ch._{HS2}$ 81+500 and the associated Anglian Water Sewer outfall pipe crossing beneath the HS2 route
- Buried HP Gas pipe, at approximately Ch_{HS2} 80+900, which is a diverted (as built) UTX at the start of the Twyford Embankment asset. The gas pipe has been installed at about 9m depth.

More information on environmental features and environmental constraints are available in the Twyford Environmental General Principles Compliance Note (1MC06-CEK-EV-REP-CS06_CL10-000001).

Figure 4-5 – Main site features and land uses centred on Twyford Embankment asset

4.3 Asset Description

4.3.1 Dimensions

The HS2 project layout and associated ground elevations in Twyford Embankment can be found on the following project drawings:

- Report of Cross Sections Ref [65]
- General Arrangement Drawings – Earthwork and Drainage Layout Sheets Ref [83], [84] and [85].

The principal dimensions of the Twyford Embankment are summarised in Table 4-4 below.

Table 4-4 – Dimensions of Twyford Embankment earthwork asset including Landscape bunds

Parameters	Description
Contract/section/lot	C2/CS06/CL10
Name of design element	080-L1 Twyford Embankment
HS2 Asset ID	HS2-000001045
Type	Embankment
Start - end chainage (HS2)	Ch.HS2 80+862 - Ch.HS2 82+289
OS Grid reference	E 444439 / N 255931
Length	1427 m
Proposed Maximum height and Minimum height	Embankment: 5.9m (Ch.81+600) / 0.1m (Ch.80+862) At grade: Ch.$_{HS2}$ 80+990-81+120 and 81+340-81+430
Average height	1.5m(Ch.80+862 to Ch.81+450) 5 m (Ch.81+500 to Ch.82+289)
Detail Design angle (GDR)	Sections in embankment: 1V:2H
Landscape bunds	Downside: Ch.$_{HS2}$ 80+862 to Ch.$_{HS2}$ 82+200 • Slope facing HS2: 1V:4H • H_{max} = 10.5 m (H=5.5 m above rail level) at Ch 81+660

The IMD access tracks, Electrified Loop, IMD Chord 1 and 2 share the same earthwork platform, and run parallel to, the HS2 mainlines on the Up side. The principal dimensions and characteristics of the IMD access tracks are summarised in Table 4-5 to

Table 4-7 below. The ‘length’ provided in the tables refers to the interface with Twyford Embankment, all these additional lines extend to the south, beyond the limits of Twyford Embankment, into Calvert Cutting.

Table 4-5 – Dimensions of the Electrified Loop

Parameters	Description
Contract/section/lot	C2/CS06/CL10
Name of design element	Electrified Loop
HS2 Asset ID	HS2-000001045
Type	Embankment
Start - end chainage (HS2)	Ch.HS2 80+862 - Ch.HS2 82+257
OS Grid reference	E 444439 / N 255931
Length	1395 m
Proposed Maximum height and Minimum height	Embankment: 5.9m (Ch.81+600) / 0.1m (Ch.80+862) At grade: Ch.$_{HS2}$ 80+990-81+120 and 81+340-81+430
Average height	1.5m(Ch.80+862 to Ch.81+450) 5 m (Ch.81+500 to Ch.82+289)
DJV Slope angle (GDR)	Sections in embankment: 1V:2H

Table 4-6 – Principal characteristics of IMD Chord 1

Parameters	Description
Contract/section/lot	C2/CS06/CL10
Name of design element	IMD Chord 1
HS2 Asset ID	HS2-000001045
Type	Embankment
Start - end chainage (HS2)	Ch.HS2 80+862 - Ch.HS2 81+657
OS Grid reference	E 444439 / N 255931
Length	795 m
Proposed Maximum height and Minimum height	Embankment:5.0m (Ch.81+600) / 0.1m (Ch.80+862) At grade: Ch.$_{HS2}$ 80+990-81+120 and 81+340-81+430
Average height	1.5m(Ch.80+862 to Ch.81+450) 5 m (Ch.81+500 to Ch.82+289
DJV Slope angle (GDR)	Sections in embankment: 1V:2H

Table 4-7 – Principal characteristics of IMD Chord 2

Parameters	Description
Contract/section/lot	C2/CS06/CL10
HS2 Asset ID	HS2-000001045
Type	Embankment
Start - end chainage (HS2)	Ch.HS2 80+862 - Ch.HS2 81+565
OS Grid reference	E 444439 / N 255931
Length	703 m
Proposed Maximum height and Minimum height	Embankment: 5.0 m (Ch.$_{HS2}$ 81+500) At grade: Ch.$_{HS2}$ 80+990-81+120 and 81+340-81+430
Average height	1.5m(Ch.80+862 to Ch.81+450) 5 m (Ch.81+500 to Ch.82+289)
DJV Slope angle (GDR)	Sections in embankment: 1V:2H

The limits of the sections on embankment and at grade are shown on the Figure 4-6.

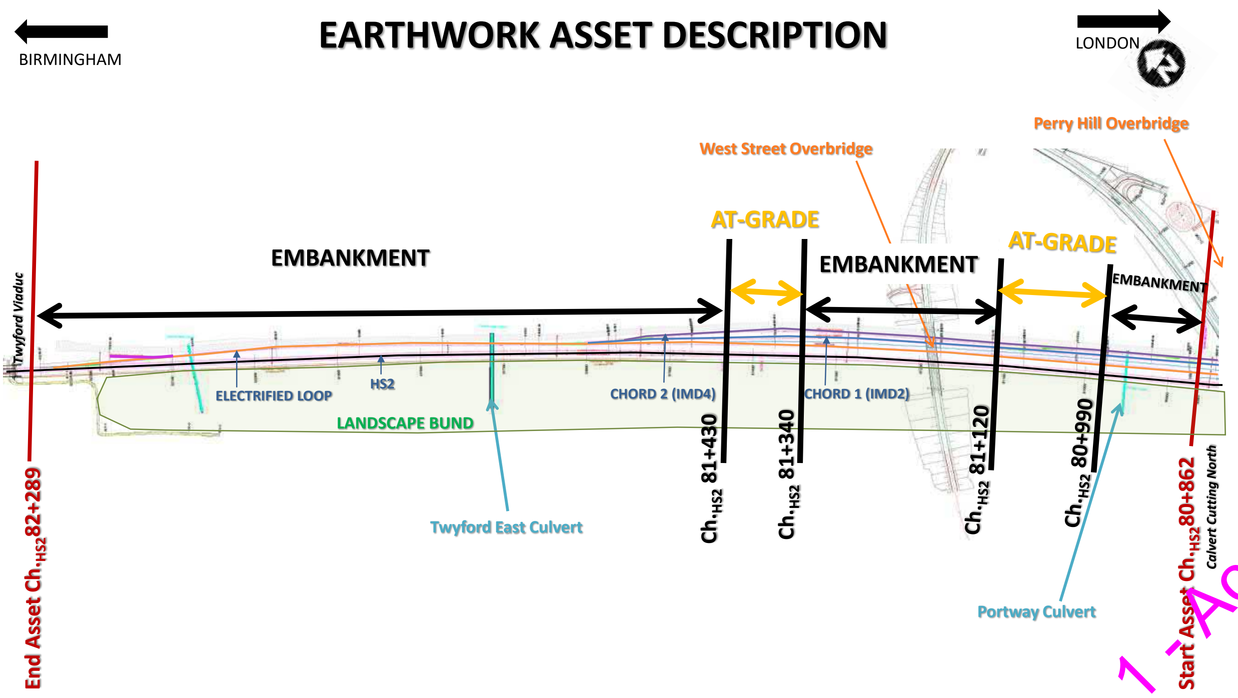


Figure 4-6 – Schematic plan showing sections of embankment and at grade – Twyford Embankment (indicative only)

4.3.2 Geometry

The geometry alone the 080-L1 Twyford Embankment is shown in the report of cross sections Ref [65] which containing asset specific cross sections at 20m intervals. The following commentary provides a brief description on horizontal and vertical alignment.

Commentary on horizontal and vertical alignment

- On Twyford Embankment the HS2 mainline shares the earthwork platform with :
  - Electrified Loop from Ch.$_{HS2}$ 80+862 to Ch.$_{HS2}$ 82+257
  - IMD Chord 1 from Ch.$_{HS2}$ 80+862 to Ch.$_{HS2}$ 81+657
  - IMD Chord 2 from Ch.$_{HS2}$ 80+862 to Ch.$_{HS2}$ 81+565

- At the low chainage end of the asset (at chainage 80+862 to chainage 80+990) Electrified loop, Chord 1 and Chord 2 run-on embankment with a maximum height of 3.1m at Ch 80+940.
- From chainage 80+990 to chainage 81+120 the tracks are at grade with a maximum height of 1.5m
- A landscape bund located will be located between chainage 80+862 to chainage 82+200 with a maximum height of 10.5m (5.5m above rail level) at chainage 81+660.

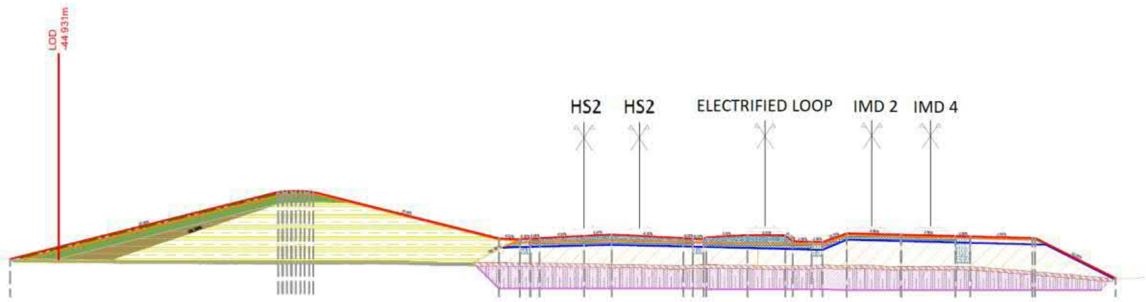


Figure 4-7 – Cross Section of Twyford Embankment at Ch.$_{HS2}$ 80+940

- From chainage 81+120 to chainage 81+340 the route is at grade.

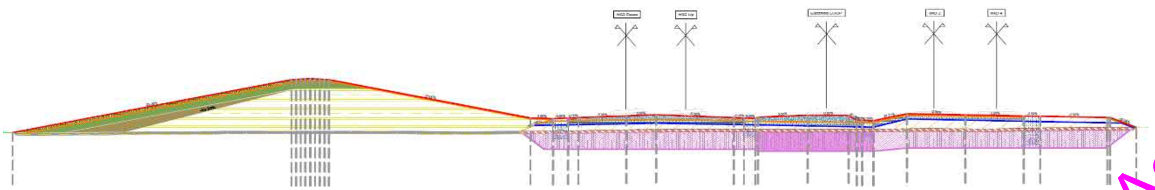


Figure 4-8 – Cross Section of Twyford Embankment at Ch.$_{HS2}$ 81+140

- West Street overbridge is located at Ch. 81+186. The associated highways earthworks have a maximum height of 11.5m and are approximately 450m long – this includes demolition of an existing bridge over an abandoned railway line and incorporation of the existing embankments into the new earthwork on the southern approach embankment.

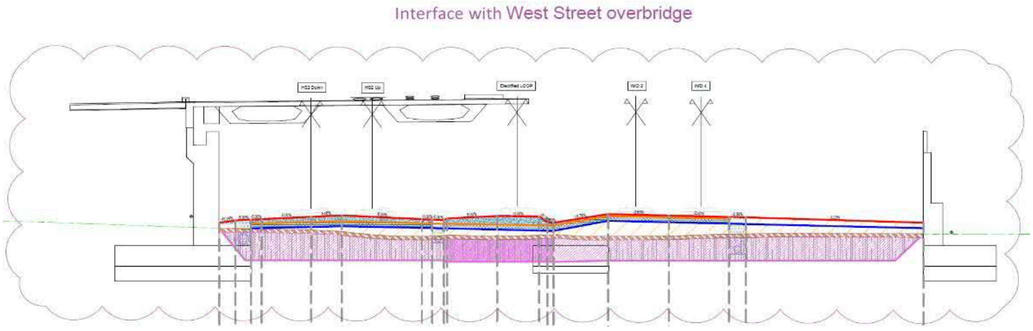


Figure 4-9 – Cross Section of Twyford Embankment at Ch.HS2 81+186

- From chainage 81+340 to chainage 81+500 the route is on low embankment reaching a maximum height of 5m at chainage 81+500.
- From chainage 81+500 to chainage 81+580 the Chord 2 is in the same corridor with the Chord 1 until chainage 81+565.
- At chainage 81+500 the Sewage Treatment Works and Pond Access Roads are located on the Down side (487m long new access road at-grade or on shallow embankment and access to pond).

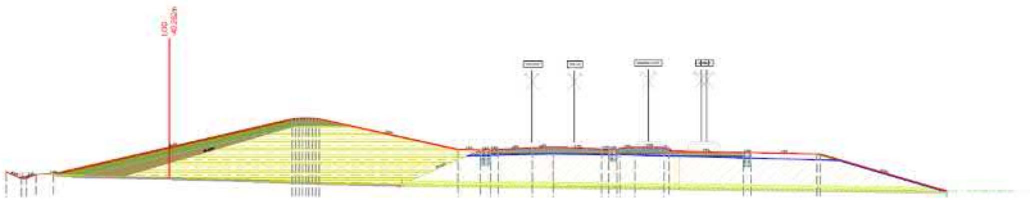


Figure 4-10 – Cross Section of Twyford Embankment at Ch.HS2 81+540

- From chainage 81+580 to chainage 81+660 the HS2 route is on embankment with a height maximum of 5.9 m at chainage 81+600. The Chord2 will share the same trace as Electrified loop until chainage 81+657.

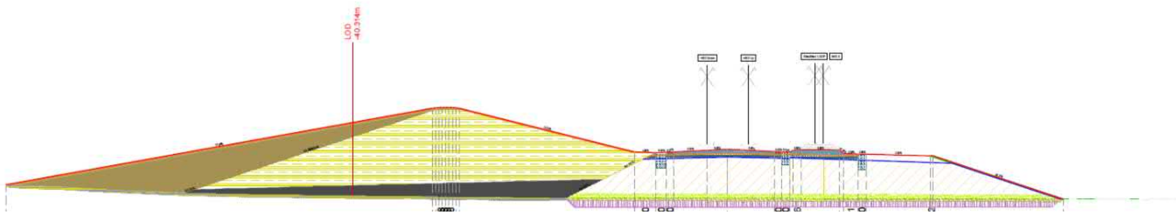


Figure 4-11 – Cross Section of Twyford Embankment at Ch.HS2 81+620

- From chainage 81+660 to chainage 82+260 HS2 and Electrified loop are on embankment with a height maximum of 5.8 m at chainage 81+687. The S&C of the turnout to the Electrified Loop is located at about Ch. 82+257.

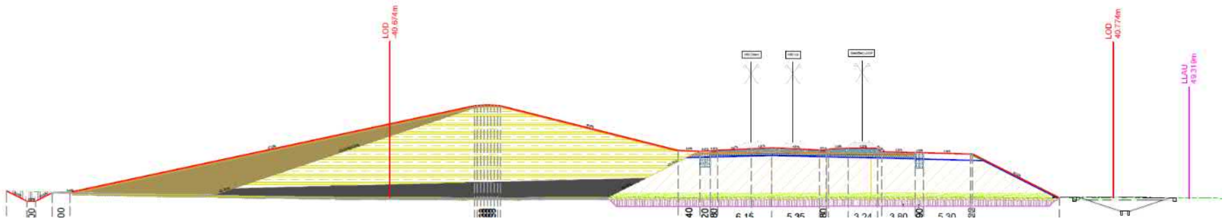


Figure 4-12 – Cross Section of Twyford Embankment at Ch.$_{HS2}$ 81+700

- The Twyford East culvert is located at 81+715, where the embankment height is about 5m.

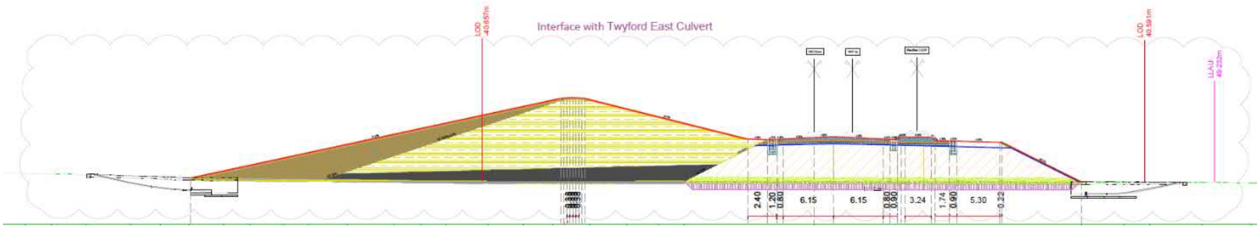


Figure 4-13 – Cross Section of Twyford Embankment at Ch.$_{HS2}$ 81+715

- No landscape from chainage 82+200 to the end of Twyford Embankment asset.

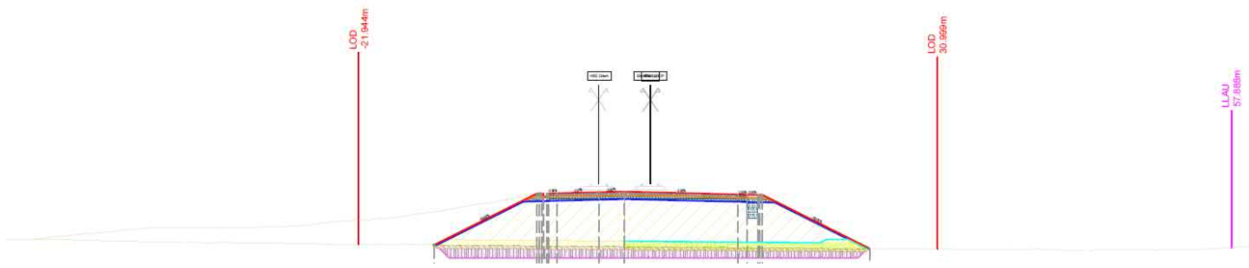


Figure 4-14 – Cross Section of Twyford Embankment at Ch.$_{HS2}$ 82+240

- The transition Twyford Embankment with Twyford Viaduct will be detailed in the structure GDR (refer to Section 3.4).

Proposed transition details from earthworks to structures for this asset are given in

Table *4-8* below:

Table 4-8 – Structures requiring earthworks transitions in Twyford Embankment

Asset Name / HS2 Ref.	Chainage	Drawing ref.
Twyford East Culvert / HS2-000001428	81+715	1MC06-CEK-CV-DGA-C002-000659 rev C03
Portway Culvert / HS2-000001373	80+950	1MC06-CEK-CV-DGA-C002-000658 rev C01

4.3.3 Construction sequence

Design has been undertaken based on the following construction sequence assumptions for Twyford Embankment.

The general construction sequence of "mainline" embankments (incl. transition zones to Twyford East Culver)t:

- Foundation treatment (Excavate & Replace), if required
- Permanent embankment and landscape bund construction including the culverts, the Electrified Loop and the IMD Chords.
- Hold period: 1 to 6 months; the hold period is meant for consolidation to occur, thus allowing for settlement before the slab track is installed,
- Construction of ponds and drainage system

The IMD platform (or part of) will be used as a temporary works and stock piling area during construction works.

The DD-GDR has considered the following construction programme given in Table 4-9 and discussions with EKFB regarding the placement of the landscape bunds, which formed the basis of TQ-2107 in February 2022.

Table 4-9 – Construction programme – Twyford Embankment

Asset	Chainage	Programme			Dates	Duration (day)
080-L1 Twyford Embankment (HS2-000001045)	80+862-82+289	Construction Asset	Twyford Embankment Construction Earthworks Summary		12-Oct-21_ 24-Jun-25	885
			Topsoil Stripping		18-Nov-21_ 29-Aug-24	504
			Ground Improvement	Surcharge 30kPa Settlement from 81+450 to 81+715	11-Oct-22_ 10-Dec-22	61

Asset	Chainage	Programme			Dates	Duration (day)
				Surcharge 30kPa Settlement from 81+715 to 82+121	11-Oct-22 – 09-Jan-23	91
				Cons Settlement from 81+121 to 82+264	11-Oct-22 – 09-Apr-23	181
				Cons Settlement from 82+264 to 82+289	11-Oct-22 – 05-Nov-23	391
			Earthworks	CUT (ME 70T) - EM-080-L1-CL 4 -> EM-080-L1-Landscape	31-Mars22– 20-Jul-22	73
				FILL (ME 70T) - EM-080-L1-CL 4 -> EM-080-L1-Landscape	31-Mars22– 22-Jul-22	75
				FILL (ME 90T) - Finemere Borrow Pit-CL 1 -> EM-080-L1-Structural Backfill - OB	26-May-22- 31-May-22	2
				FILL (ME 90T) - Finemere Borrow Pit-CL 1 -> EM-080-L1-Ground Improvement	21-Jul-22 – 26-Jul-22	4
				FILL (ME 70T) - VD-082-L1-CL 4 -> EM-080-L1-Landscape	21-Jul-22 – 05-Jul-23	176
				FILL (ME 90T) - CU-087-L2-CL 2 LP+IP -> EM-080-L1-LEM	27-Jul-22 – 05-Jul-23	2
				FILL (ME 70T) - A4421 - Roadhead-CL 6 -> EM-080-L1 -Selected Fill for Starter L	27-Jul-22 – 03-Aug-22	6
				FILL (ME 90T) - CU-087-L2-CL 2 LP+IP -> EM-080-L1-UEM	29-Jul-22 – 03-Oct-22	45
				FILL (ME 90T) - CU-087-L2-CL 2 LP+IP -> EM-080-L1-Temporary Protection La	04-Oct-22 – 05-Oct-22	2

Asset	Chainage	Programme			Dates	Duration (day)
				FILL (ME 90T) - CU-087-L2-CL 2 LP+IP -> EM-080-L1-Temporary Protection La	06-Oct-22 – 10-Oct-22	3
				FILL (ME 50T) - CU-082-L3-CL 4 -> EM-080-L1-Landscape	08-Nov-22 – 13-Mar-23	26
				FILL (ME 70T) - CU-084-L2-CL 2 HP -> EM-080-L1-Highway	28-Sep-23 – 29-Sep-23	2
				FILL (ME 90T) - CU-093-L1-CL 2 LP+IP -> EM-080-L1-Landscape	15-Aug-24 – 29-Oct-24	52
				FILL (ME 70T) - A4421 - Roadhead-CL 6 -> EM-080-L1-Selected Fill	04-Mar-25 – 25-Apr-25	35
				FILL (ME 70T) - A4421 - Roadhead-CL 6 -> EM-080-L1-Selected Fill for Protec	09-Jun-25 – 24-Jun25	12
			Track Drainage	Track drainage - Pipes - (anticipation from end of bulk earthworks)	14-Nov-24 – 06-Dec-24	17
				Track drainage - Ditches - 080-L1	28-Apr-25 – 22-May-25	18
			Land Drainage		12-Oct-21 _ 11-Nov-24	581
			Noise Barrier	Noise Barrier 080-L1 - Pile installation (anticipation from end of bulk earthworks)	02-Dec-24 – 07-Feb-25	40
				Noise Barrier 080-L1 - Panel erection	02-May-25– 06-Jun-25	24

Design assumptions for construction sequencing:

It is assumed that the landscape bund located on the Down side from Ch.80+862 to Ch. 82+200 will be built after the completion of the HS2 subgrade improvement (excavate and replace) at the base of the embankment and at the same time as the mainline embankment (including HS2 and Electrified Loop, IMD chord 1 and IMD chord 2) to avoid differential settlements.

Within the construction sequence assumptions, it is considered in this GDR that the ponds and the other drainage elements will be built after the hold period for settlement of the mainline embankment and landscape bund.

4.3.4 Level 2 Assets

The HS2 civil engineering assets located within the limits of the Twyford Embankment Level 1 Group that require geotechnical design are identified in the following table.

Table 4-10 – Level 2 and associated Civil Engineering Assets

HS2 ID	Asset Name	Asset Type	Approximate Chainage (HS2)	Drawing Ref.
HS2-00002BJUG	Perry Hill Road Realignment	Carriageway	80+900	1MC06-CEK-HW-DGA-CS06_CL09-000128 C01
HS2-000020NL8	Maintenance Access Road to Pond and MAP (Off Byway PBI/5A)	Carriageway	81+800-82+289	
HS2-000001318	West street Overbridge	Overbridge	81+185	1MC06-CEK-HW-DGA-CS06_CL09-000137 P01
HS2-000020RM2	West Street Realignment	Carriageway	81+185	1MC06-CEK-HW-DGA-CS06_CL09-000138 P02
HS2-000020NL1	Field Access track (Off West Street)	Carriageway	81+270	
HS2-000020356	Sewage Works Accomodation and Pond Access Road	Carriageway	81+100-81+550	
HS2-000001373	Portway Culvert	Culvert	80+950	1MC06-CEK-BR-DGA-CS06-CL P02.1
HS2-000001428	Twyford East Culvert	Culvert	81+715	1MC06-CEK-BR-DGA-CS06-CL10-0000 P01.1
HS2-00002CT8T	Perry Hill Road Drainage System	Attenuation pond	81+000	1MC06-CEK-DR-DGA-CS06_CL09-000040 C01 1MC06-CEK-CV-DGA-CS06_CL09-000041-C01
HS2-00002CT8U	West Street Drainage System	Attenuation pond	81+200	1MC06-CEK-DR-DGA-CS06_CL09-000042 C01 1MC06-CEK-DR-DGA-CS06_CL09-000043 C01

Notes:
The chainages relating to underbridges, culverts and retaining walls are approximate and determined using HS2 ASC Level 2 asset information presented on the Geographical Information System application.

4.3.5 Geotechnical Category - Earthworks

The Geotechnical Category (GC) for HS2 earthwork cases (EW 1 to EW 9), and the category of check required (CAT I to III) are presented in the Technical Standard – Earthworks Ref [2], Table 2.2/2.

This HS2 asset has been classed as Geotechnical Category GC3 requiring a Category 2 check.

5 Existing Information

This section of the report presents a review and update of the existing information initially presented in the Scheme GIR Ref [7].

5.1 Walkover surveys

5.1.1 HS2 Walkovers

A partial walkover was completed by HS2 during the Desk Study phase. Details of this walkover survey are contained within the Atkins Desk Study Ref [9]. Due to access restrictions the walkover was conducted via highway routes and using public ways near the proposed route.

5.1.2 Scheme Design Virtual Walkovers

No geotechnical walkover survey was undertaken at Scheme Design.

However, use was made of the existing LiDAR data and Google Earth in conjunction with GIS to amplify and enhance the landform to conduct a virtual 'walkover' and to provide data to support the HS2 geomorphological study information Ref [10].

The results of the virtual walkover were incorporated into Sections 3.14 to 3.18 of the Scheme Design (SD) GIR (SD-GIR) Ref [7]. A summary is given in Section 5.4 below.

This virtual walkover has been developed further at detailed design using aerial photography, refer to Section 5.5.

5.1.3 Detailed Design Walkovers

A Site Walkover survey was carried out by ASC in November 2021.

5.2 Topography

The Scheme Design GIR identified discrepancies in the LiDAR information available at scheme design.

The detailed design has been undertaken using updated LiDAR information and Topography survey: LiDAR SENSAT Files 2019 (ground model) from SENSAT based on composite form of LiDAR and road/rail/watercourse topography survey adjusted for vegetation.

5.3 Geological Maps and Memoirs

An overview of the regional geology in the Clay Vales in the Calvert Area is provided in the Scheme GIR Ref [7].

A detailed description of the geological setting at Twyford Embankment is given in Section 7.3 of this DD-GDR.

5.4 Geomorphological Assessment

Details of the geomorphological mapping is summarised in Sections 3.14 to 3.18 of the Scheme Design GIR Ref [7].

This work relates to the identification of potential hazards that can be determined by a study of the geomorphology of the route and associated landforms. This includes, relevant to the geology present and geological history, the following hazards:

- Identified landslips.
- Risk of unidentified landslips or the presence of relic shear surfaces.
- Cambering and Valley Bulging.
- Dissolution features.

Reference should be made to the Scheme GIR for the various studies undertaken by HS2 and ASC at scheme design. The key desk study information includes:

- HS2 Phase One Engineering Geomorphology Assessment Report by HS2 Ref [11]
- HS2 Phase One Engineering Geomorphology Site Inspection Report by HS2 Ref [10]

A summary of the main findings of the Scheme GIR relevant to the Twyford Embankment is provided below.

- The risk of relic landslips and shear surfaces is linked to the inherent characteristics of the Oxford Clay Formation, which was subjected to glacial and periglacial activity, and the presence of groundwater in the overlying superficial deposits. At Twyford Embankment the natural slope gradient is generally <5°, except between Perry Hill Road Alignment and West Street realignment from Ch. 80+862 and Ch. 81+220.
- The alluvial soils that cover the asset are not prone to relic slip surfaces.
- There is no risk of cambering and valley bulging.
- There is no risk of dissolution features.

The provision for risk of unmasking relic slip surfaces is recommended (refer to Section 17 for more details).

An elevated risk of relic slips between Perry Hill and West Street realignments will be managed through additional GI and trial trenches prior to construction, as well as I&M during construction. Outside of this section the low risk of relic slips will be verified by site inspection of excavation surfaces.

The Walkover survey completed by ASC did not reveal any evidence of relic slip surfaces in this area.

5.5 Aerial Photographs

The following sources of information were reviewed as part of the SD-GIR to assist in, but not limited to the hazard / feature identification including evidence of dissolution features, landslips, and historical mining:

- Atkins Desk Study Ref [9]
- GIS data set Ref [12]
- 125mm (12.5) resolution orthorectified colour aerial imagery. Aerial surveying data captured since 2012 (1st phase of survey) and 2014 (2nd phase of survey) by Blom Aerofilms, as commissioned by HS2.
- Google Earth (online).
- Bing Maps (online).

The virtual walkover has been developed further at detailed design using aerial photography (Google Earth). The main observations of the virtual walkover surveys are summarised below.

- The route in this section is largely agricultural.
- At chainage 80+900 the route crosses a drain ditch.
- At chainage 81+000 on the Down side there are low rise buildings associated with Portway Farm approximately 300 m west of the route alignment.
- Several small ponds are located in the fields adjacent to the downside of HS2, between Ch 80+900 and 82+100. There are also ponds near to Portway Farm.
- Between chainage 81+100 and 81+200 the route crosses a road.
- A sewage works is located 100m west of the route at Ch.81+500-Ch.81+600.

- At chainage 81+650 there is an old bridge crossing the disused railway line (Great Central Railway Line) to the west of HS2. It is nowadays crossed by a footpath. The associated earthworks either side of the bridge are covered in trees.
- Twyford Embankment crosses the floodplain of Padbury Brook and one watercourse called Padbury Brook Tributary at Ch.81+715. A large warehouse labelled as 'Three Bridge Mill' is located 500m east of the route at Ch.81+600.
- A variety of buildings associated with the village of Twyford are located approximately 200m to the west of the proposed alignment at Ch.82+000.
- Twyford village includes a 'Special Protection Area' approximately 500 m away from HS2.

Further features of lesser importance on the geotechnical design within Appendix C of the Atkins Desk Study report [9]. These were considered in the relevant parts of Sections 3 and Section 5 of the Scheme GIR.

5.6 Historical Maps

A review of the historical maps traversed by the scheme is presented in Section 6.15 of the Atkins Desk study Ref [9].

A review of the available historical maps as part of detailed design indicates the following developments within Twyford Embankment:

- Ordinance Survey Sheet No 219 Buckingham (Hills) 1896 include the presence of roads in this section, two of them (Cowley Lodge Road and Portway road) run parallel to the proposed alignment on the west and eastern sides respectively and the other one links the two roads together and crosses the proposed line in chainage 81+200.
- Ordinance Survey Sheet No 219 Buckingham (Hills) 1905 shows the Great Central Railway line (now dismantled)running roughly parallel to the proposed alignment. This feature is located on the western side of the proposed HS2 route and crosses the OXD line in the vicinity of EWR intersection overbridge.
- The Sheet No 146 Buckingham 1946 clearly shows the sections of cutting and embankment along the Great Central Railway line and footpaths crossing the route. The Great Central Railway line is crossed by watercourses and a road by overbridge.
- Developments shown on Sheet 146 dated 1968 that the Great Central Railway line is disused, however, the embankment and cuttings are still shown. Houses and ponds are also present near the mainline. Buildings include Portway Farm.

5.7 Records of Mines / Quarries / Gravel Pits

No mines/quarries/pits have been recorded in proximity to Twyford Embankment. The nearest quarrying activity is at Glebe Lake and Jubilee Lake, which are former clay pits.

5.8 Land Use and Soil Survey Information

Full details of the land use are given in Section 3.7 of the Scheme Design GIR Ref [7]. The main land uses include the former railway lines and agricultural land.

5.9 Ecology

The Scheme GIR references the available documentation and provides the background information linked to ecological constraints.

Details of known ecological constraints are contained within the relevant sections of the Environmental Statement Report - HS2 Phase One Environmental Statement Volume 5 located at: https://www.gov.uk/government/collections/hs2-phase-one-environmental-statement-documents

The constraints are captured on the HS2 ASC Ground Engineering Viewer. A map extract of the GIS Viewer in the vicinity of Calvert Junction is shown in Appendix A.

The confirmed species habitats near to the proposed lines include:

Table 5-11 – Confirmed species habitats – Twyford Embankment Asset

Chainage	Ecology constraint	Offset from the HS2 centreline
Ch 80+700 to 81+000	Badger Sett Confirmed Presence (Up side)	300m
Ch 81+150	Badger Sett Confirmed Presence (Down side)	150m
Ch 81+250	Badger Sett Confirmed Presence (Up side)	575m
Ch 81+350	Badger Sett Confirmed Presence (Up side)	550m
Ch 81+400	Reptiles Population Assessment Confirmed Presence (Up side)	290m
Ch 81+450	Bats Building Roosts Confirmed Presence (Up side)	350m
Ch 81+500	Bats Tree Roosts Confirmed Presence (Up side)	375m
Ch 81+625	Bats Tree Roosts Confirmed Presence (Up side)	200m
Ch 81+675	Badger Sett Confirmed Presence (Down side)	100m
Ch 81+875	Bats Tree Roosts Confirmed Presence (Down side)	50m
Ch 81+800	Amphibians Pond Survey GCN Confirmed Presence (Down side)	400m
Ch 81+950	Amphibians Pond Survey GCN Confirmed Presence (Down side)	500m
Ch 82+075	Amphibians Pond Survey GCN Confirmed Presence (Down side)	165m
Ch 82+075	Badger Sett Confirmed Presence (Down side)	220m

Chainage	Ecology constraint	Offset from the HS2 centreline
Ch 82+075	Amphibians Pond Survey GCN Confirmed Presence (Down side)	220m
Ch 82+125	Bats Building Roosts Confirmed Presence (Down side)	210m
Ch 82+100	Bats Building Roosts Confirmed Presence (Down side)	225m

5.10 Archaeological and Cultural Heritage

The Scheme GIR presents the Archaeological and Cultural Heritage sites on Hazard and Constraints Plans in Appendix D.

The main constraints are indicated on the HS2 ASC Ground Engineering Viewer. An extract of the GIS viewer is provided in Appendix A and summarised below:

- From chainage 82+000 to chainage 82+175 eight grade 2 buildings (Down side). The nearest building is located more than 150m from the HS2 route.
- At Chainage 82+137 one grade 1 building (260m to the Down side of HS2 route).
- From chainage 81+875 to chainage 81+200 heritage mitigation hot spot site.

5.11 Existing Ground Investigations

The historical Ground Investigations (GI) that pre-date HS2 Main GI are very limited in extent in the Calvert area and described in Section 3.10 of the Scheme Design GIR Ref [7].

A summary of the Historical GI that have been carried out and that are relevant to these works is presented below. The GI are located approximately at 300 m to the west of the mainline.

Table 5-12 – Summary of Historical GI

BGS ID	Exploratory Hole Description	Nearest Mainline Asset ID /Asset Name	Distance from nearest mainline (m)	Depth	Year
SP62NE11	Portway Farm Twyford	Twyford Embankment	300m to the West	-	-
SP62NE3	Twyford 2	Twyford Embankment	250m to the West	153m	1961
SP62NE9	Public well Twyford	Twyford Embankment	350m to the west	-	-

The excavation for a buried gas pipe at Perry Hill as part of the HS2 diversion of non-contestable utilities encountered a layer of hard limestone boulders at relatively shallow depth.

5.12 Consultation with Statutory Bodies

Consultations are ongoing with Statutory Bodies with respect to provision of geological, geotechnical, Hydrogeological; and geo-environmental information to support Stage 2 Detailed Design.

The Geo-Environmental remediation strategy and material reuse criteria has been developed based on discussions with the Environment Agency (EA). Regular fortnightly progress meetings have been held to date with Environment Agency/EKFB/HS2

5.13 Contaminated Land

Refer to Section 7.6 of this report.

5.14 Unexploded Bombs

The Scheme GIR Ref [7] provides reference to the GIS information and the Desk Study Ref [9] produced by Zetica and provided to EKFB and HS2.

There are no bomb impact sites that affect Twyford Embankment.

Hillesden Bombing Range is a high risk area located roughly 800m from the HS2 route or r 230 m beyond the eastern LLAU boundary at Ch.81+550. There is no HS2 construction activity proposed near to the bombing range.

There is an area of moderate risk of UXO (overspill from Hillesden Bombing Range) within eastern LLAU between ch.81+500 and ch.81+700.

5.15 Utilities

The following utility plans have informed the DD-GDR assessment.

Table 5-13 – Utilities plans

Drawing title	Drawing ref.
Combined Utility Drawing – Scheme Design	1MC06-CEK-UT-DGA-C002_000024 Rev. C03
Twyford STW Key Plan – Detailed Design	1MC06-CEK-UT-DGA-CS06_CL09-000021 Rev. P02.1
Twyford CSO-03-7102 Long Section	1MC06-CEK-UT-DSE-CS06_CL10-000001 Rev P02.1

The following table provides a list of contestable and non-contestable utility assets within Twyford Embankment.

Table 5-14 – Contestable Utility and Non-contestable Utility Assets Identified in the DD-GMIA report

Reference No	Type	Utility Company	Structure ID Reference	Category	Chainage	Requirement
CSO-03-3101	Telecom	Openreach BT	Twyford Embankment	C	81+150	To be diverted
CSO-03-6101	Foul Sewer	AW	Twyford Embankment	C	81+150	To be diverted
C23-081-0001	Telecom	Gigaclear	Twyford Embankment	C	81+150	To be diverted
CSO-03-1304	11kV underground	WPD	Twyford Embankment	C	81+300	to be diverted
CSO-03-3108	Telecom underground	BT	Twyford Embankment	C	80+862	to be removed
Unknown	Private water supply	Private supply	Twyford Embankment	C	81+200 And 81+100	Existing UTX
CSO-03-7102	Foul Sewer	AW	Twyford Embankment	C	81+550	New UTX
Unknown	Telecom underground	BT	Twyford Embankment	C	81+100 to 81+500	New asset
Unknown	Private WM pipe	Private supply	Twyford Embankment	C	82+050	To be installed in UTX
CSO-03-2203	HP gas main	SGN	Twyford Embankment	NC	80+900	New UTX (diverted)
CSO-03-1404	HV UG	SSE	Twyford Embankment	NC	81+300	Existing UTX (diverted)

<u>Note:</u>

C: Contestable utility NC : Non-contestable utility

The impact assessment of HS2 on third-party assets such as existing utilities is discussed in Section 14 of this DD-GDR.

The I&M related to third party assets is described in the Twyford Embankment DMP Ref [88].

6 HS2 and EKFB Field and Laboratory Studies

6.1 Introduction

This section satisfies the requirements set out in Section 6.2 of BS EN 1997-2 Ref [16] and describes all the investigations carried out by HS2 and the ASC to inform the geotechnical design that post-dates GI data identified as part of the HS2 Desk Study. The data referred to in this Section of the report includes:

- The HS2 Main GI
- The EKFB Supplementary GI
- The EKFB Stage 2 GI
- EKFB field trials

The results of the in-situ tests and monitoring are captured in Section 6.3.3 of this report.

6.2 Walkover Survey and Geomorphological Mapping

Details of walkovers and geomorphological mapping, either physical or virtual, are summarised in Section 5.1 of this report.

6.3 Ground Investigations

There are three phases for Ground Investigation (GI) associated with the HS2 Project appropriate to OXD line:

- The HS2 Main GI, with fieldwork undertaken between 2016 and 2017. This GI was designed to provide sufficient data to characterise the ground conditions and identify geotechnical risks in sufficient detail to geotechnical and environmental information for the detailed safe design and construction of the proposed scheme including earthworks and track bed, civil engineering structures, tunnels, stations, depots and associated drainage, highway, rail works, temporary works, borrow pits and environmental mitigation/sustainable placement earthworks.
- The EKFB Supplementary GI undertaken between 2018 and 2020, based on a review of the as-encountered ground conditions during the HS2 Main GI and a gap analysis around geotechnical risks and additional geotechnical data required to reduce the risks embedded in the Scheme Design Assumptions. Due to restrictions on land access and associated delays, only between 54% and 67% of the Supplementary GI was completed.
- The EKFB Stage 2 GI which commenced in 2020. This was designed to provide sufficient GI data for Detailed Design and Construction to manage the associated risks associated with compliance with HS2 Standards, safety and performance. The Stage 2 GI also incorporated incomplete scope associated with the Supplementary GI.

The Scheme Design GDR Ref [18] provides details of the GI and groundwater monitoring used to inform the design and associated risk assessments at Stage 1 Scheme Design.

This GDR incorporates all the EKFB Stage 2 GI data.

The review of the Stage 2 GI data has been completed in the New Ground Engineering – Impact Assessment Report Ref [86] and the findings incorporated into this DD-GDR.

6.3.1 Summary of Data Received

The status of the GI data received at the start of detailed design and incorporated in this revision of the GDR is summarised in the Table below.

Table 6-15 – Summary of GI data received

GI Contract	Contract ID	Chainage	AGS status	Drop Nos.	Factual Report AGS Reference	Factual Report PDF Reference	Groundwater Monitoring AGS Reference
HS2 Main GI	CGA	80+862 – 82+289	First Final Issue	P02 – 24/04/2020	1G072-SEN-GT-AGS-000-000038	TE7930_FRpt05V1_2019-08-13 TE7930_FRpt05V2_2019-08-13 TE7930_FRpt05V3_2019-08-13 TE7930_FRpt05V4_2019-08-13	1G063-BAM-GT-REP-000-000002
EKFB Supplementary GI	TB8121 Interim Report		NA	C01 – 20/02/2020	1MC06-CEK-GT-AGS-C002-000005	1MC06-CEK-GT-REP-C002-000062	NA
	TB8121 Second Interim Report		NA	C01 – 13/02/2020	1MC06-CEK-GT-AGS-C002-000006	1MC06-CEK-GT-REP-C002-000064	NA
	TB8121 Third Interim Report		NA	C01 – 13/02/2020	1MC06-CEK-GT-AGS-C002-000008	1MC06-CEK-GT-REP-C002-000068	NA
	TB8121 Second Calvert Design Report		NA	C01 – 13/02/2020	1MC06-CEK-GT-AGS-C002-000009	1MC06-CEK-GT-REP-C002-000069	NA
	TB8121 Calvert Design Report		NA	C01 – 13/02/2020	1MC06-CEK-GT-AGS-C002-000007		NA
EKFB Stage 2 GI	C2 Supplementary		NA	Data Drop 6 – 26/01/2021	1MC06-CEK-GT-AGS-C002-000022	-	NA
EKFB Stage 2 GI	C2 North and Calvert		NA	Data Drop 8- 19/04/2021			NA
EKFB Stage 2 GI	C2 Calvert NWR		NA	Data Drop 10 – 26/05/2021	1MC12_Monthly update AGS data	-	NA
EKFB Stage 2 GI	C2 North and Calvert		NA	Data Drop 11 – 30/06/2021 Data Drop 12 – 28/07/2021 Data Drop 14 – 29/09/2021 Data Drop 16 – 01/12/2021	C23 Supplementary Detailed Design Ground Investigation SEGL_Monthly update AGS data	-	NA

GI Contract	Contract ID	Chainage	AGS status	Drop Nos.	Factual Report AGS Reference	Factual Report PDF Reference	Groundwater Monitoring AGS Reference
EKFB Stage 2 GI	C2 Supplementary		NA	Data Drop 16 – 01/12/2021	1MC06-CEK-GT-AGS-C002-000022	-	NA

6.3.2 Description of Fieldwork

The table below summarises the HS2 and EKFB fieldwork available at commencement of this GDR in the vicinity of Calvert IMD and OXD line.

Table 6-16 – Summary of available HS2 and EKFB GI data

Fieldwork	HS2 Main GI			Stage 1 Supplementary GI		Stage 2 Supplementary GI		Data drop nr-Date
	Total No.	Exploratory Hole ID's	Depth Range (mbgl)	Total No.	Exploratory Hole ID's	Total No	Exploratory Hole ID's	
Cone Penetration Test (IP + CPT)	15	ML081-CT001 ML081-CT002 ML081-CT003 ML081-CT004 ML081-CT005 ML081-CT006 ML081-CT007 ML081-CT008 ML081-CT009 ML082-CT005 ML082-CT007 ML082-CT008 ML082-CT013 ML082-CT014 ML082-CT015	3.17 to 10.88	-	-	3	ML081-CT400 ML081-CT428 ML082-CT404	Data Drop 11-30/06/2021 Data Drop 11-30/06/2021
Inspection Pit + Cable percussion (IP + CP)	13	ML080-CP024 ML080-CP031 ML081-CP001 ML081-CP009 ML081-CP014 ML081-CP019 ML081-CP021 ML081-CP022 ML081-CP024 ML082-CP006 ML082-CP008 ML082-CP009 ML082-CP026	4.23 to 10.8	-	-	2	ML080-CP405 ML081-CP400 ML081-CP431 ML081-CP436	Data drop10 -26/05/2021 Data drop10- 26/05/2021
Inspection Pit + Cable percussion + Rotary Core (IP + CP + CR)	4	ML081-CR008 ML081-CR011	25 to 35	-	-	3	ML081-CR402 ML080-CR463	Data drop 16 -01/12/2021 Data Drop 11-30/06/2021

Fieldwork	HS2 Main GI			Stage 1 Supplementary GI		Stage 2 Supplementary GI		Data drop nr-Date
	Total No.	Exploratory Hole ID's	Depth Range (mbgl)	Total No.	Exploratory Hole ID's	Total No	Exploratory Hole ID's	
		ML082-CR002 ML082-CR008					ML081-CR440	
Inspection Pit + Dynamic Sampling (IP + WS)	22	ML080-WS001 ML080-WS015 ML080-WS016 ML081-WS004 ML081-WS005 ML081-WS006 ML081-WS007 ML081-WS008 ML081-WS009 ML081-WS010 ML081-WS011 ML081-WS012 ML081-WS013 ML081-WS015 ML081-WS016 ML081-WS019 ML081-WS021 ML082-WS003 ML082-WS005 ML082-WS008 ML082-WS009 ML082-WS010	1.7 to 5	-	-	2	ML081-WS435 ML081-WS444	Data drop 16 -01/12/2021 Data drop 14 -29/09/2021
Pavement coring (PC)	6	ML080-PC005 ML081-PC001 ML081-PC002 ML081-PC003 ML081-PC004 ML081-PC005	0.11 to 0.32	-	-	-	-	-
Surface water sampling point (SW)	3	ML081-SW001 ML081-SW002 ML082-SW001	-					
Trial Pit (TP)	-	-	-	2	ML081-TP402 ML081-TP403	14	ML081-TP401 ML081-TP410 ML081-TP416 ML081-TP419 ML081-TP425	

Fieldwork	HS2 Main GI			Stage 1 Supplementary GI		Stage 2 Supplementary GI		Data drop nr-Date
	Total No.	Exploratory Hole ID's	Depth Range (mbgl)	Total No.	Exploratory Hole ID's	Total No	Exploratory Hole ID's	
							ML081-TP426 ML082-TP400 ML080-TP451 ML081-TP437 ML081-TP407 ML081-TP429 ML081-TP432 ML082-TP438 ML082-TP439	Data Drop 6- 26/01/2021 Data Drop 8-19/04/2021 Data Drop 11 – 30/06/2021 Data Drop 11 – 30/06/2021 Data Drop 11 – 30/06/2021 Data Drop 11 - 30/06/2021 Data Drop 11 - 30/06/2021 Data drop 14 -29/09/2021 Data drop 14 -29/09/2021
Continuous wave surface (CW)						6	ML080-CW430 ML081-CW438 ML081-CW424 ML081-CW425 ML081-CW427 ML081-MA400	Data drop 16 -01/12/2021 Data drop 12 -28/07/2021 Data Drop 11 – 30/06/2021 Data Drop 11 – 30/06/2021 Data Drop 11 - 30/06/2021
Total No.	**63**	**N/A**	**0.11 – 35.00**	**2**	**N/A**	**10**	**N/A**	**-**

The borehole location plan is presented in Appendix B.

6.3.3 In-Situ Testing and Monitoring

A summary of specialist in-situ test numbers for IMD line is given in Table 6-16

Table 6-17 – In-situ Data Summary

In-Situ Tests	HS2 Main GI Total No. of tests	Supplementary GI Total No. of tests	Data Total No. of tests drop GI	Depth Range (mbgl)
Static Cone Penetration Test	15	3	0	0.01 – 10.88
Standard Penetration Test (SPT)*	153	31	10	1.2 – 12.20
Permeability test	2	-	-	2.2
Hand Penetrometer Test				
Vane Test (HSV)	0	110	15	0.5 – 3.5
Soakaway Test				
Static Cone Dissipation Test				
Total No.	**170**	**144**	**25**	**0.01 – 12.20**

6.4 Drainage Studies

No infiltration tests were performed in the vicinity of this asset.

6.5 Geophysical Surveys

Five Continuous Surface Wave tests have been carried out along the HS2 lines between Ch. 81+000 and Ch. 81+600.

One MASW test was carried out at approximately Ch. 81+300.

6.6 Additional fieldwork

6.6.1 Stage 2 GI

All Stage GI data has been incorporated into this DD-GDR update with the exception of 11 remaining exploratory holes for contamination testing as detailed in Section 7.6.1.

At the beginning of detailed design the uncertainty in ground conditions for Twyford Embankment was scored at Class 4 based on the following:

- Variations in thickness of soft strata near to surface,
- Presence of faults,
- Principal residual risks are the potential presence of relic surfaces and high/shallow water,
- Possible risk of changes to depth of ground improvement (excavate and replace) Going forward it is anticipated that regular data-drops from the on-going Stage 2 GI. These will be evaluated as part of the MUGC strategy and will form part of an impact assessment report as described in Section 3.6 above.

Based on the findings of the GI impact assessments Ref [86] the management in ground uncertainty on the Twyford embankment can be reduced to Class 2

6.6.2 Rayleigh Wave Trial

A Rayleigh Wave trial has been carried out near to Calvert Rail Head site in Calvert Cutting.

The analysis of the trial was ongoing at the time of publication of this DD-GDR. The results will be reviewed under separate cover and managed post-L3 in line with the guidance provided in GC-1737.

It is noted that the ground improvement in Twyford Embankment is predominantly governed by settlement design with the exception of relatively small sections of low embankment and at grade ground at the southern end of the asset. Refer to Section 9.8.2 for more details.

6.6.3 Boddington Trial Cutting and Settlement Trial

The Scheme Design GIR provides details of the Boddington Trial Cutting, aligned approximately northeast to southwest and coincides with the initial 350m of the north western end of the Boddington Cutting (approximate SnakeGrid Chainage 117+380 to 117+730) within Contract C3.

It represents a full-scale trial cutting excavated to principally monitor the scale and rate of heave to inform Stage 2 Detailed Design for heave prone cuttings.

A settlement trial has also been undertaken at the general location of the Boddington Trial Cutting, using excavated material from the trial cutting as surcharge for the settlement trial, as set out in the Boddington Compound Embankment Settlement Trial Methodology Ref [26].

The monitoring results of the Boddington Settlement trial are reported in Ref [27] and the data managed in accordance with the Strategy given in the GEDBS-MUGC Ref [5].

Whilst the ground conditions (Charmouth Mudstone Formation) in the Boddington Cutting area are not encountered within Section C2, information gained from this trial such as time for consolidation, depth of influence and proportion of immediate settlement in overconsolidated clays and mudstones have been used to calibrate the more general settlement methodology used by ASC in overconsolidated clays and mudstones.

6.6.4 Newton Purcell Embankment Trials and Foundation Treatment Works

Field trials have recently started at Newton Purcell (T2G Section near to Barton to Mixbury Cutting).

The primary objective of the Embankment Trials will be to understand the compaction methods and end-product performance of the Glacial Till materials after stabilisation.

The Foundation Treatment Trials will verify the foundation required to meet the end-product performance requirements. Ground improvement techniques will include class 1 backfills and geogrids,

Control and verification testing will include CBR, Light weight Deflectometer (LWD), Nuclear Density Gauge, Sand Replacement Tests (SRD) and geophysical tests (ex. CSW tests).

The results of the Newton Purcell Trials will be reported separately to this detailed design GDR and the data managed in accordance with the Strategy given in the GEDBS-MUGC Ref [5].

6.7 Laboratory Testing

6.7.1 Geotechnical Testing

Laboratory testing was undertaken on soil samples recovered from the site during the HS2 Main GI. Testing was undertaken in accordance with BS 1377:1990 Ref [28] and the ISRM Ref [29].

The quantities of geotechnical and chemical laboratory tests are summarised in Table 6-18. The tests summarised include the total number of tests received in AGS or for certain more specialist tests non-AGS or pdf format.

Table 6-18 – Geotechnical Laboratory Test Summary

Laboratory Test	HS2 Main GI Total No.	Supplementary GI Total No.	Stage 2 GI Total No
Classification			
Moisture content (MC)	150	32	-
Atterberg limits (AL)	122	32	-
Linear Shrinkage	18	-	-
Particle size distribution (PSD)	82	35	-
Density	21	2	-
Chemical			
Soluble sulphates	-	-	-
Total sulphates	14	21	-
pH	23	22	-
Compaction Related			
Compaction (proctor)	10	7	-
Moisture condition value (MCV)	8	14	2 (Datadrop 6 & 10)
California Bearing Ratio (CBR)	30	-	-
Consolidation Related			
Consolidation (Oedometer)	20	4	3 (Datadrop 10) 2 (Datadrop 16)
Shear Strength			
Triaxial total stress	32	3	2 (Datadrop 6 & 10)
Triaixal effective stress	4	-	-
Shear box	2	-	-
Rock Testing			
Rock uniaxial compressive strength (UCS)	25	1	-
Point load tests (PLT)	48	2	-
Rock Porosity	14	-	
Water content of rock	21	-	-
Total	**644**	**175**	**9**

6.7.2 Geo-Environmental Testing

Geo-Environmental testing relevant to the proposed assets is included within the following two Geo-Environmental Reports:

- Aylesbury Link and Dismantled Great Central Railway Geo Environmental Assessment Report (1MC06-CEK-EV-REP-CS05-000001). Ref [87]

6.7.3 Copies of Test Results

Due to the quantity of test data across large numbers of reports, the raw test data (logs, test results etc.) have not been provided in this GDR. Copies can be found in the relevant final factual reports.

The quantity of geotechnical investigation is presented in Section 6.

6.7.4 Lime stabilisation

The available results from the lime testing on Glacial Till to verify the mechanical characteristics are discussed in Section 19 – Material Reuse.

Future results of lime testing will be reported under separate cover and the findings incorporated into the Calvert Area E-GDR.

7 Ground Summary

7.1 Introduction

This section provides a summary of the ground conditions considering the existing information and the available ground investigation data presented in the previous sections of this GDR. The following conditions are described.

- geology
- hydrology
- hydrogeology
- contaminated land

This is followed by a review of the geo-hazards that form an important part of the baseline information used in the selection of the geotechnical characteristic design values presented in Section 8 of this GDR.

7.2 Topography

The natural topography comprises low lying, smoothly undulating terrain of the Clay Vales in Buckinghamshire. A more detailed description is given in Section 4.2 together with a satellite image of the area indicating the main features and land uses.

7.3 Geology

7.3.1 General setting

The geology of the Clay Vales in the Calvert Junction Area predominantly comprises Oxford Clay Formation (OXC) generally overlain by alluvial soils and/or River terrace Deposits undifferentiated (see Figure 7-15 and Figure 7-16).

The BGS map (Figure 7-15) shows the ground surface to be covered with Alluvium Deposits (ALV) on the entire length of the asset. River Terrace Deposits undifferentiated (RTD) are encountered mainly within watercourses channel from $Ch._{HS2}$ 81+350 to $Ch._{HS2}$ 81+715 (Padbury Brook Tributary) and from $Ch._{HS2}$ 82+050 to $Ch._{HS2}$ 82+300 (Padbury Brook main Chanel).

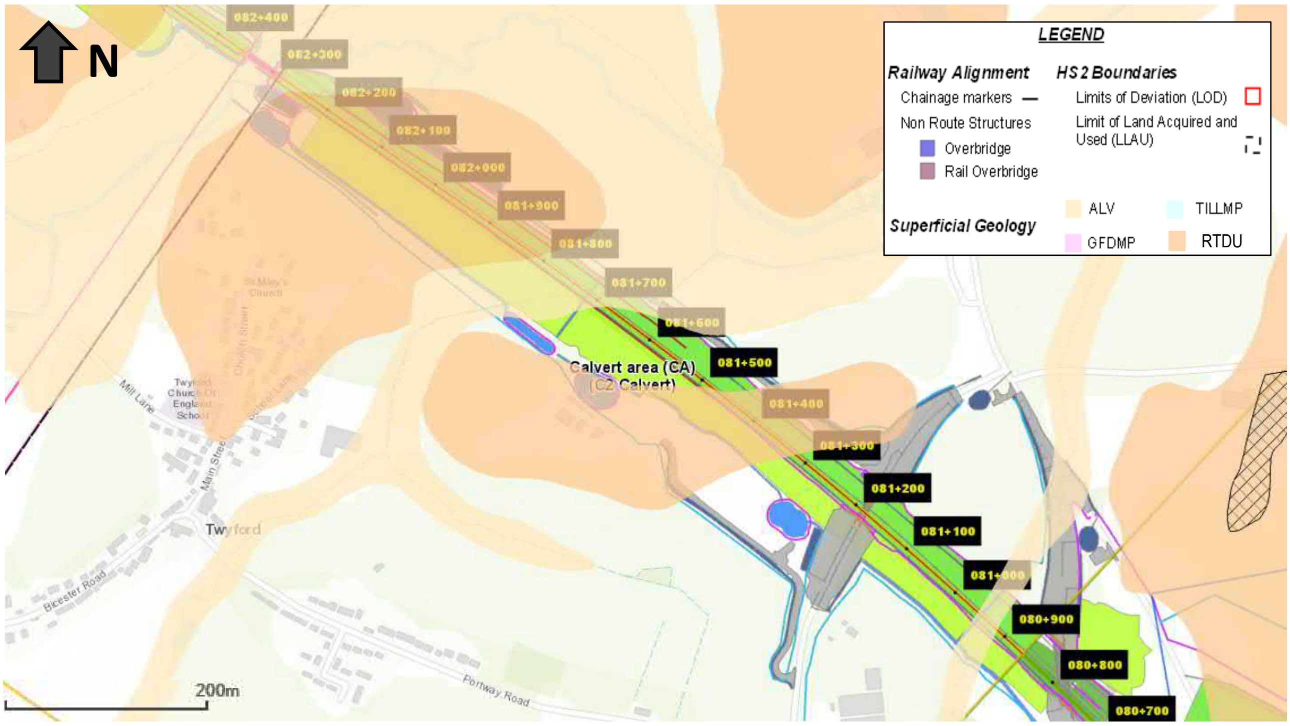


Figure 7-15 – Drift Deposit Maps Ref [31]

Figure 7-16 – Solid Geology Map Ref [30]

Two geological faults are suspected, respectively near Ch.HS2 81+920 and Ch.HS2 82+050, crossing the HS2 mainline with a SW – NE strike.

The interpretive geological long section is presented in appendix C

The interpreted ground models used in the geotechnical analysis are presented in the below section 7.3.2 of this report.

7.3.2 Ground Model

The available exploratory holes confirm the general geological setting.

The ground predominantly comprises weathered firm to stiff Oxford Clays (OXC) which reveal increasing stiffness in depth, underlain by Kellaway Formation (KLB) and a sequence of GOG formation comprehending Cornbrash (CB) and Forest Marble Formations (FMB), mainly composed of strong limestone.

These layers are covered by Alluvial soils (ALV), composed of silty sandy clays, and more sandy River Terrace deposits (RTD) in the vicinity of Padbury Brook Tributary.

Two suspected geological faults were identified between Ch.$_{HS2}$ 81+860 and Ch.$_{HS2}$ 82+050 during Stage 1 Scheme Design.

Considering the additional GI, the suspected fault initially interpreted at Ch.$_{HS2}$ 81+860 is shifted by 60 m to Ch.$_{HS2}$ 81+920

Twyford Embankment has been divided into sections according to the ground conditions and geometry; each section is represented by a ground model for geotechnical assessment as presented illustrated in Figure 8-20. The interpreted stratigraphy is detailed in the following tables.

The ground conditions are also shown on the geological long section in Figure 7-17.

Table 7-19 – Summary of the Ground Model in Twyford Embankment

Geological strata	Geology expected	Base (m bgl)	Thickness expected (m)
GM1-a: Ch.$_{HS2}$ 80+862 – Ch.$_{HS2}$ 81+100			
ALVc	Sandy slightly gravelly clays	2.70	2.70
OXC w	Weathered firm clays	4.00	1.30
OXC u1	Unweathered firm to stiff mottled clays	7.00	3.00
OXC u2	Unweathered stiff mottled clays	9.00	2.00
KLB S	Dense to very dense clayey Sandstone	12.00	3.00
KLB C	Very stiff thinly laminated clays	14.00	2.00
GoG indiff CB	Mainly limestones alternating with mudstone and siltstone beds Limestones	Bed Rock	
GM1-b: Ch.$_{HS2}$ 81+100 – Ch.$_{HS2}$ 81+225			
ALVc	Sandy slightly gravelly clays	2.70	2.7
OXC w	Weathered firm clays	4.00	1.3

Geological strata	Geology expected	Base (m bgl)	Thickness expected (m)
OXC u	Unweathered firm to stiff mottled clays	7.00	3.00
KLBs	Dense to very dense clayey Sandstone	9.50	2.50
KLBc	Very stiff thinly laminated clays	12.00	2.50
GoG indiff CB	Mainly limestones alternating with mudstone and siltstone beds Limestones	Bed Rock	
GM1-c: Ch.HS2 81+225 – Ch.HS2 81+350			
ALVc	Sandy slightly gravelly clays	2.40	2.40
OXCw	Weathered firm clays	5.00	2.60
OXCu	Unweathered stiff mottled clays	6.00	1.00
KLB S	Dense to very dense clayey Sandstone	8.00	2.00
KLBc	Very stiff thinly laminated clays	10.00	2.00
GoG indiff CB	Mainly limestones alternating with mudstone and siltstone beds Limestones	Bed Rock	
GM2: Ch.HS2 81+350 – Ch.HS2 81+525 & Ch.HS2 81+575 – Ch.HS2 81+610			
ALVc	Sandy slightly gravelly clays	2.80	2.80
RTDs	Gravel and sand	4.00	1.20
RTDc	Gravelly sandy clay	6.00	2
KLBs	Dense to very dense clayey Sandstone	8.50	2.5
KLBc	Stiff thinly laminated clays	10.00	1.50
GoG indiff CB	Mainly limestones alternating with mudstone and siltstone beds Limestones	Bed Rock	
GM3: Ch.HS2 81+525 – Ch.HS2 81+575			
RTDs	Gravel and sand	2.80	2.80
RTDc	Gravelly sandy clay	3.70	0.90
KLBs	Dense to very dense clayey Sandstone	5.00	1.30
KLBc	Stiff thinly laminated clays	6.20	1.20

Geological strata	Geology expected	Base (m bgl)	Thickness expected (m)
GoG indiff CB	Mainly limestones alternating with mudstone and siltstone beds Limestones	Bed Rock	
GM4: Ch.HS2 81+610 – Ch.HS2 81+915			
ALVs (81+650-81+775)	Clayey fine to medium sand	2.70	2.70
ALVc	Slightly gravelly sandy clays	4.50	1.80
KLBs	Dense to very dense clayey Sandstone	6.00	1.50
KLBc	Stiff thinly laminated clays	8.00	2.00
GoG indiff CB	Mainly limestones alternating with mudstone and siltstone beds Limestones	Bed Rock	
GM5: Ch.HS2 81+915 – Ch.HS2 82+050			
ALVc	Sandy slightly gravelly clays	2.00	2.00
OXCw	Weathered firm sandy clays	4.00	2.00
OXC u	Stiff mottled clays	5.70	1.70
KLBs	Dense to very dense clayey Sandstone	9.20	3.50
KLBc	Stiff thinly laminated clays	10.60	1.40
GoG indiff CB	Mainly limestones alternating with mudstone and siltstone beds Limestones	Bed Rock	
GM6: Ch.HS2 82+050 – Ch.HS2 82+289			
ALVc	Sandy slightly gravelly clays	2.00	2.00
RTDs	Gravel and sand	2.50	0.50
RTDc	Gravelly sandy clay	3.00	0.50
OXCw	Weathered sandy clays	5.00	2.00
OXC u1	Unweathered firm to stiff mottled clays	7.00	2.00
OXC u2	Unweathered stiff mottled clays	9.00	2.00
KLBs	Dense to very dense clayey Sandstone	10.50	1.50

Geological strata	Geology expected	Base (m bgl)	Thickness expected (m)
KLBc	Stiff thinly laminated clays	14.00	3.50
GoG indiff CB	Mainly limestones alternating with mudstone and siltstone beds Limestones	Bed Rock	

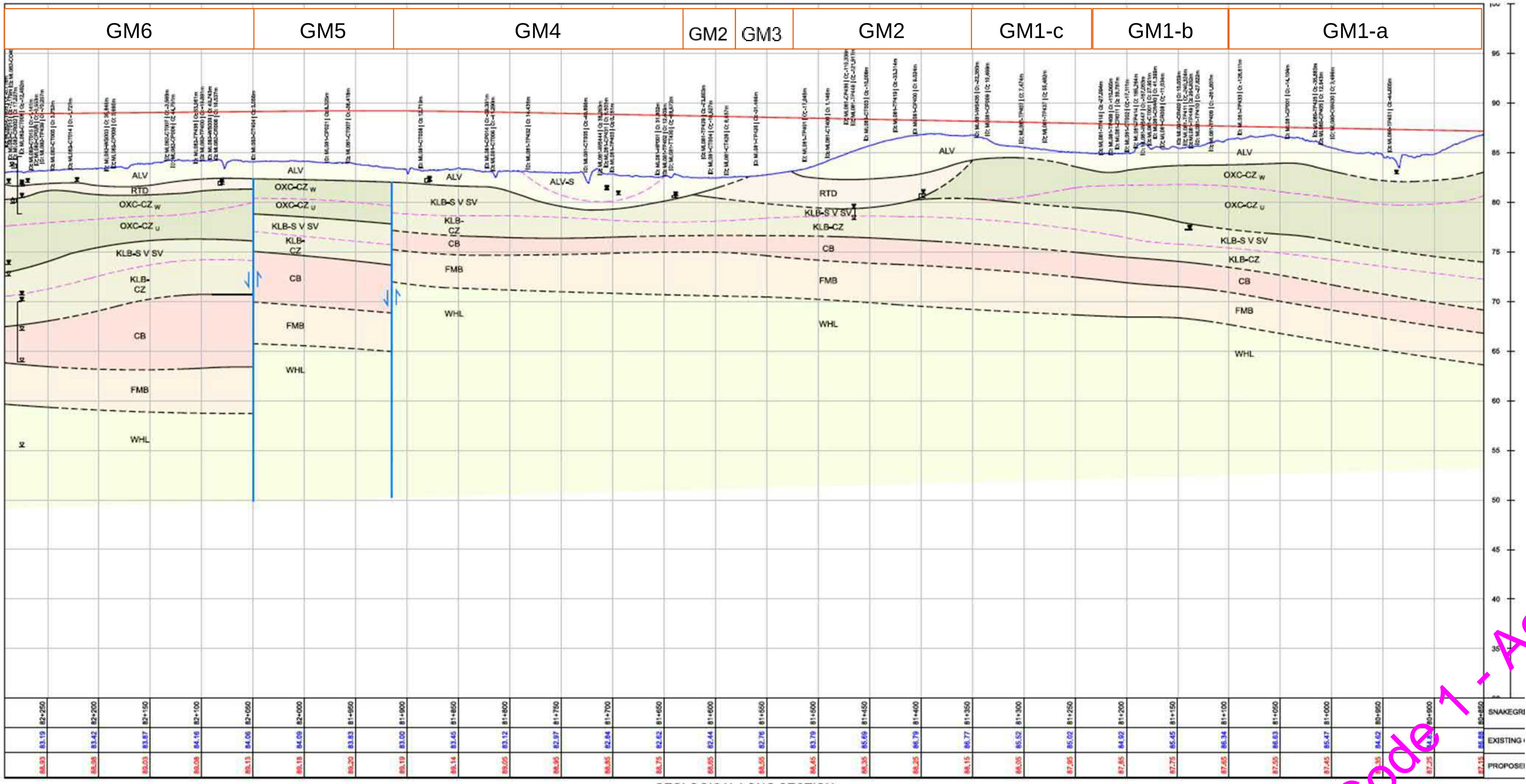


Figure 7-17 – Geological long section (for further including legend, see Appendix C)

7.4 Hydrogeology

The following sections provide a summary of the Hydrogeological Appraisal Report (HAR) Ref.[8], which has assessed the impact of the permanent state of the Twyford Embankment.

The transient risk during temporary construction works of this asset is outside of the ASC design scope for the HARs and has not therefore been assessed. General comments are however included below.

7.4.1 Hydrogeological conditions

The following solid geology and superficial deposits are present beneath the Twyford Embankment, and these have been classified by the Environment Agency (EA) as detailed in the table below.

Table 7-20 – Geological summary and aquifer classification in relation to Twyford Embankment asset

Formation	Geological Definition	Designation
Alluvium (ALV)	Superficial deposits	Secondary A Aquifer
River Terrace Deposits (RTD)	Superficial deposits	Secondary A Aquifer
Oxford Clay Formation (OXC)	Bedrock	Unproductive Strata
Kellaways Formation (KLB)	Bedrock	Secondary A Aquifer
Cornbrash Formation (CB)	Bedrock	Secondary A Aquifer
Forest Marble Formations (FMB)	Bedrock	Secondary A Aquifer
White Limestone Formation (WHL)	Bedrock	Principal Aquifer

The available GI reveals a long band of Alluvial soils (ALV) all along this asset (Ch. 80 + 862 to Ch. 82 + 289), underlain by two bands of River Terrace Deposits (RTD) at the center (Ch. 81 + 350 to Ch. 81 + 610), and at the northern end of the proposed embankment (Ch. 82 + 050 to Ch. 82 + 289). Both the Alluvium and the River Terrace Deposits have been classified by the Environment Agency (EA) as Secondary A Aquifers. The superficial deposits are underlain by the OXC (Unproductive Strata), KLB (Secondary A Aquifer), CB (Secondary A Aquifer), FMB (Secondary A Aquifer) and WHL (Principal Aquifer).

7.4.2 Groundwater Levels

Groundwater levels beneath this asset are recorded at seven locations along the 1427m length of this asset. The summary is presented in the table below:

Table 7-21 – Summary of groundwater maximum levels in relation of Twyford Embankment asset

Borehole ID	Chainages	Geological Unit Screened in	Number of readings	Maximum groundwater level below (-) and above (+) proposed base of excavation (m)
ML082-CR002	82+290	OXC	4	+1.5
ML082-CR003	82+280	OXC	4	+1.5
ML081-CP021	81+980	KLB to CB	3	-4
ML081-CP024	81+500	Alluvium and River Terrace Deposits	4	+2
ML081-CP009	81+300	OXC to KLB	5	-0.1
ML081-CR011	81+210	FMB	2	+2.5
ML080-CP405	80+960	OXC	1	+2

The proposed base of excavation given in the table includes the ground improvement.

Based on the geotechnical analysis provided in this DD-GDR there is a need to remove the soft alluvial soils found at surface, except locally where RTD sandy deposits are encountered.

Perched water has been recorded in the superficial deposits (Alluvium and River Terrace Deposits). Perched water is likely to be encountered during the excavation works (note: construction works are outside of the ASC scope for the HARs). Perched groundwater is localised and discontinuous and the impacts from this interaction are considered to be short lived and not require any special provisions or mitigation.

The base of the excavation is proposed to be at a maximum approximately 4 m below the recorded maximum groundwater level at location ML081-CP021. Note that the Oxford Clay Formation is clay dominated with limited groundwater flow and connectivity. Therefore, any productivity is likely to be restricted to relatively thin interbedded higher permeability strata. A starter layer is required where the water level is near to the base of the embankment in the permanent state.

7.4.3 Source Protection Zones

There are no Source Protection Zones (SPZs) in the study area.

7.4.4 Water supplies

An initial search for abstractions of groundwater and other interests within an approximate buffer of 1 km on either side of the proposed track has been carried out using the following data sources:

- Environment Agency Licenced Abstractions;
- Environment Agency Deregulated Abstractions;
- Local Authority Data (limited response received);
- Review of British Geological Survey (BGS) Data; and
- Review of published mapping.

In the Calvert Cutting to Twyford Embankment HAR three potential groundwater abstractions were identified within the 1 km buffer zone of the embankment:

- Public Well Twyford, located approximately 360 m southwest of the embankment. This borehole is assumed to abstracted in the KLB, CB and/or FMB. The Licence status is unknown;
- Well At Briarhill, located approximately 350 m northeast of the embankment. This borehole is assumed to abstracted in the KLB, CB and/or FMB. The Licence number 6/33/02/*G/0033. The Licence status is deregulated, and;
- Portway Farm, located approximately 410 m southwest of the embankment. This borehole is assumed to abstracted in the KLB, CB and/or FMB. The Licence status is unknown.

7.4.5 Groundwater Features

The only groundwater features present in the study are routewide Undertakings and Assurances (U&A):

- Routewide U&A (Assurance 49). General protection of groundwater. Potential significant adverse effects on groundwater, due to construction, (such as excavations to form cuttings or tunnels, including green tunnels), will be mitigated locally wherever reasonably practicable.
- Routewide U&A (Assurance 2256). National Farmers Union. Related to the protection and maintenance of farm water supplies during construction.
- Routewide U&A (Assurance 2783). Provision of suitable groundwater monitoring; and
- Routewide U&A (U&A 2220_27). No excavations, surfaces water or groundwater may be discharged onto the Trusts property until it can be demonstrated to the reasonable satisfaction of the Trust that it is not contaminated. Where such material or water is contaminated, any proposed remediation prior to discharge should be approved by the Trust.
- Routewide U&A (U&A 2220_29). Any Authorised Works that may adversely impact on the Trust's water supplies (short term or long term) from surface water feeders or groundwater pumps will be mitigated by the Promoter to the reasonable satisfaction of the Trust prior to commencement of such Authorised Works.
- Routewide U&A (Assurance 2256). Flood risk and water consenting. Consenting strategy for the water aspects of works required, including works that have the potential to affect the level, flow, and quality of water bodies.

7.4.6 Groundwater Protection

The HAR identified the following potential impacts and mitigation measures for Twyford Embankment asset:

- Perched water is present in the Alluvium and the River Terrace Deposits within the footprint of the embankment. Therefore, surcharging of superficial deposits by the loading of the embankment could lead to displacement of localised perched water where sufficient permeability exists. Such effects are therefore expected to be short-lived and no long-term risks are envisaged due to the discrete and discontinuous nature of any perched groundwater. Risks associated with pore water pressure are addressed by geotechnical assessments;
- Where the superficial deposits will be excavated, interception of perched groundwater may occur. Where perched groundwater is present, then it is likely to be discrete and discontinuous in nature and

so will likely only require minor dewatering provision as inflow rates are expected to be minor (please note that temporary dewatering works are outside of the ASC scope of works).

- No source protection zone located in the vicinity of these assets.

Overall, the risk to the groundwater environment due to the earthworks is negligible due to limited interaction with the perched water and the unproductive nature of the Oxford Clay Formation.

7.5 Hydrology

The Padbury Brook, an ordinary watercourse and tributary of the River Great Ouse, is crossed by Twyford Viaduct at the north-western of Twyford Embankment. A tributary of the Padbury Brook will pass through Twyford Embankment at Twyford East Culvert, at approximate chainage 81+715. To the north of Twyford Embankment, the Padbury Brook passes through HS2 twice, at Godington West and East Viaducts.

Flood modelling has been completed to demonstrate that the scheme satisfied HS2 requirements with respect to flood risk. Since HS2 runs parallel to the former Grand Central Mainline (GCML) embankment in this area, the principal flood mechanism is that floodwater backs up through HS2 as a result of restrictive culverts through the GCML embankment. Twyford embankment and the other embankments within this catchment reduce floodplain capacity to accommodate floodwater that backs up here, hence floodplain compensation areas are required to lower existing floodplain levels and provide additional capacity to prevent flood risk impacts elsewhere.

The table below presents the flood levels predicted by the flood model for crossings adjacent to/through Twyford Embankment. The design flood event is a 1 in 100 (1%) flood including a 65% allowance for climate change (CC).

Table 7-22 – Scheme design flood levels at the proposed crossing locations Refs [33] and [34].

Watercourse	Culvert	Predicted flood level (scheme design) (mAOD)			
		1 in 100 (1%) plus 65% CC		1 in 1,000 (0.1%)	
		Upstream	Downstream	Upstream	Downstream
Padbury Brook Tributary	Twyford East Culvert	82.99	82.85	82.98	82.85
Padbury Brook main channel	Twyford Viaduct	83.38	83.29	83.38	83.29

Flood extents, illustrating where floodwater has potential to act on Twyford Embankment, are shown in the figure on the following page.

The verification of these predicted flood levels in the earthworks model confirms that flood protection measures are required on the slopes of the embankment near to Padbury Main Channel between the following chainages:

- Up side: from Ch. 82+180 up to Twyford Viaduct
- Down side: End of landscape bund (Ch. 82+252) up to Twyford Viaduct

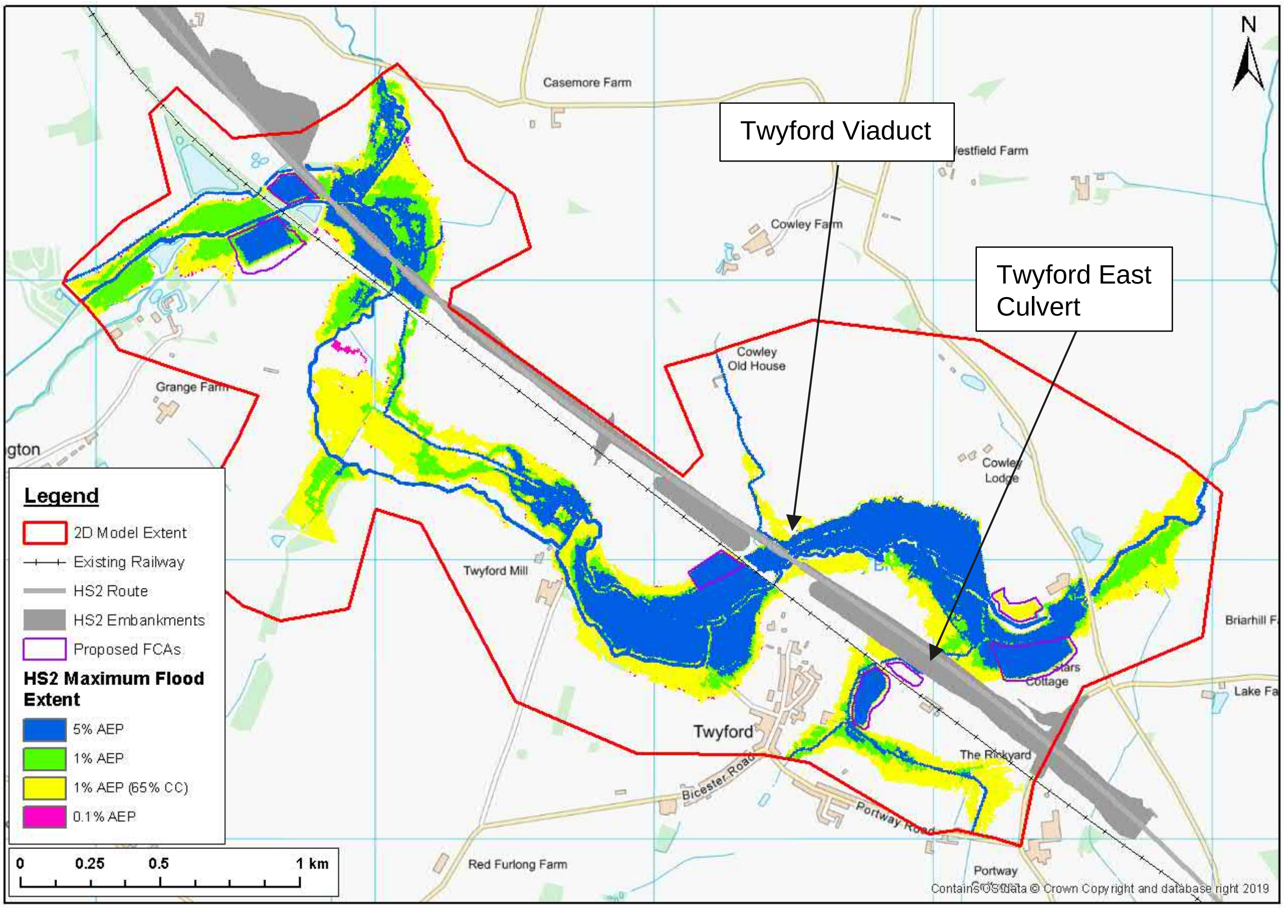


Figure 7-18 – Maximum post-scheme flood extents from Padbury Brook Flood Model.

Flood protection is not required at Twyford East Culvert nor Portway Culvert because the embankment on the Down side is protected by the old railway embankment and the HS2 landscape bund.

7.6 Assessment of Potential Contamination

7.6.1 Potential contamination and remediation requirements

The primary potential sources of contamination identified within the Twyford Embankment area are the Dismantled Rugby to Quainton Great Central Railway Line (LQ 13.07) which is partially within the western LOD at ch. 81+100 to ch. 81+400 and the Sewage Works (LQ 13.06) which is partially within the western LOD at ch 81+500 to ch 81+600.

The geo-environmental assessment of the above identified LQ constraint areas within the Twyford Embankment area address the potential risk to human health, controlled waters, infrastructure, and ecological receptors. This is reported in the Aylesbury Link and Dismantled Great Central Railway Geo-Environmental Assessment Report (1MC06-CEK-EV-REP-CS06_CL09-000001), Ref [87].

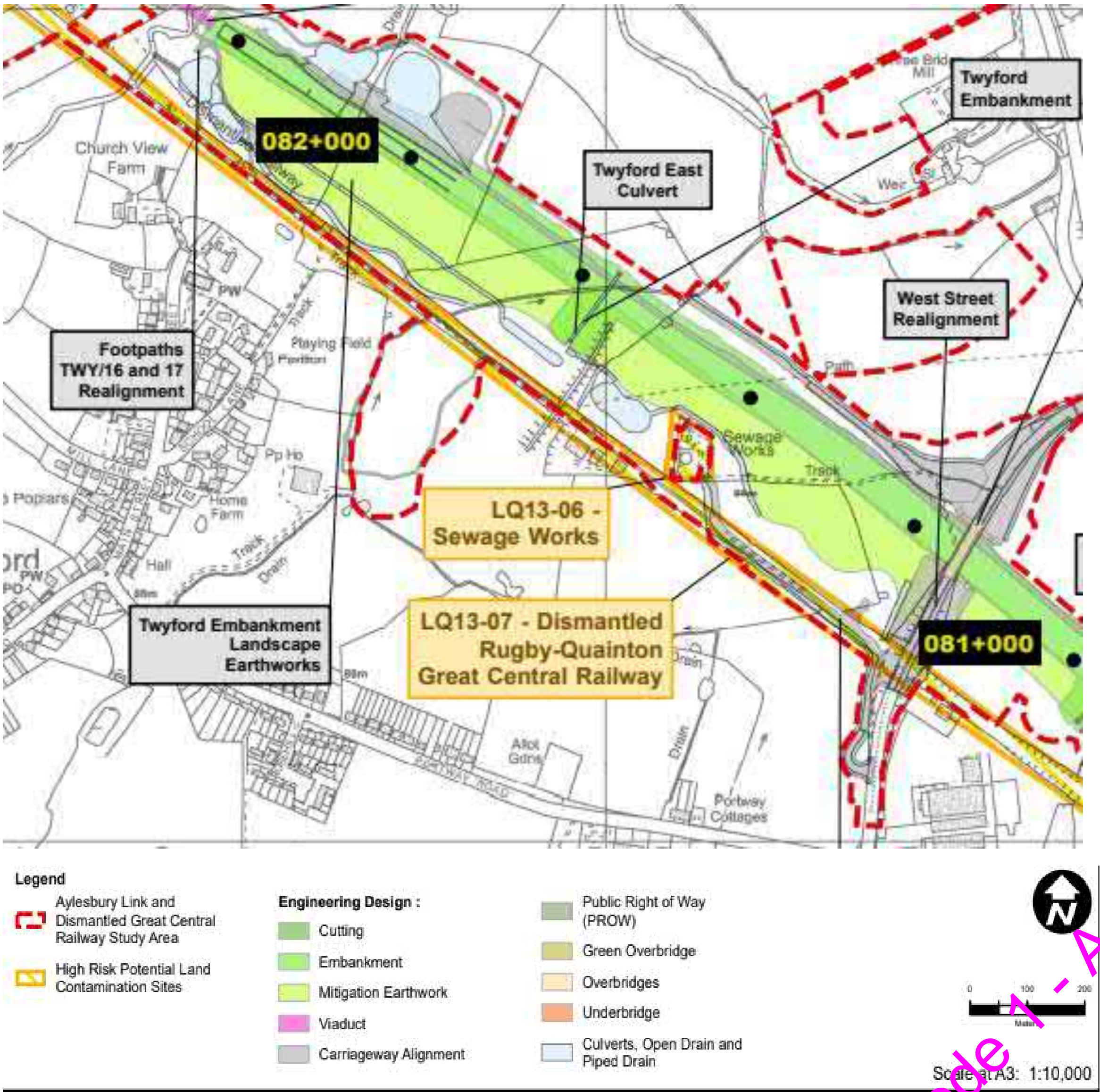


Figure 7-19 – Potential contamination within Twyford Embankment

The contamination assessments within the geo-environmental reports are based on limited available ground investigation data including soil, leachate, groundwater and surface water chemical test results and ground gas data. At the time of writing the Geo-Environmental Report, limited Ground Investigation and Geo-Environmental testing has been undertaken within the Dismantled Rugby to Quainton Great Central Railway (LQ 13.07). Whilst no Ground investigation was undertaken within the Sewage Works (LQ 13.06), due to the area not being within HS2 land ownership.

One instance of Made Ground has been identified within the Twyford Embankment and its surrounding area. No Made Ground was encountered within the LQ areas (LQ 13.06 and LQ 13.07), but this is due to no GI works being scheduled within the LQ areas within the constraints of the Twyford Embankment Group. Made Ground encountered was in the centre of the Twyford embankment located at Ch. 81+705 (ML081-CP431). This was encountered to a depth of 1.8m bgl (strata thickness of 1.5m), the Made Ground was described as a greyish brown mottled orangish brown slightly sandy slightly gravelly clay. Sand is fine. Gravel sized fragments are angular to subrounded fine to coarse of sandstone, flint, and Limestone. There were anthropogenic inclusions noted within the borehole logs, with charcoal and brick being encountered. It is also expected that Made Ground may be encountered at Ch. 81+200, where West Street crosses the Embankment although this is expected to be minimal in extent.

At the time of writing this report the Geo-environmental assessment report, there were 11 remaining geo-environmental exploratory holes within the Dismantled Rugby to Quainton Great Central Railway (LQ 13.07) (5 WS, 2 CP, 2 TP, and 2 CT), although these may not be specific to the Twyford Embankment. No further GI is scheduled to be undertaken within the confines of LQ 13.06. The data from these outstanding boreholes will be reported within an updated version of the Geo-environmental report, although it is thought that this is unlikely to alter the conclusions contained within the report.

Chemical testing was undertaken across the site within 4 borehole locations (ML082-TP400, ML081-CP431, ML081-TP402, ML081-TP426), from these a total of 6 soil samples were collected. Exceedance of metals (nickel) was recorded within ML081-CP431, against the most conservative Human Health screening criteria (LQM S4UL Allotments - 1% SOM). Leachate testing was conducted on the same 4 borehole locations and 6 soil samples. From these two exceedances were noted for metals within ML082-TP400 and ML081-TP402, for copper and mercury against the corresponding Environmental Quality Standard (EQS) within both boreholes whilst there were also exceedances of nickel and cadmium within ML082-TP400 against the relevant EQS.

Groundwater testing was undertaken in 5 locations within the Twyford Embankment (ML082-CR002, ML082-CR003, ML081-WS005, ML081-CP021, ML081-CP431). Exceedances were noted in 4 of the 5 borehole locations (ML082-CR002, ML082-CR003, ML081-WS005, ML081-CP021). Exceedances of metal contaminants were seen across all four borehole locations, inorganic contaminants within 2 borehole locations (ML082-CR002, ML081-CP021), whilst individual exceedances of fluoranthene (PAH) within ML082-CR003, and an exceedance of total TPHs within ML081-CP021. All exceedances were noted against the relevant EQS screening criteria, although the following exceedances also exceeded the relevant drinking water standard:

- ML081-CP021
  - Total TPHs
- ML082-CR002
  - Manganese
  - Sodium

These exceedances were all within their natural strata, and due to their location within the embankment, it is likely that these contaminants are associated with land usage and or natural background concentrations within the associated strata.

One surface monitoring location was undertaken within the Twyford Embankment, at the northern boundary of the embankment group (ML082-SW001). This noted a single exceedance of fluoranthene (PAH) against the freshwater EQS. There were exceedances of fluoranthene across the full scope of the geo-environmental assessment report, potentially suggesting this could be attributed to a natural background concentration.

Groundwater monitoring was undertaken across the Twyford Embankment site, with 7 boreholes (ML081-CP024, ML081-CP431, ML081-WS005, ML081-CP021, ML082-CR008, ML082-CR002, ML082-CR003) undertaking groundwater level monitoring. Groundwater monitoring across the embankment indicated that groundwater levels ranged between 0m bgl to 3.96m bgl. Therefore, based on this data in the northern part of the Embankment, there is potential for groundwaters to be encountered during the proposed earthworks.

Ground gas monitoring undertaken across the site indicates that the area is of CS1 (Characteristic Situation), thus indicating that there is a very low risk, as across the site there were low flow rates and low gas concentrations. This further indicates that any migration of ground gas is unlikely to present a significant risk to the proposed scheme.

The primary source of potential contamination associated with the proposed embankment is localised Made Ground associated with the Dismantled Rugby to Quainton Great Central Railway (LQ 13.07) and Sewage Works (LQ 13.06). Despite there being no direct interaction between the LQ areas mentioned within the report and the Twyford Embankment, there remains a risk that further localised potential contaminated soils/ Made Ground, groundwater and ground gas sources may be encountered. Mitigation measures, where appropriate, are captured in the Aylesbury Link and Dismantled Great Central Railway Remediation Outline Strategy (1MC06-CEK-EV-REP-C002-000200) Ref [87].

Remedial actions for contamination and potential contamination identified within the proposed Twyford Embankment area are set out in the Aylesbury Railway Link, Calvert Landfill and Dismantled Great Central Railway Remediation Outline Strategy Report (1MC06-CEK-EV-REP-C002-000029).

7.6.2 Summary of commitments

The proposed remediation strategy and material reuse criteria for the Aylesbury Link/ Calvert area including the proposed Twyford Embankment area are captured in the Aylesbury Railway Link, Calvert Landfill and Dismantled Great Central Railway Remediation Outline Strategy Report (1MC06-CEK-EV-REP-C002-000029).

The remediation strategy and material reuse criteria are based on discussions with the Environment Agency (EA) (see meeting minutes - 1MC06-CEK-EV-MRC-C002-000008). Regular fortnightly progress meetings have been held to date with Environment Agency/EKFB/HS2.

7.6.3 Summary of risk assessment and remedial approach

The contamination risk assessment within the Geo-Environmental Assessment Report (1MC06-CEK-EV-REP-CS06_CL09-000001) has identified potential unacceptable risks associated with soil, controlled waters and property pollutant linkages (pre-remediation); hence sensitive receptors will need to be protected from risks arising from the proposed development. Mitigation measures are captured in the Aylesbury Railway Link, Calvert Landfill and Dismantled Great Central Railway Remediation Outline Strategy Report (1MC06-CEK-EV-REP-C002-000029), Ref [87].

The Remediation Strategy includes a Materials Management (segregation) and Cover Systems (appropriate placement of materials within the proposed earthworks embankments) remediation approach across the Site. This will provide a viable and effective solution for managing impacted materials and severing the identified source-pathway-receptor linkages through the placement of a cover layer of a minimum thickness of 600mm to protect human health end users.

Excavated materials will need to be segregated and will be suitable for re-use as a part of the proposed development subject to careful handling, treatment and appropriate confirmatory chemical and geotechnical testing in accordance with a specification and the CL:AIRE Definition of Waste: Development Industry Code of Practice (DoWCoP) Materials Management Plan (MMP). Any off-site disposal of material will require appropriate pre-classification and pre-treatment to minimise the waste volume.

Anthropogenic impacted Made Ground will be segregated and stockpiled separately from the 'natural' Made Ground (i.e., contains little to no anthropogenic material), and natural soil. Made Ground materials will be moved to an appropriate area for re-use at an appropriate depth within the works based on the chemical characteristics and the material re-use zone as noted in the Aylesbury Railway Link, Calvert Landfill and Dismantled Great Central Railway Remediation Outline Strategy Report (1MC06-CEK-EV-REP-C002-000029), Ref [87].

All Made Ground material will be tested to identify whether they are chemically suitable i.e., acceptable which will include geotechnically acceptable material including Class U1A or U1B and U2. Unacceptable contaminated earthworks materials shall fall into the Classes U1B and U2 as defined below:

- Unacceptable material Class U1B are contaminated materials excavated within the site, whose level of contamination is above the set re-use criteria noted in the earthworks specification Appendix 6/14 and Appendix 6/15 and can be managed by appropriate placement of the materials or treated and processed to meet suitability requirements.
- Unacceptable material Class U2 are contaminated materials excavated from within the site which shall not be used in the permanent works (in terms of chemical use), as they are impacted materials which are unsuitable for remediation or fail acceptance or re-use criteria following treatment; hence may require offsite disposal. Class U2 materials are likely to be radioactive waste (as defined in the Radioactive Substances Act 1993), asbestos unsuitable for incorporation within earthworks materials, heavy end hydrocarbons (compounds >40 carbon atoms) materials unsuitable for remediation or failing to meet the remediation targets.

Appropriate construction management practices should be adopted during construction works including a watching brief, measures to intercept run off to prevent contamination of controlled waters, minimise potential favourable conditions that can cause leaching of contamination, dust suppression measures to damp down excavated arisings. Precautionary safety measures are required in relation to the potential ground gas risk to construction workers entering confined spaces. Potentially contaminated perched water within the Made Ground and contaminated groundwater if encountered during excavation will need to be collected, tested and removed/treated prior to discharge or offsite disposal. Unforeseen contamination will be managed in accordance with the EKFB Construction Environmental Management Plan (CEMP). Further mitigation measures are provided in the Aylesbury Railway Link, Calvert Landfill and Dismantled Great Central Railway Remediation Outline Strategy Report (1MC06-CEK-EV-REP-C002-000029), Ref [87].

7.7 Geotechnical Risks carried forward from Scheme Design

This section of the DD-GDR provides a summary of the ground risks identified in the SD-GDR Ref. [7] and carried forward into Detailed Design.

The purpose of this section is to establish an understanding of status of the ground risks at the start of Detailed Design and outline any considerations or assumptions that will inform the detailed design of the earthwork asset.

The residual ground risks after the detailed design mitigation measures are summarised in Section 9.11 and the management of uncertainty in ground risks after mitigation are reported in Section 15 of this DD-GDR.

A full description of the risks and mitigation measures is provided in the Geotechnical Risk Register Ref. [72].

Table 7-23 – Summary of geotechnical risks and considerations for Detailed Design

Geo-risks	Risk description	Scheme design mitigation	Risk level Post-Scheme Design	Considerations for detailed design
Rayleigh Waves	There is a threat of the speed of Rayleigh waves caused by trains moving at high speed due to soft ground conditions. This could result in excessive vibration and deflection of the combined slab track and earthworks, impacting the safe operation and maintenance of the Railway and the stability of the embankment.	Excavate and replace 2m bFL from Ch80+862 to 81+240 and from 81+440 to 81+640 where the high of embankment is between 0 and 2 m.	Low	Incorporate the findings of the GI Impact assessment report [86] undertaken using the 1D tool analysis and new guidance on methodology e.g. partial factor of 1.1.
Presence of soft ground	Soft ground associated with ALV, RTD or weather Oxford Clay (OXC), which could cause: - instability of embankment slopes - unacceptable total or differential settlements - unacceptable subgrade performance"	Local excavate and replace	low	Incorporate the findings of the GI Impact assessment report [86] with regards to sandy layers. Consider impact of landscape bunds.
Periglacial shear	Periglacial shear in Clay-rich materials leading to weakened in-situ geology and increased risk of slope instability	Perfom stability calculations with reduced cohesion to ensure safe slope angle	Low	Use a reduced (cautious) value of long-term drained cohesion to account for the potentially weakened soil.
Relic slip surfaces	Potential for relic slip shear surfaces in the OXC particularly where the natural slope gradient is>5°	Low risk slope gradient<5° no mitigation required	Low	Incorporate the findings of the GI Impact assessment report [86] with regards to section of elevated risk and requirement for site inspection of sub-excavations.
Chemically aggressive ground	OXC CZ Formation contain an elevated sulphate levels leading to lower reuse. This may attack buried concrete structures	DS5/AC4	Low	Incorporate the findings of the GI Impact assessment report [86].
Shrink-swell	Susceptibility of highly plastic fine-grained soils to changes in volume arising from the changes in water content from seasonal variation from the action of vegetation and climate. These changes can cause: - shrinkage and swelling of formation soils, changes in ground stress, ground movement and cracking in soil deposits. - longitudinal and lateral shrinkage / swelling in subgrade formation leading to uneven track profile and unacceptable total and differential settlement	Ground improvement to provide adequate stiffness support for EV2 and dynamic performance.	Low	According to HS Railways design and construction international standards, the shrink/swell behaviour of high plasticity clays is mastered through subgrade treatment to comply with the minimum performance criteria for high-speed rail.
Faulting	The presence of faulting has been identified around Ch.81+920 and Ch.82+050. Variations within the ground conditions (stiffness) can be expected due to weakened or broken ground within the fault zone.	Very low seismic zone Appropriate slopes	low	Use cautious geotechnical parameters in settlement and stability calculations. Inspection and control of the base of the excavation during construction. Any additional soft soils shall be removed. Minimum undrained shear strength requirement of Cu > 50 kPa.
Burrowing animals	Vulnerability of earthworks slopes to burrowing animals and potential impact on stability	No risk at scheme	n/a	Use latest ecological data.
Inadequate / uncertain GI data	Lack of information in the permeability of the layer of RTD	Conservative values used in design "	Low	Incorporate the findings of the GI Impact assessment report [86].

Geo-risks	Risk description	Scheme design mitigation	Risk level Post-Scheme Design	Considerations for detailed design
Inadequate / uncertain GI data	Lack of information in the compressibility and permeability of the layer of ALV S V SV and KLB	No risk at scheme	n/a	Incorporate the findings of the GI Impact assessment report [86].
UTX SGN gas pipe	Existing gas pipe approximately to chainage 80+900, SGN gas main adjacent to Portway Culvert. -3d model of pipe provided, but only 2d pdf of cover slab provided. Now shown in federated model for info. -Risk of temp. works clash of the cover slab with Portway Culvert, design to mitigate"	n/a	n/a	Non contestable UTX (as built) is located at approximately 9m below the Formation Level. The pipe will be protected by a concrete slab.
UTX Private water	New private water located approximately at Ch. 82+050 Existing privates water located approximately at Ch. 81+150	n/a	n/a	Incorporate latest findings of GMIA report.
UTX Foul Sewer	New Foul sewer located approximately at chainage 81+550 Existing Foul sewer located approximately from chainage 81+200 to 81+600	n/a	n/a	Incorporate latest findings of GMIA report.
Existing building (Sewage Treatment Works)	Damage may occur on existing building : - Twyford sewage treatment works building : Ch 81+500 - 81+600	n/a	n/a	Incorporate latest findings of GMIA report.
High/shallow groundwater	High groundwater level in the ground level, which could cause instability.	Starter layer	Moderate	Incorporate the findings of the GI Impact assessment report [86]: - site inspection of cut slopes - dewatering may be required in sub-excavations
Flood Risk	There is a risk of flooding associated with Padbury Brook crossing HS2 mainline, which might impact the stability of the embankment	No risk at scheme	n/a	Update Flood analysis in line with DD.
Ponds	Several small ponds are located in the fields adjacent to the Down side of HS2, between Ch 81+300 and Ch. 82+100, including also Portway farm in the south-west of the asset	No risk at scheme	n/a	Located far from HS2 mainline.
New Ponds	New Ponds located on the of HS2 at 3m from the bottom of the embankment are located at Ch. 81+920 to 82+160.	No risk at scheme	n/a	Check impact on stability.
Contamination	Likely risk of contamination linked to dismantled sewage works (LQ13.06) and Rugby to Quainton Great Central Railway Line (LQ13.07). Refer to Environmental Assessment Report 1MC06-CEK-EV-REP-CS06_CL09-000001	n/a	n/a	Incorporate findings of updated geo-environmental reports and remediation strategy.
UXO Risk	Moderate risk within eastern LLAU between ch.81+500 and ch.81+700 linked to Hillesden Bombing Range located approx. 230 m north-east of the eastern LLAU boundary at ch.81+550.	n/a	n/a	Review of construction activities in this area. Deep dig will require further investigation.

8 Geotechnical Model

8.1 Introduction

This section of the report details the soil parameters used in the geotechnical analysis. The selection of parameters is based on the soil parameter analysis presented in Appendix D using the available GI data at the asset location and also the routewide data sets for the particular formation under consideration to ensure a reasonably cautious estimation of ground conditions.

Six geotechnical models have been identified to consider the variability of the geology beneath the embankment, varying geometry and particular constraints such as S&C and transition to the viaduct area.

Ground models and descriptions of the stratigraphy are detailed in 7.3 of this report.

The limits of the six ground models are indicated on the below Figure 8-20.

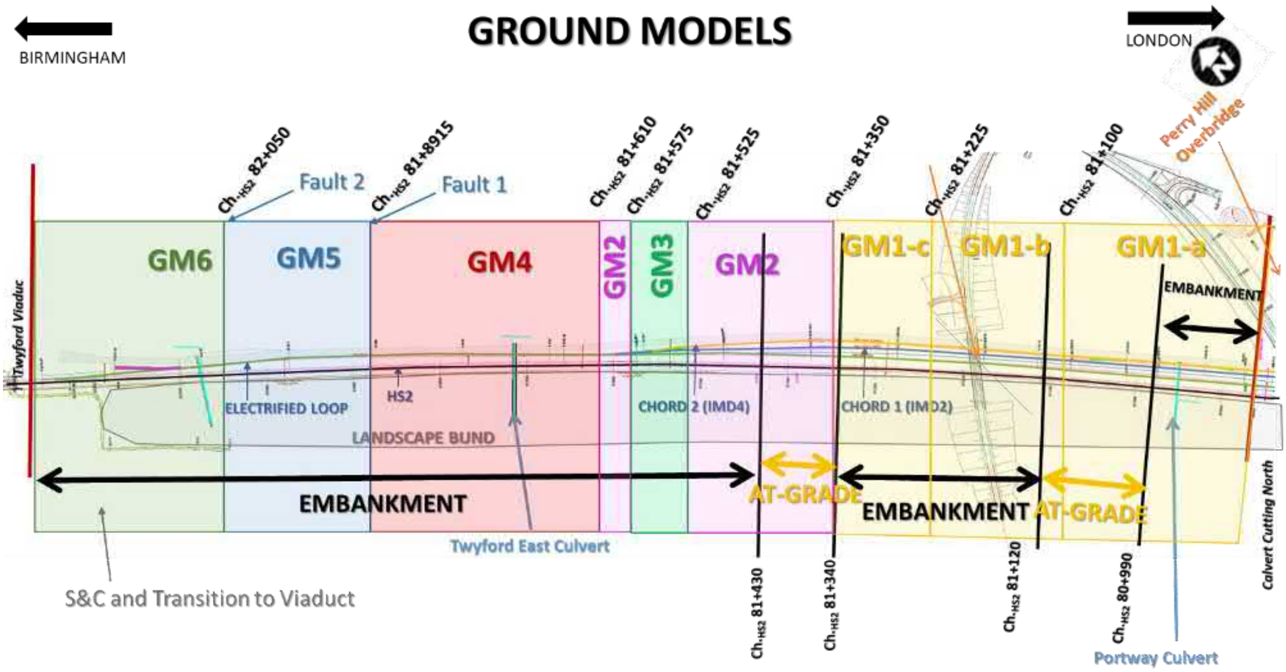


Figure 8-20 – Geotechnical Models used in the geotechnical assessment of Twyford Embankment Earthwork

8.2 Stratigraphy and Material Parameters – In situ Materials

The geotechnical characteristic design parameters adopted in the six geotechnical models are summarised in the below table.

Table 8-24 – Ground models – Twyford Embankment

Geological strata	Base strata (m bGL)	Thickness (m)	Plasticity Index (%)	γ' (kN/m^3)	N SPT	qc (MPa)	c' (kPa)	Φ'(°)	Cu (kPa)	E' (MPa)	Eoed(MPa)	ν	Cv (m2/s)	Cr(m2/s)
GM1-a (80+862 – 81+100)														
ALV- C Z	2.7	2.7	32	20	11	-	2	24	49	6	6	0.2	1.2 E-7	
OXC w	4.0	1.3	32	20	12	1.7	2	25	54	7	7.8	0.2	3.80E-7	
OXC u1	7.0	3.0	32	20	25	2	5	28	100	12.5	13.9	0.2	5.00E-7	
OXC u2	9.0	2.0	32	20	34	3	5	28	150	20	21	0.2	4.20E-7	
KLB- S V SV	11	3.0	14	20	48	>5	0	25	250	94.4	85	0.2	1 E-6	
KLB – C Z	14	2.0	36	20	47	/	3	28	207	31	34.4	0.2	4.2 E-7	
GOG (CB, FMB, WHL)	Substratum – hard bedrock													
GM1-b (81+100 – 81+225)														
ALV- C Z	2.7	2.7	32	20	11	-	2	24	49	6	6	0.2	1.2 E-7	
OXC w	4.0	1.3	32	20	12	1.7	2	25	54	7	7.8	0.2	3.80E-7	
OXC u1	7.0	3.0	32	20	25	2	5	28	100	12.5	13.9	0.2	5.00E-7	
KLB- S V SV	9.5	2.5	14	20	48	>5	0	25	250	94.4	85	0.2	1 E-6	
KLB – C Z	12	2	36	20	47	/	3	28	207	31	34.4	0.2	4.2 E-7	

Geological strata	Base strata (m bGL)	Thickness (m)	Plasticity Index (%)	γ' (kN/m^3)	N SPT	qc (MPa)	c' (kPa)	Φ'(°)	Cu (kPa)	E' (MPa)	Eoed(MPa)	ν	Cv (m2/s)	Cr(m2/s)
GOG (CB, FMB, WHL)														
GM1-c (81+225 – 81+350)														
ALV- C Z	2.4	2.4	32	20	11	-	2	24	49	6	6	0.2	1.2 E-7	
OXC w	5.0	2.6	32	20	12	1.7	2	25	54	7	7.8	0.2	3.80E-7	
OXC u1	6.0	1.0	32	20	25	2	5	28	100	12.5	13.9	0.2	5.00E-7	
KLB- S V SV	8.0	2.0	14	20	48	>5	0	25	250	94.4	85	0.2	1 E-6	
KLB – C Z	10	2.0	36	20	47	/	3	28	207	31	34.4	0.2	4.2 E-7	
GOG (CB, FMB, WHL)	Substratum – hard bedrock													
GM2=Geotechnical Model 2 (81+350 – 81+525, 81+575 - 81+620														
ALV- C Z	2.8	2.8	32	20	11	-	2	24	49	6	6	0.2	1.2 E-7	
RTD-S V SV	4	1.2	15	20	24	-	0	27	108	24	26	0.2	1 E-6	
RTD-C Z	6	2	31	20	18	-	2	24	83	5.7	6.3	0.2	1.2 E-7	
KLB- S V SV	8.5	2.5	14	20	48	>5	0	25	250	94.4	85	0.2	1 E-6	
KLB – C Z	10.5	2	36	20	47	/	3	28	207	31	34.4	0.2	4.2 E-7	
GOG (CB, FMB, WHL)	Substratum – hard bedrock													
GM3=Geotechnical Model 3 (81+525 – 81+575)														
RTD-S V SV	2.8	2.8	15	20	32		0	27	108	-	24	0.2	1 E-6	
RTD-C Z	3.7	0.9	31	20	18		2	24	80	6.3	5.7	0.2	1.2 E-7	
KLB- S V SV	5	1.3	14	20	48	>5	0	25	250	94.4	85	0.2	1 E-6	
KLB – C Z	6.2	1.2	36	20	47	/	3	28	207	31	34.4	0.2	4.2 E-7	
GOG (CB, FMB, WHL)	Substratum – hard bedrock													
GM4 (81+610 – 81+915)														
ALV- S V SV (81+650-81+775)	2.7	2.7	33.5	20	15	-	0	25	40	6	6.7	0.2	1 E-6	
ALV- C Z	4.5	1.8	32	20	11	-	2	24	49	6	6	0.2	1.2 E-7	

Geological strata	Base strata (m bGL)	Thickness (m)	Plasticity Index (%)	γ' (kN/m^3)	N SPT	qc (MPa)	c' (kPa)	Φ'(°)	Cu (kPa)	E' (MPa)	Eoed(MPa)	ν	Cv (m2/s)	Cr(m2/s)
KLB- S V SV	6	1.5	14	20	48	>5	0	25	250	94.4	85	0.2	1 E-6	
KLB – C Z	8	2	36	20	47	/	3	28	207	31	34.4	0.2	4.2 E-7	
GOG (CB, FMB, WHL)	Substratum – hard bedrock													
GM5 (81+915 – 82+050)														
ALV- C Z	2	2	32	20	11	-	2	24	49	6	6	0.2	1.2 E-7	
OXC w	4	2	32	20	12	1.7	2	25	54	7	7.8	0.2	3.80E-7	
OXC u1	5.7	1.7	32	20	25	2	5	28	100	12.5	13.9	0.2	5.00E-7	
KLB- S V SV	9.2	3.5	14	20	48	>5	0	25	250	94.4	85	0.2	1 E-6	
KLB – C Z	10.6	1.4	36	20	47	/	3	28	207	31	34.4	0.2	4.2 E-7	
GOG (CB, FMB, WHL)	Substratum – hard bedrock													
GM6 (82+050 – 82+289)														
ALV- C Z	2	2	32	20	11	-	2	24	49	6	6	0.2	1.2 E-7	
RTD-S V SV	2.5	0.5	15	20	24		0	27	108	-	24	0.2	1 E-6	
RTD-C Z	3	0.5	31	20	18		2	24	80	6.3	5.7	0.2	1.2 E-7	
OXC w	5	2	32	20	12	1.7	2	25	54	7	7.8	0.2	3.80E-7	
OXC u1	7	2	32	20	25	2	5	28	100	12.5	13.9	0.2	5.00E-7	
OXC u2	9	2	32	20	34	3	5	28	150	20	21	0.2	4.20E-7	
KLB- S V SV	10.5	1.5	14	20	48	>5	0	25	250	94.4	85	0.2	1 E-6	
KLB – C Z	14	3.5	36	20	47	/	3	28	207	31	34.4	0.2	4.2 E-7	
GOG (CB, FMB, WHL)	Substratum – hard bedrock													

8.3 Characteristic Parameters – Fill Material

The geotechnical properties presented in Table 8-25 have been assumed for fill materials.

The latest EK mass haul indicates that the Twyford Embankment will be constructed with stabilised Glacial Till.

The minimum soil parameters values for fill materials to be used as embankment are also given in the below table.

Table 8-25 – Fill material properties

Fill material	Origin of material	Treatment type	Thickness (m)	c_u (kPa)	γ_b (Mg/m^3)	c'(kPa)	ϕ' (°)	Comments
Embankment Fill	Stabilised cohesive materiel (Glacial Till)	-	-	-	2.0	5	26	Assumed stabilised cohesive material
Starter Layer	-	-	0.6	-	2.0	0	35	Assumed to be granular - Class (6.C.1)
Flood zone materials	-	-	-	-	2.0	0	35	Assumed to be granular – (6.C.2)
Fill for E&R	Class 1 – A	-	Variable	-	2.0	0	35	Due to the presence of formation with high sulphate content, lime stabilised materials are prohibited.
Landscape Bunds	All asset	-	Variable	-	1.9	1	23	High plasticity clays.

Notes to table:

- landscape bund material will also comprise material with undrained strength greater than 40kPa; where lower strength material is used it will be placed in an appropriate non-critical location within the bund beyond any slopes facing the HS2 mainline. The fills to be used in landscape bunds are given in Table 6/1 of the earthwork specification Ref. [91].
- Laboratory tests in OXC Formation reveal high total potential sulphate values, this formation is not suitable for lime stabilisation; although the excavation in the OXC Formation is likely to be limited at Twyford Embankment.

8.4 Design Groundwater Level

As described in Section 7.4, there is likely to be perched water in the superficial deposits (alluvium and River Terrace Deposit) that cover the OXC Formation.

Due to the seasonal fluctuations, the groundwater level is assumed to be at 0.2m bGL for all geotechnical models (GM 1 to 6 included).

9 Geotechnical calculations- Earthwork (Mainline)

9.1 Introduction

This section sets out the design criteria and design assumptions and presents the output of calculations relevant to earthworks design in accordance with the HS2 standard Ref. [2] taking into consideration the geohazards (Section 7.7) and the geotechnical ground models (Section 8).

9.2 Loading

The load applied in the embankment slope stability analyses are summarised in the Table 9-26 below.

Table 9-26 – Loads applied in design

Loads	Load (kPa)	Comments
Long term load (For stability calculation in long term conditions)	57 kPa	57 kPa has been utilised to the platform for stability calculation
	10 kPa	10 kPa has been applied in the cess for surcharge associated with long term operation of maintenance plant (1)
Temporary load (construction stage)	20 kPa	Exceptional loading due to construction plant and activities (1) – conservatively applied in the cess area 0.5 m behind the crest of cutting
Track load - Short term load	30 kPa	For settlement and stability calculations

(1) Abnormal loadings above the assumed surcharge which may be imposed during construction will be addressed as part of the temporary works design.

9.3 Calculation Profiles and Constraints

The calculation profiles selected for geotechnical stability and settlement calculations were selected on the basis of the following criteria:

- height of the earthwork. The maximum height within a particular zone has been used in design calculations. The general geometry along the asset is described in Section 4.3
- ground conditions
- closely spaced structures
- location of S&C
- location of ponds and ditches

Table 9-27 – Calculation profiles-Twyford Embankment (Ch. 80+862 to Ch.82+289)

N° profile	Chainage (Ch.HS2)	Type	Max height (m)	Side slope	Defining Criteria	Landscape	Ground model	Groundwater level (m bgl)	Post construction settlement
1	80+940	Embankment	2.7	1V/2H	Height, geology and Culvert (Portway culvert)	Landscape bund downside, max 3 m height– Slope= 1V/4H	1-a	0.2	15 mm
2	81+225	Embankment	2.7	1V/2H	Thickness of OXC weathered Formation		1-c	0.2	15 mm
3	81+600	Embankment	5	1V/2H	Height and geology	Landscape bund downside, max 5.5 m height– Slope= 1V/4H	2	0.2	15 mm
4	81+715	Embankment	5.80	1V/2H	Height, geology, and Twyford East culvert		4	0.2	15 mm

N° profile	Chainage (Ch.HS2)	Type	Max height (m)	Side slope	Defining Criteria	Landscape	Ground model	Groundwater level (m bgl)	Post construction settlement
5	81+920	Embankment	5.1	1V/2H	Height and geology		5	0.2	15 mm
6	82+100	Embankment	4.3	1V/2H	Height and geology		6	0.2	15 mm
7	82+289	Embankment	5.5	1V/2H	Transition to Viaduct	None	6	0.2	15 mm
8	81+420	Embankment	2	1V/2H			2	0.2	15mm
9	81+560	Embankment	5.6	1V/2H			3	0.2	15mm

Notes:

- For the Pond located at chainage 81+150, the stability calculation is not done because the pond is located at a safe distance from the toe of the embankment.
- The post construction settlement limit (allowable residual settlement) targeted in design is 15 mm due to the presence of S&C along this Twyford Embankment.
- The groundwater levels used in design calculations are described in Section 8.4.
- Calculation Profiles chosen for geotechnical calculations represents the worst-case scenario with regards to structure height and ground conditions
- Calculation Profiles have been carried out in line with the construction sequence provided by EKFB and confirmed in TQ-2107, whereby the landscape will be constructed together at the same time.

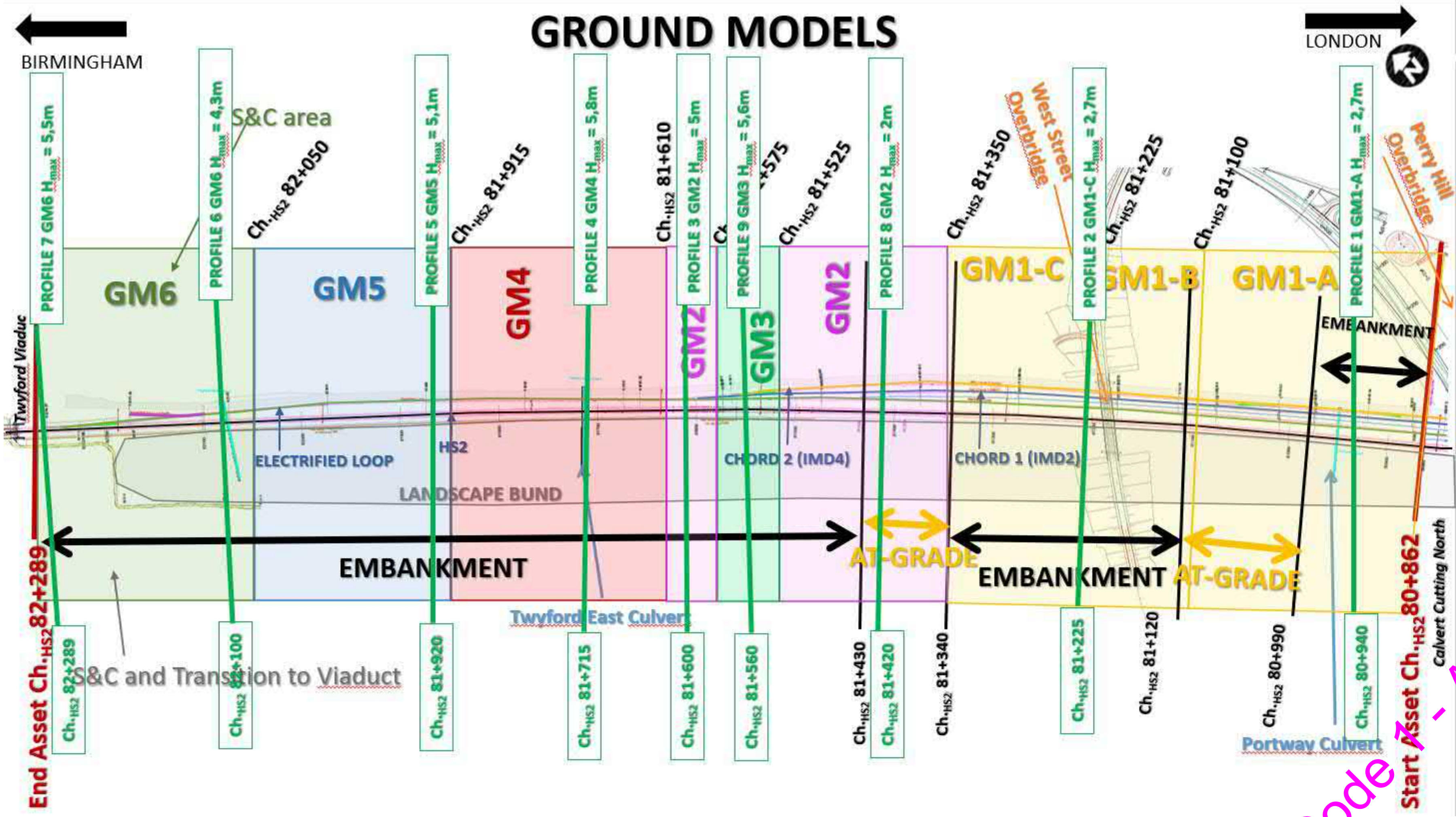


Figure 9-21 – Calculation Profiles locations on Twyford Embankment

9.4 Slope Stability Analysis

The calculation methodology for earthwork stability is detailed in this section.

9.4.1 Static slope stability

9.4.1.1 Calculation Methodology

- Slope stability was modelled using Talren 5 software.
- Bishop circular method of analysis is used due to soil conditions.
- Analysis is undertaken in accordance with the methodology given in the Technical Standard for Earthworks [2] using Eurocode 7 Ref [16] Design Approach, Combination 1 (DA1 C1) and Combination 2 (DA1 C2).
- Non-circular analysis is not performed as it is not representative of the likely failure plane in the soils encountered.
- In accordance with Eurocode 7, slope geometries are considered stable when the minimum reported Factor of Security (FoS) was ≥1.
- The seismic condition was also modelled in accordance with the HS2 Seismic Design Criteria Report and the methodology outlined in the Design Basis Statement Ref [5]
- Where stability analysis shows that FoS is less than 1, then mitigation measures are to be applied such as slope slackening or if not possible ground improvement.
- A rapid drawdown calculation is performed where pond or swale features are located close to the mainline earthworks to verify the slope stability in flood event. This is presented in Appendix E.
- For the short-term case, an equivalent overload of 1.5 m over the top of the embankment is verified to model the additional rail loading (installation of slab track etc) after construction of the earthworks to protection layer.
- The calculations were performed with both effective stress (c' phi') and undrained shear strength (cu) in the founding soils.
- For the drained analysis, the effective stress parameters correspond to a cautious estimate of the angle of friction obtained by laboratory testing in line with the guidance by Nowak and Gilbert.
- Appendix E provides the results of the calculations performed with combination DA1 C2, which is the worst-case condition for earthwork stability.

9.4.1.2 Assumptions in slope stability

The following mitigation measures have been considered in the slope stability calculations:

- Ch. 80+862 to Ch. 81+400: E&R 2m bGL to remove soils with inadequate stiffness where the height of the of embankment is H <1m.
- Ch.81+470 to Ch.82+269: Starter layer is recommended to act as a capillary break beneath embankment.

9.4.1.3 Calculations Results

This section presents the results of the general slope stability calculations for sections of mainline embankment situated within the limits of Twyford Embankment.

Table 9-28 – Result of slope stability calculations

Slope stability (Safety factor Γmin)											
Geometry			Embankment								
Chainage (HS2)			80+940	81+225	81+600	81+715	81+920	82+100	82+289	81+420	81+560
Geotechnical Ground Model			1-A	1-C	2	4	5	6	6	2	3
Calculation profile			1	2	3	4	5	6	7	8	9
Height			+2.7 m	+2.7 m	+5 m	+5.80 m	+5.1m	+4.3m	+5.5m	+2m	+5.6
Groundwater			0.2 m bGL	0.2 m bGL	0.2 m bGL	0.2 m bGL	0.2 m bGL	0.2 m bGL	0.2 m bGL	0.2 m bGL	0.2 m bGL
Slope Geometry			1V:2H	1V:2H	1V:2H	1V:2H	1V:2H	1V:2H	1V:2H	1V:2H	1V:2H
Basal Mitigations measures			E&R Class 1A1 2m	E&R Class 1A1 2 m	Starter layer Class 6C1 300mm	Starter Layer Class 6C1 300mm	Starter Layer Class 6C1 300mm	Starter Layer Class 6C1 300mm	Starter Layer Class 6C1 300mm	Starter Layer Class 6C1 300mm	Starter Layer Class 6C1 300mm
Transition stage (Static)	Surface stability	Undrained:	1.29	1.33	1.15	1.16	1.19	1.23	1.17	1.33	1.17
	General stability	Undrained	1.59	1.60	1.27	1.02	1.31	1.33	1.15	1.46	1.32
		Drained:	1.38	1.35	1.06	1.01	1.08	1.08	1.05	1.16	1.08
Long term	Surface stability	Drained	1.30	1.34	1.15	1.17	1.19	1.15	1.12	1.41	1.17

Slope stability (Safety factor Γmin)											
(Static)	General stability	Undrained:	1.28	1.53	1.24	1.04	1.26	1.17	1.18	1.64	1.32
		Drained:	1.38	1.32	1.06	1.01	1.07	1.04	1.01	1.16	1.09

Note:

- the starter layer is placed at the base of the embankment above ground level and does not include backfill for topsoil stripping or ground improvement.

9.4.1.4 Additional mitigation of soft soils

The ground models assume that the superficial deposits (ALV and RTD) have an undrained shear strength more than 50 kPa; however the available GI data indicates that softer alluvial soils will be encountered on surface from Ch.81+620 to Ch.82+269. Additional stability calculations indicate an elevated risk of failure in these softer deposits due to the additional loading by the landscape bund. A minimum excavate and replace of the alluvial soils up to 1m bGL is recommended beneath the embankment in this section to ensure slope stability.

9.4.2 Seismic conditions

9.4.2.1 Seismic Analysis Methodology

The approach to seismic design for earthworks is outlined in the Design Basis Statement Ref. [5] and summarised below.

The ground accelerations (PGA) for ULS are determined for an area of low seismic activity and using the 2500years return period.

The following partial factors in Table 9.28 have been adopted from NA to BS EN 1998-5:

Table 9-29. Partial factors from NA to BS-EN-1998-5

Subclause	Nationally Determined Parameter	Eurocode recommendation	UK decision
3.1(3)	Partial factors for material properties.	$\gamma_{cu} = 1,4$ $\gamma_{\tau cy} = 1,25$ $\gamma_{qu} = 1,4$ $\gamma_{\phi'} = 1,25$	Use the recommended values.

Undrained (short term) soil strength parameters and conservative water levels are considered for modelling of the seismic event.

Stability has also been checked at the location of the ponds.

9.4.2.2 Seismic Analysis Results

The results of slope stability in seismic condition are shown in Table 9-30.

The slope stability profiles are included within Appendix E.

The results of the slope stability calculations are summarised in the below table.

Table 9-30 – Stability calculations - HS2 Mainline for seismic conditions

Slope stability (Safety factor Γmin)									
Geometry	Embankment								
Chainage (HS2)	80+940	81+225	81+600	81+715	81+920	82+100	82+289	81+420	81+560
Geotechnical Model	1-A	1-C	2	4	5	6	6	2	3
Calculation Profile	1	2	3	4	5	6	7	8	9
Height	+3.1m	+2.7m	+5.9m	+5.8m	+5.1m	+4.3m	+5.5m	+2m	+5.6m
Groundwater level	0.2m bgl	0.2m bgl	0.2m bgl	0.2m bgl	0.2m bgl	0.2m bgl	0.2m bgl	0.2m bgl	0.2m bgl
Slope Geometry	1V:2H	1V:2H	1V:2H	1V:2H	1V:2H	1V:2H	1V:2H	1V:2H	1V:2H
Mitigation	E&R Class 1A1 2m	E&R Class 1A1 2 m	Starter layer Class 6C1 300mm	Starter Layer Class 6C1 300mm	Starter Layer Class 6C1 300mm	Starter Layer Class 6C1 300mm	Starter Layer Class 6C1 300mm	Starter Layer Class 6C1 300mm	Starter Layer Class 6C1 300mm

Slope stability (Safety factor Γmin)										
Seismic: 2500 years return period (+)	Skin stability	1.42	1.50	1.18	1.19	1.21	1.25	1.17	1.50	1.20
	General stability	1.36	1.63	1.29	1.07	1.29	1.41	1.34	1.92	1.31
Seismic: 2500 years return period (-)	Skin stability	1.44	1.50	1.18	1.20	1.29	1.25	1.16	1.59	1.21
	General stability	1.37	1.57	1.17	1.09	1.33	1.22	1.36	1.88	1.16

9.4.3 Landscape Bund Stability

Landscape bunds are located on the Down side along the entire length of the mainline asset, between Ch.80+862 to Ch. 82+200, with 1V/4H side-slopes facing the HS2 mainline.

The slope stability calculation has been carried out at the worst-case location in terms of geometry and ground model. The main assumptions are:

- maximum height 5.5m above ground level
- slope gradient of 1V:4H facing HS2
- high plasticity clay fills in the landscape bunds with long parameters as defined in Table *8-25*
- 10kPa surcharge has been adopted on the top of the landscape to allow for temporary trafficking.

The stability calculations are summarised in Table 9-*31*.

Table 9-31 – Stability calculations – Landscape

Slope stability (Safety factor Γmin)	
Calculation profile .	10
Ground Model	6
Location	Ch. 81+660
Groundwater level	0.2m bGL
SLOPE GEOMETRY	1V/4H
Landscape Height (m)	5.5m
WITHOUT MITIGATION MEASURES	**FoS**
Skin stability	1.51
General stability	1.54

9.5 Settlement Analysis

This section of the report presents the settlements calculations beneath the mainline embankment taking into the influence of the landscape bund on the Down side.

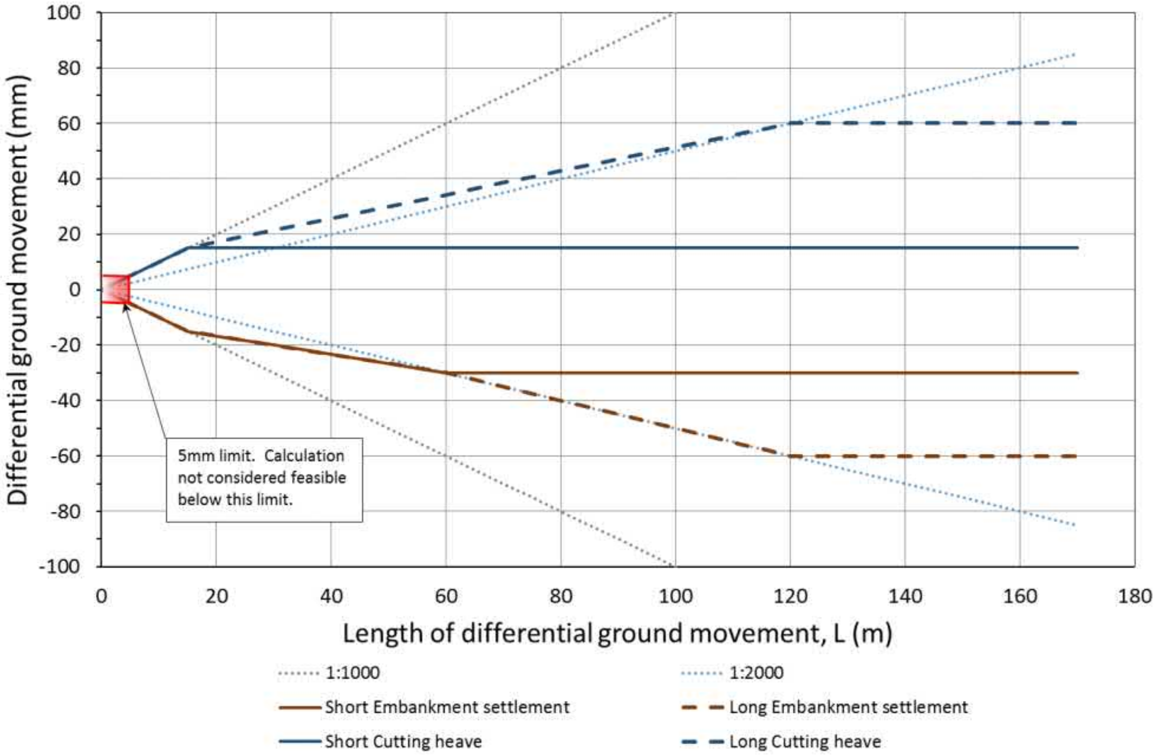
The settlement calculations have been performed on Calculation Profiles 1 to 7.

Settlement calculations at transitions to structures are presented in Section 9.7 of this report.

9.5.1 Calculation methodology

In accordance with HS2 standard for Earthworks Ref. [2] and Track Alignment Design Ref [74] the maximum acceptable post-construction settlement limit is 30mm to be applied from the time of installation of slab track as a general case.

Within a distance of 150m of S&C – Switches & Crossings, the settlement limit is max. 15mm and at transitions cut/fill the maximum longitudinal distortion in short embankments/cuttings is 1/1000 (see Figure 9-22) considering that the transition length is L=20m, the maximum settlement limit will be 15mm at transitions too.



Note: these are ground movement limits not acceptable track deformations

Figure 9-22 – Differential ground movements limits for slab track on high-speed line (extracted from HS2 Standard Earthworks Ref.[2])

In accordance with HS2 Technical Standard – Track Alignment Design Ref.[74], the total settlement on embankments between structures spaced at less than the minimum separation (minimum separation = line speed /2 = 180m) will be <15mm.

Due to a combination of closely spaced structures and S&C units the settlement calculations along the entire length of Twyford Embankment have been performed using the maximum 15mm post construction settlement requirement.

Given the HS2, Electrified Loop, IMD chord 1 and IMD chord 2 lines will be constructed on the same 'shared' platform (earthwork) the HS2 settlement criteria has been applied in design of both lines.

The following assumptions have been considered in settlement calculations with regards to construction sequence:

- the embankments for both HS2 mainline, Electrified Loop, IMD chord 1 and IMD Chord 2 lines will be constructed at the same time.
- the base of the landscape bund (up to a height corresponding to HS2 Formation level) will be constructed at the same time as the mainline embankment. This assumption has been validated by EKFB in TQ-2107.
- the landscape fill above rail level will cause additional settlement at the centreline of HS2 route.

The total settlement beneath the embankments incorporates the effects of loading from the adjacent landscape bund located on the Down side.

The improvement in shear strength due to the consolidation under loading of the normally consolidated alluvial soils has not considered in the design.

The calculation of consolidation times with/without drainage have been estimated using Cv obtained from oedometer tests.

The geotechnical parameters used in the assessment are presented in Section 8.2 and justified in Appendix D.

The settlement calculation sheets are presented in Appendix E.

9.5.2 Calculation Results – Impact of landscape bunds

The settlements created by the landscape bund have been added directly to the consolidation beneath the mainline earthworks.

9.5.3 Calculation Results – Earthwork centreline

The maximum settlement limit considered along the asset (per chainage), the principal assumptions (chainage, ground model, height, etc.) and the results of the settlement calculations are summarised in Table 9-*34* – Civil engineering under-structures crossing HS2.

Table 9-32 – Results of calculations for HS2 and others Railway Lines (under shared embankment). Reviewed according to New GI Impact Assessment Report, Ref. [86].

	Max. Acceptable settlement limit	15mm	15mm	15mm	15mm	15mm	15mm	15mm	15mm
Geometry	Location	**80+862 – 81+350**		**81+350 – 81+525**	**81+525 – 81+575**	**81+575 – 81+610**	**81+610 – 82+915 (Fault N°2)**	**81+915 – 82+050 (S&C Area)**	**82+050 – 82+269 (S&C Area)**
	Calculation profiles	1	2	8	9	3	4	5	6
	Ground Model	GM1a	GM1c	GM2	GM3	GM2	GM4	GM5	GM6
	Chainage (HS2)	80+940	81+220	81+420	81+560	81+600	81+715	81+920	82+100
	Embankment height (m)	2.7	2.7	2.0	5.6	5	5.8	5.1	4.3
	Landscape bunds height (m)	5.9	7.6	5.9	8.4	10.4	10.2	10	10
	Rail load (Slab track + rail) (kPa)	30	30	30	30	30	30	30	30
Embankment construction	**Maximum total settlement without rail load (mm)**	**54**	**50**	**39**	**59**	**116**	**109**	**92**	**112**
	Additional settlement due to rail load (mm)	**31**	**34**	**31**	**6**	**13**	**29**	**29**	**18**
	Maximum immediate settlement without rail load (mm)	19	26	14	**38**	42	64	52	61
	Maximum consolidation settlement without rail load (mm)	**34**	**24**	**25**	**21**	**74**	**44**	**40**	**51**
	Additional consolidation settlement due to rail load (mm)	**20**	**29**	**19**	**2**	**8**	**12**	**12**	**8**
Hold Period	**SETTLEMENT HOLD PERIOD**	**Minimum 2 months - Maximum 6 months**							
	Consolidation settlement after HP without rail load (mm) See Note 1	**12**	**10**	**3**	**8**	**6**	**7**	**12**	**11**
Rail load	Additional settlement due to RAIL LOAD (mm)	19	19	18	3	19	11	12	15
	Consolidation settlement remaining after HP with rail load (mm) See Note 2	**31**	**29**	**21**	**11**	**25**	**18**	**24**	**26**
Mitigation measures	Anticipation of rail load	**No**	**No**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
	SETTLEMENT HOLD PERIOD (months)	**6**	**6**	**2**	**2**	**6**	**6**	**6**	**6**
	Ground Improvement E&R (m bGL) – Settlements **See Note 3**	**2**	**2**	**2**	**0**	**0**	**1**	**1**	**1**

Table 9-32 – Results of calculations for HS2 and others Railway Lines (under shared embankment). Reviewed according to New GI Impact Assessment Report, Ref. [86].

	Max. Acceptable settlement limit	15mm	15mm	15mm	15mm	15mm	15mm	15mm	15mm
Geometry	Location	**80+862 – 81+350**		**81+350 – 81+525**	**81+525 – 81+575**	**81+575 – 81+610**	**81+610 – 82+915 (Fault N°2)**	**81+915 – 82+050 (S&C Area)**	**82+050 – 82+269 (S&C Area)**
	Calculation profiles	1	2	8	9	3	4	5	6
	Ground Model	GM1a	GM1c	GM2	GM3	GM2	GM4	GM5	GM6
	Chainage (HS2)	80+940	81+220	81+420	81+560	81+600	81+715	81+920	82+100
	Embankment height (m)	2.7	2.7	2.0	5.6	5	5.8	5.1	4.3
	Landscape bunds height (m)	5.9	7.6	5.9	8.4	10.4	10.2	10	10
	Rail load (Slab track + rail) (kPa)	30	30	30	30	30	30	30	30
	E&R (mbGL) – Durability (high Org.Matter Contents) **See Note 4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.5**
	Ground Improvement E&R (mbGL) – Stability **See Note 5**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
	Ground Improvement Rayleigh waves (mbFL) **See Note 6**	**3**	**3**	**3**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
	Landscape bunds Minimum Hold Period (months)	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**
After mitigation measures	**Consolidation settlements remaining after mitigation without rail load (mm)** **See Note 7**	**3**	**4**	**2**	**6**	**6**	**5**	**6**	**7**
	Consolidation settlements remaining after mitigation with rail load (mm) **See Note 8**	**10**	**14**	**12**	**8**	**8**	**7**	**7**	**9**
	Additional residual settlements due to landscape bund after landscape hold period (mm)	1	1	<1	5	4	4	3	5
	Total consolidation settlements remaining after HP and mitigation (incl. Settlement due landscape but not including ground improvement due to Rayleigh Wave)	**14**	**15**	**13**	**13**	**12**	**11**	**10**	**14**

Notes:

1. Settlement after 2-6 months settlement hold period (without rail load and no ground improvement)
2. Settlement after 2-6 months settlement hold period with rail load, included the settlement due to landscape, where applicable. The additional settlement caused by the rail load corresponds to the placement of the slab track. If the settlement exceeds the post construction limit of 15mmt, then further mitigation is required
3. Ground improvement (excavate and replace) to reduce the remaining settlement to within the acceptable limit. This is required in this section due to clayey nature of the alluvial soils above almost 5m of weathered OXC Formation in Ground Model 1.
4. Consideration of the ground improvement due to presence of organic matter in the superficial deposits.
5. Consideration of the ground improvement to ensure slope stability (refer to Section 9.4)
6. Consideration of ground improvement to comply to the minimum requirements for dynamic stiffness (refer to Section 9.8.2). This mitigation will need to be considered in tandem with the settlement mitigation. The worst-case mitigation is maintained in the earthwork model.
7. Settlement after 2-6 months settlement hold period and ground improvement without rail load.
8. Settlement after 2-6 months settlement hold period and ground improvement with rail load. The additional settlement caused by the rail load corresponds to the placement of the slab track

The following observations and conclusions can be drawn from these settlement results:

- Total settlements range between approximately 39 mm and 116mm depending on embankment height, influence of the landscape bund and ground conditions.
- In GM1 and GM2 (Ch. 80+862 to Ch. 81+470), the settlement remaining after an E&R of 2 m bGL to ensure adequate dynamic performance, corresponding approximately to the excavation of the Alluvium deposits, is 12-15mm after 2 to 6 months settlement hold period.
- In GM3 to GM6 (Ch. 81+470 to Ch. 82+269), where the embankment is higher, the settlement remaining after excavate and replace (Ch. 81+620 to Ch. 81+269) and the anticipation of a surcharge of 30kPa is 13-15mm after 6 months settlement hold period.
- The detailed design study of the transition to viaduct falls within the scope of T2G. Vertical drains are designed in this section due to the very tight settlement tolerance (<5mm).

9.5.4 Bearing resistance failure

9.5.4.1 Calculation methodology

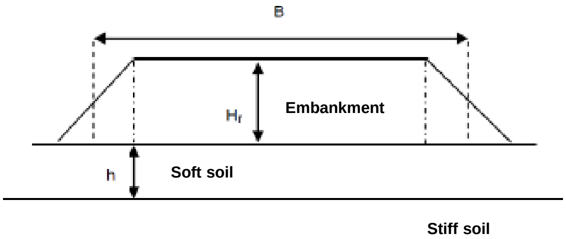
A calculation has been performed to verify the bearing resistance failure.

In short term conditions, a safety factor F ≥ 1.5 is required.

Safety factor regarding bearing resistance of soil is given by the relation below:

$$F = \frac{q_{\max}}{q} = \frac{Cu \; x \; Nc}{\gamma_r H_r + Q}$$

c_u: undrained shear stress, γ_r: embankment's bulk density,
H_r: embankment's high, Q: surcharge
N_c: bearing capacity factor for a structure with width (B) build on soft soil with thickness (h)



for $0 < \frac{B}{h} \leq 1{,}49 \Rightarrow Nc = \Pi + 2$

for $1{,}49 < \frac{B}{h} \leq 10 \Rightarrow Nc \approx 0{,}49\frac{B}{h} + 4{,}225$

for $\frac{B}{h} > 10 \Rightarrow Nc \approx 9{,}125$

Figure 9-23 – Bearing resistance failure calculation.

Calculations have been performed on the worst-case scenario for the ground model 6 where the ALV deposits and OXC W (weathered facies) are presents and the hight of the embankment and the landscape are high at Ch. 82+100.

Table 9-33 – Calculation results for bearing resistance failure

Calculation profile	Under Highest railway line embankment	Under Highest landscape embankment
Ground model	**GM 6**	**GM 6**
Hr (m)	3.95 m	4.4 m
N° profile	6	6
γr (kN/m3)	20	20
Q (kPa)	30	0
B (m)	39.8	32.5
h (m)	14.0	14.0
B/h	2.78	2.32
Nc	5.62	5.36
Cu (kPa)	49	49
SAFETY FACTOR F	**2.53**	**2.98**

9.6 Heave

Not applicable.

9.7 Transition to structures

Twyford Embankment will be crossed by the following civil engineering under-structures.

Table 9-34 – Civil engineering under-structures crossing HS2

Asset type	Name and location
Culverts	Portway culvert: Ch. 80+950 Twyford East culvert: Ch. 81+715

As mentioned in Section 3.7, the geotechnical assessment presented in this section for transitions to structures is based on Detailed Design structural drawings.

The culverts are boxed structures (refer to Table 4-10 for more details).

9.7.1 Design Criteria

The principal design requirements at transitions to structures are as follows.

In accordance with Clause 6.3.1 of the HS2 Technical Standard for Earthworks, the transitions to structures shall be designed to control the internal settlement of approach embankments and the differential settlement of natural soils beneath them. The transition in dynamic stiffness of the earthworks shall be smoothed progressively between high and low stiffness areas.

In accordance with HS2 Technical Standard – Track Alignment Design Ref.[74], the total settlement on embankments between structures spaced at less than the minimum separation (minimum separation = line speed /2 = 180m) will be <15mm. The design criteria are summarised in Table 9-35 together with the assessment of Twyford Embankment.

Table 9-35 – Definition of closely spaced structures

Design criteria	Unit	Desirable	Limiting	Applicable to Twyford Embankment YES/NO	Comments
Distance between structures – minimum length of embankment (higher than 5m) between two consecutive underbridge structures. Including any combination of the following	m	V/2 = 180	V/2.5 = 144	NO	-
• Viaducts	-	-	-	YES	• Twyford viaduct
• Other underbridges including culverts and underpasses whose internal diameter >0.9m and whose foundation is not within the embankment and either:	-	-	-	YES	• -
○ the top of the structure is <2m below the base of the Protection Layer, or	-	-	-	YES	• Portway Culvert • Twyford East Culvert
○ has a different foundation type to the embankment	-	-	-	NO	• shallow foundations • culvert base often situated deeper than embankment foundation, potentially placed on stiffer soils after excavation
• where minimum separation cannot be achieved, specific settlement limits are specified in HS2 TS EW Ref. [2]	-	-	-	YES	• <15mm

Based on this analysis:

- Portway Culvert and Twyford East Culvert are adjacent structures, the distance between each neighbouring culvert respect the minimum ‘desirable’ limit of separation, which is 180m in accordance with HS2 TS Track Design Ref.[74]. However, the culverts are located in close proximity to S&C units.
- The length of this group of structures requiring settlement design to a max. limit of 15mm extends from Ch. 80+862 to Ch. 82+245.

For typical details of the technical fill arrangements at transition to culverts refer to Typical HS2 Mainline Earthworks Transition Embankment to Culvert Ref. [78].

9.7.2 Underbridge transition

Not Applicable

9.7.3 Culvert transitions

The culverts located within the limits of Twyford Embankment are listed in the table below.

9.7.3.1 Calculation profiles and constraints

The settlement calculations have been performed at the following locations.

Table 9-36 – Transition calculation profiles – Culverts

N° profile	Chainage	Type	Side slope	Maximum height (m)	Ground model	GW level	Settlement requirements
1	80+950	Portway Culvert	1V:2H	2.0m	1-a	0.2m bGL	15mm – within S&C
4	81+715	Twyford East Culvert	1V:2H	5.2m	4	0.2m bGL	15mm – within S&C

Portway Culvert is perpendicular to HS2.

Twyford East Culvert is skewed to HS2.

The calculation method used to estimate settlements at culvert transitions follows the same methodology as described in section 9.5.1 of this GDR.

Table 9-37 presents the predicted settlements at the location of each culvert assuming the maximum embankment height.

In accordance with the HS2 Technical Standard for Earthworks Ref. [2] the minimum standard length at transitions is 20m.

Table 9-37 – Summary of settlement calculations at transitions to the culverts

	Location	Portway Culvert Ch. 80+948 (below embankment) <15mm	Twyford East Culvert Ch. 81+715 (below embankment) <15mm
Geometry	Calculation profiles	1	4
	Chainage (HS2)	80+948	81+687
	Ground Model	GM1-a	GM4
	Rail load (Slab track + rail) (kPa)	30	30
	Embankment net height (m)	3.1	5.8
	Cover (m)	2.5	3.3
	Landscape bunds height (m)	3.3	4.3
Construction stage (without mitigation)	**Maximum total settlement without rail load (mm)**	**67**	**111**
	Additional settlement due to rail load (mm)	34	29
	Maximum immediate settlement without rail load (mm)	**24**	**64**
	Maximum consolidation settlement without rail load (mm)	**43**	**47**
Hold period	SETTLEMENT HOLD PERIOD (months)	6	6
	Consolidation settlement after HP without rail load (mm)	14	10
Rail load	Additional settlement due to RAIL LOAD (mm)	21	13
	Consolidation settlement after HP without E&R and with rail load (mm)	35	23
Mitigation measures and features	Anticipation of rail load required during construction	**No**	**Yes**
	Hold Period (months)	**6**	**6**
	Current GROUND LEVEL (mAoD)	**+84.47**	**+82.65**
	Ground Improvement E&R (m bGL)	**2**	**0**
	Ground Improvement BASE LEVEL (mAoD)	**+82.4**	**+82.65**
Construction stage (with E&R)	**Maximum total settlement without rail load (mm)**	**44**	**111**
	Additional settlement due to rail load (mm)	22	29
	Maximum immediate settlement without rail load (mm)	**22**	**64**
	Maximum consolidation settlement without rail load (mm)	**22**	**47**
	Additional consolidation settlement due to rail load (mm)	11	12
Settlement after hold period	Consolidation settlement remaining after HP and mitigation without rail load (mm)	2	22
	Consolidation settlement remaining after HP and mitigation with rail load (mm)	13	13
	Additional residual settlement due to landscape bund after landscape hold period	1	1
	Total consolidation settlement remaining after HP and mitigation (incl. Settlement due landscape)	**14**	**14**
	Settlement over 12 months after opening to rail traffic (mm)	10	2

Notes:

1. Embankment cover corresponds to the depth between the top of the culvert and the top of the protection layer
2. The ground improvement is measured from ground level and does not consider the minimum depth of ground improvement beneath the culverts to ensure adequate foundation (refer to Table 9-38).

9.7.3.2 Mitigation Measures

The following table provides a summary of the main requirements and mitigation measures at the transitions to Culverts situated in Twyford Embankment.

Table 9-38 – Transitions to culverts – mitigation measures

Structures	Foundations	Transition Locations	Transitions Design
All culverts	Box Structure	See above	Anticipation of rail load is required from Ch. HS2 81+450 to 82+269. Build embankment fill to Formation Level + 1.5m Settlement hold period of minimum 2 to 6 months All soft material below culvert is required to be removed to a competent bearing stratum, bearing strata of minimum c_u= 50 kPa will need to be verified at founding level. Settlement mitigation measures beneath the adjacent HS2 embankment shall also apply to culvert location. Minimum 500mm thick blinding layer shall be installed beneath the structure. I&M is required in-ground instruments that will need to be installed prior to constructing the embankment. Monitoring is to be carried out following completion of adjacent HS2 embankment to show that settlement is within acceptable limits. Where trigger levels are exceeded, it may be necessary to prolong the hold period. Excavation to include allowance for pumping/dewatering.

NOTES:

1. *Monitoring required to verify settlement and pore water pressures predictions during construction and for 2-6 months after embankment construction or for a period sufficient to demonstrate that the HS2 Technical Standards limit for post-construction to rail traffic settlement will be met.*
2. *There will be a minimum 2 months hold period post-construction at each structure.*
3. *Additional pre-load and/or extended monitoring period may be required if I&M trigger levels are breached, as described in the Designers Monitoring Plan (DMP) Ref. [56]*

For typical details of the technical fill arrangements at transitions to underbridges refer to the Earthworks Typical Details Ref. [77] and for typical details at transition to culverts refer to Typical HS2 Mainline Earthworks Transition Embankment to Culvert Ref. [78].

The arrangement drawings for Twyford East Culvert and Portway Culvert, are listed below:

- Twyford East Culvert Earthworks transition Ref. [79]
- Portway Culvert Earthworks transition Ref. [92]

The instrumentation and monitoring details are presented in the Designer's Monitoring Plan, Ref. [56]

9.8 Subgrade Performance Design

9.8.1 Static Performance

In addition to the HS2 requirements for long term stability, in accordance with HS2 Technical Standard – Earthworks Ref. [2], particular mitigation measures may need to be applied to meet the performance requirements of the subgrade.

Key requirements from HS2 standards are listed in Table 9-39.

Table 9-39 – HS2 Technical Standard Earthworks requirements

Elements			Design assumptions	Comments / justifications
Subgrade / Platform design	Existing subgrade classification		QS0/QS1	>15% fines, EV2<60MPa (EV2=modulus of deformation)
	Foundation treatment. Note to table 4.2/2	DS ≥230Kph	EV2 ≥ 60 MPa at least 2m below formation level	If necessary, excavate and replace until 2mbFL with Class 1, 3 or 9 materials. Dig may be stopped if soils Ev2>60 MPa encountered at higher level
		DS ≤ 230Kph	EV2 ≥ 60 MPa at least 1.5m below formation level	If necessary, excavate and replace until minimum 1.5mbFL with Class 1, 3 or 9 material. Dig may be stopped if soils Ev2>60 MPa encountered at higher level
	Targeted bearing capacity class of subgrade platform after foundation treatment		P3 (EV2 ≥ 60MPa) (EV2=modulus of deformation)	-
	Thickness of prepared subgrade		400mm (minimum)	Class 6F8/6F9 high quality granular fill in accordance with Definition of Scheme Design - Earthwork Material Re-Use: Class 6F Thickness in accordance with table 4.2/2 of HS2-ST-Earthworks
	Dynamic Railway Loading		Rayleigh Wave velocity measured at the Formation of >1.6* Design Speed (DS)	Dig and replace –in accordance with ASC Rayleigh Wave Risk Assessment and Mitigation Design, Ref. [80] and the ASC Rayleigh guidance note for 1D tool analysis dated December 2021 including a partial factor of 1.1 applied to the Vr requirement.

NOTES:

- IMD Chord lines track bed is on ballasted track
- Electrified Loop is on slab track

9.8.2 Dynamic Performance

Reference should be made to the Rayleigh Wave Risk Assessment and Mitigation Design Report Ref. [80].

The detailed design analysis for Rayleigh Waves is presented in the New Ground Engineering Data - Impact Assessment Report, Ref. [86] incorporating the latest GI information including CSW testing and ASC 1D tool analysis. A summary of the results and the final recommended depth of excavate and replace to meet the performance requirements are given in the below table.

Table 9-40 – Summary of findings of the Rayleigh wave analysis

Ch.	Location ID	Chainage	Ground level	Embankment Height	Formation Level	1. VS > 170 m/s bGL (Depth)	2. 1D Tool E&R depth bGL (m) Vr> 176 m/s	3. 1D Tool Base E&R Vr >176 m/s bFl	Final Design E&R Depth bFL (m)
80+862 - 81+140	**ML080-CW430**	**81000**	**85,55**	**0,85**	**86,4**	4,5	0,9	1,75	3
	ML080-CP405	81015	85,62	0,78	**86,4**	4,2	0	0,78	
	ML081-CP001	81045	86,13	0,37	**86,5**	4,9	2,3	2,67	
80+140 - 81+350	**ML080-CW438**	**81150**	**85,6**	**1,1**	**86,7**	3,3	1	2,1	3
	ML081-CR402	81145	85,4	1,2	86,6	4,7	0	1,2	
	ML081-CR008	81165	85,29	1,41	86,7	4,5	0	1,41	
	ML081-CR440	81175	85,97	0,73	86,7	4	0	0,73	
	ML081-CT001	**81175**	**85,5**	1,2	86,7	3,5	1	2,2	
	ML081-CP019	81185	85,35	1,35	86,7	4,5	1,8	3,15	
	ML082-CT009	**81190**	**84,5**	2,3	**86,8**	3	0	2,3	
	ML081-CT002	**81200**	**84,8**	**1,9**	**86,7**	3,4	0,7	2,6	
	ML081-CR011	81210	85	1,7	86,7	4,6	2,2	3,9	
	ML081-CW424	**81265**	**85,14**	**1,76**	**86,9**	3,8	0,8	2,56	
	ML081-CP009	81335	86,5	**0,5**	87	4,5	2,2	2,7	
81+350 - 81+470	**ML081-CW425**	**81400**	**86,8**	**0,4**	**87,2**	3,1	1,5	1,9	3
	ML081-CP400	81405	86,67	0,43	87,1	4,7	0	0,43	
	ML081-CT003	**81455**	**85,9**	1,4	**87,3**	3	0,6	2	
	ML081-CP436	81470	85,3	2	87,3	2,9	0	2	
81+470 - 81+610	**ML081-CW427**	**81590**	**82,7**	**4,8**	**87,5**	1,1	0	4,8	0
	ML081-CP024	81545	83	4,5	87,5	3,9	0	4,5	

Note : VR 176 m/s = Vs 187 m/s

Points to note:

- Pre-earthwork demonstration areas and control testing will be required to confirm the depth of excavate and replace at the asset location. Further details are provided in the asset specific earthwork specifications Ref. [91].

The mitigation measures for foundation treatment are confirmed in Section 9.11.

9.9 Durability

Analysis of the available chemical testing results has been undertaken as part of detailed design, and a classification linked to different geological formations has been developed and is presented below.

A summary of the results of the durability tests carried out on the Twyford Embankment is provided in Table *9-41*.

The average TPS has been calculated from the Total sulphur test results. The results of Total sulphur test are presented in Appendix D.

Table 9-41 – Summary of durability tests results

Geological strata	Total Potential Sulphate (%) (=total sulphur · 3)	Design Sulphate Class	ACEC Class
ALV SV SV	0.09	DS1 – No risk	AC-1
ALV CZ	0.60	DS2 – Low risk	AC-2
RTD SV SV	0.48	DS2 – Low risk	AC-2
RTD CZ	0.05	DS1 – No risk	AC-1
OXC CZ	4.3	DS4	AC-4s
KLB CZ	3.99	DS4	AC-4s

Concrete Class

In accordance with Part C5 of BRE Special Digest 1 Ref. [72] “a limitation can be applied [to the Design sulphate Class] if the sulphate class for the total potential sulphate (TPS) is initially found to be Sulphate Class 5, but the sulphate classes for groundwater and the water extracts tests are Sulphate Class 3 or less. In this case, the Design Sulphate Class for the site location can be limited to DS-4.

The TPS at the asset location is DS5.

The routewide data for water soluble sulphate in the OXC Formation in Calvert Area consistently gives DS3.

In this case it is acceptable to use a design sulfate class of DS4.

The higher DS class of 4 is maintained for all concrete structures at Twyford Embankment due to the predominance of the OXC Formation and relatively thin superficial deposits.

Soil stabilisation or Modification

For suitability of treatment with lime/cement, the following guidance has been adopted for soils:

- TPS <0.25%: Low Risk.
- TPS >= 1.0%: Significant Risk.

Available routewide data suggest that the Alluvium deposits (ALV) and River Terrace deposits (RTD) are below the lower trigger concentration of 0.25% TPS and can be considered suitable for stabilisation, albeit the volumes of these soils are very limited and are not considered for reuse as mainline fills.

9.10 Assessment of potential Contamination

9.10.1 Potential contamination and remediation requirements

The primary potential sources of contamination identified within the Twyford Embankment area are the Dismantled Rugby to Quainton Great Central Railway Line (LQ 13.07) which is partially within the western LOD at ch.$_{HS2}$ 80+100 to ch.$_{HS2}$ 88+00 and the Sewage Works (LQ 13.06) which is partially within the western LOD at ch.$_{HS2}$ 81+450 to ch.$_{HS2}$ 81+475.

The geo-environmental assessment of the above identified LQ constraint areas within the Twyford Embankment area address the potential risk to human health, controlled waters, infrastructure, and ecological receptors. This is reported in the Aylesbury Link and Dismantled Great Central Railway Geo-Environmental Assessment Report **(**1MC06-CEK-EV-REP-CS06_CL09-000001).

The contamination assessments within the geo-environmental reports are based on limited available ground investigation data including soil, leachate, groundwater and surface water chemical test results and ground gas data. At the time of writing the Geo-Environmental Report, limited Ground Investigation and Geo-Environmental testing has been undertaken within the Dismantled Rugby to Quainton Great Central Railway (LQ 13.07) (comprising two exploratory hole locations with chemical data). No potential contaminants of concern have been identified. No Ground investigation was undertaken within the Sewage Works (LQ 13.06). Therefore, there remains the potential for contamination to be present. Further ground investigation is ongoing as described in Section 7.6.1.

Metals were identified within groundwater samples outside the LQ areas, indicating that background groundwater quality could be poor. Soil leachate analysis indicates that metals and inorganics are potentially leachable from the Made Ground and natural strata at concentrations that would exceed Water Quality Standards.

Further GI is ongoing in the fourth phase of GI including soil, leachate and groundwater sampling and testing. The geo-environmental report will be updated when the results become available although as mentioned in Section 7.6.1 'it is thought that this [the results] is unlikely to alter the conclusions contained within the report'.

Remedial actions for contamination and potential contamination identified within the proposed Twyford Embankment area are set out in the Aylesbury Railway Link, Calvert Landfill and Dismantled Great Central Railway Remediation Outline Strategy Report (1MC06-CEK-EV-REP-C002-000029).

9.10.2 Summary of commitments

The proposed remediation strategy and material reuse criteria for the Aylesbury Link/ Calvert area including the proposed Twyford Underwood Embankment area are captured in the Remediation Outline Strategy Report (1MC06-CEK-EV-REP-C002-000029).

The remediation strategy and material reuse criteria are based on discussions with the Environment Agency (EA) (see meeting minutes Ref.[83]- 1MC06-CEK-EV-MRC-C002-000008). Regular fortnightly progress meetings have been held to date with Environment Agency/EKFB/HS2.

9.10.3 Summary of risk assessment and remedial approach

Although no asset specific contamination has been identified in the limited available test data, the contamination risk assessment within the Geo-Environmental Assessment Report **(**1MC06-CEK-EV-REP-CS06_CL09-000001) has identified potential unacceptable risks associated with soil, controlled waters and property pollutant linkages; hence sensitive receptors will need to be protected from risks arising from the proposed development. Mitigation measures are captured in the Remediation Strategy Report (1MC06-CEK-EV-REP-C002-000029).

Further contamination testing will need to be conducted at the asset location.

The Remediation Strategy includes a Materials Management (segregation) and Cover Systems (appropriate placement of materials within the proposed earthworks embankments) remediation approach across the Site. This will provide a viable and effective solution for managing impacted materials and severing the identified source-pathway-receptor linkages through the placement of a cover layer of a minimum thickness of 600mm to protect human health end users.

Excavated materials will need to be segregated and will be suitable for re-use as a part of the proposed development subject to careful handling, treatment and appropriate confirmatory chemical and geotechnical testing in accordance with a specification and the CL:AIRE Definition of Waste: Development Industry Code of Practice (DoWCoP) Materials Management Plan (MMP). Any off-site disposal of material will require appropriate pre-classification and pre-treatment to minimise the waste volume.

Anthropogenic impacted Made Ground will be segregated and stockpiled separately from the 'natural' Made Ground (i.e. contains little to no anthropogenic material), and natural soil. Made Ground materials will be moved to an appropriate area for re-use at an appropriate depth within the works based on the chemical characteristics and the material re-use zone as noted in the Remediation Outline Strategy Report (1MC06-CEK-EV-REP-C002-000029).

All Made Ground material encountered during construction will be tested to identify whether they are chemically suitable i.e. acceptable which will include geotechnically acceptable material including Class U1A or U1B and U2. Unacceptable contaminated earthworks materials shall fall into the Classes U1B and U2 as defined below:

Unacceptable material Class U1B are contaminated materials excavated within the site, whose level of contamination is above the set re-use criteria noted in the earthworks specification Appendix 6/14 and Appendix 6/15, and can be managed by appropriate placement of the materials or treated and processed to meet suitability requirements.

Unacceptable material Class U2 are contaminated materials excavated from within the site which shall not be used in the permanent works (in terms of chemical use), as they are impacted materials which are unsuitable for remediation or fail acceptance or re-use criteria following treatment; hence may require offsite disposal. Class U2 materials are likely to be radioactive waste (as defined in the Radioactive Substances Act 1993), asbestos unsuitable for incorporation within earthworks materials, heavy end hydrocarbons (compounds >40 carbon atoms) materials unsuitable for remediation or failing to meet the remediation targets.

Appropriate construction management practices should be adopted during construction works including a watching brief, measures to intercept run off to prevent contamination of controlled waters, minimise potential favourable conditions that can cause leaching of contamination, dust suppression measures to damp down excavated arisings. Precautionary safety measures are required in relation to the potential ground gas risk to construction workers entering confined spaces. Potentially contaminated perched water within the Made Ground and contaminated groundwater if encountered during excavation will need to be collected, tested, and removed/treated prior to discharge or offsite disposal. Unforeseen contamination will be managed in accordance with the EKFB Construction Environmental Management Plan (CEMP). Further mitigation measures are provided in the Remediation Outline Strategy Report (1MC06-CEK-EV-REP-C002-000029).

9.11 Summary of Mitigation Measures

9.11.1 Twyford Embankment (HS2 and Electrified Loop)

The recommended earthwork mitigation measures beneath Twyford Embankment are highlighted in green in the following summary table of mitigations.

Table 9-42 – Mitigation measures beneath Twyford Embankment – HS2 and Electrified Loop

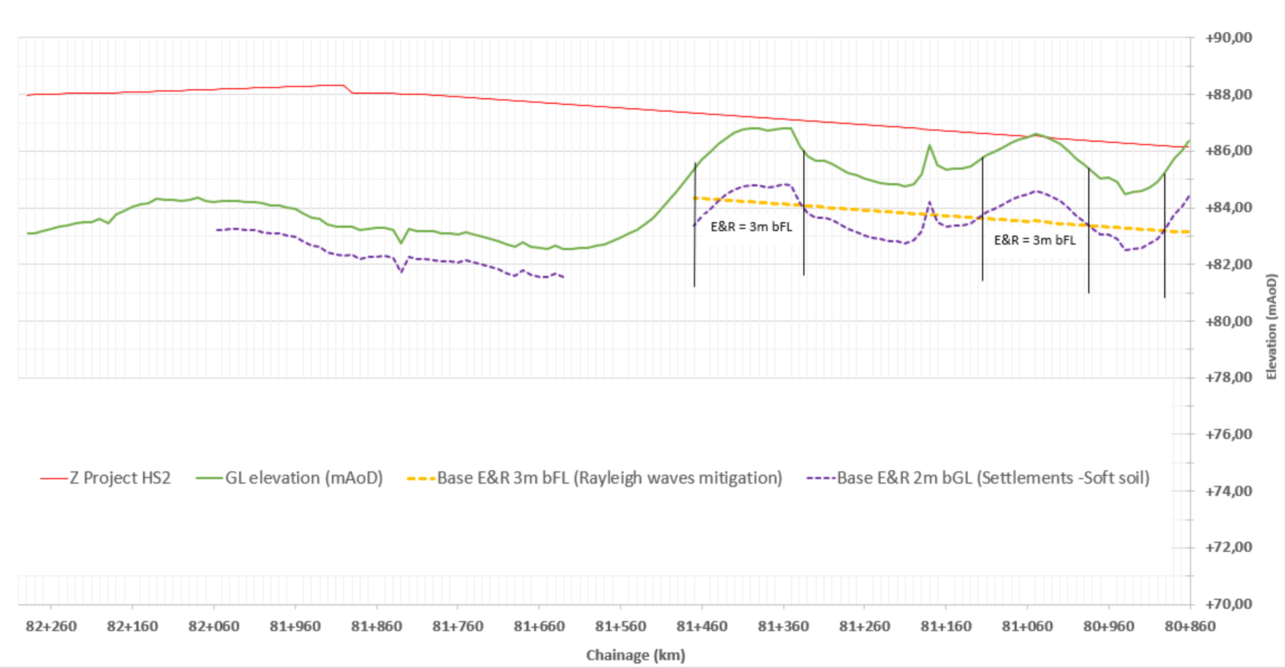
		Mitigation measures							
Type		Embankment							
Mainline slope		1V/2H							
Chainage		Ch. 80+862 to Ch. 81+470						Ch. 81+470 to Ch. 82+269	
		Ch.80+862 to Ch. 80+920	Ch.80+920 to Ch. 81+000	Ch.81+000 to Ch. 81+140	Ch.81+140 to Ch. 81+320	Ch.81+320 to Ch. 81+440	Ch.81+440 to Ch. 81+470	Ch. 81+470 to Ch. 81+620	Ch. 81+620 to Ch. 81+269
Embankment maximum height (m)		At grade to 1.5m high embankment (H_{av}=2m, H_{max}=3.1m locally)						5 to 6 m high embankment	
Settlement mitigation		E&R = 2m bGL Hold Period 2 to 6 months						-	E&R = 1m bGL (1)
								Anticipation of surcharge (3) (30kPa) Hold Period 6 months	
Drainage Mitigation		None						Starter layer	
Subgrade improvement	Static Ev2	E&R = 2m bFL						-	
	Dynamic RW	E&R = 3m bFL						-	
Flood protection								Flood protection - from Ch. 82+180 (on Up side) and - from Ch. 82+252 on Down side up to the Viaduct	
Aggressive ground mitigations		DS4/AC4							
E&R - Combined mitigations measures (2)		3m bFL	2m bGL	3m bFL	2m bGL	3m bFL	2m bGL	-	1m bGL (1)
Instrumentation		Refer to Section 20							

NOTES

- Subgrade improvement for Rayleigh waves is not required beneath the Chord Lines, however settlement mitigation is required beneath the entire embankment. In accordance with the HS2 technical standard for earthworks where the embankment is less than 2m Class 6B or Class 6C starter layer materials shall not be used.
- (1)minimum value of cu=50kPa beneath the base of E&R=1.0m bGL will be necessary to ensure long term stability.
- The ground improvement for settlement mitigation and subgrade mitigation will need to be considered in tandem and will depend on the embankment height. In most cases the settlement mitigation will be the most unfavourable (measured below ground level). The worst-case mitigation is maintained in the earthwork model.
- (2) Applicable mitigation measure within each section. When the final applicable mitigation is bFL it means that the E&R mitigation bGL is > 2m. In the case of the remaining bGL, it means that the mitigation by Rayleigh wave in that area is less than that given by settlements. This can be evidenced within the report of cross section Ref [64].

- [3] Anticipation of surcharge corresponds to the anticipation of rail loading (slab track) and 30 kPa.
- There is an opportunity to reduce E&R in the at grade sections governed by Rayleigh wave mitigation – bFL (i.e. Ch. 80+862 to Ch. 80+920, Ch. 81+000 to Ch. 81+140 and Ch. 81+320 to Ch. 81+470), through on-site demonstrations prior to construction to include sufficient dynamic probing and EV2 testing at base of excavation and full acceptance testing at Formation level.

The following figure, taken from the GI impact assessment report Ref. [86] shows the result of the mitigation measures and the 'at grade' sections where there is a possible opportunity to reduce the depth of excavate and replace due to Rayleigh wave risk, as listed above.



9.11.2 Twyford Embankment (IMD Chord 1&2)

The recommended earthwork mitigation measures beneath the chord lines are highlighted in green in the following summary table of mitigations.

Table 9-43 – Mitigation measures beneath Twyford Embankment – Chord lines

		Mitigation measures		
Type		Embankment		
Mainline slope		1V/2H		
Chainage		Ch. 80+862 to Ch. 81+470	Ch. 81+470 to Ch. 82+269	
Embankment maximum height (m)		At grade to 1.5m high embankment (H_{av}=2m, H_{max}=3.1m locally)	5 to 6 m high embankment	
Settlement mitigation		E&R = 2m bGL Hold Period 2 to 6 months	-	E&R = 1m bGL[(1)]
			Anticipation of surcharge (30kPa) Hold Period 6 months	
Drainage Mitigation		None	Starter layer	
Subgrade improvement	Static Ev2	E&R = 1m bFL	-	
	Dynamic RW	NA	-	
Aggressive ground mitigations		DS4/AC4		
E&R - Combined mitigations measures		2m bGL	-	1m bGL [(1)]
Instrumentation		Refer to Section 20		

NOTES

- Subgrade improvement for Rayleigh waves is not required beneath the Chord Lines, however settlement mitigation is required beneath the entire embankment. In accordance with the HS2 technical standard for earthworks where the embankment is less than 2m Class 6B or Class 6C materials shall not be used.
- [(1)]minimum value of c_u=50kPa beneath the base of E&R=1.0m bGL.
- There is an opportunity in reducing the dig and replace below the IMD lines in the low embankment sections between Ch. 81+020 to Ch. 81+120 and Ch. 81+340 to Ch. 81+420 under condition that the undrained shear strength is minimum Cu=50 kPa beneath the base of E&R=1m bFL.

10 Earthworks (Non-Mainline)

For earthworks associated with other Level 2 assets refer to Twyford Embankment transverse asset earthwork GDR please refer to Ref [58].

11 Structures

For Twyford East Culvert and Portway Culvert refer to the transverse asset GDR please refer to Ref [58][58].

12 Strengthened Earthworks

Not applicable.

Reference should be made to the Twyford Embankment Transverse Asset GDR Ref [58] to understand the strengthened earthworks associated with the highway's assets.

The risk of burrowing animals affecting the earthworks of the mainline embankment is considered to be low due to the type of fills (Class 9) which are not favourable to burrowing animals.

The badger setts near to the HS2 line will be relocated as part of the early works by Fusion (refer to Section 5.9).

The results of lime stabilisation including field trails will need to be incorporated into the Calvert Area E-GDR and works specifications.

13 Drainage

The drainage design at Twyford Embankment is shown on the General Arrangement Drawings – Earthwork and Drainage Layout Sheets Ref [83], [84] and [85].

A starter layer is required at the base of the embankments to prevent the upward migration of groundwater into the mainline embankment fills Ch. 81+470 to Ch. 82+269.

As mentioned in the notes beneath Table 9-42 where the embankment is less than 2m high, the Class 6B or Class 6C starter layer materials shall not be used. The lineside drainage will ensure good drainage and the integrity of the subgrade layers in these [at grade / low embankment] sections between Ch. 80+862 to Ch. 80+920, Ch. 81+000 to Ch. 81+140 and Ch. 81+320 to Ch. 81+470.

14 Third Party Assessment

14.1 Zone of Influence

The Zone of Influence (ZoI) for ground movement due to the impact of HS2 earthworks is presented in the detailed design Ground Movement Impact Assessment (DD-GMIA) Report – Phase 2 Ref. [90].

The following sections provide a summary of the main findings of the assessment.

14.2 Affected Assets

The results of the assessment of the 3rd party assets located within the ZoI of the Twyford Embankment are indicated in the below tables extracted directly from the DD-GMIA report.

Twenty 3rd Party assets (seventeen contestable utility, two non-contestable utilities and one non-listed building) might be impacted by ground movements generated by the construction of Twyford Embankment and West Street (highway) Overbridge and required further Phase 2 assessment.

14.3 Phase 2 Assessment - Utilities

14.3.1 Contestable and Non-contestable Assets

The 3rd party assets identified within the Phase 2 assessment as being within the Zone of Influence (ZoI) are summarised as set out below.

- The contestable Anglian Water foul sewer CSO-03-7102 PE pipe runs beneath the railway embankment and the landscape bund at Ch. 81+550. It passes phase 2 assessment because settlement in the sandy RTD deposits found in this area remain within tolerable limits (around 50mm). Furthermore, the utility will be installed within a 375mm concrete sleeve for protection. No further assessment is required.
- CSO-03-2203: The non-contestable utility is installed at 9m depth therefore, it is not subjected to ground movement due earthworks. No further assessment is required.
- CSO-03-1404: The existing non-contestable Scottish and Southern Energy (SSE) HV underground electric cable runs beneath the planned embankment and landscape bund at Ch. 81+300. It is installed at 4m depth bgl, below the more compressible soil units and protected with a concrete slab. Predicted settlements are within tolerable limits. No further assessment is required.

All the other utilities have passed phase 2 assessment by screening.

It is assumed that the three private water supply pipes crossing the HS2 route at different locations will be removed.

No further assessment of the permanent utilities is required within the limits of Twyford Embankment level 1 Group.

Importantly: the temporary high voltage underground electricity cable located at Ch. 81+330 must be placed deep enough, or removed, by EKFB before the construction of the mainline to avoid any clash with the 2m bgl excavate and replace.

The only building identified in the vicinity of Twyford Embankment is Twyford Sewage treatment works at Ch. 81+500. However, it is located outside of the updated ZoI, no further assessment is required.

14.4 Phase 2 Assessment – Building and Structures

The only building identified in the vicinity of Twyford Embankment is Twyford Sewage treatment works at Ch. 81+500. However, it is located outside of the updated ZoI, no further assessment is required.

West Street Overbridge is located at Ch. 81+180, it will be demolished and reconstructed as part of the HS2 works.

No further damage risk assessment is required for buildings and structures located within the limits of Twyford Embankment Level 1 Group.

14.5 Conclusions and recommendations

Based on the findings of the GMIA Ref. [90] there is no requirement for I&M monitoring.

Nonetheless, engagement is recommended with the asset owners to confirm the acceptability of the GIMA report to close out the Phase 2 GMIA and finalise mitigation and monitoring proposals on 3rd party assets, if required.

This may include any data on the condition of the asset or surveys required to confirm the condition of the asset prior to construction.

A building condition survey of the Sewage Works is recommended prior to construction.

15 Geotechnical Risk Register

The Geotechnical Risk Register GRR [9] presents the grounds risks, the mitigation measures to eliminate or reduce the risk and the residual risk after Detailed Design. An extract of the GRR at the time of publication of this DD-GDR update is provided in Appendix F.

The GDR is a live document and will be updated through the Detailed Design by other disciplines, such as structures.

The following table provides a summary of the 'level of risk' indicated in the GRR after consideration of the proposed earthwork mitigation measures and proposes the method for the onward management of ground risks still carrying uncertainty.

The risks still carrying uncertainty and the proposed method of onward management of ground risks are marked with a tick [✓] in Table 15-44. The communication of residual ground risks is developed further in the following sections of this DD-GDR:

- Section 16 – GI Impact Assessment: this section will outline uncertainty in ground conditions that require additional review of outstanding GI at the design stage, which may lead to a subsequent update to this GDR
- Section 17 – Risk Management During Construction: this section will inform EKFB on any uncertainty in the ground model requiring construction stage management such as site inspection by a qualified geotechnical engineer or pre-earthwork trial trenches
- Section 18 – CDM Register: this register will inform on the HSE risks that will be transferred to EKFB or HS2
- Section 20 – Earthworks verification and Monitoring Plan: this section will inform EKFB of the Site testing and verification and/or monitoring plans required to control and manage the uncertainty related to design assumptions and requirements in order to comply to the Technical Standard requirements Ref [2] and the SCEW Earthworks 600 series requirements
- Section 21– Specification Appendices: this section will inform the earthwork engineers responsible for the development of the earthwork specification appendices on the asset specific specification requirements to ensure linkage between geotechnical earthwork reports.

Table 15-44 – Geotechnical risk management for the Twyford Embankment

RISK TITLE		LEVEL OF RISK MITIGATION	UNCERTAINTY (residual ground risk)		ONWARD MANAGEMENT OF GROUND RISK					
	Actual Hazard present	Reduced to Acceptable Level	Uncertainty in ground model	Uncertainty in earthwork performance	Impact Assessment on outstanding GI, field trialsl or DD study	Request additional GI	Asset specific specification requirements	Construction stage management	Verification Testing and I&M	CDM register
Soft/ Compressible Ground (Rayleigh waves)	✓	✓ E&R 3m bFL (locally) ✓ Anticipation of rail load (locally) ✓ max 15mm post construction settlement limit	✗ good understanding of depth of alluvial soils	✓ Potential opportunity to reduce the depth of E&R in at grade sections	✓ Review Stage 2 GI (CSW tests) [completed]	✗	✓ Demonstration areas at cut/fill transition with Calvert cutting ✓ Control testing in line with Table 1/5 of the earthwork specification	✓ Provision for geotextile separator at the base of excavation	✓ Verification testing ✓ I&M with hold period of up to 6 months	✗
Soft / Compressible Ground	✓	✓ Calculations performed with cautious parameters ✓ Soils with cu < 50 kPa will be removed ✓ 3m bFL in at grad sections ✓ 2m bGL in embankment sections between Ch. 80+862 and Ch. 81+470 ✓ No E&R Ch. 81+470 to Ch. 81+620 due to sandy soils ✓ 1m bGL in embankment sections between Ch. 81+470 and Ch. 82+269	✓ Alluvial Soils might be more sandy or more clayey than expected	✗	✓ Impact assessment on outstanding GI [completed]	✗	✓ Hold period of up to 6 months and strength testing at foundation level. Min 50 KPa undrained shear strength prior to placing fill materials. ✓ Site inspection at base of foundation by competent geotechnical engineer to check presence of sandy soils from Ch. . 81+470 to Ch. 81+620	✓ Hold period : Control (undrained shear strength) testing after topsoil/subsoil strip ✓ Provision for geotextile separator at the base of excavation	✓ I&M with hold period of up to 6 months ✓Verification testing at foundation level	✓
High/shallow groundwater	✓	✓ Use of starter layer at base of embankment (300mm thick)	✓	✗	✓ Review additional groundwater monitoring [completed]	✗	✓ Starter layer	✓ Temporary drainage of sub-excavations ✓ Provision for dewatering	✗	✓
Flood Risk	✓	✓ Flood protection on the embankment slope on the approach to Twyford Viaduct : - Up side Ch. 82+180 to Viaduct	✓ HS2 protected by existing disused railway embankment ✓ HS2 protected by landscape	✓	✓ Review DD-FLAR when available ✓ Review flood velocity of Padbury Main Channel when available	✗	✓ Class 6C2 materials in flood zone	✗	✗	✓

RISK TITLE		LEVEL OF RISK MITIGATION	UNCERTAINTY (residual ground risk)		ONWARD MANAGEMENT OF GROUND RISK					
	Actual Hazard present	Reduced to Acceptable Level	Uncertainty in ground model	Uncertainty in earthwork performance	Impact Assessment on outstanding GI, field trialsl or DD study	Request additional GI	Asset specific specification requirements	Construction stage management	Verification Testing and I&M	CDM register
		- Down side Ch. 82+252 to Viaduct	bund on Down side							
Potential Relic Slip surfaces	✗	✓ relatively elevated from Ch. 80+862 to Ch. 81+220 where elevated risk	✓ Inherent risk in OXC Formation	✗	✓ Review outstanding GI to check for Relic shear surfaces [completed]	✗	✓ Site inspection of sub-excavations and cut slopes – bespoke mitigation on site based on typical details	✓ Hold period and site inspection of sub-excavations	✗	✓
Periglacial shear	✗	✓ reduced cohesion in calculations	✗	✗	✗	✗	✗	✗	✗	✗
Shrink-swell	✓	✓ Avoided by HS2 mitigation measures for subgrade improvement	✗	✗	✗	✗	✗	✗	✗	✗
Faulting	✗	✓ reduced calculation parameters	✓	✗	✓ Review outstanding GI to check for soft ground in area of faulted ground [completed]	✗	✓	✓ Hold period: Control (undrained shear strength) testing after topsoil/subsoil strip	✓ Verification testing to verify minimum undrained shear strength of 50 kPa ✓ I&M planned to follow settlements	✓
Chemical aggressive ground	✓	✓ Special BRE design for structures	✗	✗	✓ (sulfate testing) [completed]	✗	✓ DS-4 / AC-4 concrete Class	✗	✗	✗
Contaminated Ground	✓	✗	✗	✗	✓Review outstanding GI to check for contaminated ground [completed]	✗	✗	✓ Contamination testing of Made Ground	✓ Contamination testing of Made Ground	✓
Existing utilities	✓	✓ 3 UTX in ZoI and several temporary crossings incl. HV electric cable in zone of E&R to 2m bGL	✗	✗	✓ Update GMIA study at a later stage in DD with DRA (materials, settlement analysis etc) [completed]	✗	✓ Temporary works designer to check temporary utilities do not clash with ground improvement	✓ Temporary works designer	✗	✓

RISK TITLE		LEVEL OF RISK MITIGATION	UNCERTAINTY (residual ground risk)		ONWARD MANAGEMENT OF GROUND RISK						
	Actual Hazard present	Reduced to Acceptable Level	Uncertainty in ground model	Uncertainty in earthwork performance	Impact Assessment on outstanding GI, field trialsl or DD study	Request additional GI	Asset specification requirements	Construction stage management	Verification Testing and I&M	CDM register
Existing building	✓	✓	✗	✗	✓ Update GMIA study at a later stage in DD with DRA [completed]	✓ Building condition survey	✗	✗	✗	✓

16 GI Impact Assessment

16.1 GI review at Detailed Design

All GI data for the geotechnical earthworks design has been received and assessed in the New Engineering Data – Impact Assessment Report for Twyford Embankment Ref. [86] with the exception of 11 remaining exploratory holes for contamination testing as detailed in Section 7.6.1. The outstanding contamination testing will be added to the geo-environmental report Ref.[87]

The findings of the assessment have been incorporated into this DD-GDR.

16.2 Field trials

The results of the Calvert Rail Head Rayleigh Wave field trial will be incorporated in the design post L3.

As noted in Section 6.6.2, the ground improvement in Twyford Embankment is predominantly governed by settlement design with the exception of relatively small sections of low embankment and at grade ground at the southern end of the asset. Pre-earthwork demonstration areas and control testing will be required to confirm the depth of excavate and replace at the asset location or realise the potential opportunity to reduce the depth of E&R. (refer to Section 9.8.2 for more details).

The cumulated length of the at grade sections where the depth of E&R could be potentially be reduced is approximately 320 m long in three separate sections, as mentioned in the notes below Table 9-42.

17 Risk Management during construction

17.1 Groundwater risk management

There is a risk of groundwater at shallow depth in ALV and in OXCw Formations that will require temporary drainage and might require dewatering techniques in sub-excavations.

Site inspection of cut slopes is recommended to check for persistent seepages and sandy layers that could cause instability of erosion in the long term.

A provision for counterfort drains is recommended but the risk is nonetheless considered to be low due to the slope gradient of cut slopes and shallow depth of cuttings within Twyford Embankment.

17.2 Soft Compressible Ground

There is a risk of softer ground and longer consolidation settlements in the superficial deposits (ALV).

This risk of soft ground will be managed through site inspection at the base of excavation, after topsoil strip and ground improvement, and verification testing to ensure undrained shear strength is >50 kPa before backfilling.

A risk provision for additional ground improvement due to uncertainty in the depth of soft ground is recommended as part of the management strategy during construction works.

The settlement hold periods will be followed with I&M during the settlement hold periods, refer to Section 20.2.

There may be a need to place geotextile separator before laying backfill to ground improvement.

Geotextiles shall be laid prior to placing the starter layer between Ch. 81+470 and Ch. 82+269.

17.3 Relic Slip surfaces

There is an moderated risk of relic slip surfaces between Perry Hill Road Alignment and West Street realignment where the slope of the natural ground is >5° from Ch. 80+862 to Ch. 81+220.

This risk shall be managed with a site inspection of sub-excavations for ground improvement E&R 2m bgl.

17.4 Faulting

A risk of soft spots due to the presence of geological faults nearby the Ch. 81+920 and Ch.82+050 will be managed by site inspection of the base of the excavation (after topsoil strip and ground improvement) prior to backfilling and verification testing to ensure a minimum undrained shear strength of 50 kPa.

17.5 Contaminated ground

Further contamination testing will be required during site works to ensure the classification and correct placement of Made Ground associated with the Dismantled Rugby to Quainton Great Central Railway Line (LQ 13.07) which is partially within the western LOD at $ch._{HS2}$ 80+100 to $ch._{HS2}$ 88+00 and the Sewage Works (LQ 13.06) which is partially within the western LOD at $ch._{HS2}$ 81+450 to $ch._{HS2}$ 81+475.

18 CDM Register

In accordance with the requirements of Lead Designer under the CDM Regulations 2015, a Designers Risk Assessment has been undertaken in connection with the geotechnical design of the earthworks.

Reference should be made to the CDM Risk Register Ref. [14] for details of the general and asset specific risks associated with this earthwork design.

On the basis of the risk assessment presented in this GDR, the following risks will need to be added to the CDM register and transferred to EKFB:

- Working in areas of soft ground (including area of suspected fault)
- Working in areas of wet ground or high groundwater
- Flood risk
- Risk of slope instability in areas of potential relic slips (zone of elevated risk in the West Street Overbridge area – refer to Section 17.3)
- Potentially contaminated ground (environmental and health risks)
- Buried utilities (UTX) including a temporary high voltage underground electricity cable located at Ch. 81+330 that is located within the area of ground improvement (refer to Section 14.3).

More general CDM risks include :

- Health disorders due to lime stabilisation activities
- Demolition of buildings and bridges leading to collapse of earthworks and injury of demolition workers.
- Risk of slips, trips and falls from activities undertaken to carry out grass maintenance such as grass strimming, herbicide spot treatment of invasive weeds or treatment to remove establishing woody vegetation on slopes of 1v to 2h or steeper

19 Material reuse

The earthwork quantities and detailed breakdown for Twyford Embankment will be presented in the E-GDR and the SEQS

The excavated material from ground improvement is likely to be Class 2A (wet cohesive) or Class 4 : clayey Alluvial and River Terrace deposits and minor volumes of weathered oxford clay.

In accordance with the EKFB mass haul, the excavated materials will be used as landscape fills (Class 2.A.4 or Class 4) and compacted in line with Table 6/1 of the SCEW specification Appendix.

20 Earthworks Verification and Monitoring Plan

20.1 Site Testing and Verification Plan

Details of Site testing and verification proposals are developed in the earthworks specification Table 1/5.

20.2 Instrumentation and Monitoring

Based on the assessment of geotechnical risks that can cause ground movement, I&M will need to be located in areas of soft ground in the sensitive areas associated with transitions to structures (Twyford Viaduct and the two culverts), S&C units and/or embankment high points to ensure that the 15mm max. post construction settlement is obtained within the recommended hold period, so as not to disrupt the construction programme.

The I&M design including trigger levels and actions plans is given in the DMP Ref. [88]..

21 Specification Appendices

The specification appendices determine the contract specific requirements to the main HS2 SCEW Series 600 Earthworks Ref [20].

The asset specific specification requirements that have been identified in this DD-GDR and will need to be implemented during construction are briefly developed in the below table.

Series 600 Specification Appendix 6/1	Asset specific requirements
Appendix 6/1 Requirements for Acceptability and Testing etc. of Earthworks Materials	• ‘standard’ fill materials; No specific requirements. • ‘standard’ grading requirements. No specific requirements. • Unacceptable material classification required for the Made Ground and “material re-use zoning” of Class U1B. • Compliance testing at foundation level including base of culvert (Min. Cu = 50 kPa) • Adequate testing to verify lime modification • No Class 3 • Ground water management may be required near to Twyford East Culvert and Portway Culvert to maintain stability of sub-excavations – observational approach • Control of surface waters • CBM required at Portway Culvert • Demonstration areas to release opportunity for reduction of E&R in at grade sections
Appendix 6/2 Requirements for Dealing with Class U1B and Class U2 Unacceptable Materials	• Add areas of Made Ground to drawings (reference geo-environmental reports) • Potential for perched water in Made Ground
Appendix 6/3 Requirements for Excavation, Deposition, Compaction (other than Dynamic Compaction)	• Landscape bund built at same time as mainline embankment • Zoning as per standard earthwork details (provide list of drawings) • Maintain temporary slopes at less than 1v/1h. • Adequate temp. dewatering measures, especially near to water courses. • Sequential backfilling of sub-excavations may be required in areas of wet ground • Ensure adequate distance from toe of earthworks for any temp. drainage (min. offset 2m) • Weather protection and cross-falling of construction surfaces

	• Elevated risk of relic slips from Ch. 80+862 to Ch. 81+220 (site inspection of sub-excavations) • General watching brief for relic slips during ground improvement works • Hold point for inspection of foundation surface and compliance testing • Soft ground removal near watercourses to be verified by verification and control testing • Compliance testing for Rayleigh waves at cut/fill transitions • Specifiy 'Hold periods' for settlements • Specify extent of starter layer. • Class 6N or 6P below water table • Note, DD FLAR ongoing
Appendix 6/4 Requirements for Class 3 Material	• No Class 3
Appendix 6/5 Geotextiles Used to Separate Earthworks Materials	• In starter layer as per SEDs • Potentially required at base of sub-excavations for ground improvement
Appendix 6/6 Fill to Structures and Fill Above Structural Foundations	• Refer to Culvert drawing • Hold point for inspection of foundation surfaces for soft spots and compliance testing • Class 6N or 6P below water table. Potentially Class 1A above water table
Appendix 6/7 Sub Formation and Capping and Preparation and Surface Treatment of Formation	• HSR 'standard' requirements for demonstration areas • Confirm extent of clayey (ALV) soils / Sandy (RTD) soils (foundation treatment) • Risk of subgrade softening in clayey soils (general risk)
Appendix 6/8 Topsoiling	• No specific requirements%
Appendix 6/9 Earthworks Environmental Bunds, Landscape Areas, Strengthened Embankments	• In area of flooding
Appendix 6/10 Ground Anchorages, crib walling and gabions	• Not applicable
Appendix 6/11 Swallow Holes and other Naturally Occurring Cavities and Disused Mine Workings	• Not applicable
Appendix 6/12 Instrumentation and Monitoring	• Refer to asset specific drawings in DMP • Specify minimum settlement hold periods

Appendix 6/13 Ground Improvement	• Excavate and replace for settlement mitigation and subgrade performance • Inspection of base of foundations and removal of soft spots (cu<50 kPa) • Elevated risk of relic slips from Ch. 80+862 to Ch. 81+220 (site inspection of excavations and trial trenches) • Inspection of base of foundations and removal of soft spots • Class 6N or 6P below water table. Potentially Class 1A above water table. • Stabilised soils not recommended as backfill due to high sulfate in natural ground
Appendix 6/14 Limiting Values for Pollution of Controlled Waters	• Made Ground identified locally
Appendix 6/15 Limiting Values for Harm to Human Health and the Environment	• Made Ground identified locally

References

[1]HS2 MWCC Works Information WI 300 Contractors Design. Document No: 1MC01-HS2-PR-ITT-000-000420 Rev P08.
[2]HS2 Technical Standard – Earthworks. Document No: HS2-HS2-GT-STD-000-000001 Rev P08.
[3]HS2 Technical Standard – Land Quality. Document No: HS2-HS2-EV-STD-000-000027 Rev P04.
[4]Calvert Area Detailed Design – Configuration Report. Document No: 1MC06-CEK-DS-REP-C002-000015 Rev C03
[5]Ground Engineering Design Basis Statement – Management of Uncertainty in Ground Conditions. Document No: 1MC06-CEK-GT-REP-C002-000127 Rev P01.
[6]Network Rail Standard. Level 3 Geotechnical design. Documents No: NR-L3-CIV-071-Issue 4.
[7]Scheme Design Ground Investigation Report (GIR): Section 3. Report n° 1MC06-CEK-GT-REP-C002-000037.
[8]ASC Calvert Cutting to Twyford Embankment : Hydrogeological Appraisal Report. Document No 1MC06-CEK-GT-REP-CS06_CL10-000002 Rev. C02
[9]Geotechnical Desk Study, C222 Atkins. London West Midlands Country South. Document No: C222-ATK-GT-REP-020-000001 Rev P04.
[10]HS2 Phase One Engineering Geomorphology Site Inspection Report. Document No: 1D008-EDP-GT-ASM-000-000002. 06/02/2018
[11]HS2 Phase One Engineering Geomorphology Assessment Report. Document No: 1D08-EDP-GT-ASM-000-000001. 17/05/2017
[12]OS MasterMap GIS database. Document No: BMA_ORDSU_MM_TPL_TopographicLine_Ln.
[13]Supplementary Environmental Statement and Additional Provision 2 Environmental Statement. Document No: SES AND AP2 ES – VOLUME 5 SES and AP2 ES 3.5.5.1 Volume 5 – Technical Appendices.
[14]Scheme Design Ground Investigation Report (GIR). Document No: .
[15]Utility Crossings in Structures Schedule. Document No: 1MC06-CEK-UT-SCH-C002-000019
[16]BS EN 1997-2. Eurocode 7. A1:2013Geotechnical design: Ground investigation and testing
[17]New Ground Engineering Data - GI Impact Assessment Report – OXD. Document No: 1MC06-CEK-GT-REP-CS06_CL09-000023 Rev P01
[18]Scheme Design Geotechnical Design Report (GDR) - 1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley - OXD GDR. Document No: 1MC06-CEK-GT-REP-CS06_CL09-000008 Rev C01
[19]1MC06 -Stage One C2 – MWCC – North Portal of Chiltern Tunnels to Brackley [TB8121 Second Interi4 Report]. Document No: 1MC06-CEK-GT-REP-C002-000064. Rev C03
[20]HS2 Specification for Civil Engineering Works Doc N°HS2-HS2-CV-SPE-000-01600
[21]CIRIA REP R 156 Infiltration drainage – manual of good practice. 1996.
[22]BRE Digest Soakaway design (DG 365 – 2016)
[23]C2 Calvert – Stage 2 Ground Investigation Schedule 2. Document No. 1MC06-CEK-GT-SCH-C002-000017.
[24] Not used.
[25]Schedule of Ground Investigation Priorities. Document No. 1MC06-CEK-GT-SCH-C002-000020.
[26]Boddington Compound Embankment Settlement Trial Methodology. Document No. 1MC07-CEK-GT-REP-CS07-CL14-000010.
[27]Boddington Settlement Trial Interpretive Report. Document No. 1MC07-CEK-GT-REP-C003-000095
[28]BS 1377: 1990. Methods of Test For Soils For Civil Engineering Purposes. Part 5: Compressibility, Permeability and Durability Tests. ISBN No: 0-580-1800.
[29]ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 2007-2014. p293.
[30]Bedrock Geology 50k – GIS database. Document No: GEO_BGEOS_50k_Bedrock_Geology
[31]Superficial Geology 50k – GIS database. Document No: GEO_BGEOS_50k_Superficial_Geology
[32] Aerial Photography – GIS database. Document No: BMA_BLMSA_BLOM_RGB_125mm_Ph1SC

[33]Tributary of Twin Addendum to Flood Analysis Report. Document No: 1MC06-CEK-DR-REP-CS06_CL10-000001 - Rev C01
[34]Portway Stream at Portway Farm Flood Level Analysis Report. Document No: 1MC06-CEK-DR-REP-CS06_CL09-000004 - Rev C01
[35]DJV (2019). Calvert Landfill and Former Brickworks, Clay Pits and Dismantled Great Central Railway Geoenvironmental Assessment Report. Document No: 1MC06-CEK-EV-REP-CS05-000002
[36]Not used
[37]Land contamination: risk managment (LCRM) -2020. Environmental Agency (https://www.gov.uk/guidance/land-contamination-how-to-manage-the-risks)
[38]Not used.
[39]Model procedures for the management of land contamination (CLR11) -2020. Environmental Agency (https://www.gov.uk/guidance/land-contamination)
[40]High Speed 2 - 1MC06 - Stage One C2 - MWCC – North Portal of Chiltern Tunnels to Brackley. Aylesbury Railway Link, Calvert Landfill and Dismantled Great Central Railway Remediation Outline Strategy Report. Document No: 1MC06-CEK-EV-REP-C002-000029
[41]Network Rail standard (03/09/2016). Level 2 Specification- Design and construction of track. NR-L2-TRK-2102 Issue 8
[42]Network Rail standard (05/12/2015). Level 2 Track-bed Investigation, Design and Installation. NR-L2-TRK-4239-Issue 1
[43]Eurocode 7 – Geotechnical Design: Part 1 General Rules
[44]Nowak and Gilbert (2015). Earthworks: A Guide, 2nd edition 2nd edition by Paul Nowak, Peter Gilbert (2015).
[45]C23 Stage 2 – April 21 Rev 01 – Construction Programme (1MC12-EKF-PL-XC2-C000-000001) (HS2-C23-S2-01-Apr21-r1)
[46]CDM Risk Register. Document No: No. 1MC06-CEK-HS-REG-C003-000001
[47]Typical Network Rail Earthworks Details – Cutting with Ground Improvement (Excavate and replace). Document No: 1MC06-CEK-GT-DSE-C002-000115 .
[48]Typical Network Rail Earthworks Details - Embankment with Flood Protection. Document No: 1MC06-CEK-GT-DSE-C002-000113
[49]Typical Network Rail Earthworks Details – Embankment with Ground Improvement (Excavate and replace). Document No: 1MC06-CEK-GT-DSE-C002-000114
[50]Typical Network Rail Earthworks Details – Embankment with Starter Layer. Document No: 1MC06-CEK-GT-DSE-C002-000112
[51]EWR Intersection bridge foundation setting out details. Document No: 1MC06-CEK-BR-DGA-CS06_CL09-000064
[52]Charndon Lodge Underbridge – Foundation RC details. Document No: 1MC06-CEK-BR-DGA-CS06_CL09-000132.
[53]Culverts Earthworks Transition - Calvert area - Typical Cross Section Sheet 1. Document No: 1MC06-CEK-CV-DGA-C002-000658 Rev. C01
[54]Culverts Earthworks Transition - Calvert area - Typical Cross Section Sheet 2. Document No: 1MC06-CEK-CV-DGA-C002-000659 Rev. C03
[55]Earthworks and Drainage Layouts. Document Nos: 1MC06-CEK-CV-DGA-CS06_CL09-000052, 1MC06-CEK-CV-DGA-CS06_CL09-000054 and 1MC06-CEK-CV-DGA-CS06_CL09-000056.
[56]Twyford Embankment Designer's Monitoring Plan. Document No: 1MC06-CEK-GT-REP-CS06_CL10-000023.
[57]Not used.
[58]ASC (2020) - High Speed 2 - 1MC06 - Stage One C2 - MWCC – North Portal of Chiltern Tunnels to Brackley – Twyford Embankment Transverse Assets GDR. Document No: 1MC06-CEK-GT-REP-CS06_CL10-000035. Rev. P01.
[59]Twyford Embankment - Drainage Design Report - 1MC06-CEK-DR-REP-CS06_CL10-000003.
[60]Ladd, C., Foot, R., Ishihara, K., Schlosser, F and Poulos, H. (1977). Stress-deformation and strength characteristics. Proc. 9th Int. Conf. Soil Mech. Found. Eng. 3. 494.

[61]CIRIA C143 (1995) The Standard Penetration Test (SPT): Methods and Use.
[62]IMD Design Development Technical Note. Document No: 1D202-EDP-RT-NOT-CS06_CL09-000001 - Rev C02
[63]Interface Control Document for Calvert IMD. Document No: 1MC06-CEK-IN-ICD-CS06_CL09-000001 - Rev C03.
[64]IMD Earthworks, Drainage and Landscape Specification. Document No 1MC06-CEK-DR-SPE-CS06_CL09-000001
[65] Report on Twyford Embankment Cross Sections Document No 1MC06-CEK-CV-REP-CS06_CL10-000005 Rev C02
[66]Calvert IMD Utilities Drawing Document No. 1MC06-CEK-UT-DGA-C002-000023 - Rev C03
[67]OXD Geotechnical Design Report (GDR). High Speed 2 - 1MC06 - Stage One C2 - MWCC – North Portal of Chiltern Tunnels to Brackley. Document No 1MC06-CEK-GT-REP-CS06_CL09-000008 Rev P04
[68]Earthworks and Drainage Layout Sheet 24. Document No 1MC06-CEK-UT-DGA-C002-000024-C03.
[69]Not used
[70]DJV (2019). Earthworks Geotechnical Design Report (E-GDR). Document No 1MC07-CEK-GT-REP-CS07_CL26-000100
[71]DJV (2019). Earthworks Geotechnical Design Report (E-GDR). Document No 1MC06-CEK-GT-REP-C002-000041.
[72]ASC (2021) Detailed Design Geotechnical Risk Register (GRR) Document N° 1MC07-CEK-GT-REG-CS07_CL26-000017 Rev P01.
[73]HS2 - 1MC06 - Stage One C2 - MWCC –North Portal of Chiltern Tunnels to Brackley Ground Engineering Technical Note – Guidance on the Assessment of Settlement. Document No 1MC06-CEK-GT-NOT-C002-000023.
[74]HS2 (2019). Technical Standard – Track Alignment Design Document No HS2-HS2-RT-STD-000-000001. Revision P04
[75]Not used
[76]Not used
[77]DJV, Earthworks Typical Details Document No 1MC06-CEK-GT-DDE-C002-000023
[78]HS2 G022 Typical HS2 Mainline Earthworks Section Transition Embankment to Culvert using Excavate and Replace with Preload (1) Document No 1MC06-CEK-GT-DSE-C002-000091 P01.1.
[79]Twyford East Culvert Earthworks Transition Document No 1MC06-CEK-CV-DGA-CS06_CL10-000010 P04
[80]DJV (2019). 1MC06 - Stage One C2 - MWCC – North Portal of Chiltern Tunnels to Brackley. Rayleigh Wave Risk Assessment and Mitigation Design. Document No 1MC06-CEK-GT-REP-C002-000049.
[81]ASC (2021) Twyford Viaduct GDR Document No 1MC06-CEK-GT-REP-CS06_CL10-000044 (work in progress)
[82]ASC Ground Engineering Design Basis Statement - Ground Movement Impact Assessment Document No. 1MC06-CEK-GT-REP-C002-000132 P01
[83]ASC (2021). Earthworks and Drainage Layout – Sheet 77. Drawing No 1MC06-CEK-CV-DGA-CS06-CL09-000042 Rev. C01
[84]ASC (2021) Earthworks and Drainage Layout – Sheet 78. Drawing No 1MC06-CEK-CV-DGA-CS06-CL10-000026 Rev. C01
[85]ASC (2021) Earthworks and Drainage Layout – Sheet 79. Drawing No 1MC06-CEK-CV-DGA-CS06-000045 Rev C01
[86] ASC Twyford Embankment - New Ground Engineering Data - Impact Assessment Report Document No 1MC06-CEK-GT-REP-CS06-000024 Rev. C01
[87]ASC Aylesbury Link and Dismantled Great Central Railway Geo Environmental Assessment Report. Document No 1MC06-CEK-EV-REP-CS05-000001.
[88] ASC Twyford Embankment – Designers Monitoring Plan. Document No 1MC06-CEK-GT-REP-CS06_CL10-000023 Rev. C01
[89] ASC IDR 216.01 Geotechnical Risk Register. Document No 1MC06-CEK-GT-REG-CS06_CL09-000002 Rev. C03

[90] ASC Twyford Embankment – Ground Movement Impact Assessment. Document No 51 Rev. C01

[91] ASC IDR 128.01 Technical Specification (*Specification 01*). Document No 1MC06-CEK-AU-SPE-CS06-00001 Rev. C01

[92] Portway Culvert Earthworks Transition Document No 1MC06-CEK-CV-DGA-CS06_CL09-000067 P03

Appendix A Environmental (Ecology-Archaeological and Cultural Heritage)

Number of Pages: 2

Ecology

Twyford Embankment –Ch.80+862 – Ch.82+289

Fusion - Ecology

1.1 Major Constraint. Further action required prior to works commencing (e.g. protected species licence application or SSSI assent from Natural England). Seasonal restrictions likely to apply.

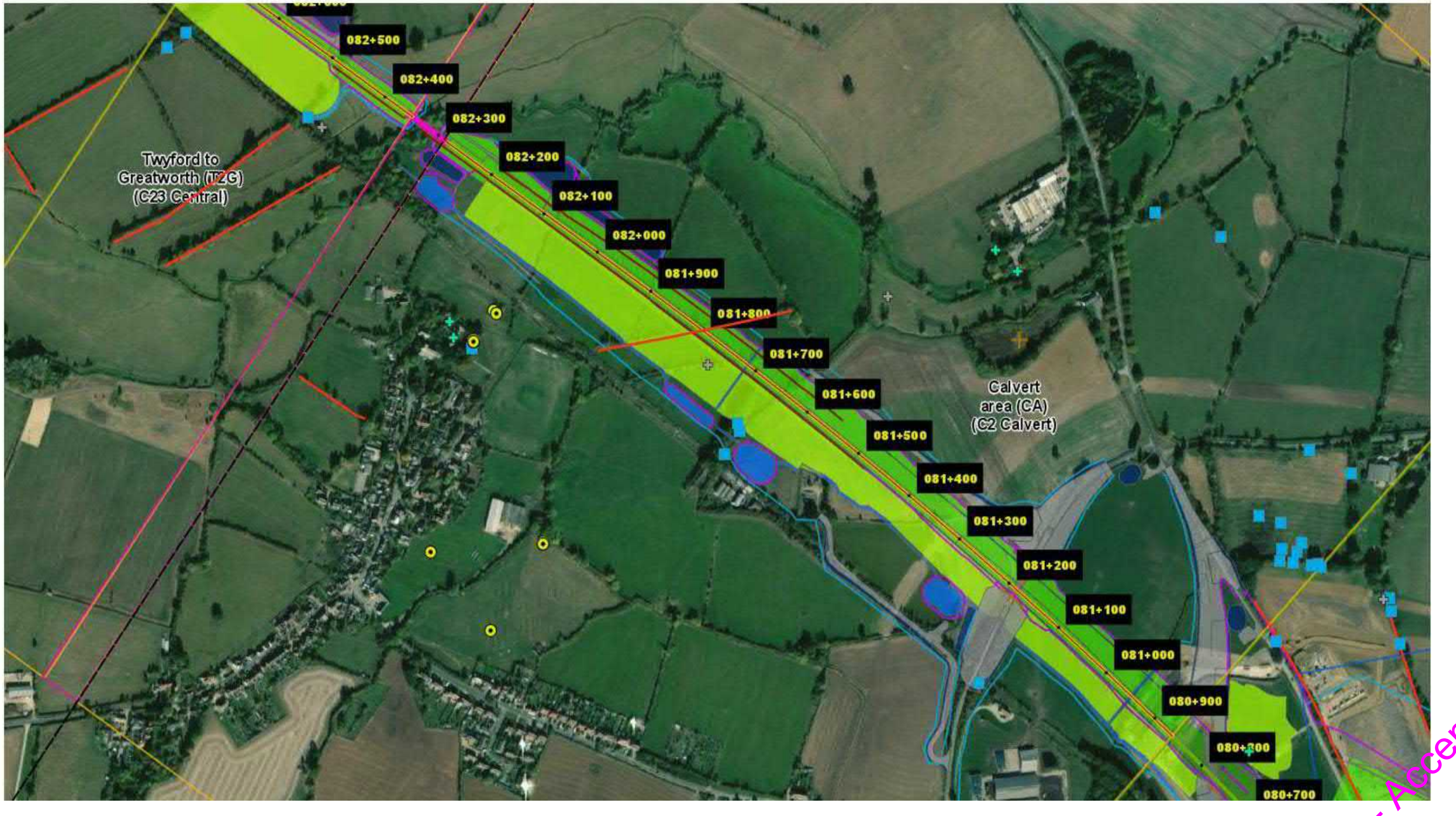
- White Clawed Crayfish Confirmed Presence (1.1)
- Otter Confirmed Presence (1.1)
- Bats Building Roosts Confirmed Presence (1.1)
- Bats Tree Roosts Confirmed Presence (1.1)
- Amphibians Pond Survey GCN Confirmed Presence (1.1)
- Bat Radio Tracking Roost Search Confirmed Presence (1.1)
- Dormouse Confirmed Presence (1.1)

1.2 Moderate Constraint. Further action potentially required prior to works commencing (e.g. species translocation or INNS treatment, but Natural England licence unlikely to be required). Seasonal restrictions likely to apply.

- Reptiles Population Assessment Confirmed Presence (1.2)
- Barn Owl Confirmed Presence (1.2)
- Badger Sett Confirmed Presence (1.2)
- Kingfisher Confirmed Presence (1.2)
- Water Vole Confirmed Presence (1.2)
- As Built Mitigation Sites (1.2)

1.3 Minor Constraint. Constraint likely to be present but simply dealt with through a watching brief and/or seasonal vegetation removal (e.g. presence of suitable nesting bird habitat). Works likely to require an Unexpected Finds Method Statement.

- Pond Survey Confirmed Presence (1.3)
- Bat Activity Assumed Commute Route (1.3)
- Important Hedgerow Confirmed Presence (1.3)



Archaeological and Cultural Heritage

Twyford Embankment –Ch.80+862 – Ch.82+289

Burial Site

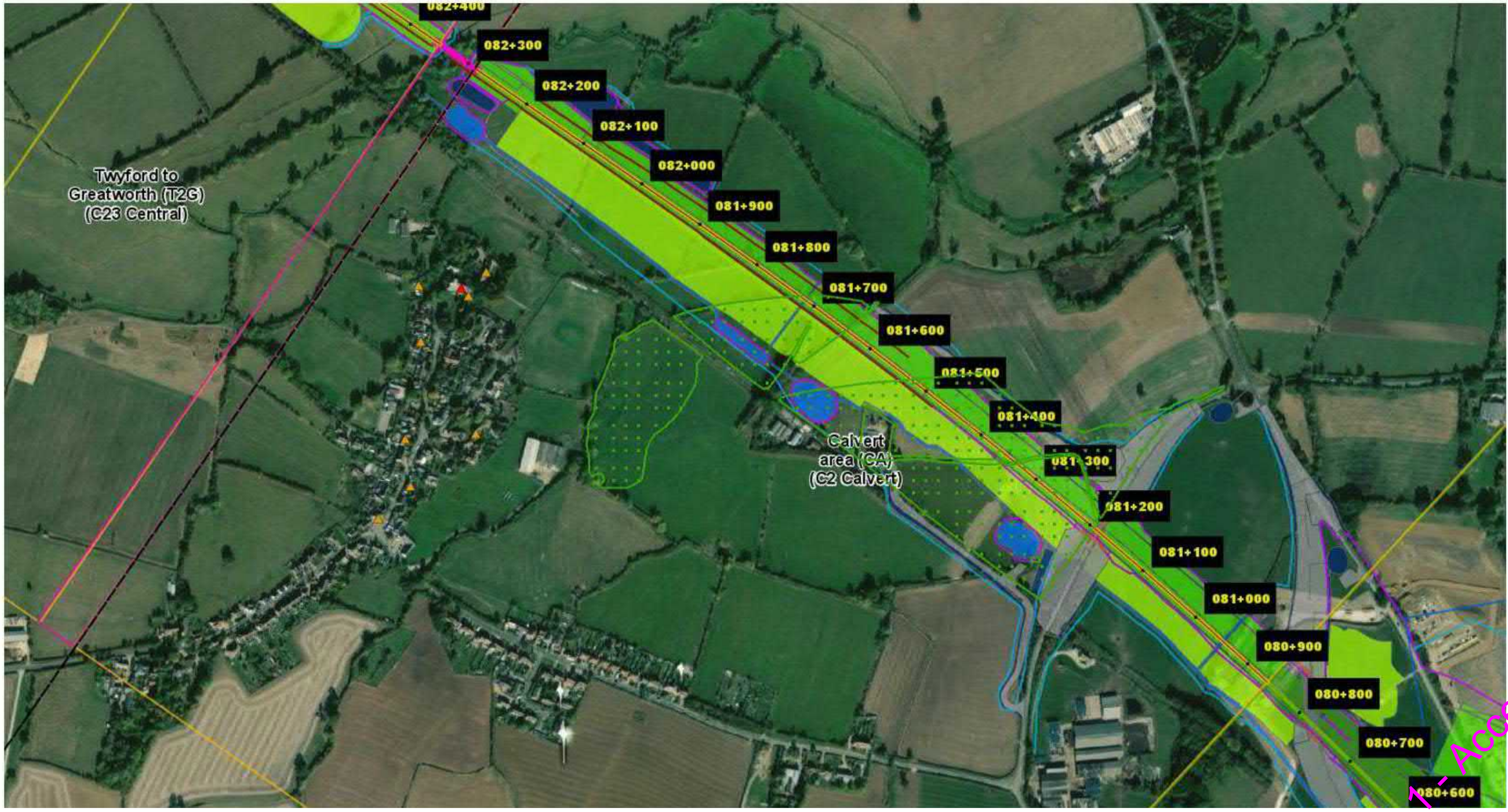
Listed Buildings
- Grade I Listed Property
- Grade II Listed Property
- Grade II* Listed Property

Scheduled Ancient Monument

Heritage Mitigation Hot Spot Sites

Registered Battlefield

Registered Parks & Gardens



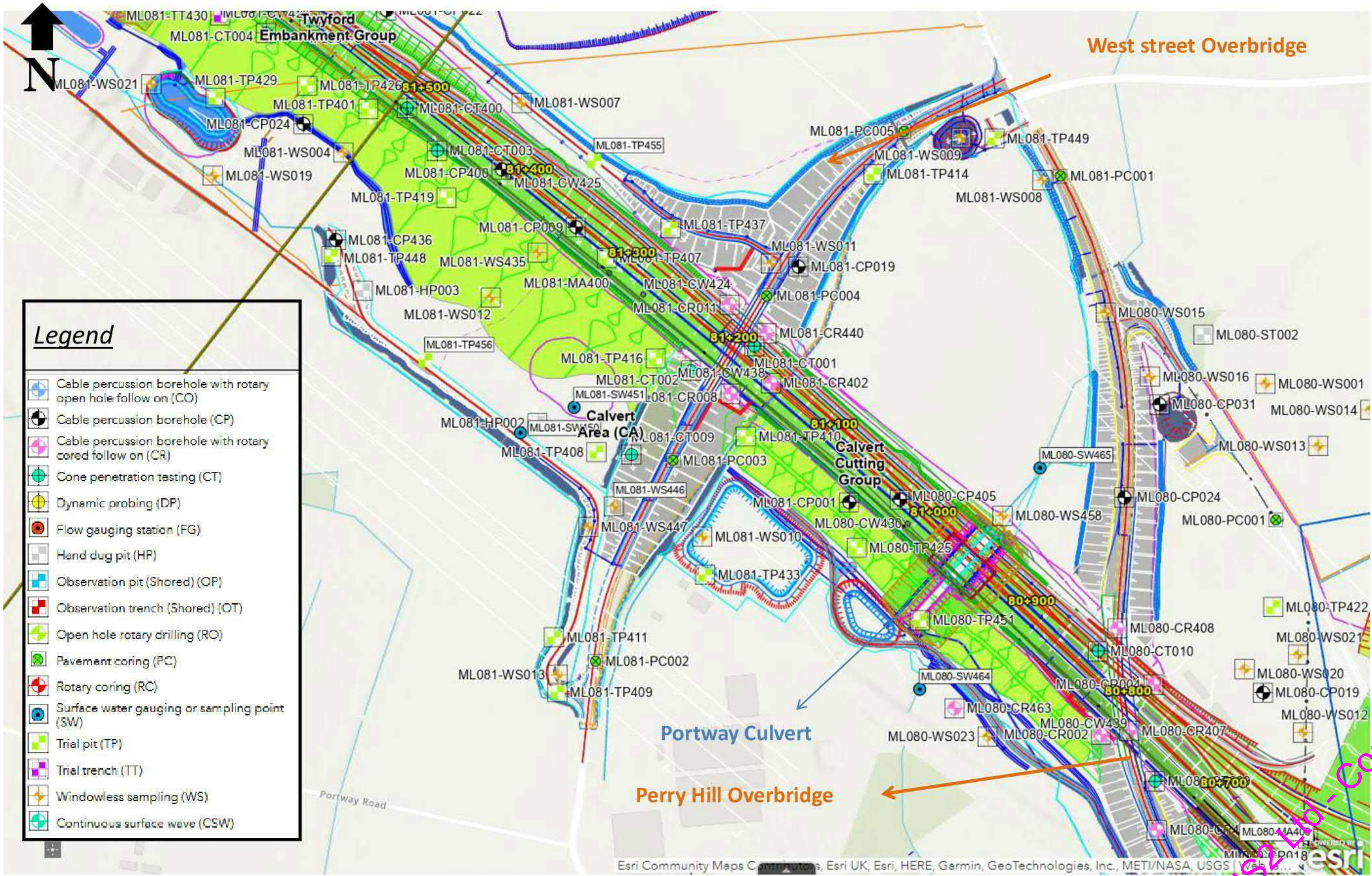
Appendix B GI Location Plan

Number of Pages: 3

Twyford Embankment

Ch. 80+862 to Ch. 81+500

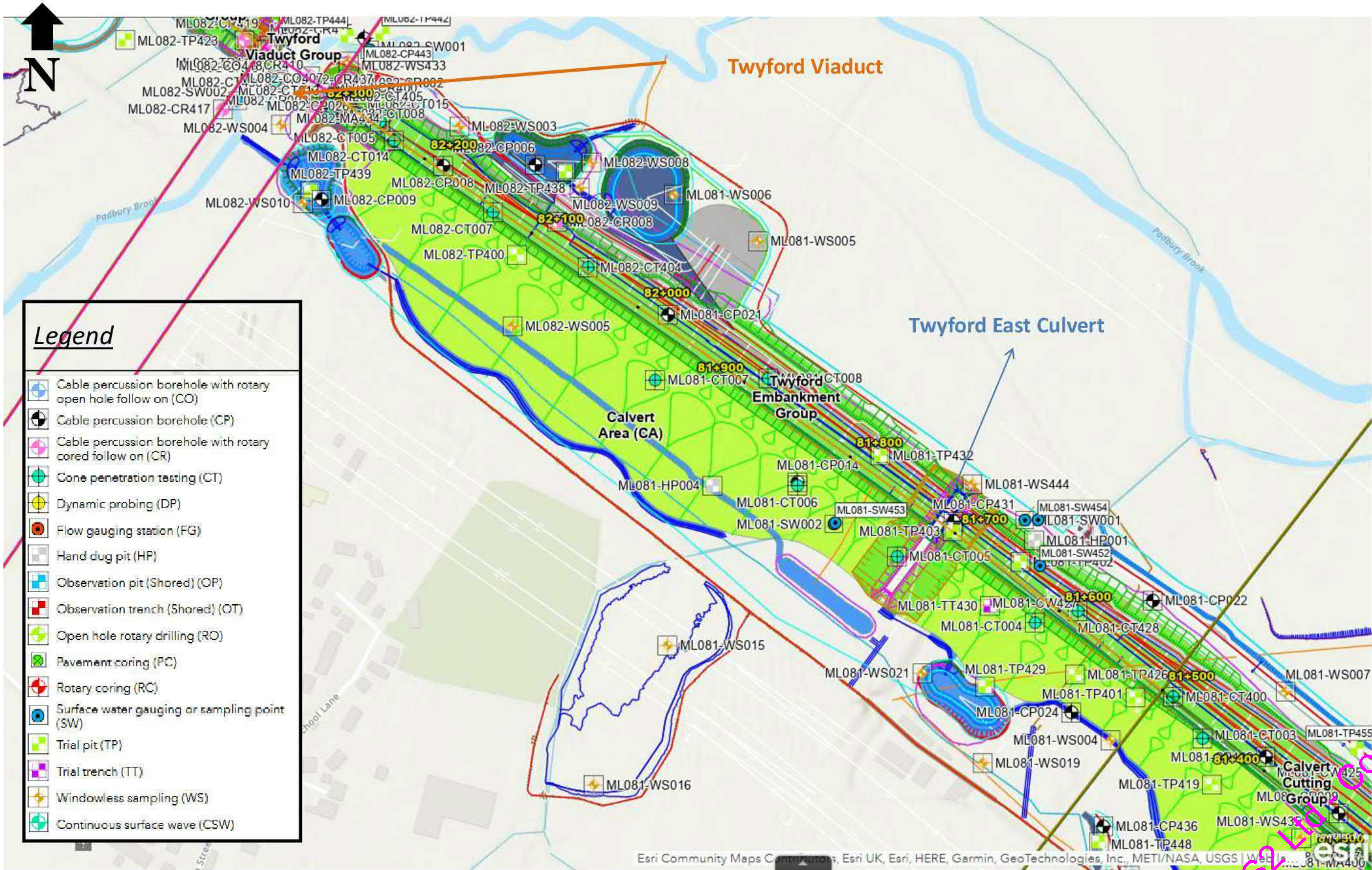
Ref: HS2 ASC Ground Engineering Viewer



Ref: HS2 ASC Ground Engineering Viewer

Twyford Embankment

Ch. 81+500 to Ch. 82+200

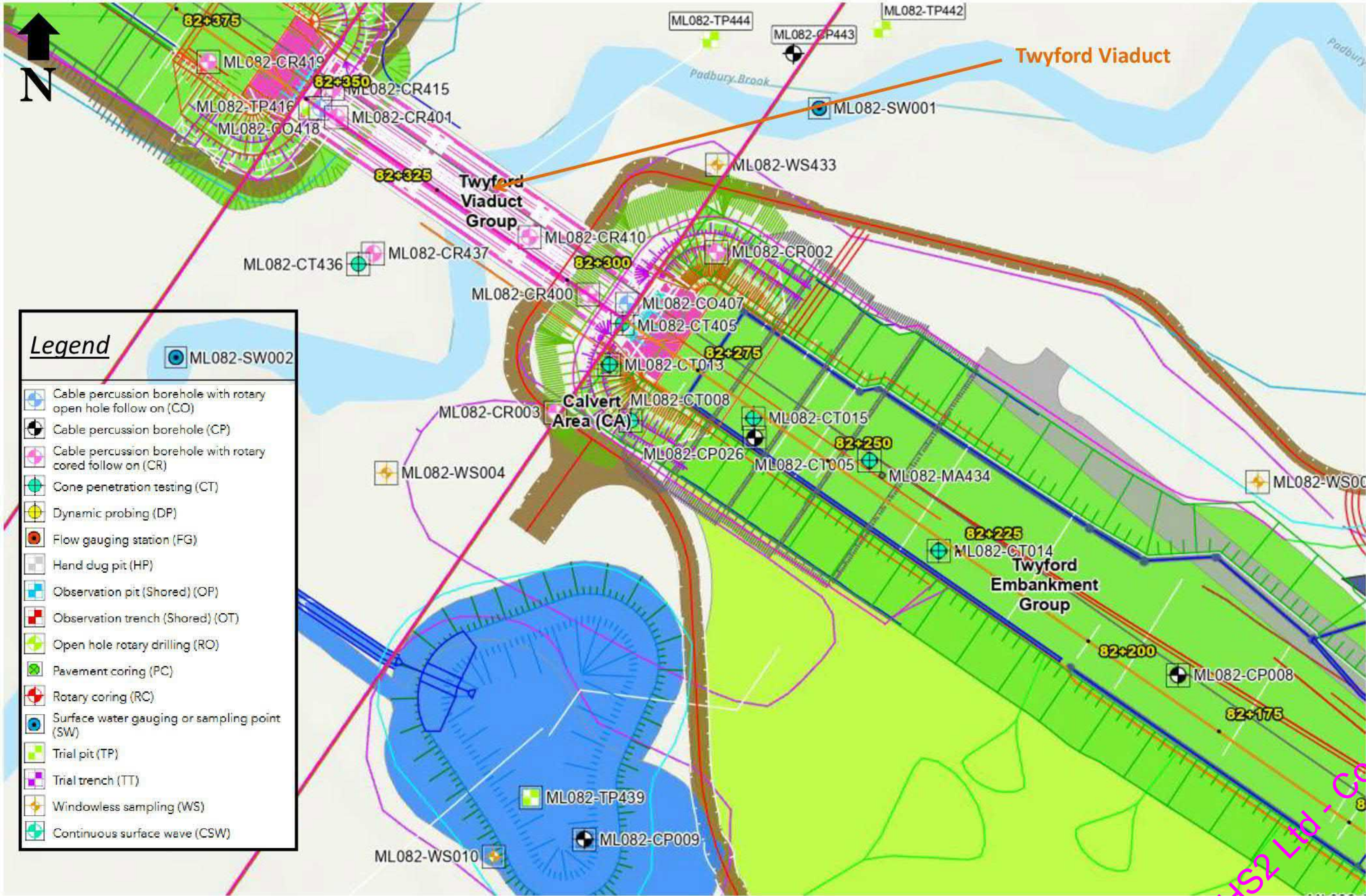


A High-Speed Design Partnership
ARCADIS COWI

Ref: HS2 ASC Ground Engineering Viewer

Twyford Embankment

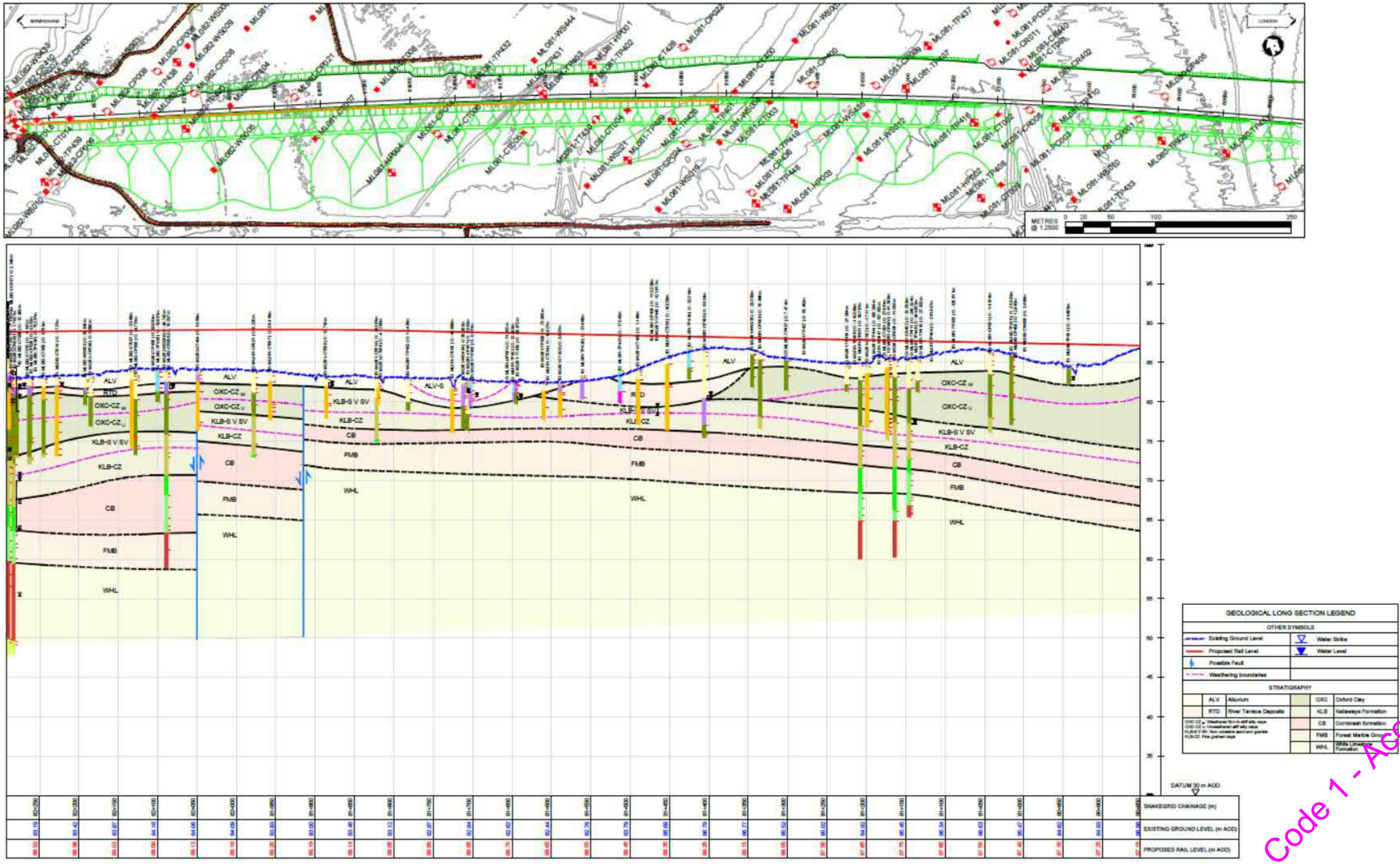
Ch. 82+200 to Ch. 82+289



HS2 Ltd - Code 1 - Accepted

Appendix C Geological long sections

Number of Pages: 1


ALV
RTD
OXC-CZ W
OXC-CZ U
KLB-S V SV
KLB-CZ
CB
FMB
WHL
ALV-S
GEOLOGICAL LONG SECTION LEGEND
OTHER SYMBOLS
Existing Ground Level
Water Strike
Proposed Rail Level
Water Level
Possible Fault
Weathering boundaries
STRATIGRAPHY
ALV Alluvium
RTD River Terrace Deposits
OXC Oxford Clay
KLB Kellaways Formation
CB Cornbrash formation
FMB Forest Marble Group
WHL White Limestone Formation
DATUM 30 m AOD
SNAKEGRID CHAINAGE (m)
EXISTING GROUND LEVEL (m AOD)
PROPOSED RAIL LEVEL (m AOD)

Appendix D Geotechnical Parameters Justification

Calculation output – Mainline Earthworks

Number of Pages: 124

Geological descriptions and geotechnical parameters used in earthworks design have been derived from several sources including published data, previous HS2 reports such as the Geotechnical Desk Study report [9]and the available GI data.

The asset specific GI data has been compared to the section wide GI data presented in the GIR [7] to ensure cautious design values in line with EC7 guidance.

In case of lack of field data, the geotechnical parameters were estimated using correlations and/or typical design values for the geological formation based on UK experience.

For slope stability design the values of c’ and φ’ were cautiously chosen based on UK experience in order to reduce the risk of progressive failure to an acceptable level over the 120 years design life.

General design methodology

Effective stress parameters

The selection of effective stress parameters has considered the following guidance by Nowak and Gilbert in the selection of drained parameters:

Gravel/silt bands

Gravel/silt bands are observed within the clay layers in the borehole logs with spacings ranging from 3m to 5m. It is considered that these thin bands will accelerate the consolidation process and the drainage height has been reduced in settlement calculations accordingly.

Given that the asset specific results coming from both laboratory and in-situ tests are considered insufficient in the asset, the GI data available within entire section named Calvert Area is taken is considered in the selection of characteristic design values.

The design has considered the following guidance by Nowak and Gilbert in the selection of drained parameters:

- Intact clays will use max. *c*'=5kPa
- Fissured clays will use max *c*'=2kPa

In those cases that asset specific results coming from both lab and in-situ tests are considered insufficient, the GI data available within entire section named Calvert Area is considered as routewide data.

Correlations used in design:

- PI used to find ϕ' (Ladd *et al*. 1977) Ref. [60]in glacial tills deposits but frequently used in UK to determine lower bound fully softened angle of friction in overconsolidated clays in absence of triaxial laboratory tests.
- $c_u = \frac{q_c}{20}$ (for over-consolidated clays); where c_u=undrained shear strength, and qc= cone resistance obtained from CPT
- $E'=K \cdot N$ where K=0.6-0.9 for over-consolidated unweathered clayey soils; *K*=0.6 for slightly over-consolidated weathered clayey soils; *k*=1-2 for normally consolidated sands (CIRIA R143) Ref.[61]
- PI is used to find $E_{oed}=1/m_v=f_2 \cdot N$ (Tomlinson and Woodward, 2008)
- When no lab results for Total Potential Sulphate TPS (%) are available, the following relationship with Total Sulphur TS (%) is considered: TPS (%)= TS(%) · 3

Guidance and correlations/derivations used to justify the geotechnical parameters are based on the HS2 - 1MC06 - Stage One C2 - MWCC –North Portal of Chiltern Tunnels to Brackley Ground Engineering Technical Note – Guidance on the Assessment of Settlement. Document No 1MC06-CEK-GT-NOT-C002-000023. Ref. [73]

Deformation Modulus relationships:

- ν'=Poisson's ratio=0.2 is assumed
- $\boldsymbol{E}' = E_u \frac{1+\nu'}{1+\nu_u}$ Where: E'=Young Modulus; E_u=Undrained Young Modulus; ν'=Poisson's ratio=0.2 and ν_u=Undrained Poisson's ratio=0.5.

- $\boldsymbol{E'} = E_{oed}\frac{(1-2\cdot\nu')\cdot(1+\nu')}{1-\nu'}$ Where: E'=Young Modulus (see below); E_{oed}=Oedometer Modulus; and ν'=Poisson's ratio=0.2

- The E' derived from oedometer tests was found to be lower than the drained triaxial E' by a factor of about 2 for the over-consolidated clays. Therefore, the E_{oed}, from oedometer lab tests have been readjusted by the same factor.
- Compression and swelling indexes (c_c and c_s) from oedometer tests are not used for settlements calculations which have been estimated using the methodology presented in Section 9.5.1 of this GDR.
- Coefficient of consolidation is defined as $\boldsymbol{c_v} = \frac{k}{m_v\cdot\gamma_w}$ where: c_v=coefficient of consolidation (m^2/s); k=hydraulic conductivity (m/s), m_v=coefficient of volume change (m^2/kN) γ_w=unit weight of pore fluid/water (kN/m^3)
  - As the *k* is proportionally related c_v and it is assumed that c_{v_insitu}= 10·c_{v_lab}, it is also assumed that $k_{\_insitu}$= 10·$k_{\_lab}$
  - Due to the lack of data, it is assumed that c_r= c_{v_insitu}

Plots references:

The following table presents the different geotechnical plots created for each geological formation.

Formation	1. Particle Size Distribution	2. Atterberg Limit Plot	3. Plasticity Index with depth	4. total sulphur vs depth	5. Bulk Density Vs Depth	6. SPT-N_{60} vs depth	7. CPT vs depth	8.Undrained Shear Strength Vs Depth	9. Normal Stress Vs Shear Stress	10. Permeability Vs Depth / Cv vs Depth	11. E Vs Depth	12. Eoed Vs Depth	Ground water Vs Chainage
Alluvium Deposits – (ALV-S V SV)	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	GW
Alluvium Deposits – (ALV-C Z)	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	
River Terrace Deposits-(RTD-S V SV)	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	
River Terrace Deposits-(RTD-C Z)	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	
Oxford Clay Formation – (OXC-C Z)	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	
Kellaways Formation – (KLB- S V SV)	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	

Formation	1. Particle Size Distribution	2. Atterberg Limit Plot	3. Plasticity Index with depth	4. total sulphur vs depth	5. Bulk Density Vs Depth	6. SPT-N_{60} vs depth	7. CPT vs depth	8.Undrained Shear Strength Vs Depth	9. Normal Stress Vs Shear Stress	10. Permeability Vs Depth / Cv vs Depth	11. E Vs Depth	12. Eoed Vs Depth	Ground water Vs Chainage
Kellaways Formation – (KLB- C Z)	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	

Quaternary Alluvium (ALV SV SV)

The below table provides brief commentary on:

- the type and quantity of tests to prove the geotechnical design values,
- general trends of geotechnical values with depth,
- the plots used to determine the design values of each geotechnical parameter.

Reference should be made to the plots for the justification of the characteristic design values adopted in the geotechnical models and calculations (refer to Section 8.2).

Table D- 1. Commentary and justification of characteristic design values in ALV SV SV.

Parameter	Symbol	Commentary / Justification	Plots
Fines content	#0.063	• only results from asset specific lab tests are plotted. • based on the test results and on the borehole logs, ALV SV SV is described as locally soft and firm slightly clayey fine to coarse sand.	A1
Plasticity index	PI	• the mean routewide value has been used as representative PI.	A2, A3
Liquid limit	LL	• only results from asset specific lab tests are considered. • a range of values around the mean value has been used in the design.	A2
Total Sulphur contents	TS	• the mean value is used to obtain the Total Potential Sulfate contents TPS (%) to assess its re-use.	A4
Bulk density	γ'	• only routewide lab tests are available. • the mean value is considered, which is consistent with the routewide average value	A5
Blow N number from SPT, corrected to 60% test energy	N_{60}	• only five test results are available within this asset. • a representative value is considered above 4m depth based in both routewide and asset specific data. • the asset specific results indicate medium dense consistency	A6
Cone resistance from CPT	q_c	• no CPT are available within this asset	N/A
Undrained shear strength	c_u	• SPT tests results are used to find the representative values	A6
		• five triaxial test results are available within this asset. • a characteristic value is defined based on both routewide and asset specific data, which is towards the medium values obtained from SPT.	A8
Drained shear strength	c'	• No triaxial Cu+u and triaxial CD tests are available in this asset. • a characteristic value is defined based on the on cohesive material due to the presence of SAND, a cautious long term drained value of c'=0 kPa has been used in design.	N/A
	ϕ'	• No CD triaxial available in this asset. • The correlation with PI for normally consolidated clays (Ladd et al. 1977) Ref. [60] (see Figure D-11) was used in the design, this value is cautious than the technical standard value.	

Parameter	Symbol	Commentary / Justification	Plots
Coefficient of Permeability and coefficient of consolidation	k, c_v	• No lab tests are available within the specific asset; and only (1) result comes from the in-situ testing. • Due to the absence of data within this layer (low presence within the asset), the reference plot corresponds to both clay and sand facies. • As cautious action, lab test results are not multiplied by any factor. • The design value for k is close to the minimum obtained value. • This value is used to define the design value for the coefficient of consolidation c_v, which leave us to the safety side.	A10
Young/Effective Deformation Modulus	E’	• SPT and Oedometer tests results are used to find the representative values	A6
		• E’ is correlated by N coming from SPT (CIRIA R143) Ref.[61] E’/N=2 for normally consolidated sands.	A12
		• Relationship between E’ and the oedometer modulus Eoed is used • The design value is very caution, as being the minimum obtained, from the oedometer relationship. This value is coherent with the minimum values obtained from SPT correlations.	A8, A12
Oedometer Deformation Modulus	E_{oed}	• SPT results are used to find the representative values	A6
		• PI is used to obtain relationship between Eoed=1/mv and N coming from SPT	A12
		• Relationship between the Oedometer Modulus Eoed and E’ coming from N of SPT (CIRIA R143) Ref.[61] • The design value is cautious value coming from the average of results coming from oedometer relationship. This value is coherent with the values obtained from SPT correlations.	A8, A13

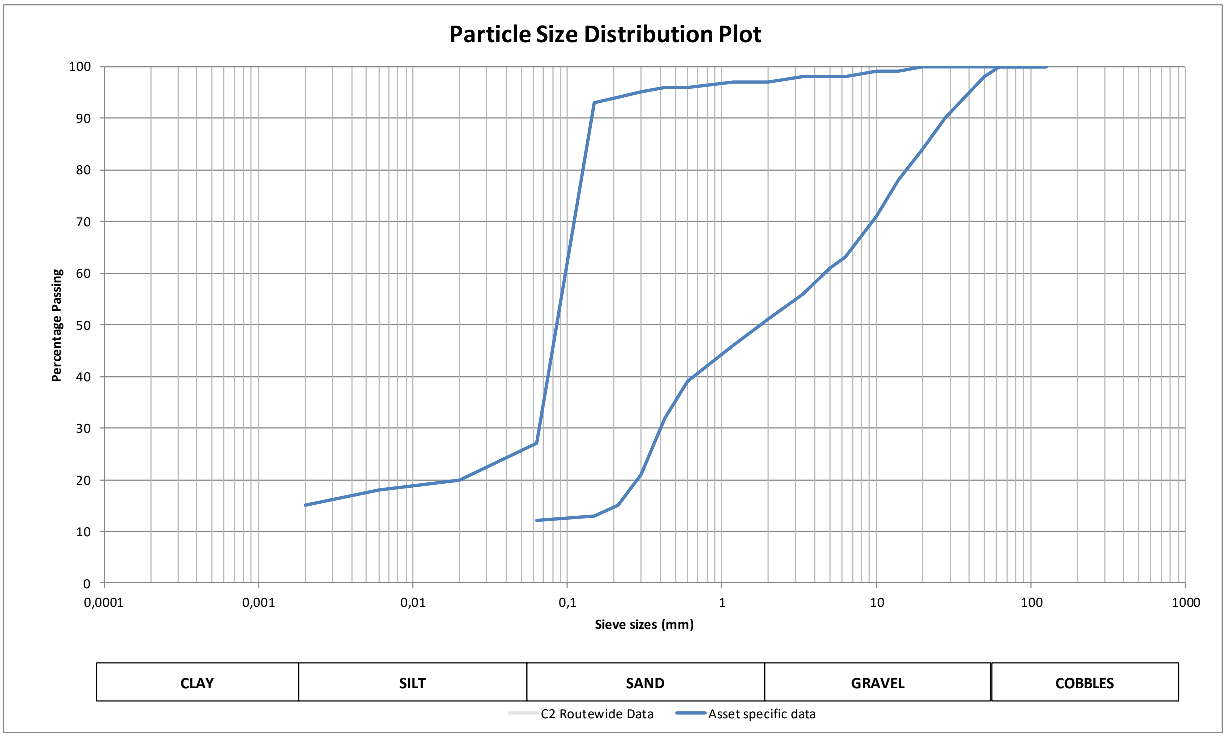
1. Vadose zone parameters

The HS2 material requirements for vadose zones have also been used on the NWR asset. These include the application of φ_{cv}, (instead of φ_{peak}) i.e., constant volume or critical state angle of shearing resistance, and a drained cohesion value c’ = 1 kPa, to consider the risk of the long-term degradation of materials at the surface of the slope. The table below give a summary of Vadose Zone parameters adopted for ALV Formation:

Table D-46: Vadose Zone parameters in Alluvium deposits on OXD and MCJ4 Lines

Asset	Geological strata	C’ vadose	φ’ cv (°) vadose
Calvert IMD	ALV Vadose	1	21

Particle size distribution (A1)

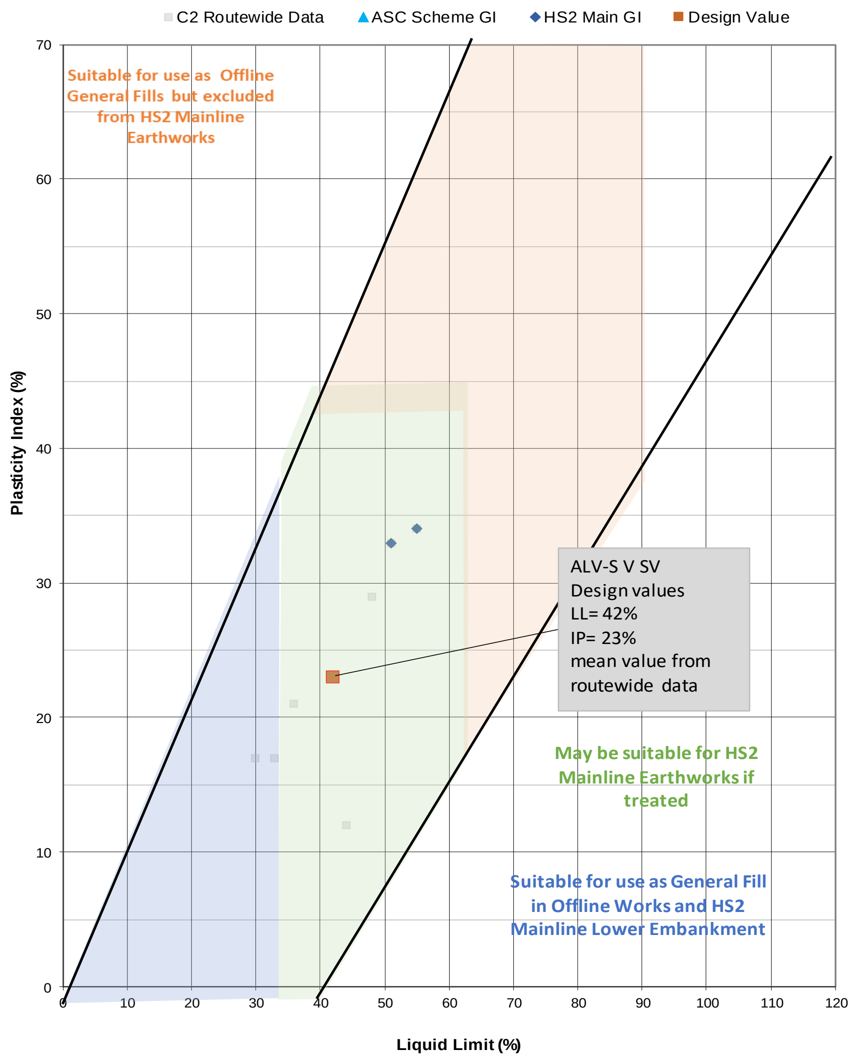


Notes	Client	Title			
Background C2 scheme wide parameters shown are based on holebase database geology codes dated 11/08/2020	HS2	: Particle Size Distribution for Alluvium			
asc A High-Speed Design Partnership ARCADIS COWI	Location	0	Project ID	10039367	
	Project Title	1MC07 - Stage One C3 -MWCC – Brackley to South Portal of Long Itchington Tunnel	Figure	A1	Date 19/07/2021

Figure D-1. Particles size distribution within the Alluvium deposits (ALV SV SV) – Twyford Embankment

Atterberg limits (A2, A3)

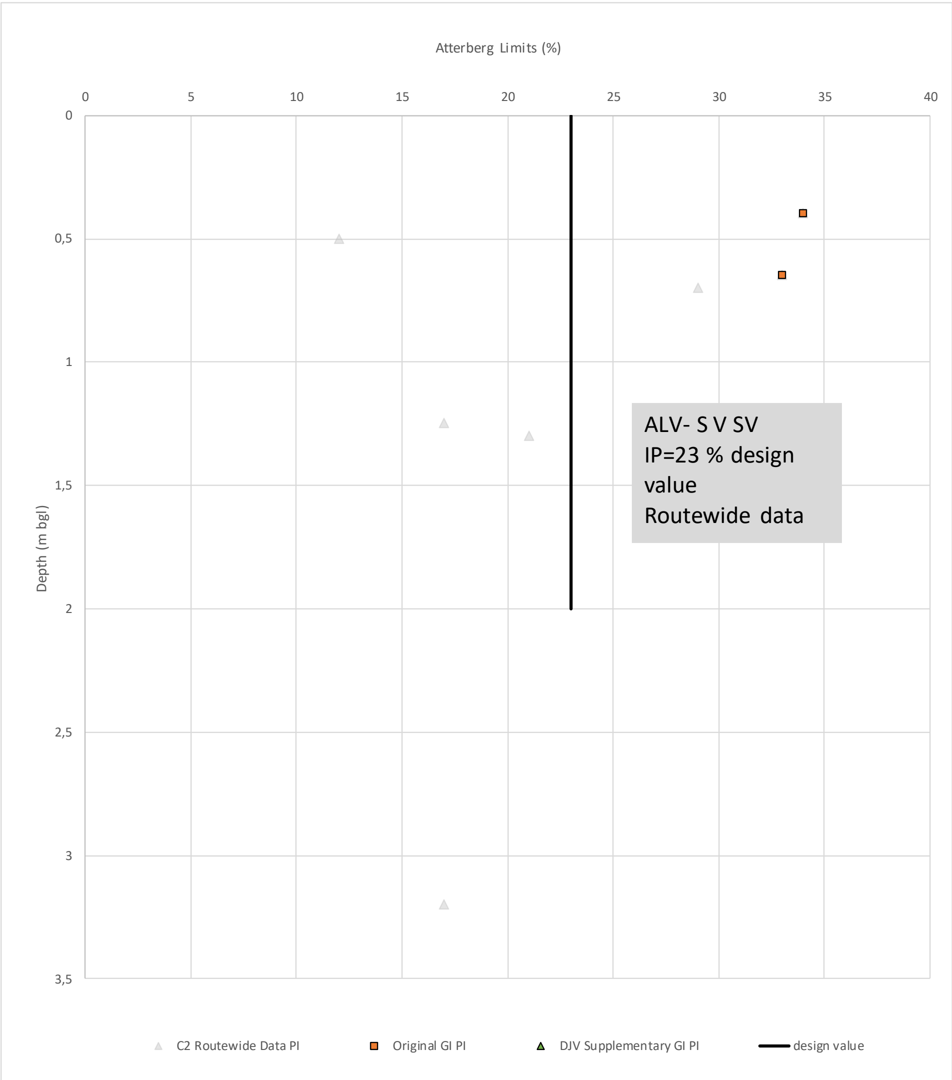
HS2	A-Line Plot - HS2 Suitability Overlay					
Project ID:	**10039367**	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment Group**
Client:	**HS2**	Geology :	**ALV-S V SV**	Figure:	**A2**



Number of Tests: Plastici Limit	Offset:	Plot Date:	19/07/2021
asc A High-Speed Design Partnership ARCADIS COWI	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	**Holebase database reference**	Datadrop 10. Published 05/2021

Figure D-2. Plasticity Index vs. Liquid Limit within the Alluvium deposits (ALV SV SV) – Twyford Embankment and Routewide

HS2	Liquid limit, Plastic limit and Plasticity Index with depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology:	ALV-S V SV	Figure:	A3



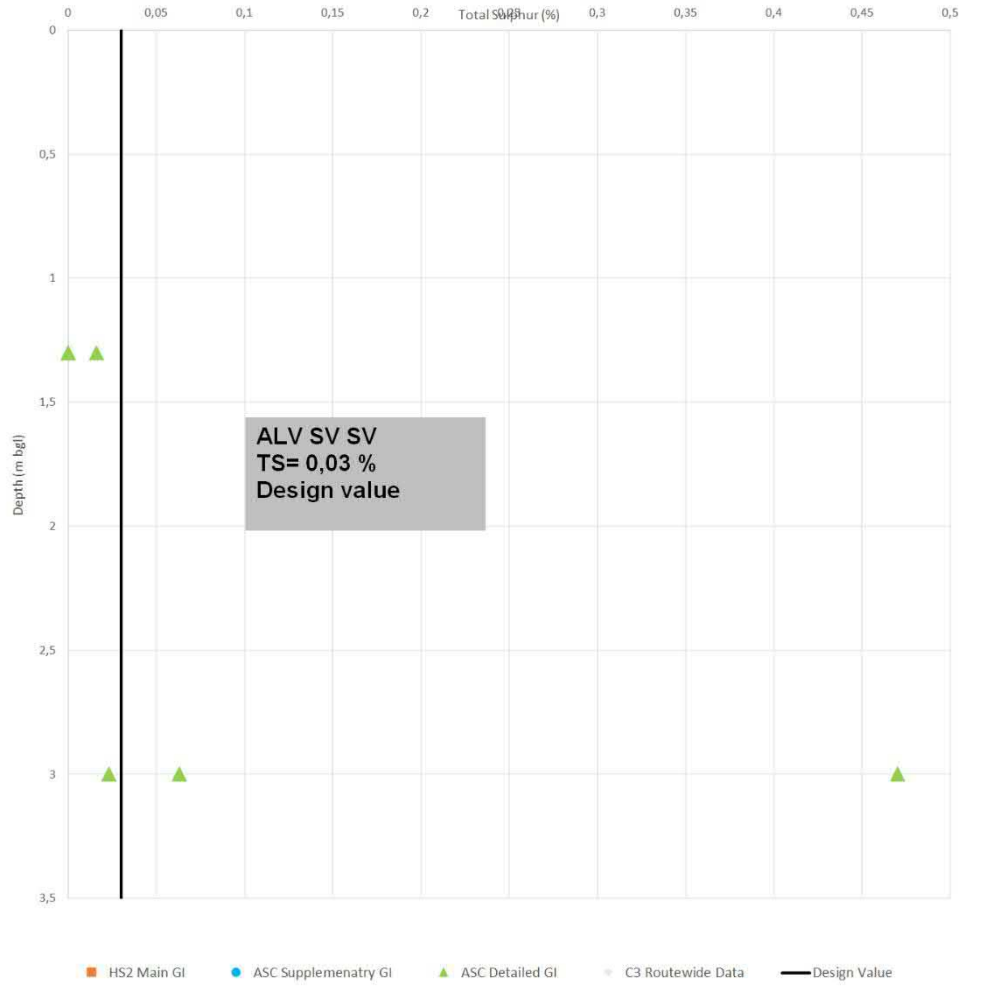
Number of test	7	Notes	Plot Date:	19/07/2021
asc A High-Speed Design Partnership ARCADIS COWI		Background C2 Routewide data shown are based on Holebase database geology codes dated 29/05/2021	Offset:	
			Holebase database reference	Datadrop 10. Published 05/2021

Figure D-3. Plasticity Index vs. depth within the Alluvium deposits (ALV SV SV) – Twyford Embankment and Routewide

Sulphur content (A4)

HS2 Total Sulphur (as % S) vs Depth (m bgl)

Project ID:	**10039367**	Project Title:	**1MC07 - Stage One C3 -MWCC – Brackley to South Portal of Long Itchington Tunnel**	Location:	**Twyford embankment**
Client:	**HS2**	Geology :	**ALV-S V SV**	Figure:	**A4**



	TS %
Number of Tests	10
Minimum	0,00
Maximum	0,47

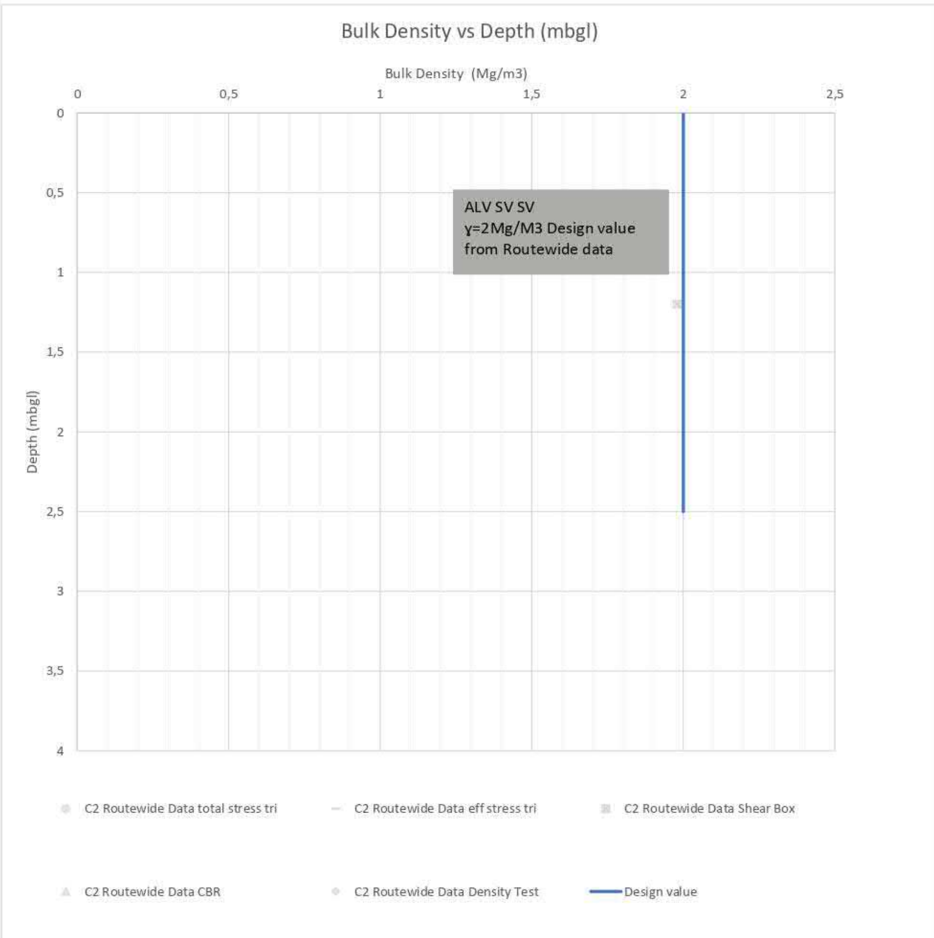
Note
Background C3 scheme wide parameters shown are based on holebase database geology codes dated 29/10/2021.

Plot Date:	15/03/2022
Database Reference	Data drop 17

Figure D-4. Total sulphur TS (%) within the Alluvium deposits (ALV SV SV) – Twyford Embankment

Bulk density γ' (A5)

HS2	Bulk Density vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Routewide_ Calvert area
Client:	HS2	Geology :	ALV-S V SV	Figure:	A5

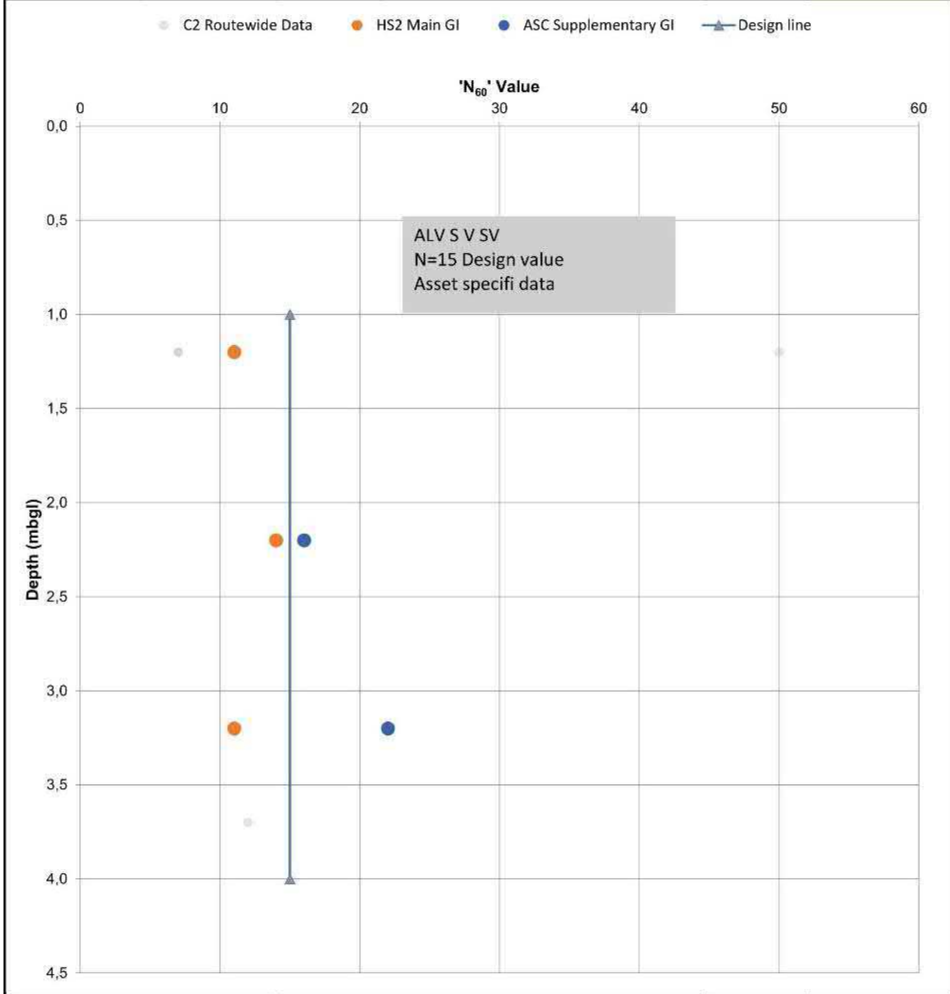


	Bulk Density	Notes	Plot Date:	01/07/2021
Number of Tests	1	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021		
Minimum	1,98			
Maximum	1,98			
			Database reference number	Datadrop 10. Published 05/2021

Figure D-5. Bulk density obtained from different lab tests within the Alluvium deposits (ALV SV SV) – Twyford Embankment and Routewide

Standard Penetration Test desistance N_{SPT} (A6)

HS2		SPT-N_{60} vs. Depth (mbgl)			
Project ID:	10039367	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment Group**
Client:	**HS2**	Geology :	**ALV-S V SV**	Figure:	**A6**



	N Value	Notes		
Number of Tests	5	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	**Plot Date:**	22/06/2021
Minimum	11			
Maximum	22			
Offset				
			Holebase Database Reference	Datadrop 10. Published 05/2021

Figure D-6. SPT results within the Alluvium deposits (ALV SV SV) –Twyford Embankment

N value (blows/ 305mm)	Consistency	Field Indications	Approximate C_u (kPa)
0 to 2	Very Soft	Excludes between the fingers when squeezed in the fist	0 – 12.5
2 to 4	Soft	Easily moulded in the fingers	12.5 – 25
4 to 8	Medium (Firm)	Can be moulded in the fingers by strong pressure	25 – 50
8 to 15	Stiff	Cannot be moulded in the fingers	50 – 100
15 to 30	Very Stiff	Brittle or very tough	100 – 200
>30	Hard	-	>200

Figure D-7.Correlation C_u with N_{SPT} values Consistency and field descriptions (source: EPRI, 1990)

Undrained shear strength Cu (A8)

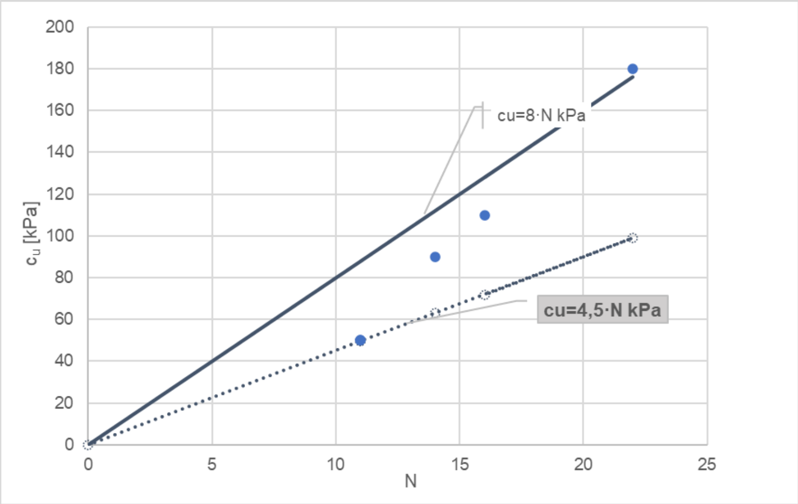


Figure D-8. Correlations C_u with N_{SPT} compared with values in EPRI, (1990)

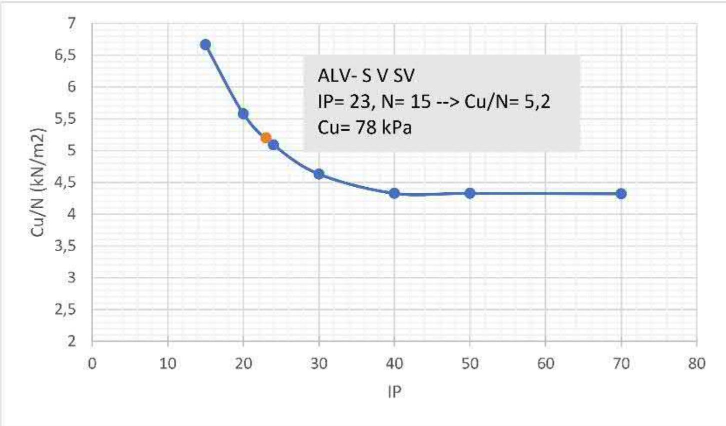
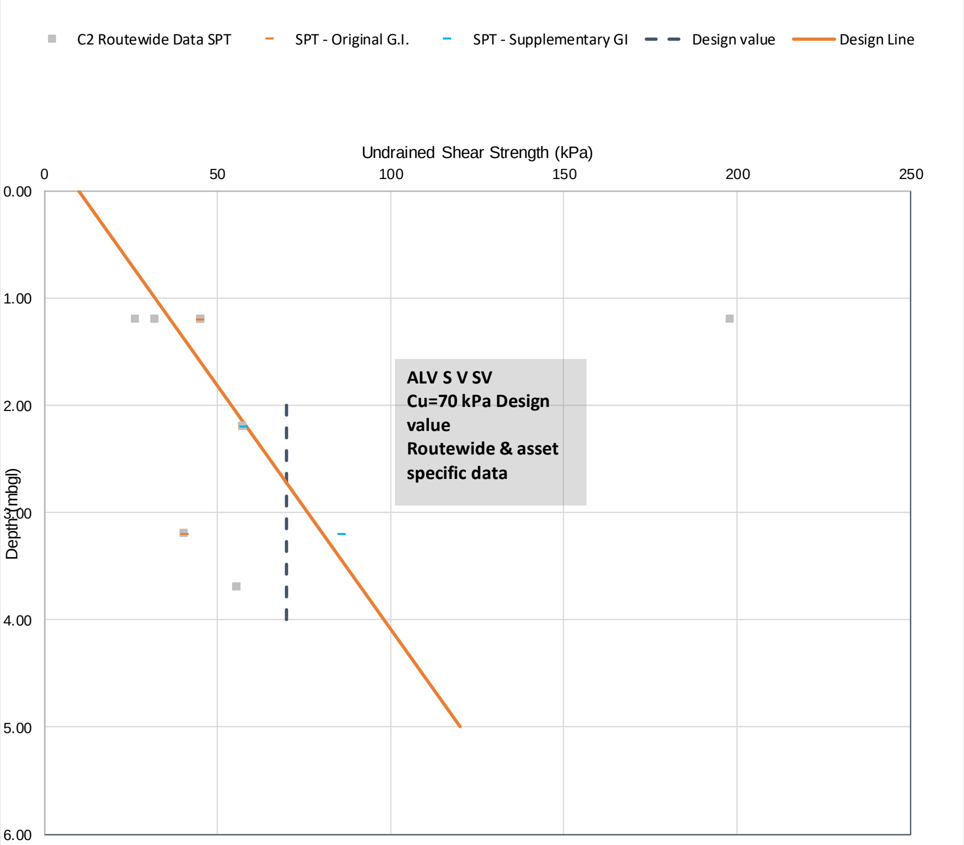


Figure D-9. Correlation between SPT N value and undrained shear strength cu, based on the Plasticity index PI Ladd et al. 1977 Ref. [60] (CIRIA R143) Ref [61]

HS2	Undrained Shear Strength vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	ALV-S V SV	Figure:	A8



	Total	Notes	Plot Date: 15/07/2021
Number of Tests	12	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	
Minimum	-		
Maximum	-		
Offset		Inferred ground conditions applied to CPT Cu profiles are based on review of exploratory hole information adjacent to the CPT position.	Holebase database reference: Datadrop 10. Published 05/2021

Figure D-10. Undrained shear strength obtained from different lab and in situ tests within the Alluvium deposits (ALV SV SV) -Twyford Embankment and Routewide

Effective cohesion c' and effective friction angle ϕ'

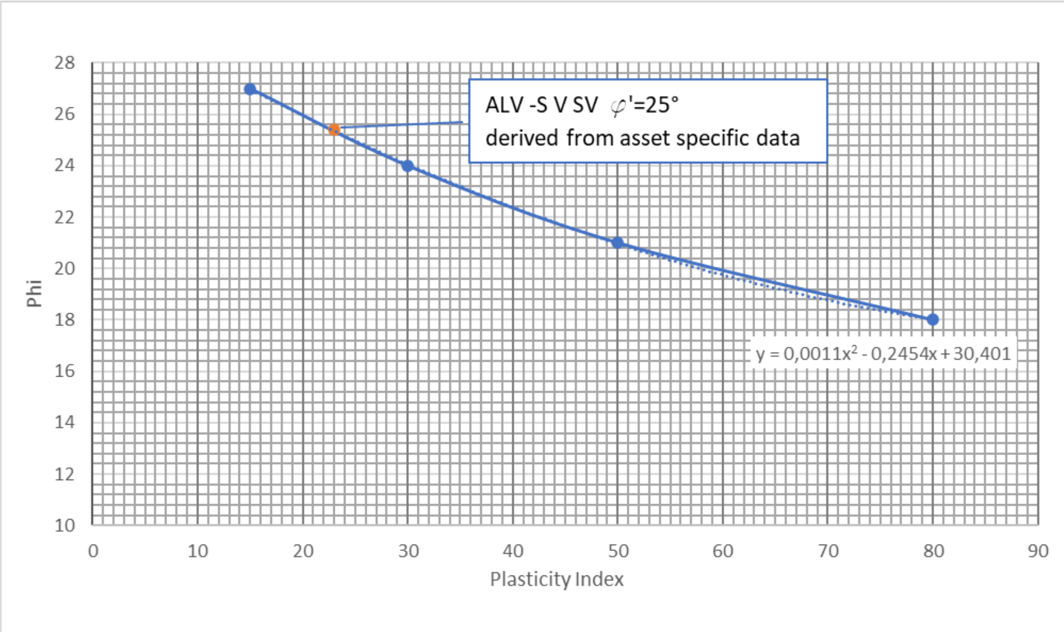
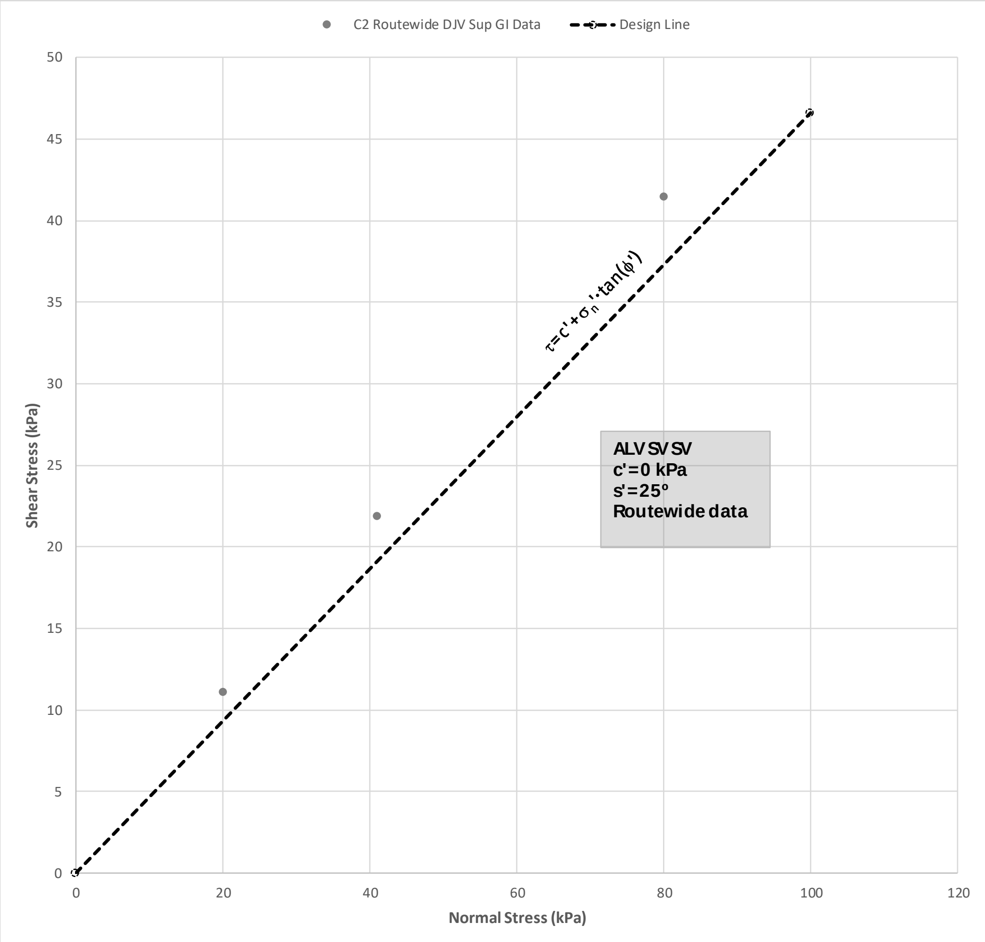


Figure D-11. Characteristic constant volume angle of shearing resistance ϕ'cv derivation (BS 8004:2015) Ref. [64] from routewide mean Plasticity Index within the Alluvium deposits

Shear Box Shear Stress Vs Normal Stress (A9)

HS2	Shear Box Shear Stress vs. Normal Stress				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment
Client:	HS2	Geology :	ALV-S V SV	Figure:	A9



Notes:	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	Plot Date:	15/07/2021
Offset			
Holebase database reference	Datadrop 10. Published 05/2021		

A High-Speed Design Partnership
ARCADIS COWI

Figure D-12. Shear stress vs. Normal Stress in Alluvium deposits (ALV SV SV) –Routewide

Coefficient of consolidation c_v

Derivation from k obtained from lab consolidation tests and in situ permeability tests

$$c_v = \frac{k}{m_v \cdot \gamma_w}$$

Where:

c_v=coefficient of consolidation (m^2/s)

k=hydraulic conductivity (m/s),

m_v=coefficient of volume change (m^2/kN)

γ_w=unit weight of pore fluid/water (kN/m^3)

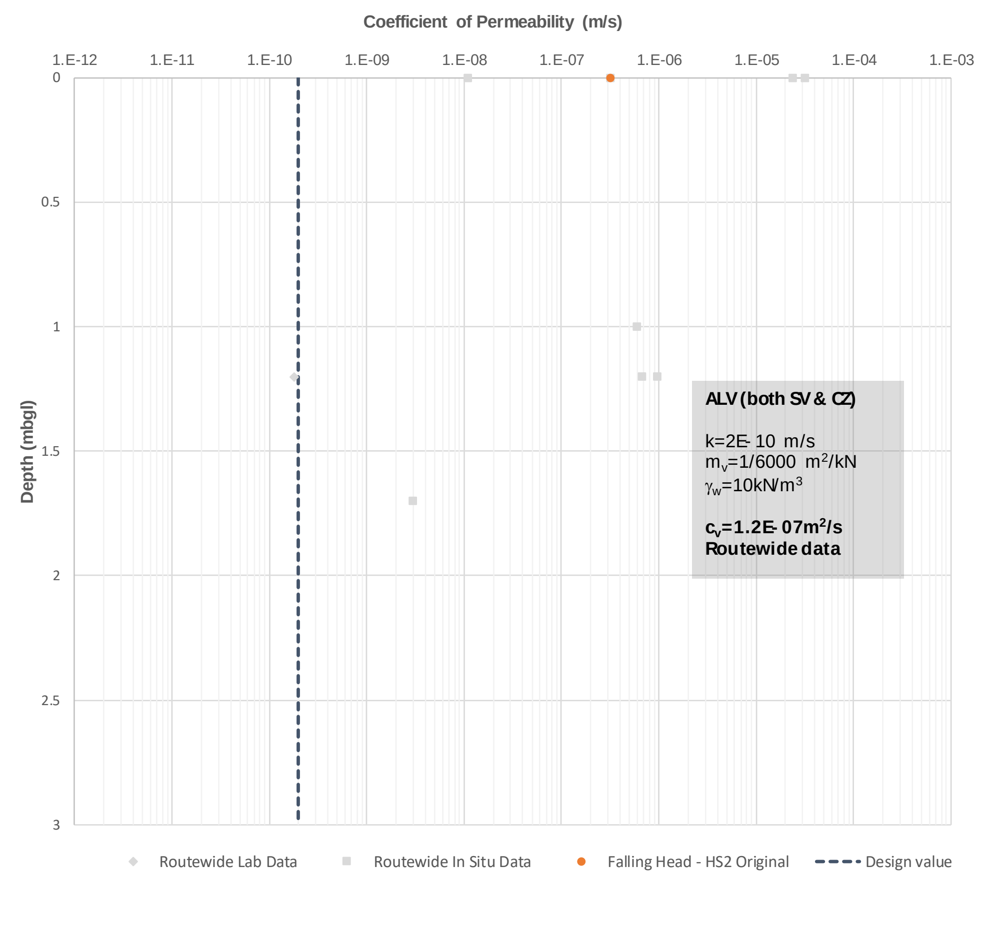
$c_{v\_insitu} = 10 \cdot c_{v\_lab}$ >> $k_{\_insitu} = 10 \cdot k_{\_lab}$

$c_r = c_{v\_insitu}$

Permeability vs Depth (m bGL) (A10)

HS2 — Permeability vs. Depth (mbgl)

Project ID:	**10039367**	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment Group**
Client:	**HS2**	Geology :	ALV SV SV	Figure:	**A10**



	Permeability
Number of Tests	1
Minimum	3.20E-07
Maximum	3.20E-07

Notes
Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021

Plot Date: 15/07/2021

Holebase database reference: Datadrop 10. Published 05/2021

Figure D-13. Permeability vs depth within the Alluvium deposits (ALV)

Young Modulus E'

Correlation with N obtained from SPT

E'=K·N

Where K=0.6-0.9 for over-consolidated unweathered clayey soils; and K=0.6 for slightly over-consolidated weathered clayey soils (CIRIA R143) Ref.[61]

Correlation E_u - c_u

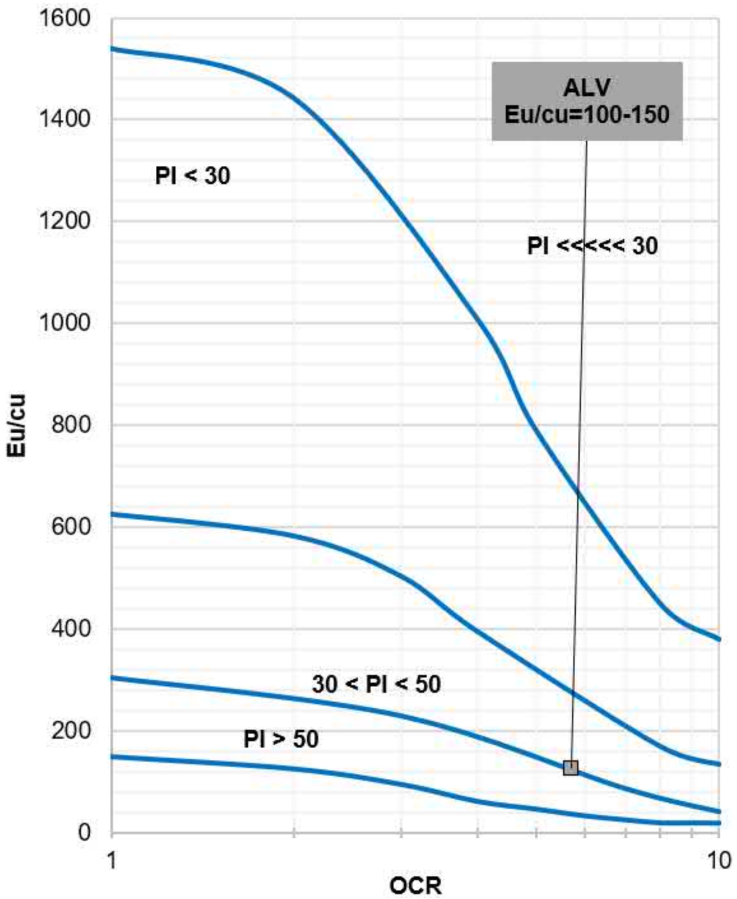


Figure D-14. Relationship between Eu/cu ratio for clays with plasticity index and degree of over-consolidation (after Jamiolkowski et al. 1979)

Relationship between E' - E_u

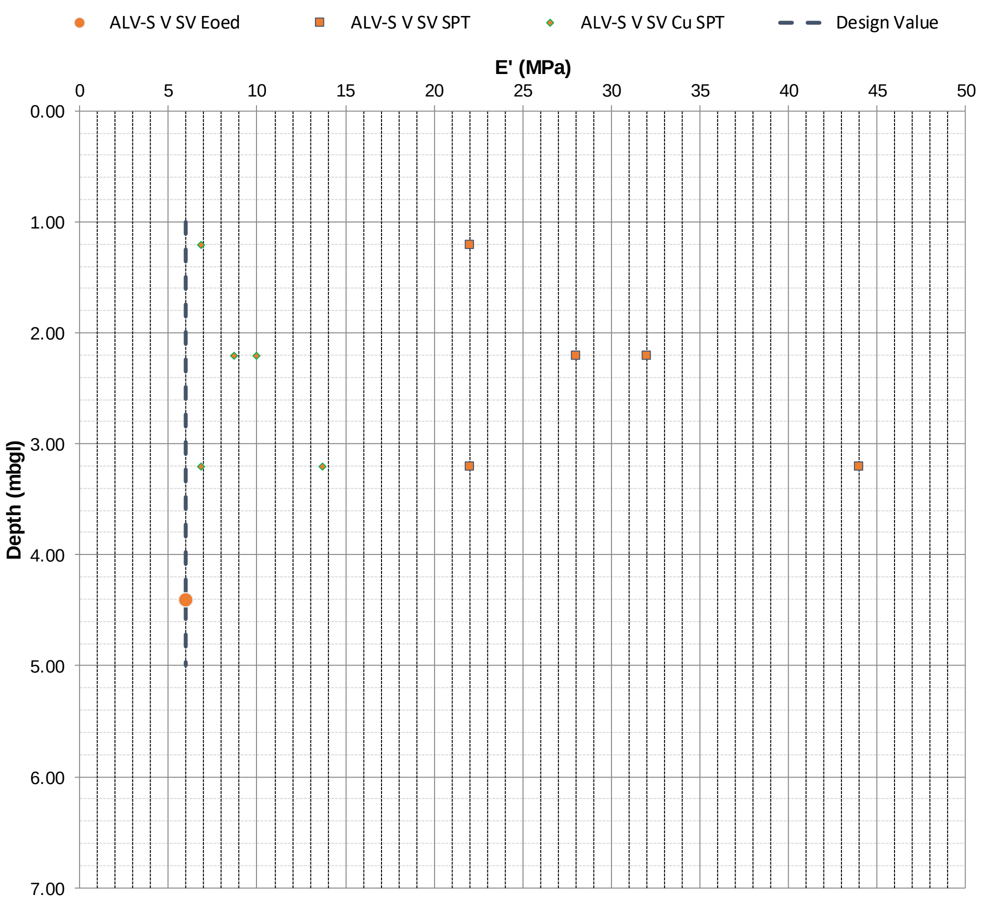
$$\boldsymbol{E'} = E_u \frac{1 + \nu'}{1 + \nu_u}$$

Where: E'=Young Modulus; E_u=Undrained Young Modulus; ν'=Poisson's ratio=0.2 and ν_u=Undrained Poisson's ratio=0.5.

Young Modulus E' (A11)

E' (MPa) vs. Depth (mbgl)

Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern	Location:	Twyford Embankment
Client:	HS2	Geology :	E' ALV S V SV	Figure:	A11



	E'
Number of Tests	13
Minimum	6.05E+00
Maximum	4.40E+01
Offset	

Notes

Plot Date:	11/06/2021
Holebase database reference	**Data drop 10. Published 05/2021**

Figure D-15. E' obtained from different lab tests within the Alluvium deposits (ALV SV SV) Twyford Embankment

Oedometer Modulus E_{oed} (or Coefficient of volume change m_v=1/E_{oed})

Correlation with N from SPT

Eoed=1/mv=f2·N (Tomlinson and Woodward, 2008)

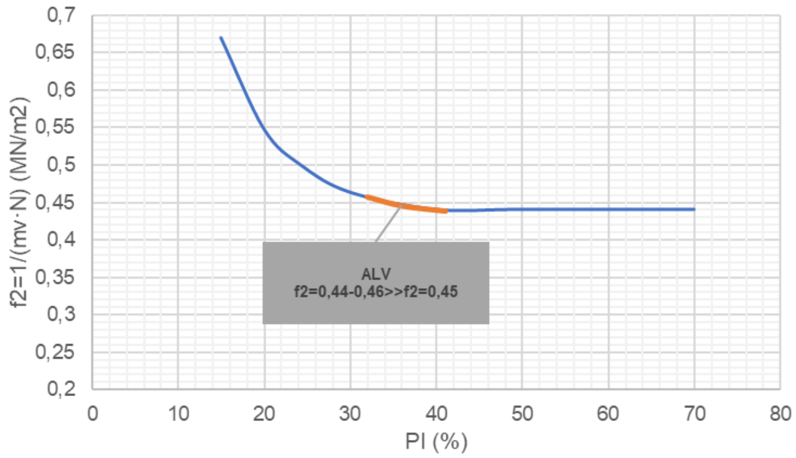


Figure D-16. coefficient f2 to correlate mv=1/Eoed from N SPT and PI within the Alluvium deposits – Routewide

Correlation of E' coming from N of SPT

$$\boldsymbol{E}' = E_{oed}\frac{(1-2\cdot\nu\prime)\cdot(1+\nu\prime)}{1-\nu\prime}$$

Where: E'=Young Modulus (see below); E_{oed}=Oedometer Modulus; and ν'=Poisson's ratio=0.2

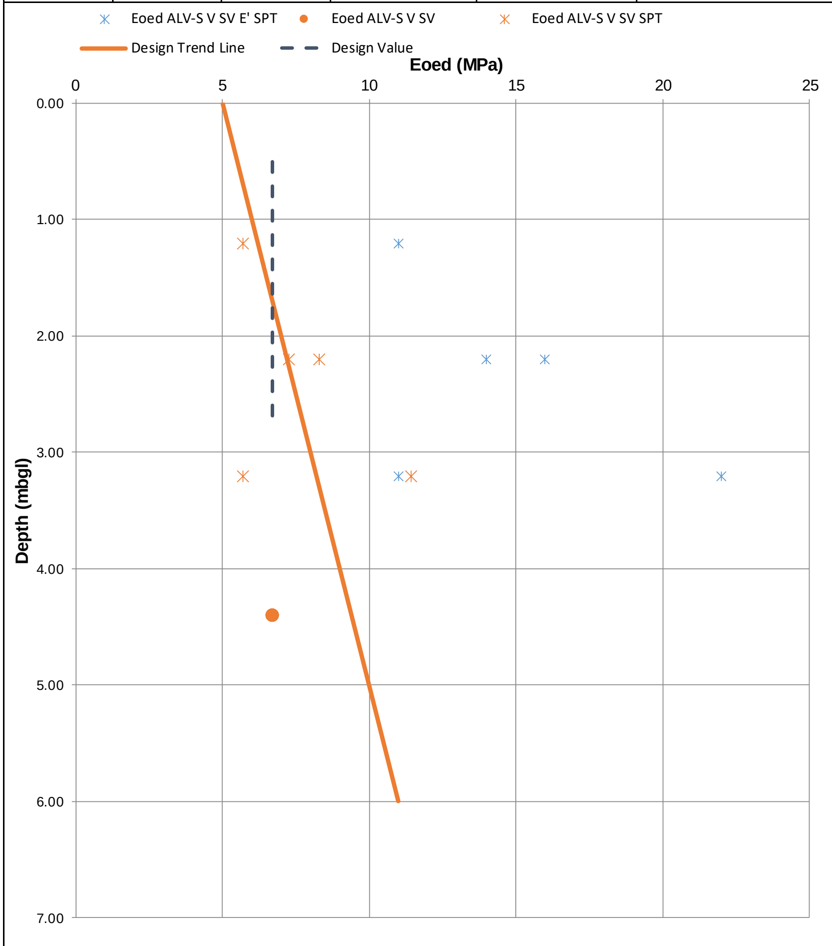
E'=K·N

Where K=0.6-0.9 for over-consolidated unweathered clayey soils; and K=0.6 for slightly over-consolidated weathered clayey soils

Oedometer modulus Eoed (A12)

Eoed (MPa) vs. Depth (mbgl)

Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North	Location:	Twyford Embankment
Client:	HS2	Geology :	Eoed ALV S V SV	Figure:	A12



	Eoed
Number of Test	13
Minimum	5.72E+00
Maximum	2.20E+01
Offset	

Notes

Plot Date: 11/06/2021

Holebase database reference	Data drop 10. Published 05/2021

Figure D-17. E_{oed} obtained from different lab tests within the Alluvium deposits (ALV SV SV) –Twyford Embankment

Quaternary Alluvium (ALV- CZ)

The below table provides brief commentary on:

- the type and quantity of tests to prove the geotechnical design values,
- general trends of geotechnical values with depth,
- the plots used to determine the design values of each geotechnical parameter.

Reference should be made to the plots for the justification of the characteristic design values adopted in the geotechnical models and calculations (refer to Section 8.2).

Table D- 2. Commentary and justification of characteristic design values in ALV

Parameter	Symbol	Commentary / Justification	Plots
Fines content	#0.063	• only results from asset specific lab tests are plotted. • based on the test results and on the borehole logs, ALV is described as locally soft and firm slightly **gravelly silty clays**	B1
Plasticity index	PI	• fifty height lab tests are available. • a range of values around the mean value has been used in the design	B2, B3
Liquid limit	LL	• fifty height lab tests are available • a range of values around the mean value has been used in the design	B2
Total Sulphur contents	TS	• six lab tests are available • the mean value is used to obtain the Total Potential Sulfate contents TPS (%) to assess its re-use	B4
Bulk density	γ'	• thirty-five (35) test results are available from the routewide • the design value is considered around the mean value	B5
Blow N number from SPT, corrected to 60% test energy	N_{60}	• thirty-one (31) test results are available within this asset • the mean value is considered as design value • the asset specific results indicate stiff (from medium to very stiff) consistency	B6
Cone resistance from CPT	q_c	• no CPT are available within this asset	N/A
Undrained shear strength	c_u	• SPT mean value are used to find the representative value	B6
		• seven (7) UU triaxial test results are available within this asset • both specific and routewide values derived from N of SPT are also represented on the reference plot. • a cautious trending line with depth has been defined. • A design value of 49kPa is considered and consistent with the above-mentioned trending line.	B8
Drained shear strength	c'	• One effective stress triaxial test is available within this asset. • No Shear box tests are available in this asset. • In view of the absence of specific data, routewide data is also considered. • Based on all the available data, a failure line on the safety side has been fitted. • A long-term drained value of c'=2 kPa has been defined, which is consistent with the best-fit line and with Nowak and Gilbert's analysis (refer to General Methodology at the beginning of the Appendix D).	B9

Parameter	Symbol	Commentary / Justification	Plots
	ϕ'	• One effective stress triaxial test is available within this asset. • No Shear box tests are available in this asset. • In view of the absence of specific data, routewide data is also considered. • Based on all the available data, a failure line on the safety side has been fitted. • Considering this best-fit line, a cautious value of ϕ'=24° is set as design value. • This value is consistent with the correlation with PI for normally consolidated clays (Ladd et al. 1977) Ref. [60] (see Figure D-11) and with the value recommended by the technical standard.	B9
Coefficient of Permeability and coefficient of consolidation	k, c_v	• No lab tests are available within the specific asset; and only (1) result comes from the in-situ testing. • Due to the absence of data within this layer (low presence within the asset), the reference plot corresponds to both clay and sand facies. • As cautious action, lab test results are not multiplied by any factor. • The design value for k is close to the minimum obtained value. • This value is used to define the design value for the coefficient of consolidation c_v, which leave us to the safety side.	B10
Young/Effective Deformation Modulus	E'	• SPT results are used to find the representative values • Only In-situ Vane tests results with IP >30 results are used to find the representative values	B6
		• Oedometer results are used to find the representative values	B12
		• E' is correlated by N coming from SPT (CIRIA R143) Ref.[61] by means of E'/N=4.55	B12
		• The design value coming from the SPT. Results coming from Vane and oedometer tests give over-estimation and less-estimation, respectively.	B12
Oedometer Deformation Modulus	E_{oed}	• Oedometer results are used	B13
		• SPT results are used to find the representative values	B6
		• PI is used to obtain relationship between E_{oed}=1/mv and N coming from SPT by means of f2=0.458	B13
		• Relationship between the Oedometer Modulus E_{oed} and E' coming from N of SPT (CIRIA R143) Ref.[61] • The design value is given by the average value coming from these three correlations	B8, B13

Particle size distribution (B1)

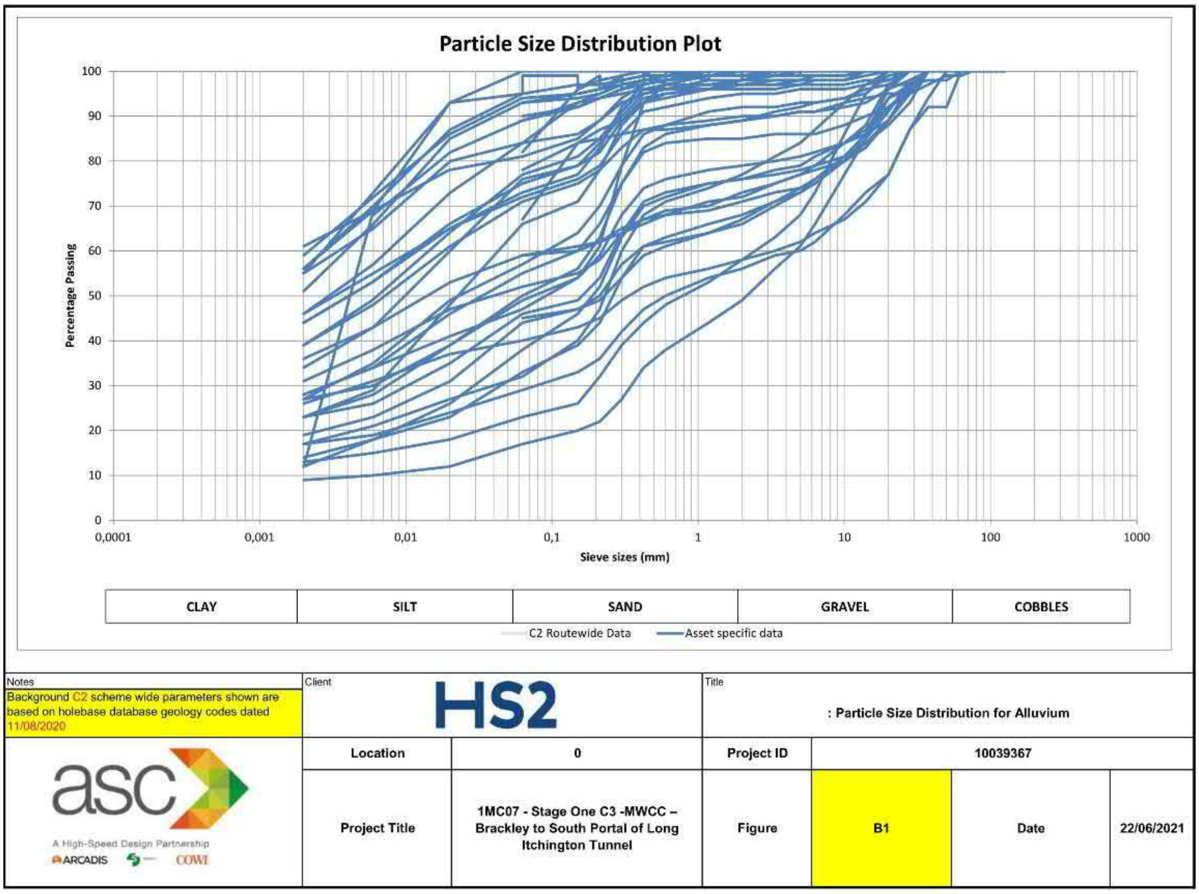
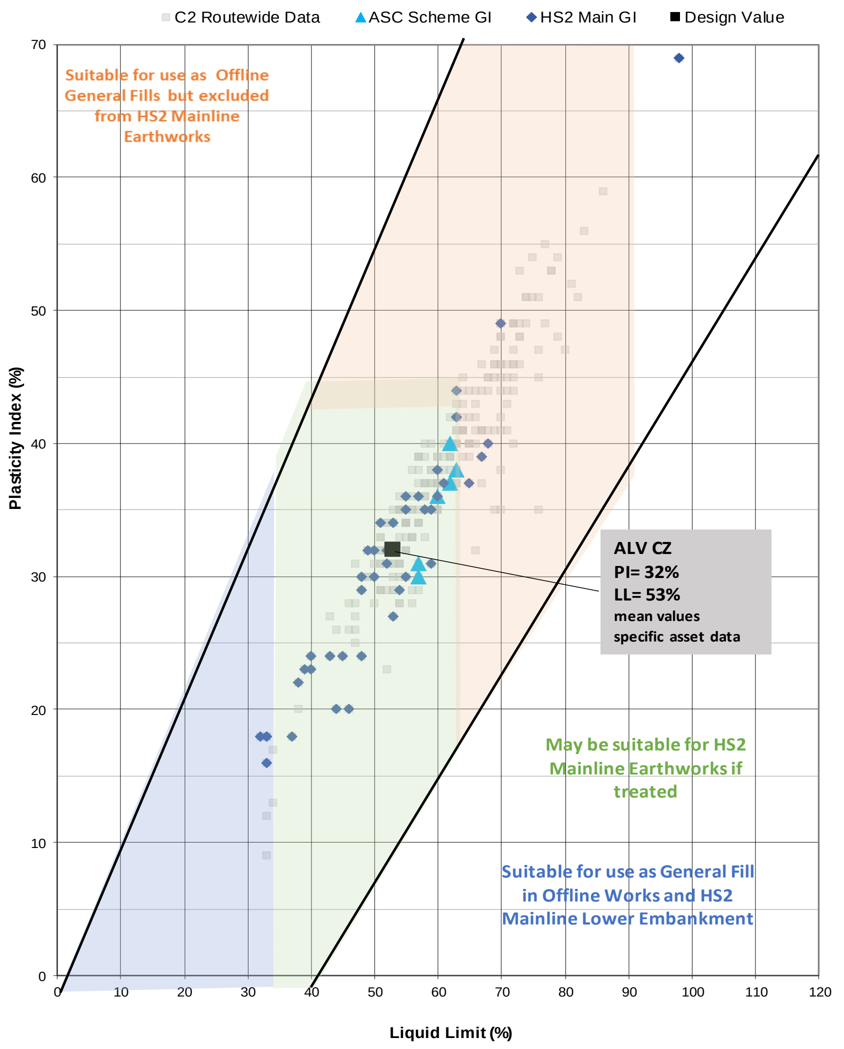


Figure D-18. Particles size distribution within the Alluvium deposits (ALV CZ) – Twyford Embankment

Atterberg limits (B2, B3)

HS2	A-Line Plot - HS2 Suitability Overlay				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	ALV-C Z	Figure:	B2

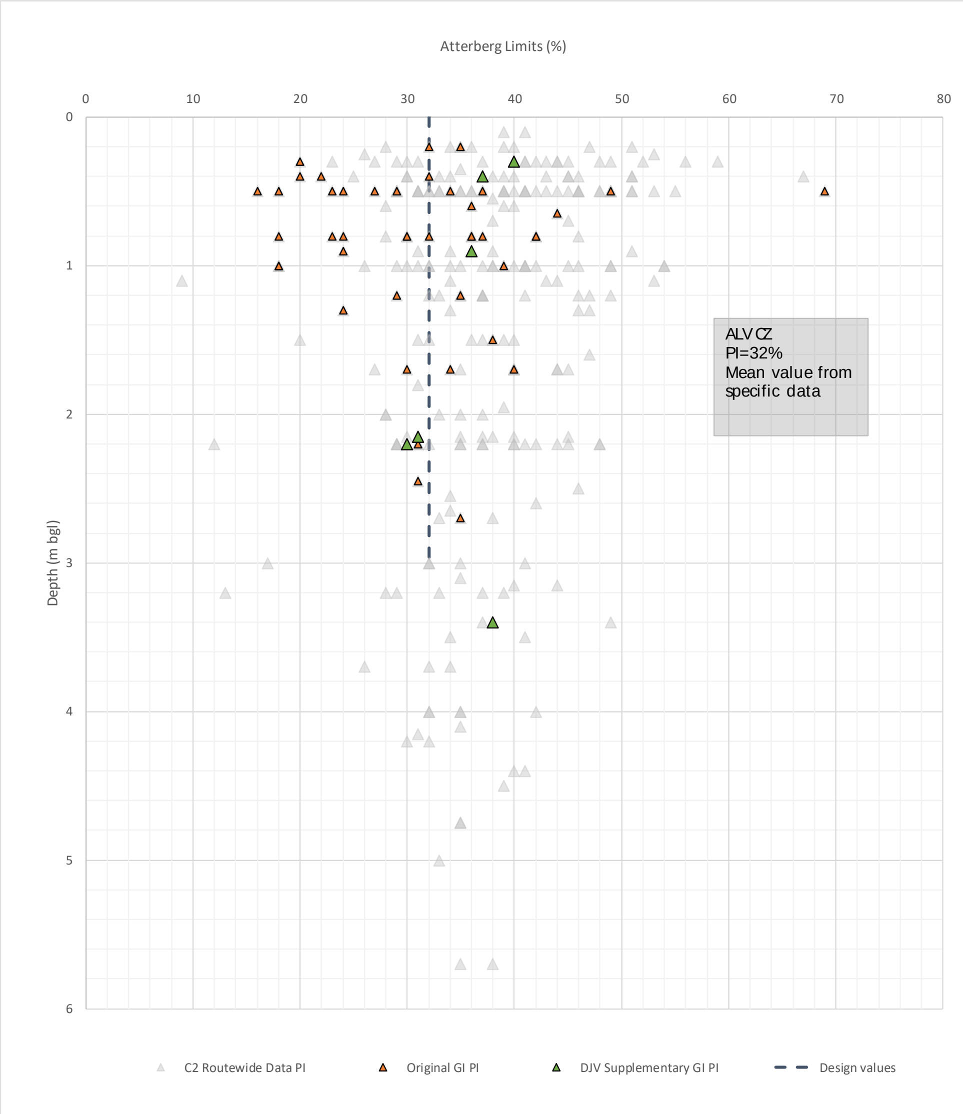


Number of Tests:	Offset:	Plot Date:	19/07/2021
	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	Holebase database reference	Datadrop 10. Published 05/2021

Figure D-19. Plasticity Index vs. Liquid Limit within the Alluvium deposits (ALV CZ) – Routewide

HS2 Ltd - Code 1 - Accepted

HS2	Liquid limit, Plastic limit and Plasticity Index with depth (mbgl)					
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley		Location:	Twyford Embankment Group
Client:	HS2	Geology :	ALV-C Z		Figure:	B3

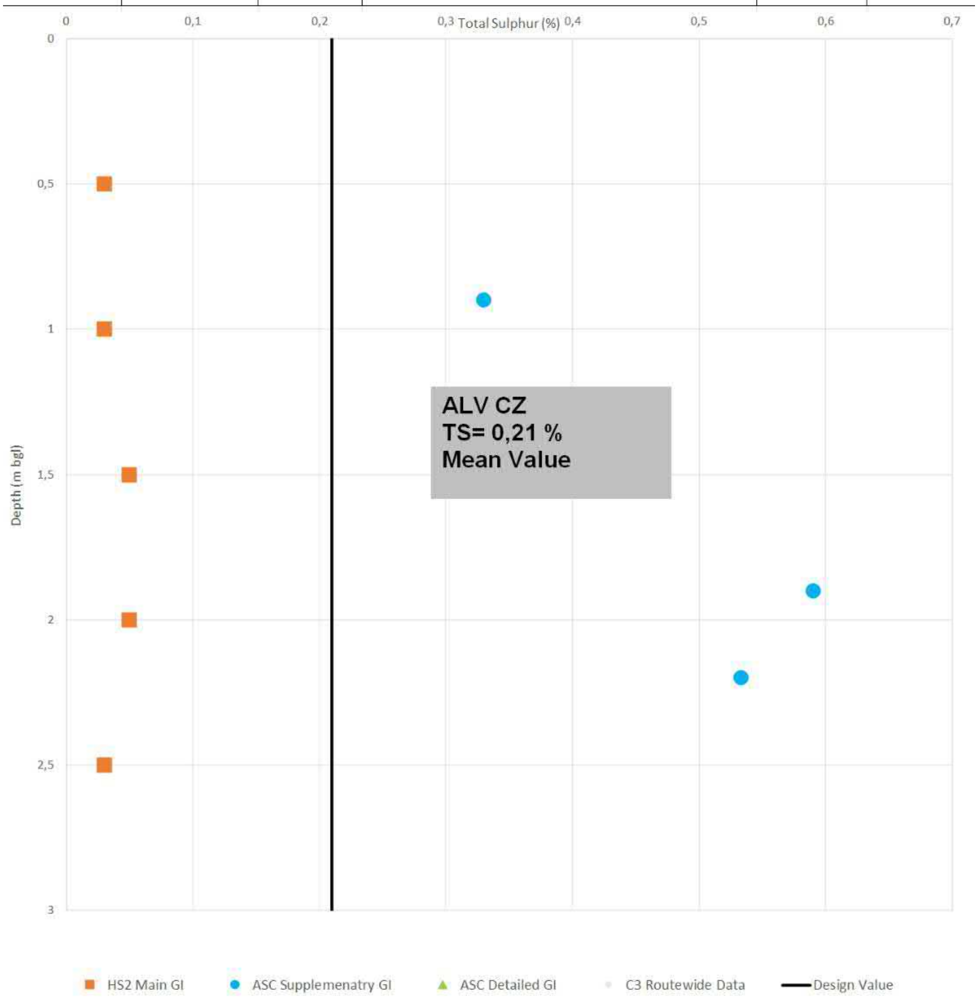


Number of test	148	Notes	Plot Date:	15/07/2021
		Background C2 Routewide data shown are based on Holebase database geology codes dated 29/05/2021	Offset:	
			Holebase database reference	Datadrop 10. Published 05/2021

Figure D-20. Plasticity Index vs. depth within the Alluvium deposits (ALV CZ) – Twyford Embankment and Routewide

Sulphur content (B4)

HS2	Total Sulphur (as % S) vs Depth (m bgl)						
Project ID:	10039367	Project Title:	1MC07 - Stage One C3 -MWCC – Brackley to South Portal of Long Itchington Tunnel	Location:	Twyford embankmen		
Client:	HS2	Geology :	ALV-C Z	Figure:	B4		

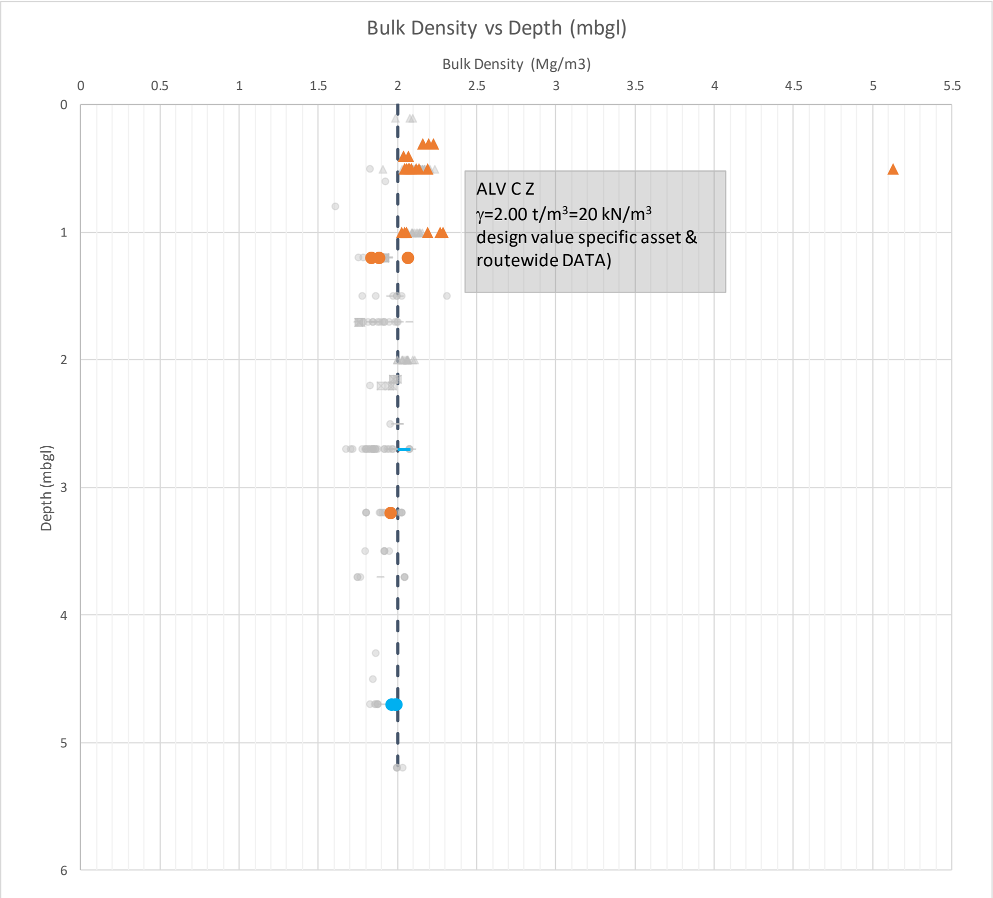


	TS %	Note		
Number of Tests	13	Background C3 scheme wide parameters shown are based on holebase database geology codes dated 29/10/2021.	Plot Date:	15/03/2022
Minimum	0,03			
Maximum	0,59			
			Database Reference	Data drop 17

Figure D-21. Total sulphur TS(%) within the Alluvium deposits (ALV CZ) – Twyford Embankment

Bulk density γ' (B5)

HS2	Bulk Density vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	ALV-C Z	Figure:	B5

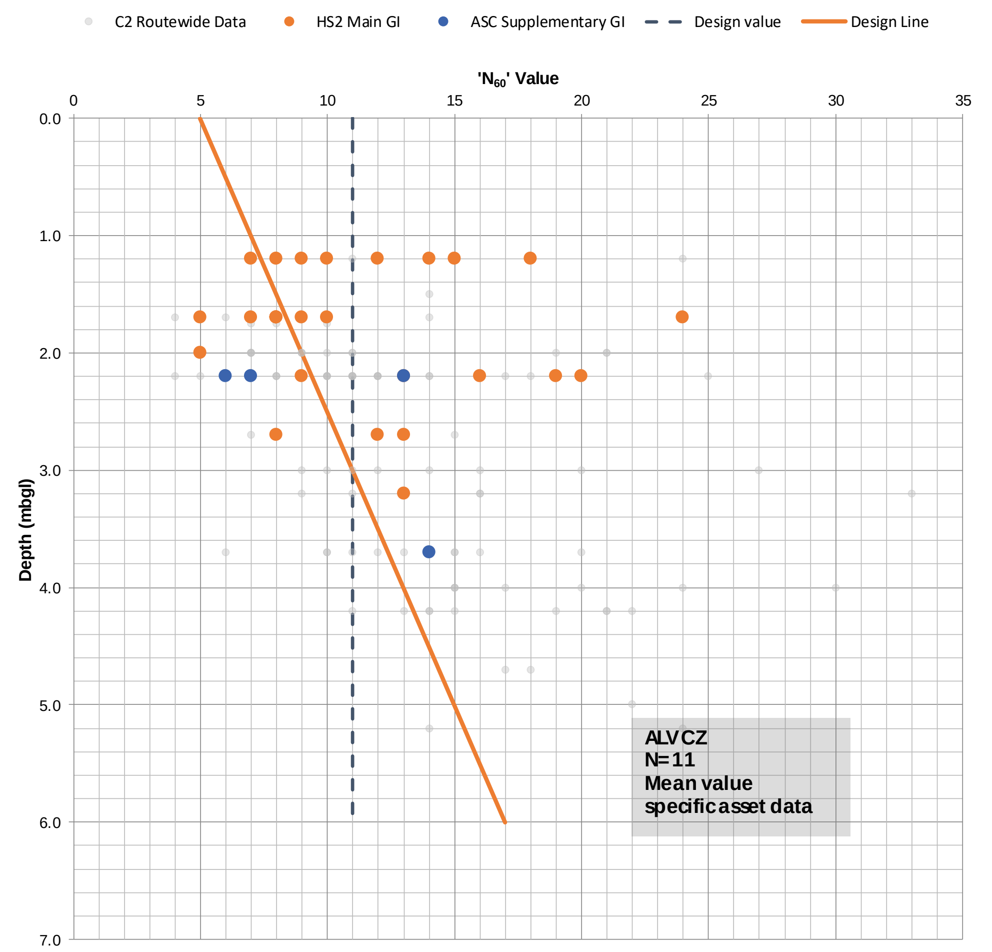


	Bulk Density	Notes	Plot Date:	15/07/2021
Number of Tests	35	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021		
Minimum	1.84			
Maximum	5.13			
asc A High-Speed Design Partnership ARCADIS COWI			Database reference number	Datadrop 10. Published 05/2021

Figure D-22. Bulk density obtained from different lab tests within the Alluvium deposits (ALV CZ) – Twyford Embankment and Routewide

Penetration desistance (B6)

HS2	SPT-N_{60} vs. Depth (mbgl)				
Project ID:	**10039367**	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment Group**
Client:	**HS2**	Geology :	**ALV-C Z**	Figure:	**B6**



	N Value	Notes		
Number of Tests	31	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	**Plot Date:**	15/07/2021
Minimum	5			
Maximum	24			
Offset				
			Holebase Database Reference	Datadrop 10. Published 05/2021

Figure D-23. SPT results within the Alluvium deposits (ALV CZ) – Twyford Embankment and routewide

N value (blows/ 305mm)	Consistency	Field Indications	Approximate C_u (kPa)
0 to 2	Very Soft	Excludes between the fingers when squeezed in the fist	0 – 12.5
2 to 4	Soft	Easily moulded in the fingers	12.5 – 25
4 to 8	Medium (Firm)	Can be moulded in the fingers by strong pressure	25 – 50
8 to 15	Stiff	Cannot be moulded in the fingers	50 – 100
15 to 30	Very Stiff	Brittle or very tough	100 – 200
>30	Hard	-	>200

Figure D-24.Correlation C_u with N_{SPT} values Consistency and field descriptions (source: EPRI, 1990)

Undrained shear strength c_u (B8)

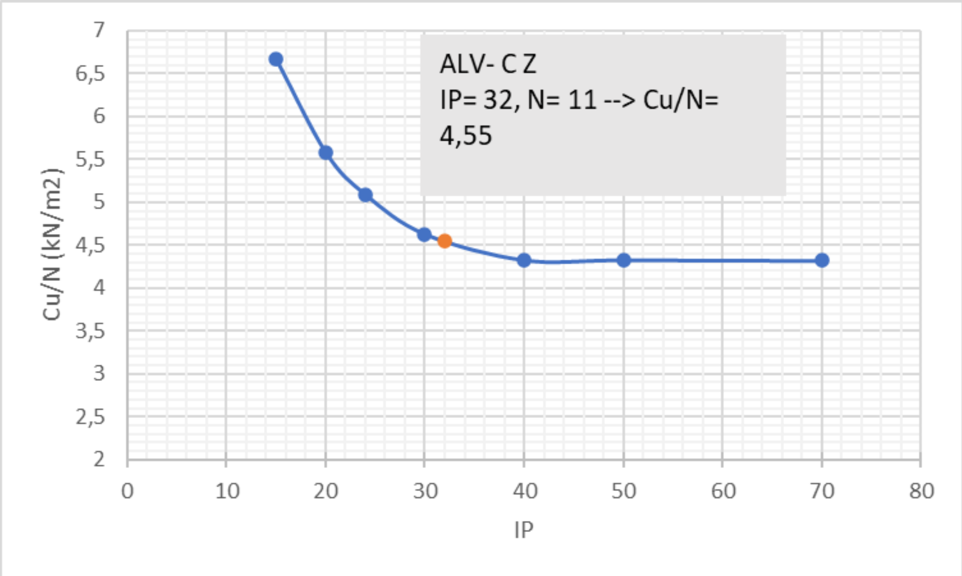
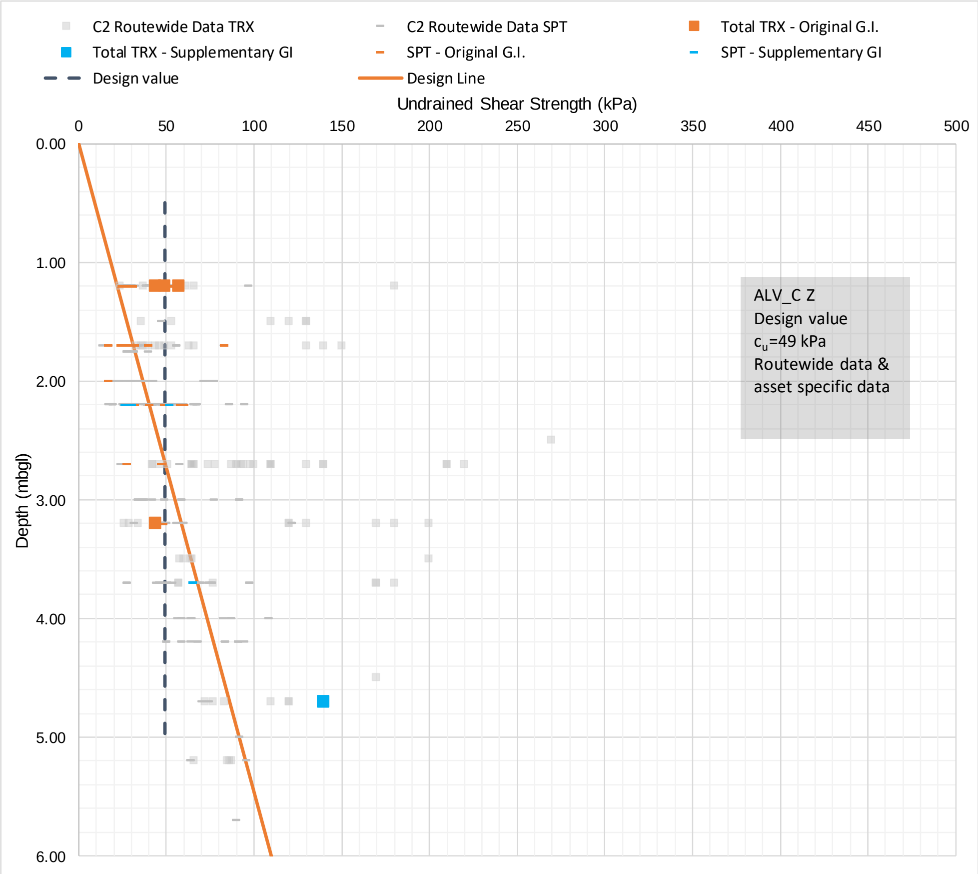


Figure D-25. Correlation between SPT N value and undrained shear strength cu, based on the Plasticity index PI Ladd et al. 1977 Ref. [60] (CIRIA R143) Ref [61]

HS2	Undrained Shear Strength vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	ALV-C Z	Figure:	B8



	Total	Notes	Plot Date:	15/07/2021
Number of Tests	-	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021		
Minimum	-			
Maximum	-			
Offset				
		Inferred ground conditions applied to CPT Cu profiles are based on review of exploratory hole information adjacent to the CPT position.	**Holebase database reference**	Datadrop 10. Published 05/2021

Figure D-26. Undrained shear strength obtained from different lab and in situ tests within the Alluvium deposits (ALV CZ)– Twyford Embankment and Routewide

Effective cohesion c' and effective friction angle ϕ' (B9)

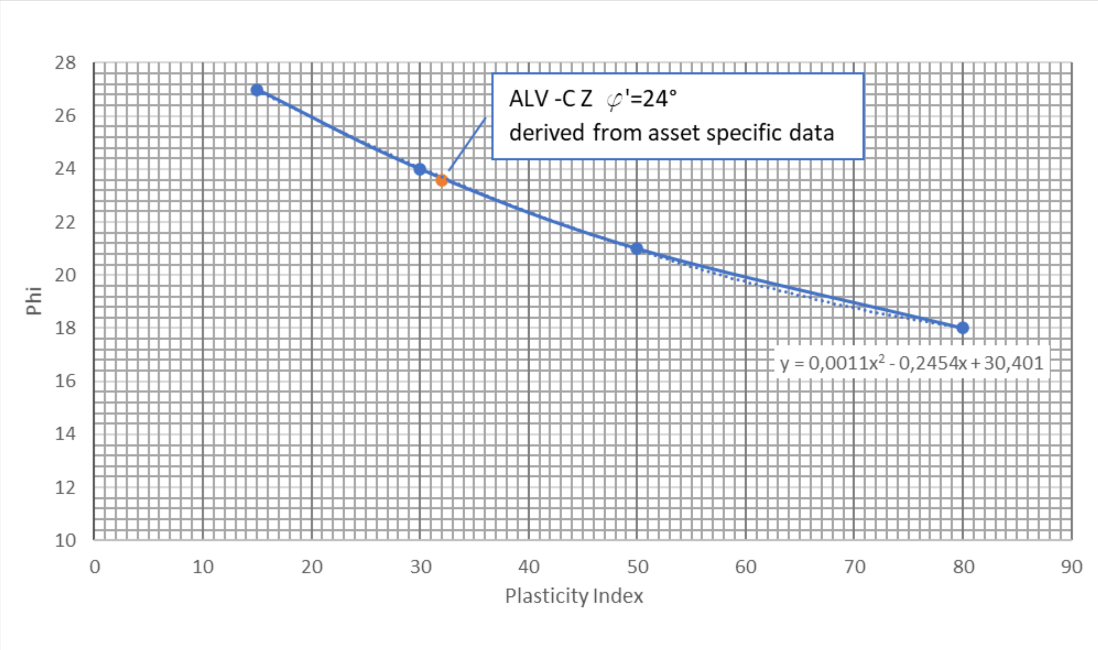
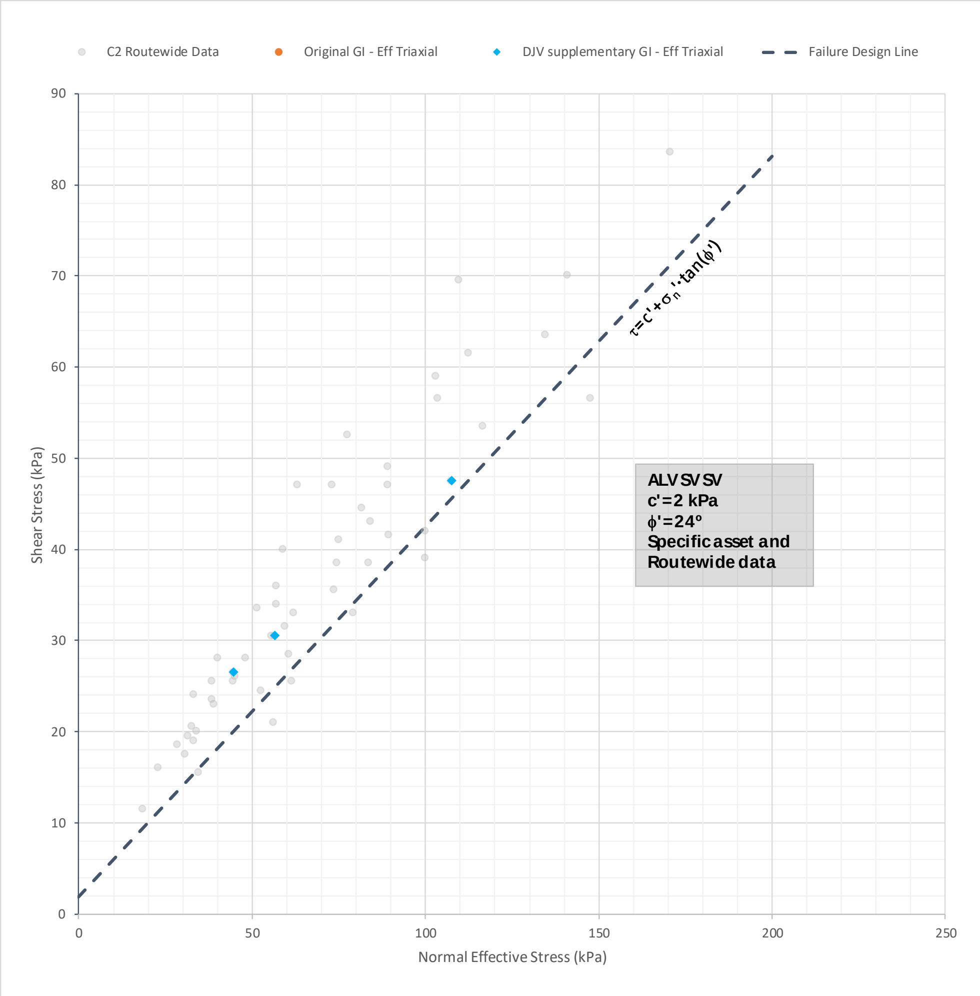


Figure D-27. Characteristic constant volume angle of shearing resistance ϕ'cv derivation (BS 8004:2015) Ref.[64] from asset specific mean Plasticity Index within the ALV -C Z

Effective Triaxial tests

Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	ALV-C Z	Figure:	B9



Notes:	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	Plot Date: 15/07/2021 Offset
Database reference	Datadrop 10. Published 05/2021	

Figure D-28. Shear stress vs. Normal Stress in Alluvium deposits (ALV CZ)

Coefficient of consolidation c_v

Derivation from k obtained from lab consolidation tests and in situ permeability tests

$$c_v = \frac{k}{m_v \cdot \gamma_w}$$

Where:

c_v=coefficient of consolidation (m^2/s)

k=hydraulic conductivity (m/s),

m_v=coefficient of volume change (m^2/kN)

γ_w=unit weight of pore fluid/water (kN/m^3)

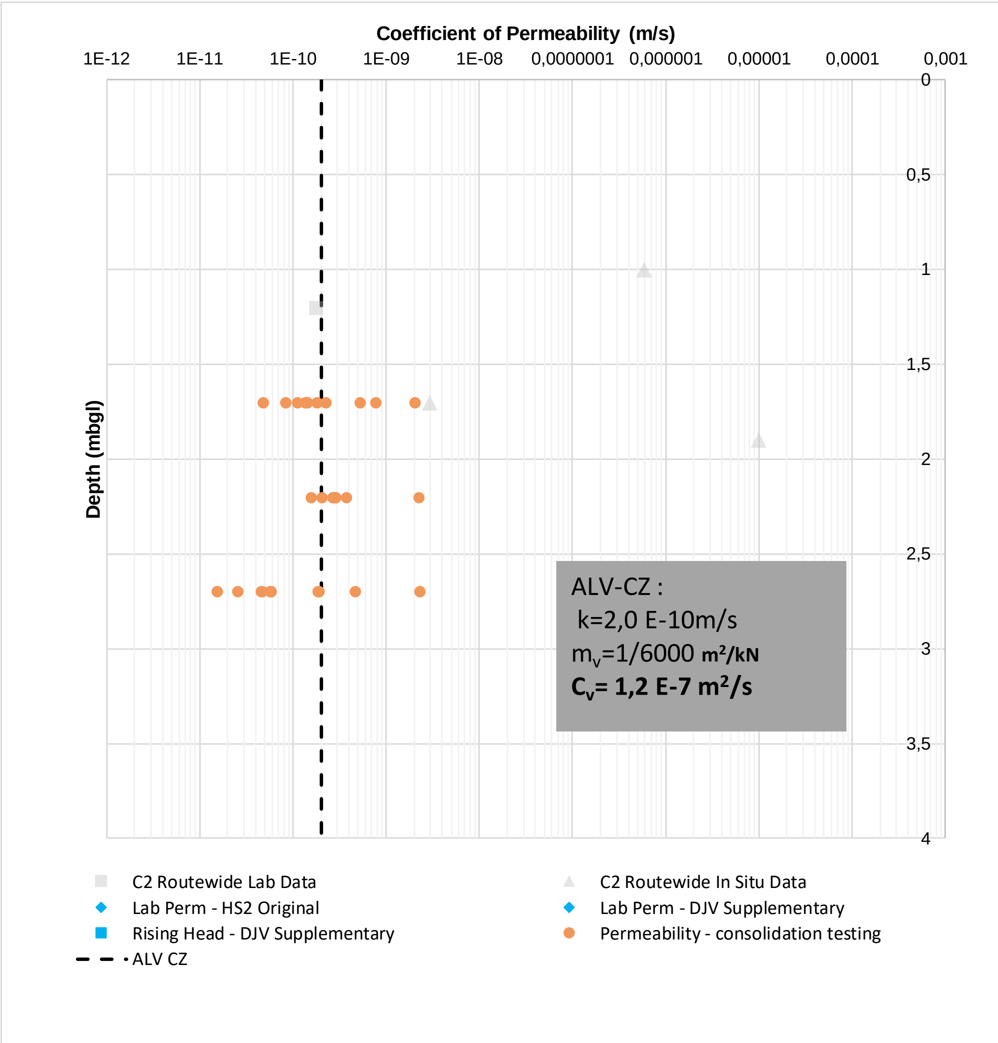
$c_{v\_insitu} = 10 \cdot c_{v\_lab}$ >> $k_{\_insitu} = 10 \cdot k_{\_lab}$

$c_r = c_{v\_insitu}$

Permeability vs Depth (m bGL) (B10)

Permeability vs. Depth (mbgl)

Project ID:	C2-C3-CONT-ASC	Project Title:	1MC06 North Portal of Chiltern Tunnels to Brackley & 1MC07 Brackley to Long Itchington Wood Green Tunnel South Portal	Location:	Twyford Embankment Group
Client:	HS2	Geology :	ALV -CZ	Figure:	B10



	Permeability
Number of Tests	-
Minimum	-
Maximum	-

Notes
Background C2 scheme wide parameters shown are based on holebase database geology codes dated 11/08/2020

Plot Date: 11/03/2022

Holebase database reference	Data drop 17

Figure D-29. permeability vs. depth in Alluvium deposits (ALV)

Young Modulus E' (B11)

Correlation with N obtained from SPT

E'=K·N

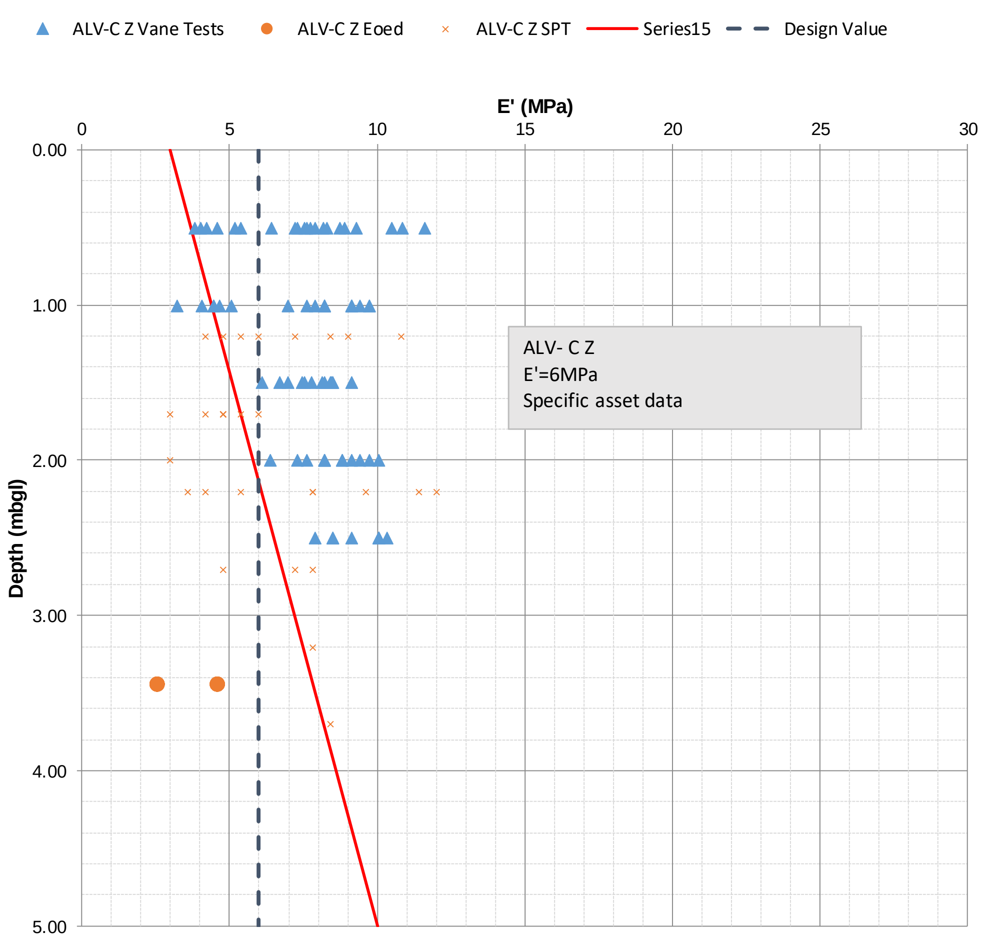
Where K=0.6-0.9 for over-consolidated unweathered clayey soils; and K=0.6 for slightly over-consolidated weathered clayey soils (CIRIA R143) Ref.[61]

Relationship between E' - E_u

$$\boldsymbol{E'} = E_u \frac{1 + \nu'}{1 + \nu_u}$$

Where: E'=Young Modulus; E_u=Undrained Young Modulus; ν'=Poisson's ratio=0.2 and ν_u=Undrained Poisson's ratio=0.5.

HS2		E' (MPa) vs. Depth (mbgl)			
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment
Client:	HS2	Geology :	E' ALV C Z	Figure:	B11



	E'	Notes	Plot Date:	11/06/2021
Number of Tests	119			
Minimum	2.585271318			
Maximum	12			
Offset				
asc A High-Speed Design Partnership ARCADIS COWI			Holebase database reference	Data drop 10. Published 05/2021

Figure D-30. E' obtained from different lab tests within the Alluvium deposits (ALV CZ) – Twyford Embankment

Oedometer Modulus E_{oed} (or Coefficient of volume change m_v=1/E_{oed}) (B12)

Correlation with N from SPT

Eoed=1/mv=f2·N (Tomlinson and Woodward, 2008)

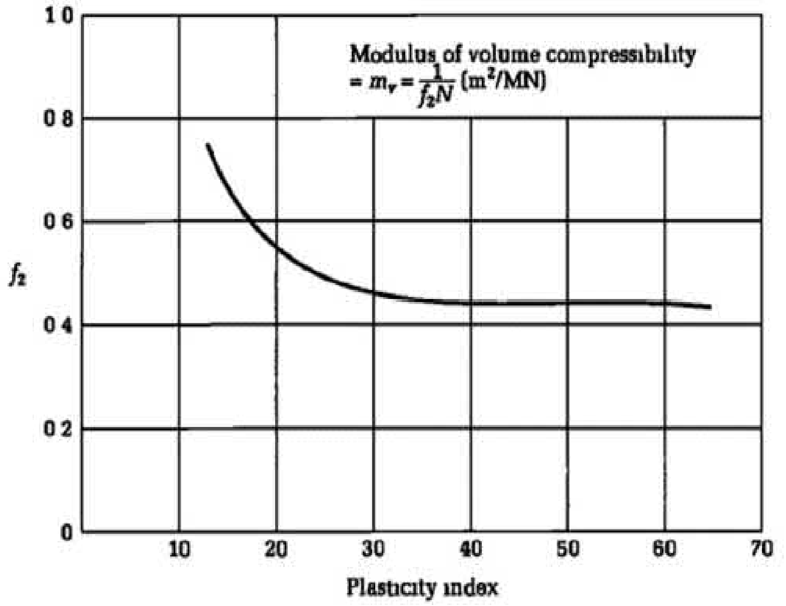


Figure D-31. coefficient f2 to correlate mv=1/Eoed from N SPT and PI within the Alluvium deposits – Routewide

Correlation of E' coming from N of SPT

$$\boldsymbol{E}' = E_{oed}\frac{(1-2\cdot\nu\prime)\cdot(1+\nu\prime)}{1-\nu\prime}$$

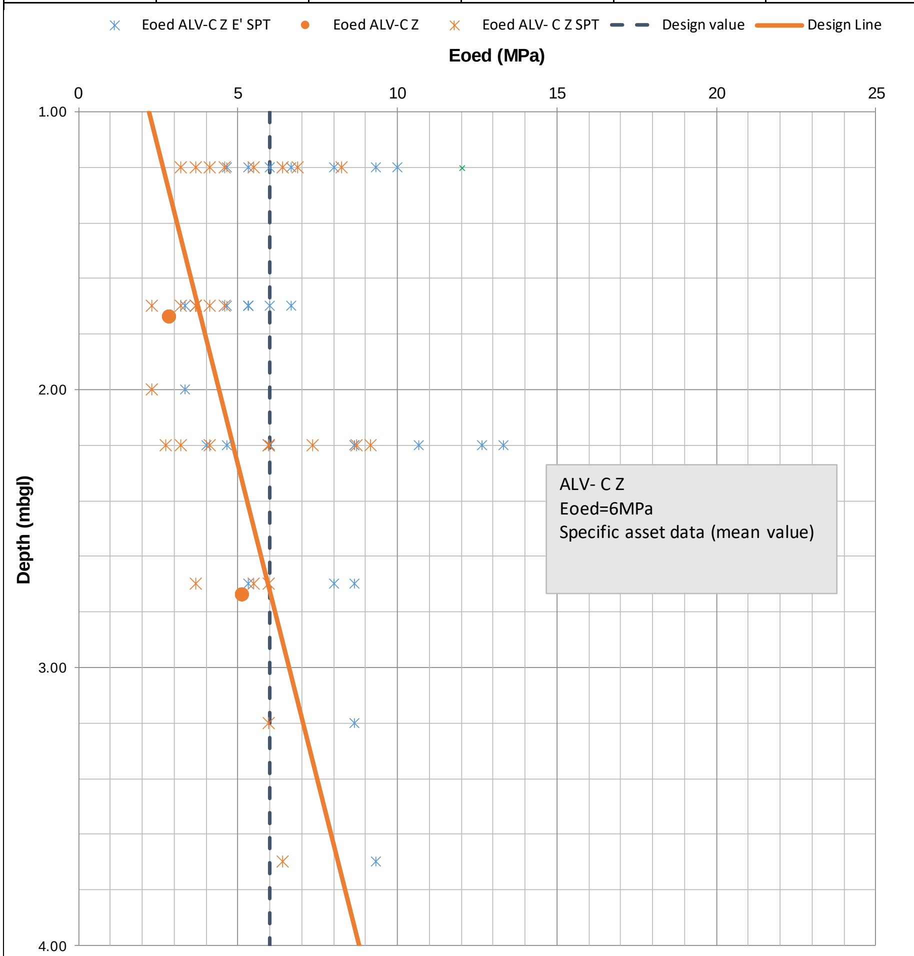
Where: E'=Young Modulus (see below); E_{oed}=Oedometer Modulus; and ν'=Poisson's ratio=0.2

E'=K·N

Where K=0.6-0.9 for over-consolidated unweathered clayey soils; and K=0.6 for slightly over-consolidated weathered clayey soils

Oedometer modulus E_{oed} (MPa) (B13)

HS2	Eoed (MPa) vs. Depth (mbgl)				
Project ID:	**10039367**	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment**
Client:	**HS2**	Geology :	**Eoed ALV C Z**	Figure:	**B12**



	Eoed	Notes	Plot Date:	11/06/2021
Number of Tests	77			
Minimum	2.29E+00			
Maximum	1.33E+01			
Offset				
asc A High-Speed Design Partnership ARCADIS COWI			Holebase database reference	Data drop 10. Published 05/2021

Figure D-32. E_{oed} obtained from different lab tests within the Alluvium deposits (ALV CZ) – Twyford Embankment

River Terrace Deposits- (RTD-S V SV)

The below table provides brief commentary on:

- the type and quantity of tests to prove the geotechnical design values,
- general trends of geotechnical values with depth,
- the plots used to determine the design values of each geotechnical parameter.

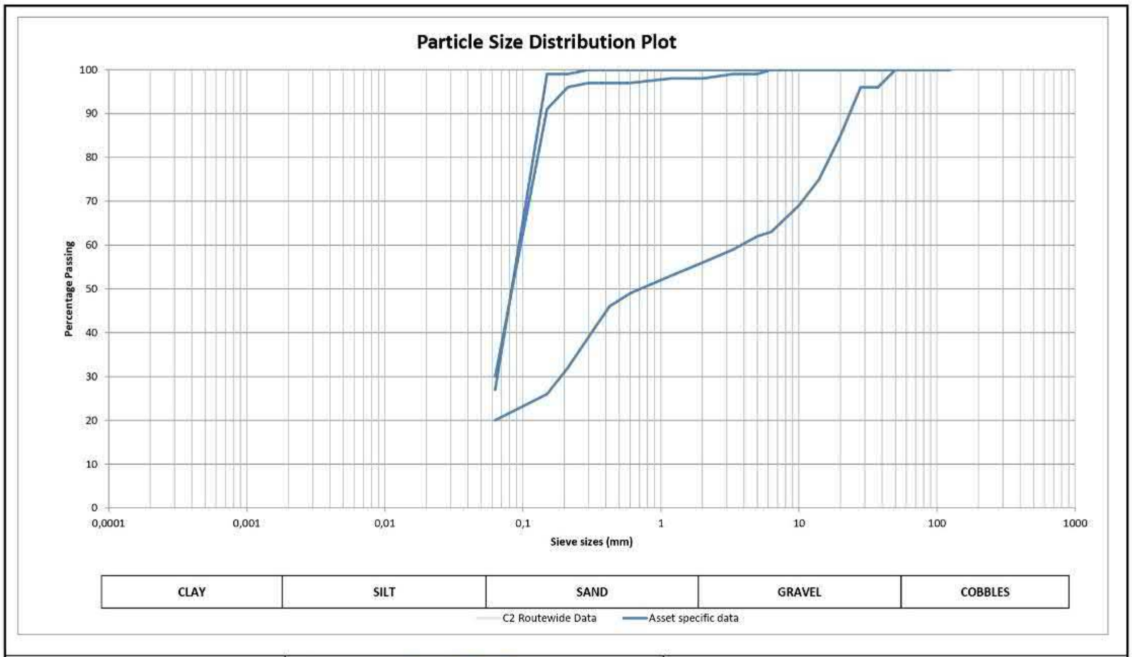
Reference should be made to the plots for the justification of the characteristic design values adopted in the geotechnical models and calculations (refer to Section 8.2).

Table D- 3. Commentary and justification of characteristic design values in RTD- S V SV

Fines content	#0.063	• only results from asset specific lab tests are considered • based on the test results and on the borehole logs, RTD is described as locally soft and firm slightly **clayey fine to medium SAND**	F1
Plasticity index	PI	• only results from asset specific lab tests are considered • ~~a range of~~ values around the mean value has been used in the design	F2, F3
Liquid limit	LL	• only results from asset specific lab tests are considered • ~~a range of~~ values around the mean value has been used in the design	F2
Total Sulphur contents	TS	• the mean value is used to obtain the Total Potential Sulfate contents TPS (%) to assess its re-use	F4
Bulk density	γ'	• only one specific asset lab test is available. • A cautious value is considered. • This value is equal to the value taking in the ALV S V SV .	F5
Blow N number from SPT, corrected to 60% test energy	N_{60}	• only seven test results are available within this asset • the asset specific results indicate medium dense to dense consistency	F6
WhCone resistance from CPT	q_c	• no CPT are available within this asset	N/A
Undrained shear strength	c_u	• SPT tests results are used to find the representative values	F6
		• One triaxial test result are available within this asset • In view of the few drained triaxial tests, a cautious cu=108 kPa has been used in the design, this value coming from the correlation with NSPT.	F8
Drained shear strength	c'	• No triaxial Cu+u and triaxial CD tests are available in this asset. • No Shear box tests are available in this asset. • In view of the absence of drained triaxial tests, a cautious long term drained value of c'=0 kPa has been used in design due to the less fine content in the material	F9
	ϕ'	• No CD triaxial available in this asset. • A cautious value of ϕ' is considered. This value is calculated with the correlation with PI for normally consolidated clays (Ladd et al. 1977) Ref. [60] which is less and cautious with the value recommended by the technical standard.	F9

Coefficient of Permeability and coefficient of consolidation	k, c_v	• No results are available within the specific asset. No results are available in the route wide . • The design value used is equal to the design value used in the KLB – S V SV as it can be observed by the logs descriptions, they have a very similar particle size distribution. • A very conservative value of $k=4 \cdot 10^{-10}$ m/s is used to obtain the design value of the coefficient of consolidation $c_v = 10^{-6}$ m^2/s	F10
Young/Effective Deformation Modulus	E'	• SPT tests results are the used data to find the representative values	F6
		• E' is correlated by N coming from SPT (CIRIA R143) Ref. [61], by means of E'/N=1.5, which can be consider for gravelly sandy soils and normally consolidated sands.	F11
Oedometer Deformation Modulus	E_{oed}	• An evaluation has been done from Relationship between the Oedometer Modulus E_{oed} and E' coming from N of SPT (CIRIA R143) Ref. [61]	F12
		• The design value is towards the average of results coming from SPT and is consistent with the trend line E'=4.1+z at the midpoint of the layer. Results coming from Vane Tests give over-estimation of this parameter.	F8, F12
Oedometer Deformation Modulus	E_{oed}	• Exclusively SPT results (as being a purely cohesionless soil) are used to find the representative values	F6
		• PI is used to obtain relationship between Eoed=1/mv and N coming from SPT	F13
		• Relationship between the Oedometer Modulus E_{oed} and E' coming from N of SPT (CIRIA R143) Ref.[61] by means of a factor f2=0.75 • Considering the relation between Eoed and E', the trend line with depth of cu is transformed to a trend line Eoed =4.5+1.05z • The design value is given by the trend line Eoed=4.5+1.05z at the midpoint of the layer, even though it is close to the highest results coming from E'=f(N). The trend line comes at the end from cu trend line coming from routewide data which is considered more representative.	F8, F13

Particle size distribution (F1)

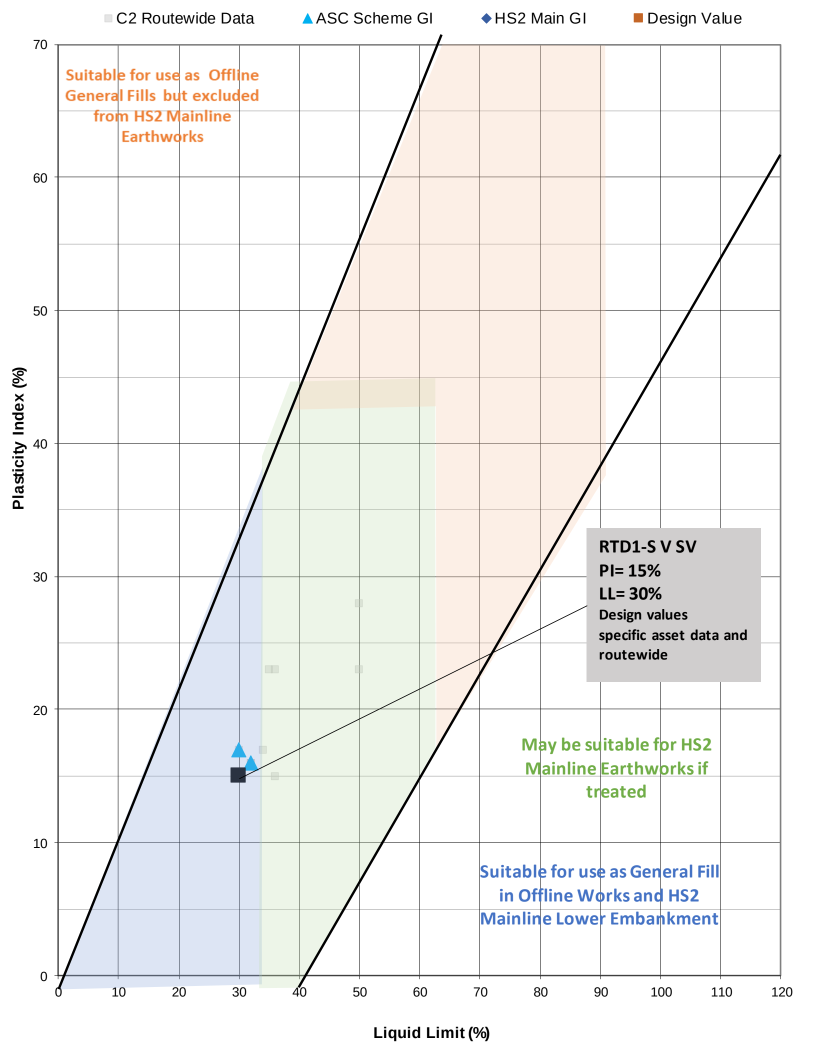


Notes	Client		Title			
Background C2 scheme wide parameters shown are based on holebase database geology codes dated 11/08/2020	HS2		: Particle Size Distribution for River Terrace Deposits			
	Location	0	Project ID	10039367		
	Project Title	1MC07 - Stage One C3 -MWCC – Brackley to South Portal of Long Itchington Tunnel	Figure	F1	Date	22/06/2021

Figure D-33. Particles size distribution within the River Terrace Deposits- (RTD-S V SV)– Twyford Embankment

Atterberg limits (F2, F3)

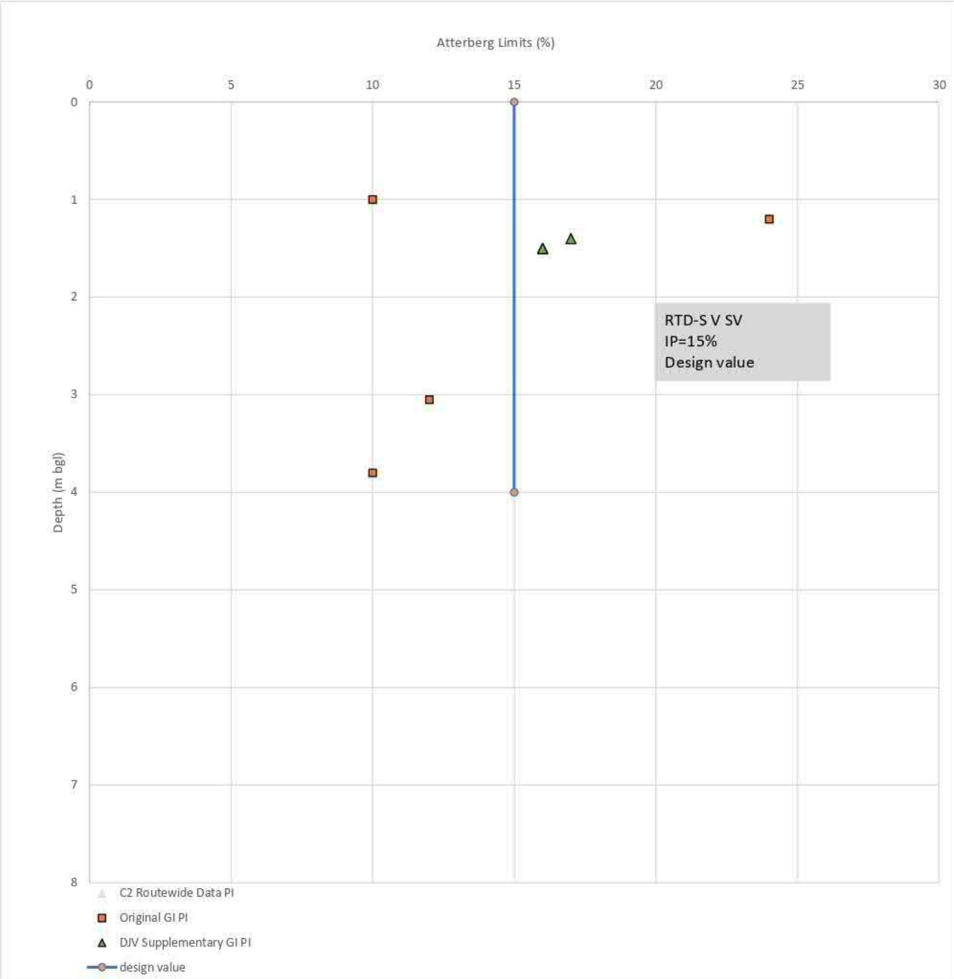
HS2	A-Line Plot - HS2 Suitability Overlay				
Project ID:	**10039367**	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment Group**
Client:	**HS2**	Geology :	**RTD1-S V SV**	Figure:	**F2**



Number of Tests:	Offset:	Plot Date:	19/07/2021
	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	Holebase database reference	Datadrop 10. Published 05/2021

Figure D-34. Plasticity Index vs. Liquid Limit within the River Terrace Deposits- (RTD-S V SV)– Twyford Embankment

HS2	Liquid limit, Plastic limit and Plasticity Index with depth (mbgl)						
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley			Location:	Twyford Embankment Group
Client:	HS2	Geology :	RTD-S V SV			Figure:	F3

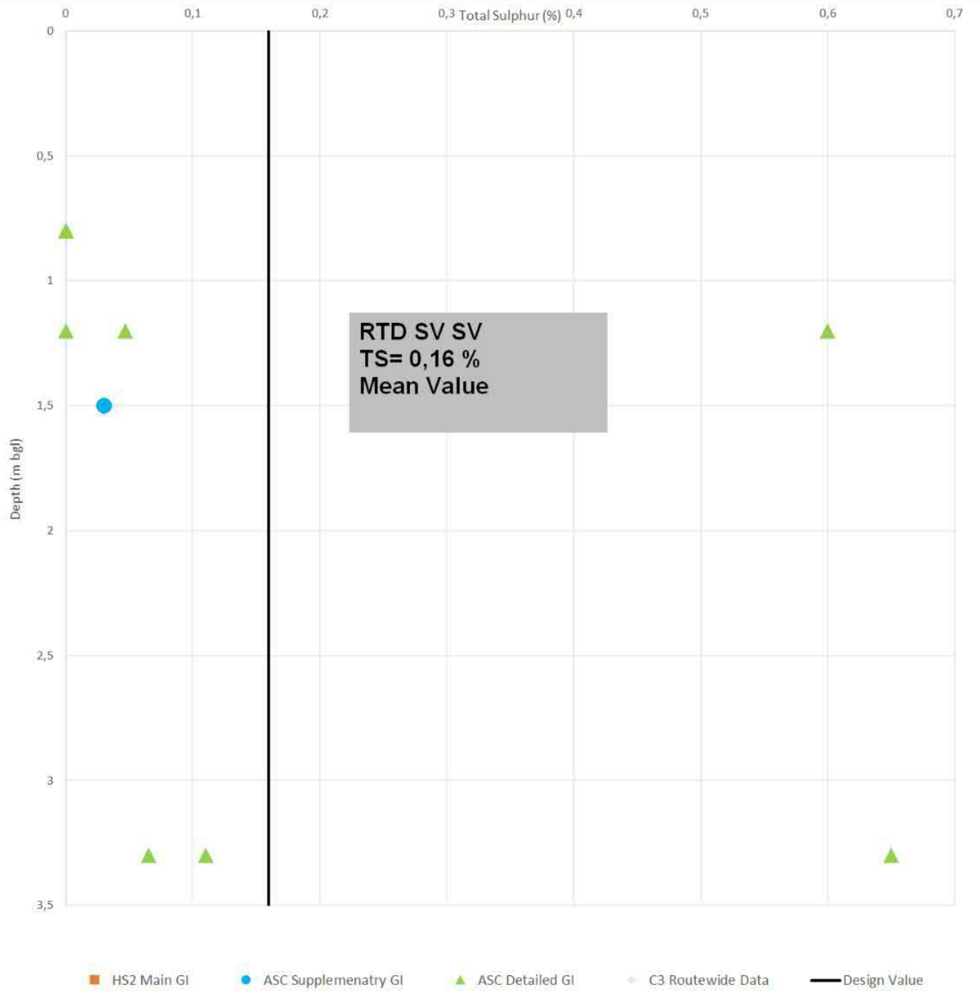


Number of test	24	Notes	Plot Date:	14/06/2021
		Background C2 Routewide data shown are based on Holebase database geology codes dated 29/05/2021	Offset:	
			Holebase database reference	Datadrop 10. Published 05/2021

Figure D-35. Plasticity Index vs. depth within the River Terrace Deposits- (RTD-S V SV) – Routewide

Sulphur content (F4)

HS2	Total Sulphur (as % S) vs Depth (m bgl)				
Project ID: 10039367	Project Title:	1MC07 - Stage One C3 -MWCC – Brackley to South Portal of Long Itchington Tunnel		Location:	Twyford embankment
Client: HS2	Geology :	RTD1-S V SV		Figure:	F4



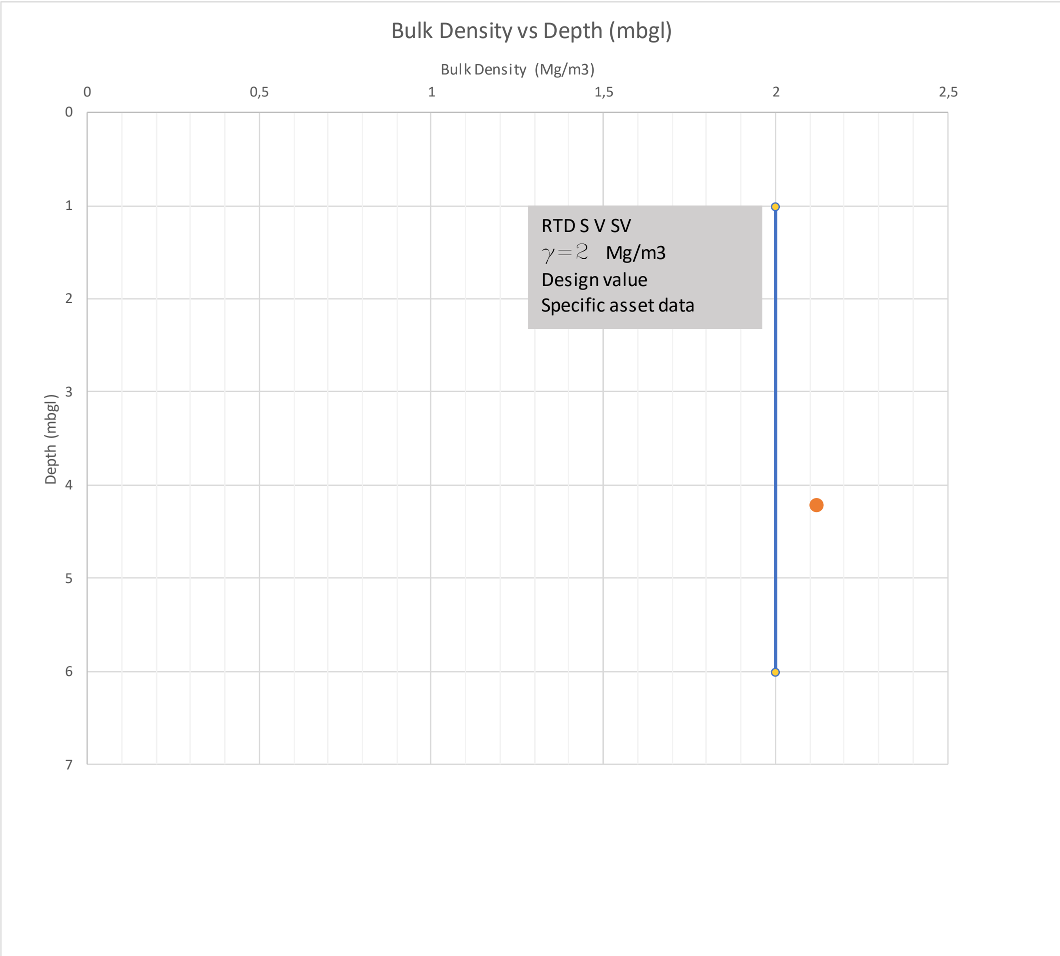
	TS %	Note		
Number of Tests	18	Background C3 scheme wide parameters shown are based on holebase database geology codes dated 29/10/2021.	Plot Date:	15/03/2022
Minimum	0,03		Database Reference	Data drop 17
Maximum	0,65			

Figure D-36. Total sulphur TS(%) within the River Terrace Deposits- (RTD-S V SV)– Twyford

Bulk density ɣ'' (F5)

Bulk Density vs. Depth (mbgl)

Project ID:	**10039367**	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment Group**
Client:	**HS2**	Geology:	**RTD-S V SV**	Figure:	**F5**

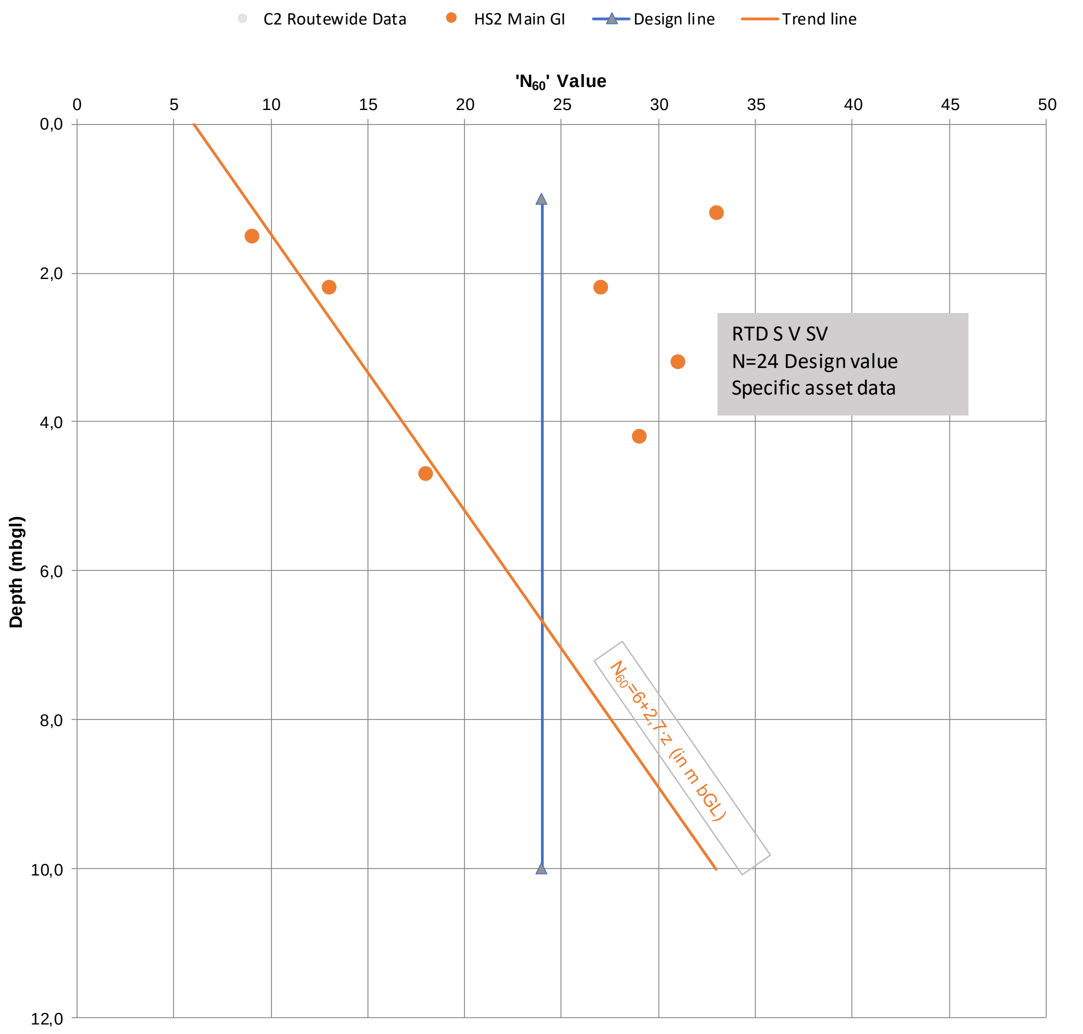


	Bulk Density	Notes	Plot Date:	19/07/2021
Number of Tests	1	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021		
Minimum	2,12			
Maximum	2,12			
			Database reference number	Datadrop 10. Published 05/2021

Figure D-37. Bulk density obtained from different lab tests within the River Terrace Deposits (RTD-S V SV)– Twyford Embankment and Routewide

Penetration Resistance (F6)

HS2	SPT-N_{60} vs. Depth (mbgl)					
Project ID:	10039367	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment Group**
Client:	**HS2**	Geology :	**RTD-S V SV**	Figure:	F6



	N Value	Notes		
Number of Tests	7	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	**Plot Date:**	19/07/2021
Minimum	9			
Maximum	33			
Offset				
			Holebase Database Reference	Datadrop 10. Published 05/2021

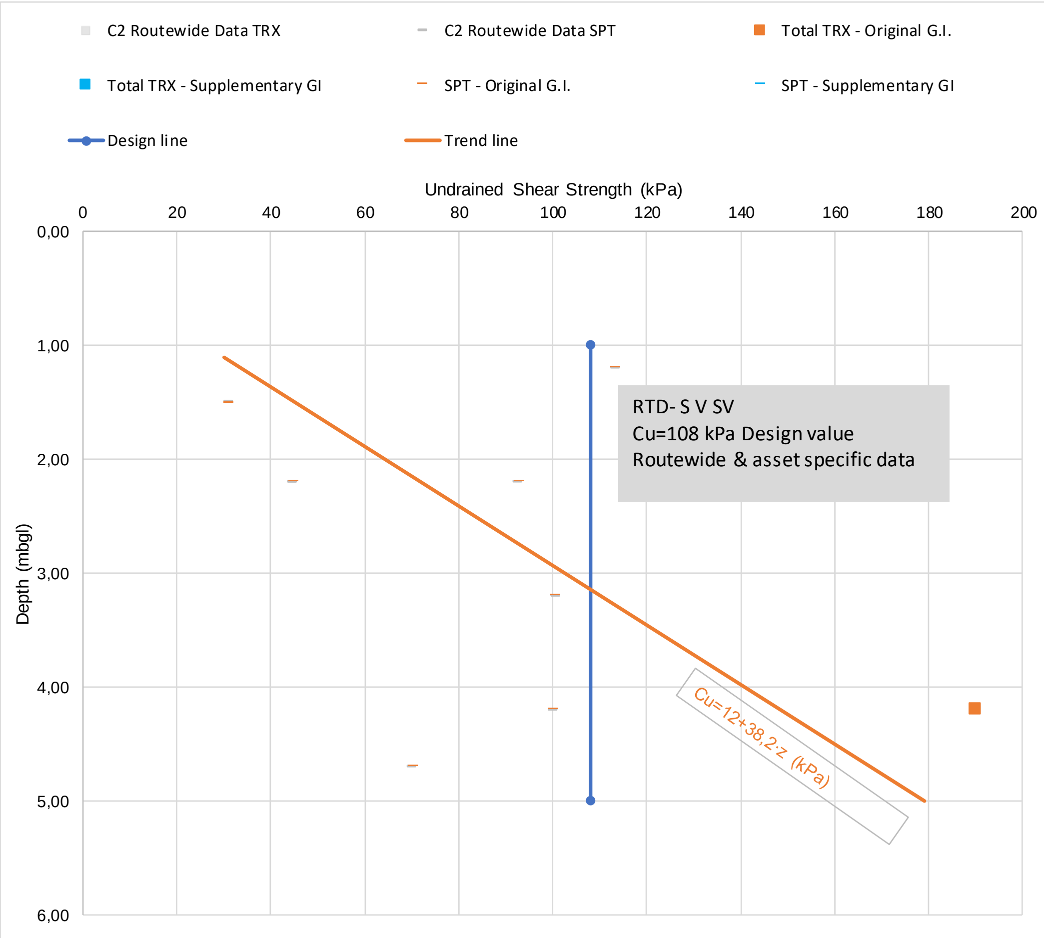
Figure D-38. SPT results within the River Terrace Deposits (RTD SV SV) – Twyford Embankment

N value (blows/ 305mm)	Consistency	Field Indications	Approximate C_u (kPa)
0 to 2	Very Soft	Excludes between the fingers when squeezed in the fist	0 – 12.5
2 to 4	Soft	Easily moulded in the fingers	12.5 – 25
4 to 8	Medium (Firm)	Can be moulded in the fingers by strong pressure	25 – 50
8 to 15	Stiff	Cannot be moulded in the fingers	50 – 100
15 to 30	Very Stiff	Brittle or very tough	100 – 200
>30	Hard	-	>200

Figure D-39.Correlation C_u with N_{SPT} values Consistency and field descriptions (source: EPRI, 1990)

Undrained shear strength c_u (F8)

HS2	Undrained Shear Strength vs. Depth (mbgl)				
Project ID:	**10039367**	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment Group**
Client:	**HS2**	Geology:	RTD-S V SV	Figure:	**F8**



	Total	Notes	Plot Date:	19/07/2021
Number of Tests	14	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021		
Minimum	-			
Maximum	-			
Offset				
asc		Inferred ground conditions applied to CPT Cu profiles are based on review of exploratory hole information adjacent to the CPT position.	**Holebase database reference**	Datadrop 10. Published 05/2021

Figure D-40. Undrained shear strength obtained from different lab and in situ tests within the River Terrace Deposits (RTD SV SV)– Twyford Embankment and Routewide

Effective cohesion c' and effective friction angle ϕ'

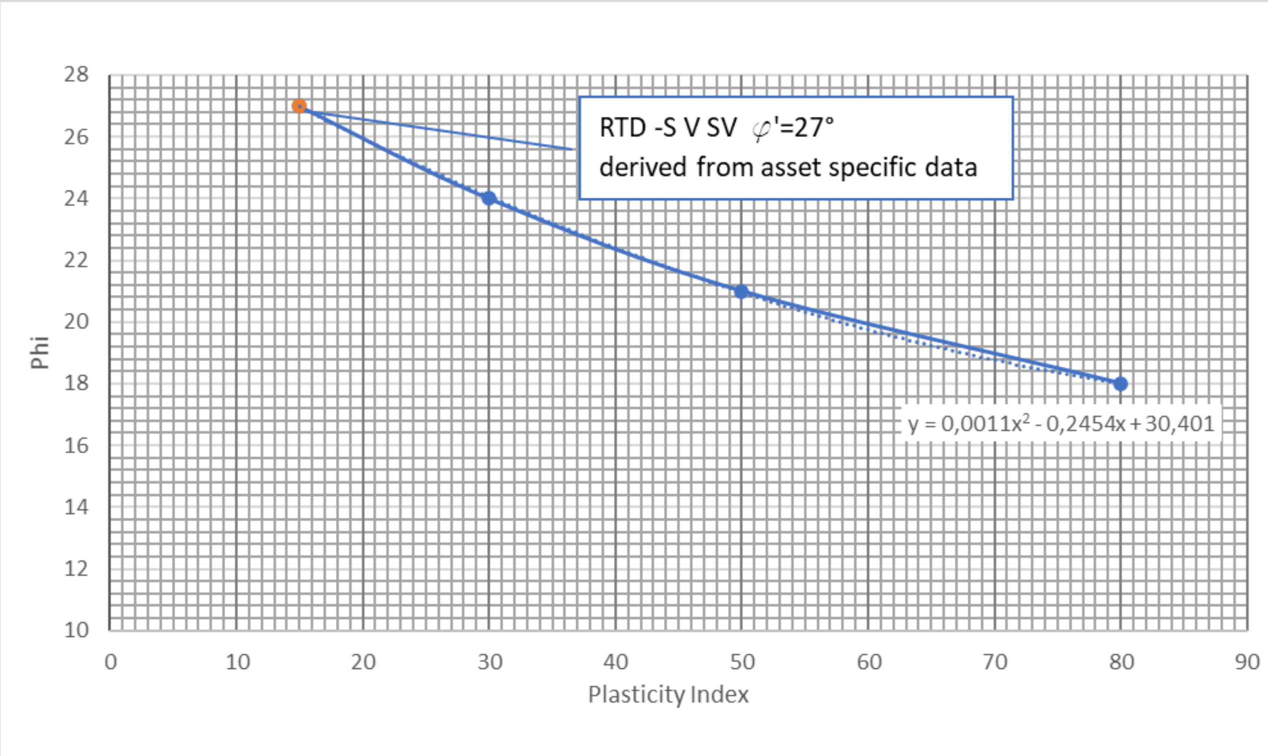


Figure D-41. Characteristic constant volume angle of shearing resistance ϕ'cv derivation (BS 8004:2015) Ref [64] from routewide mean Plasticity Index within the Alluvium deposits

Effective cohesion c' and effective friction angle ϕ' (F9)

Figure D-42. Shear stress vs. Normal Stress in the River Terrace Deposits (RTD SV SV) – Twyford Embankment and Routewide

Coefficient of permeability k and Coefficient of consolidation c_v (F10)

Derivation from k obtained from lab consolidation tests and in situ permeability tests

$$c_v = \frac{k}{m_v \cdot \gamma_w}$$

Where:

c_v=coefficient of consolidation (m^2/s)

k=hydraulic conductivity (m/s),

m_v=coefficient of volume change (m^2/kN)

γ_w=unit weight of pore fluid/water (kN/m^3)

$c_{v\_insitu} = 10 \cdot c_{v\_lab}$ >> $k_{\_insitu} = 10 \cdot k_{\_lab}$

$c_r = c_{v\_insitu}$

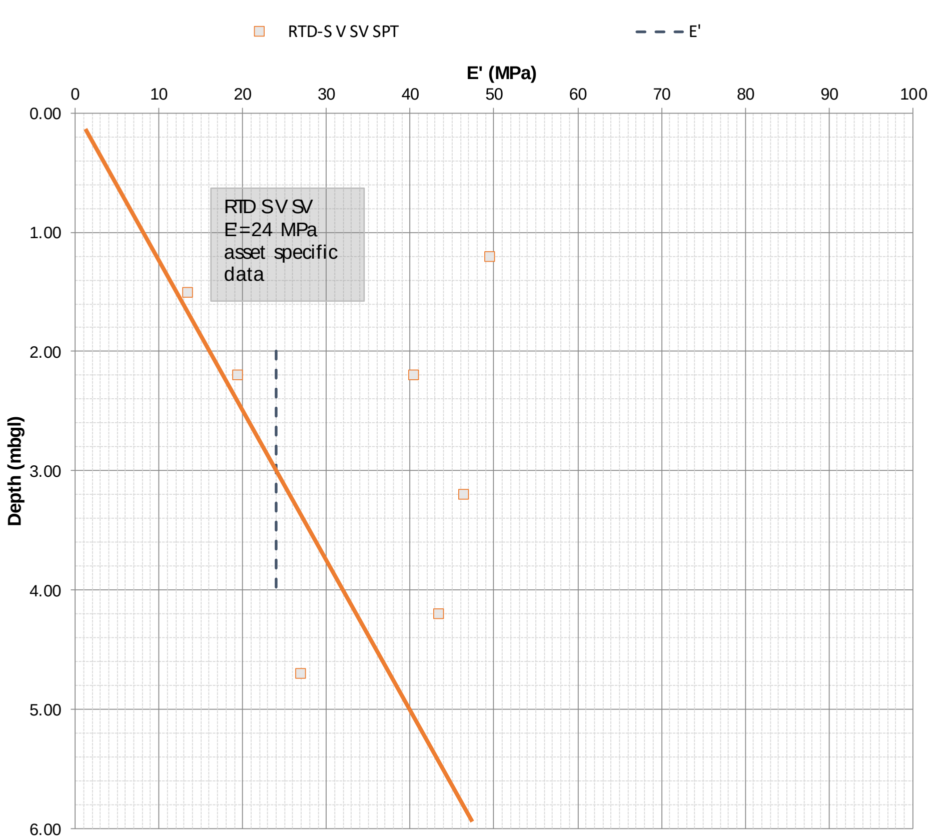
Young Modulus E' (F11)

Correlation with N obtained from SPT

E'=K·N

Where K=1-2 for gravelly sandy soil (CIRIA R143) Ref. [61]

HS2	E' (MPa) vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern	Location:	Twyford Embankment
Client:	HS2	Geology :	E' RTD S V SV	Figure:	F11



	E'	Notes	Plot Date:	11/06/2021
Number of Tests	7			
Minimum	1.35E+01			
Maximum	3.10E+01			
Offset				
			Holebase database reference	Data drop 10. Published 05/2021

Figure D-44. E' obtained from different lab tests within the River Terrace Deposits (RTD SV SV) – Twyford Embankment and Routewide

Oedometer Modulus E_{oed} (or Coefficient of volume change m_v=1/E_{oed}) (F12)

Correlation with N from SPT
Eoed=1/mv=f2·N (Tomlinson and Woodward, 2008)

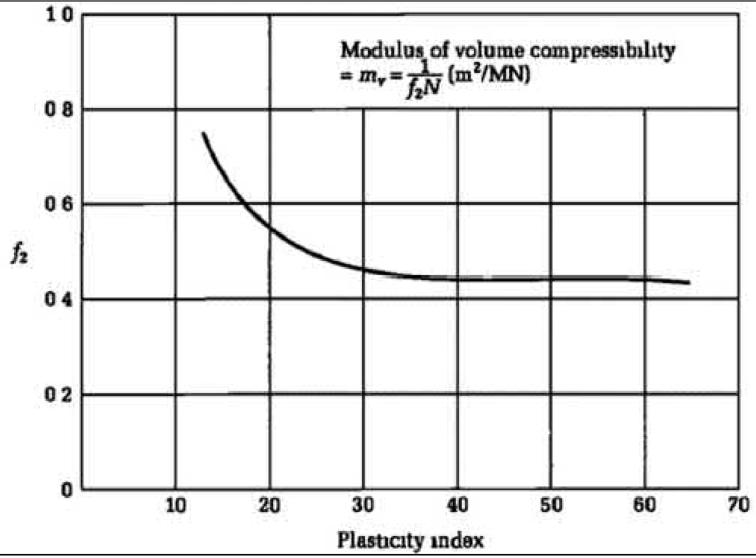
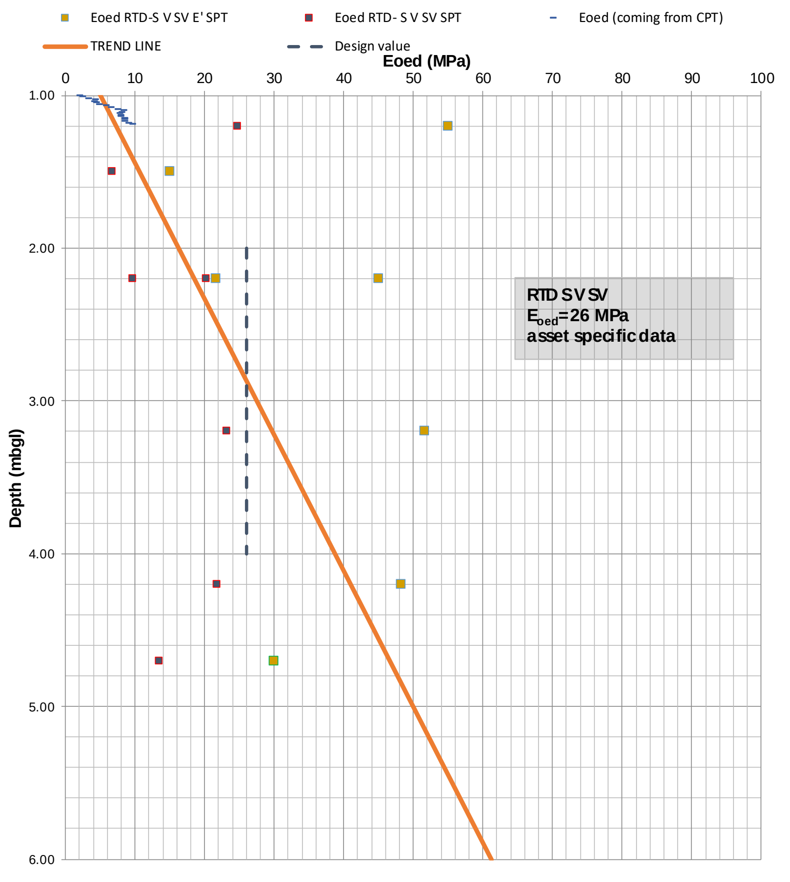



Figure D-45. coefficient f2 to correlate mv=1/Eoed from N SPT and PI
Correlation of E' coming from N of SPT
$\boldsymbol{E}' = E_{oed}\frac{(1-2\cdot\nu\prime)\cdot(1+\nu\prime)}{1-\nu\prime}$
Where: E'=Young Modulus (see below); E_{oed}=Oedometer Modulus; and ν'=Poisson's ratio=0.2
E'=K·N *Where K=0.6-0.9 for over-consolidated unweathered clayey soils; and K=0.6 for slightly over-consolidated weathered clayey soils*

HS2

Eoed (MPa) vs. Depth (mbgl)

Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment
Client:	HS2	Geology :	Eoed RTD S V SV	Figure:	F12



	Eoed
lumber of Test	16
Minimum	-
Maximum	6.00E+01
Offset	

Notes

Plot Date:	11/06/2021
Holebase database reference	Data drop 10. Published 05/2021

Figure D-46. E_{oed} obtained from different lab tests within the River Terrace Deposits (RTD SV SV) – Twyford embankment

River Terrace Deposits (RTD-C Z)

The below table provides brief commentary on:

- the type and quantity of tests to prove the geotechnical design values,
- general trends of geotechnical values with depth,
- the plots used to determine the design values of each geotechnical parameter.

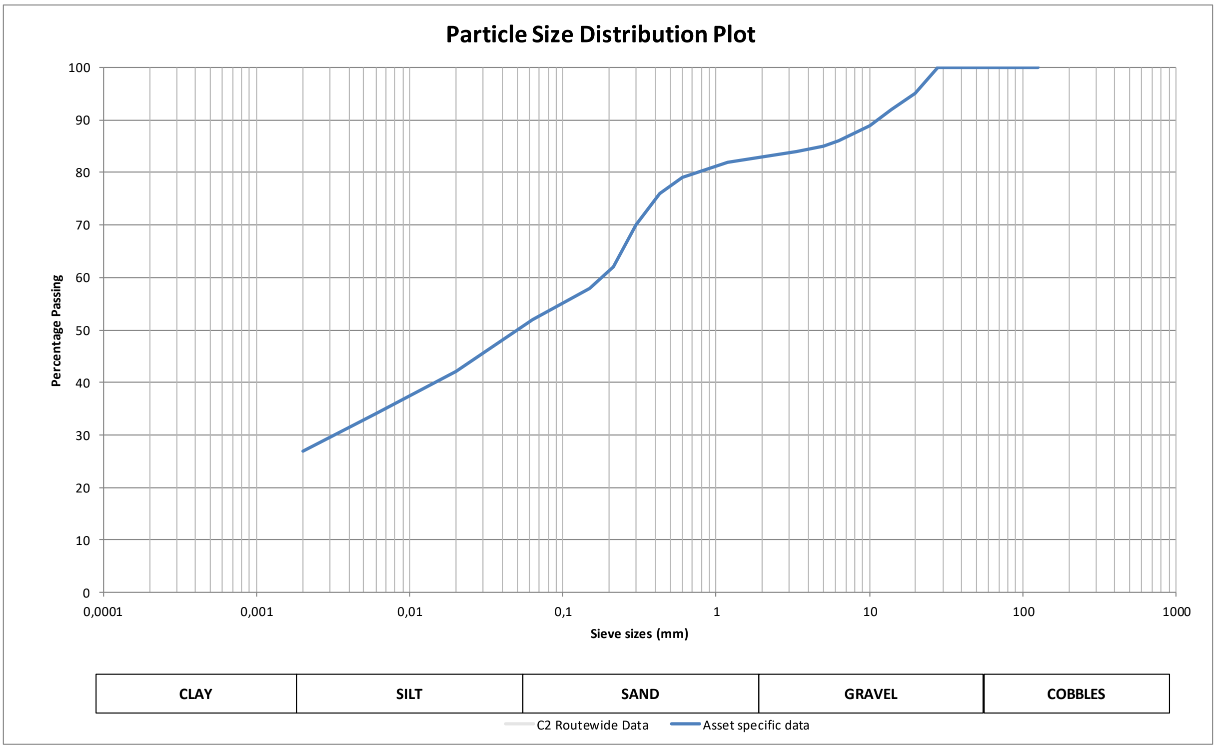
Reference should be made to the plots for the justification of the characteristic design values adopted in the geotechnical models and calculations (refer to Section 8.2).

Table D- 4. Commentary and justification of characteristic design values in ALV

Fines content	#0.063	only results from asset specific lab tests are considered based on the test results and on the borehole logs, ALV is described as locally soft and firm slightly **sandy clay**	G1
Plasticity index	PI	• only results from asset specific lab tests are considered • a range of values around the mean value has been used in the design	G2, G3
Liquid limit	LL	• only results from asset specific lab tests are considered • a range of values around the mean value has been used in the design	G2
Total Sulphur contents	TS	• the mean Total Potential Sulphate TPS (%) value is used in design	G4
Bulk density	γ'	• No bulk density test results are available within this asset • No bulk density test results are available in the routewide • The representative value that is considered in the design is the same that for ALV CZ, as they are soils very similar from the point of view of their geotechnical behaviour.	B5
Blow N number from SPT, corrected to 60% test energy	N_{60}	• only five test results are available within this asset • the mean value is considered as representative. • the asset specific results -between 13 and 23 - indicate stiff and very stiff consistency	G6
Cone resistance from CPT	q_c	• no CPT are available within this asset	N/A
Undrained shear strength	c_u	• SPT and In-situ vane tests results are used to find the representative values	G6
		• one triaxial test results are available within this asset • a cautious c_u=83 kPa has been used in the design, this value coming from the correlation with N_{SPT} which is coherent with the values derived from Vane tests	G8
Drained shear strength	c'	• No triaxial Cu+u and triaxial CD tests are available neither within the particular asset nor within the routewide area. • In view of the absence of drained triaxial tests, a cautious long term drained value of c'=2 kPa has been used in design due to the high fine content in the material	G9
	ϕ'	• A cautious value of ϕ'=24° is considered. This value is calculated with the correlation with PI for normally consolidated clays (Ladd et al. 1977) Ref. [60] which is lower and on safety side compared to the value recommended by the technical standard, Ref. XX	G9

Coefficient of Permeability and coefficient of consolidation	k, c_v	• two test results are available within the specific asset. • No results are available in the routewide data. • Lab test results are multiplied by 10 to be compared with in-site test results • The design value is the lowest value, which let the parametrisation on the safety side (lower permeability, longer period of consolidation) • The design value of k is used to obtain the design value of the coefficient of consolidation cv	G10
Young/Effective Deformation Modulus	E'	• SPT and In-situ Vane tests results are used to find the representative values	G6
		• E' is correlated by N coming from SPT (CIRIA R143) Ref.[61] means of the factor k=0.6 for slightly over-consolidated clays	G11
		• Relationship between E' and the Undrained Deformation Modulus Eu with Eu/cu ratio=150 is also used to estimate E' • A cautious design value of E'=5.7MPa is considered.	G8, G11
Oedometer Deformation Modulus	E_{oed}	• SPT results are used to find the representative values	G6
		• PI is used to obtain relationship between Eoed=1/mv and N coming from SPT. The factor f2=	G12
		• Relationship between the Oedometer Modulus Eoed and E' coming from N of SPT (CIRIA R143) Ref.[61] • Considering the relation between Eoed and E', the trend line with depth of cu is transformed to a trend line Eoed =4.5+1.05z • The design value is given by the trend line Eoed=4.5+1.05z at the midpoint of the layer, even though it is close to the highest results coming from E'=f(N). The trend line comes at the end from cu trend line coming from routewide data which is considered more representative.	G8, G12

Particle size distribution (G1)

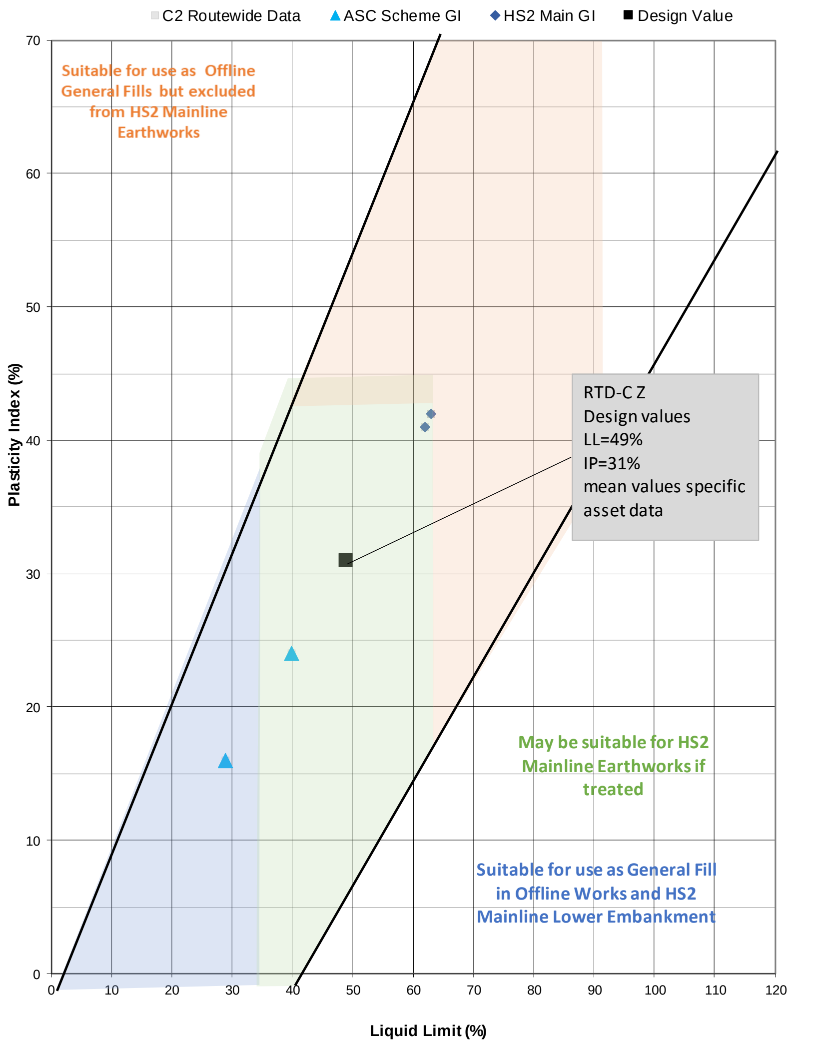


Notes Background C2 scheme wide parameters shown are based on holebase database geology codes dated 11/08/2020	Client HS2		Title : Particle Size Distribution for River Terrace Deposits		
	Location	0	Project ID	10039367	
	Project Title	1MC07 - Stage One C3 -MWCC – Brackley to South Portal of Long Itchington Tunnel	Figure	G1	Date 19/07/2021

Figure D-47. Particles size distribution within the River Terrace Deposits- (RTD-C Z)– Twyford Embankment

Atterberg limits (G2, G3)

HS2	A-Line Plot - HS2 Suitability Overlay				
Project ID:	**10039367**	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment Group**
Client:	**HS2**	Geology :	**RTD-C Z**	Figure:	**G2**



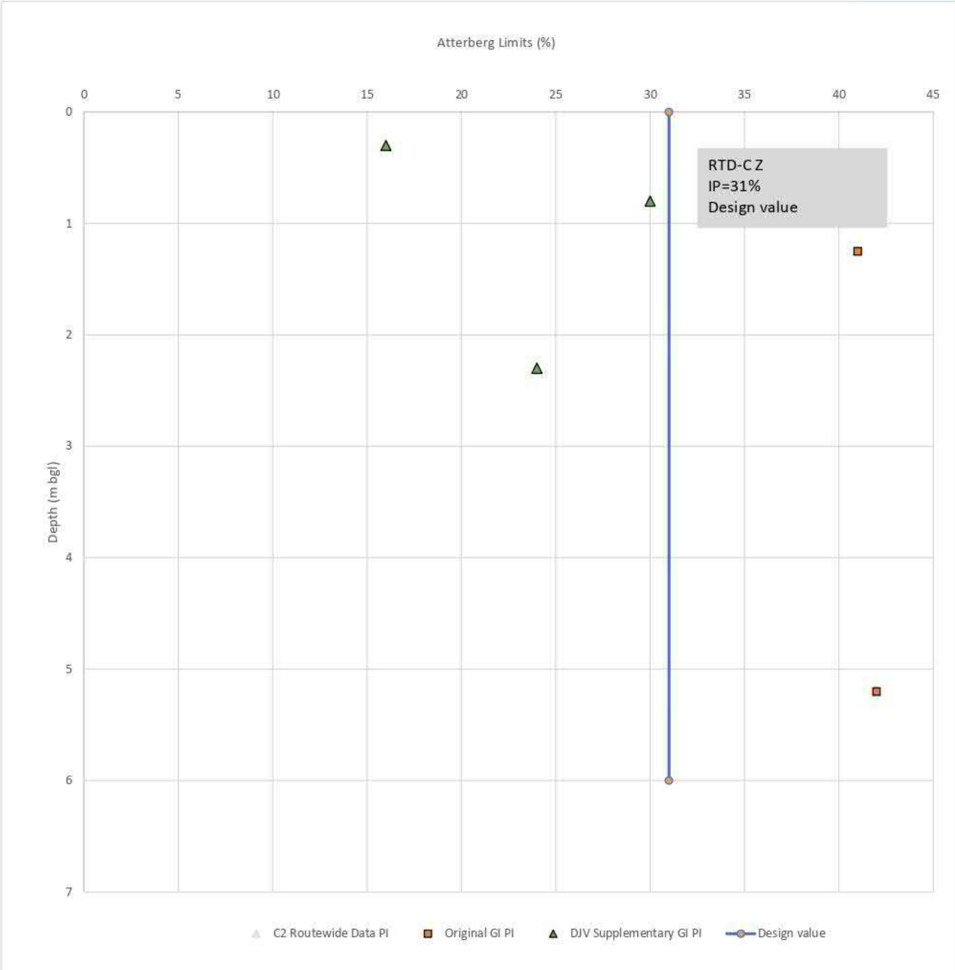
Number of Tests:	**Offset:**	**Plot Date:**	19/07/2021
asc A High-Speed Design Partnership ARCADIS COWI	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	**Holebase database reference**	Datadrop 10. Published 05/2021

Figure D-48. Plasticity Index vs. Liquid Limit within the River Terrace Deposits- (RTD-C Z)

HS2

Liquid limit, Plastic limit and Plasticity Index with depth (mbgl)

Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	RTD-C Z	Figure:	G3



Number of test	8	Notes	Plot Date:	14/06/2021
		Background C2 Routewide data shown are based on Holebase database geology codes dated 29/05/2021	Offset:	
			Holebase database reference	Datadrop 10. Published 05/2021

Figure D-49. Plasticity Index vs. depth within the River Terrace Deposits- (RTD-C Z) – Twyford Embankment and Routewide

Sulphur content (G4)

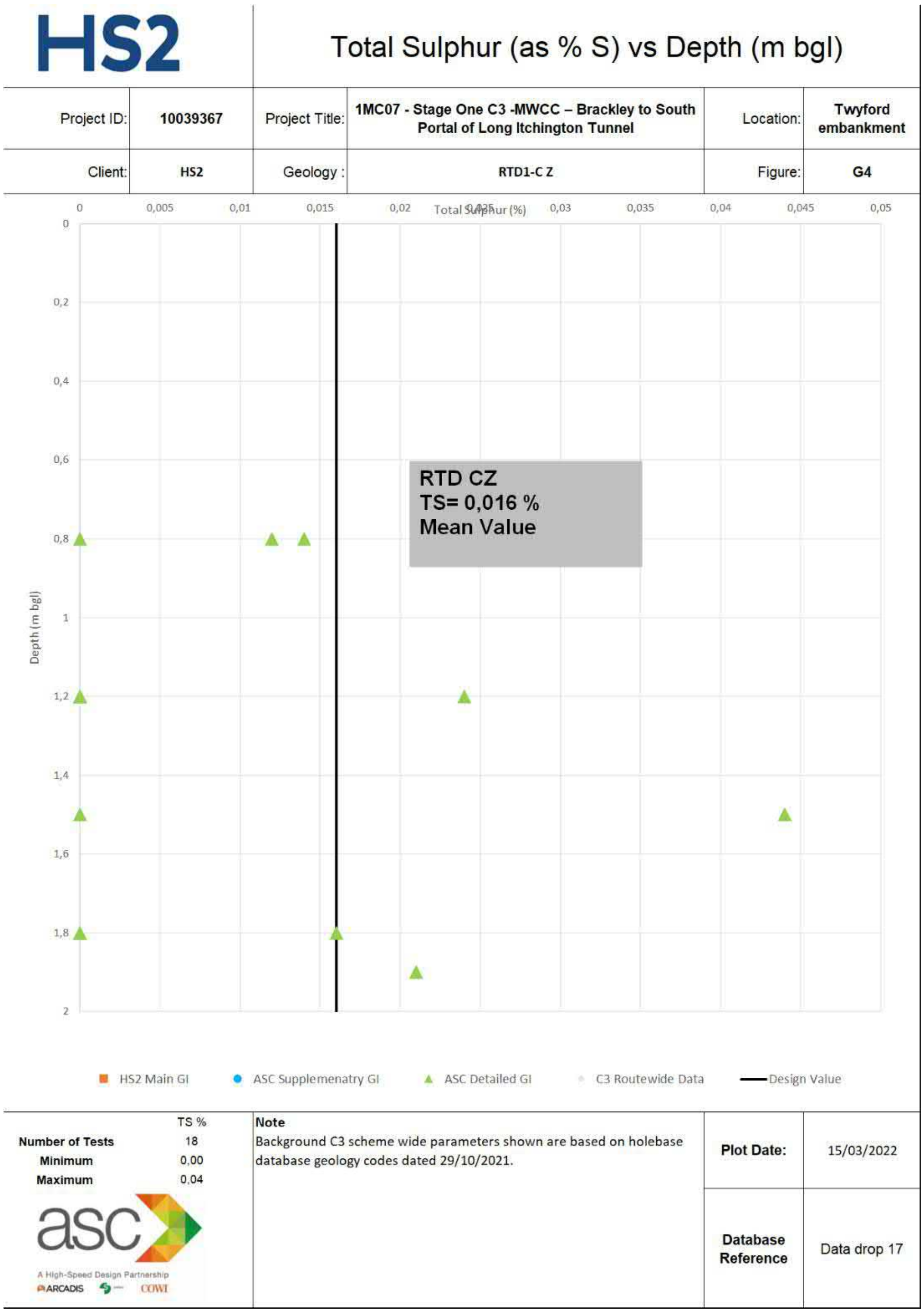
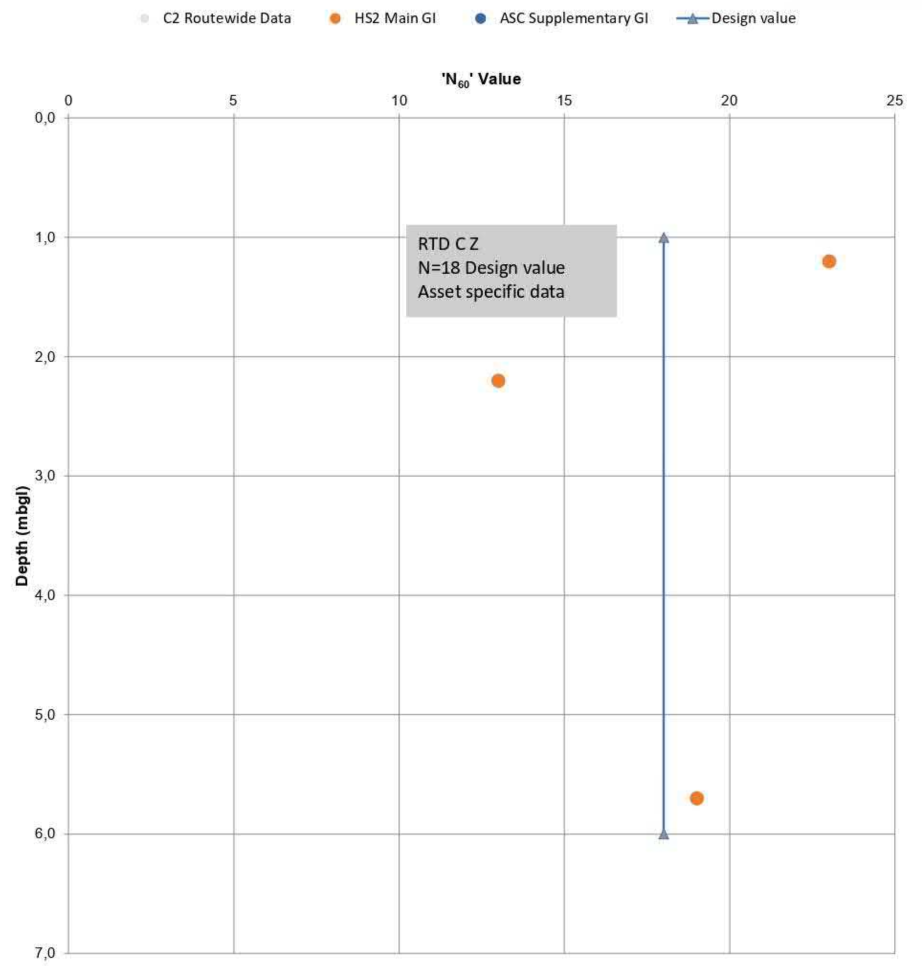


Figure D-50. Total sulphur TS(%) within the River Terrace Deposits- (RTD-C Z)– Twyford

Penetration resistance (G6)

HS2	SPT-N_{60} vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	RTD-C Z	Figure:	G6



	N Value	Notes		
Number of Tests	3	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	Plot Date:	15/06/2021
Minimum	13			
Maximum	23			
Offset				
			Holebase Database Reference	Datadrop 10. Published 05/2021

Figure D-52. SPT results within the River Terrace Deposits- (RTD-C Z)–Twyford Embankment

N value (blows/ 305mm)	Consistency	Field Indications	Approximate C_u (kPa)
0 to 2	Very Soft	Excludes between the fingers when squeezed in the fist	0 – 12.5
2 to 4	Soft	Easily moulded in the fingers	12.5 – 25
4 to 8	Medium (Firm)	Can be moulded in the fingers by strong pressure	25 – 50
8 to 15	Stiff	Cannot be moulded in the fingers	50 – 100
15 to 30	Very Stiff	Brittle or very tough	100 – 200
>30	Hard	-	>200

Figure D-53.Correlation C_u with N_{SPT} values Consistency and field descriptions (source: EPRI, 1990)

Undrained shear strength c_u (G8)

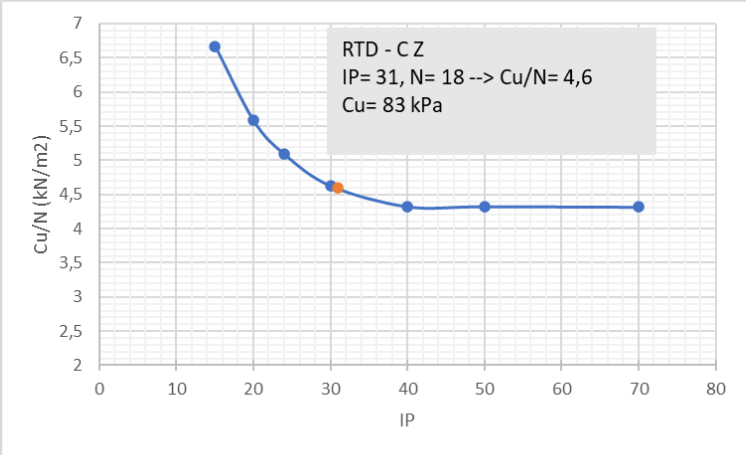
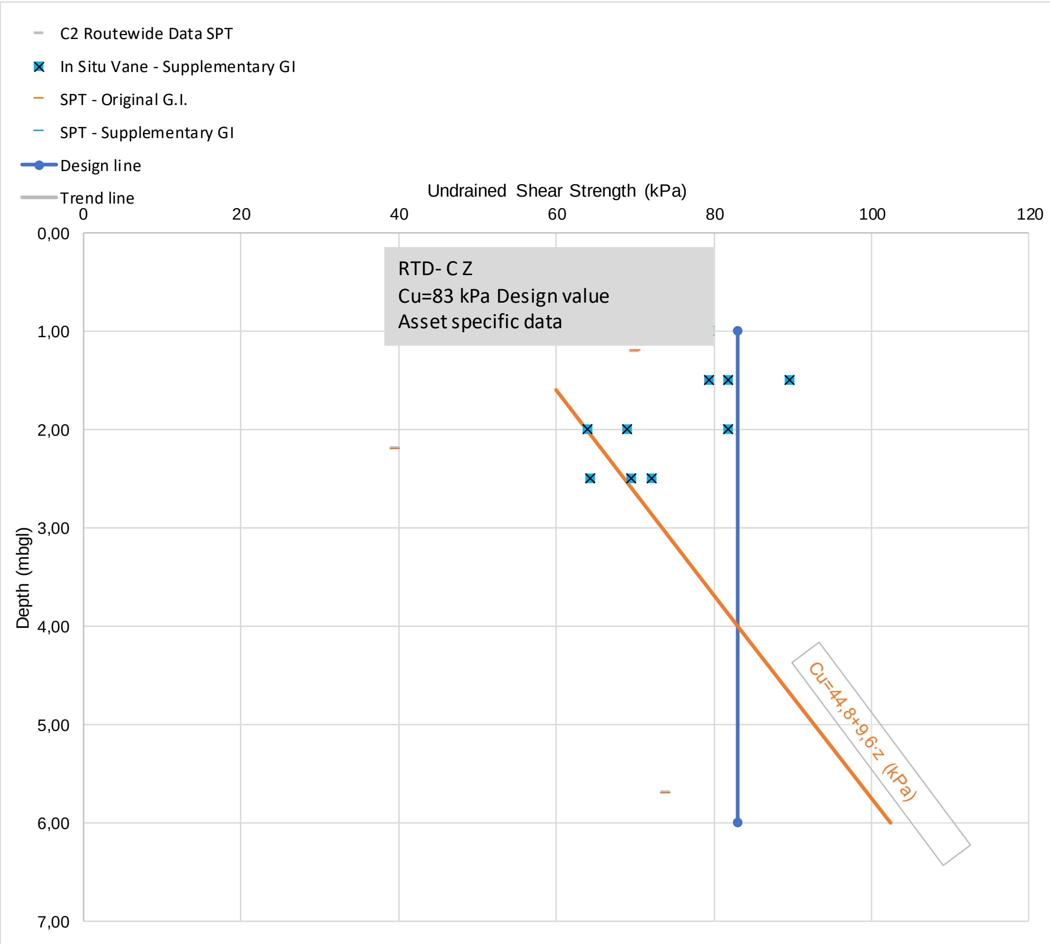


Figure D-54. Correlation between SPT N value and undrained shear strength cu, based on the Plasticity index PI Ladd et al. 1977 Ref. [60] (CIRIA R143) Ref [61]

HS2	Undrained Shear Strength vs. Depth (mbgl)					
Project ID:	**10039367**	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment Group**
Client:	**HS2**	Geology:	RTD-C Z	Figure:	**G8**



	Total	Notes	Plot Date:	19/07/2021
Number of Tests	19	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021		
Minimum	-			
Maximum	-			
Offset				
asc		Inferred ground conditions applied to CPT Cu profiles are based on review of exploratory hole information adjacent to the CPT position.	**Holebase database reference**	Datadrop 10. Published 05/2021

Figure D-55. Undrained shear strength obtained from different lab and in situ tests within the River Terrace Deposits- (RTD-C Z)– Twyford Embankment and Routewide

Effective cohesion c' and effective friction angle ϕ' (G9)

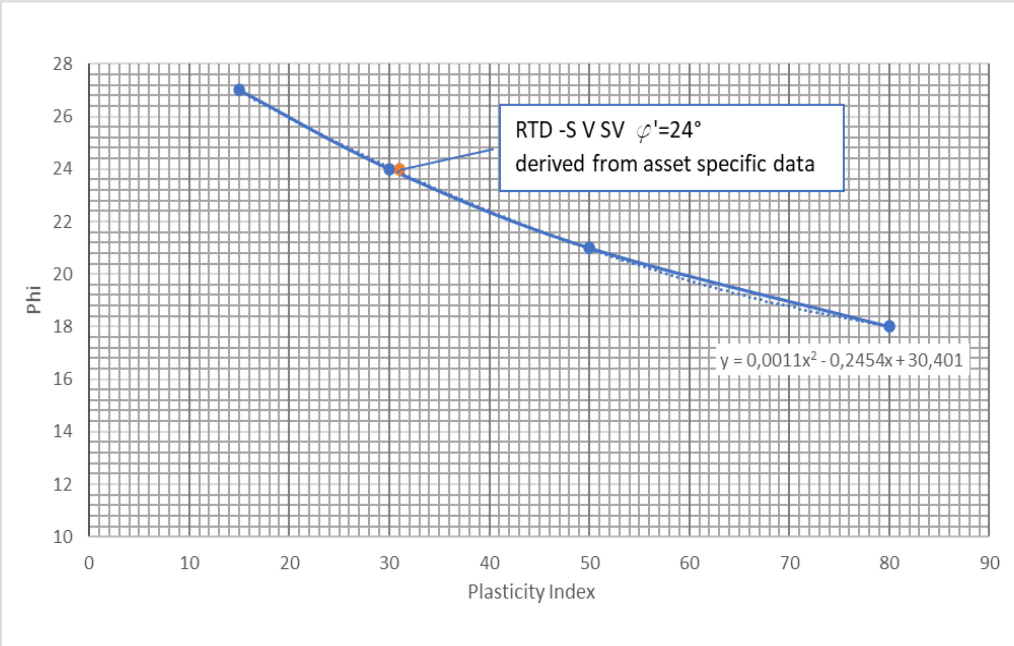


Figure D-56. Characteristic constant volume angle of shearing resistance ϕ'cv derivation (BS 8004:2015) Ref.[64] from routewide mean Plasticity Index within the Alluvium deposits

Figure D-57. Shear stress vs. Normal Stress in River Terrace Deposits- (RTD-C Z)– Twyford Embankment and Routewide

Coefficient of consolidation c_v and coefficient of permeability (G10)

Derivation from k obtained from lab consolidation tests and in situ permeability tests

$$c_v = \frac{k}{m_v \cdot \gamma_w}$$

Where:

c_v=*coefficient of consolidation* (m^2/s)

k=hydraulic conductivity (m/s),

m_v=*coefficient of volume change* (m^2/kN)

γ_w=*unit weight of pore fluid/water* (kN/m^3)

$c_{v\_insitu} = 10 \cdot c_{v\_lab} >> k_{\_insitu} = 10 \cdot k_{\_lab}$

$c_r = c_{v\_insitu}$

Young Modulus E' (G11)

Correlation with N obtained from SPT

E'=K·N

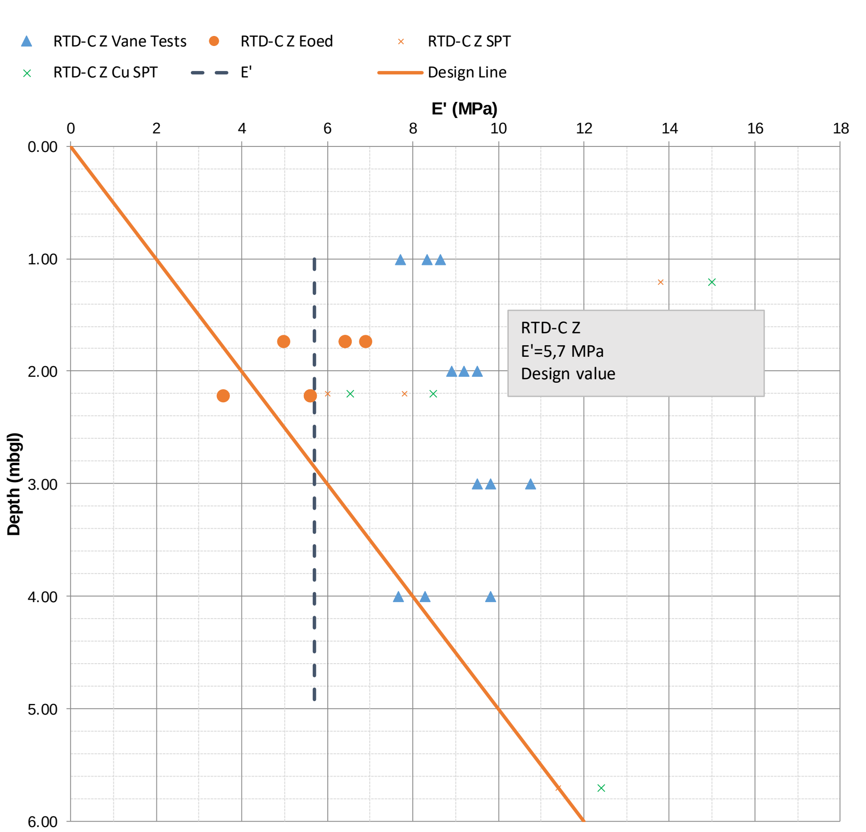
Where K=0.6 for slightly over-consolidated weathered clayey soils (CIRIA R143) Ref.[61]

Relationship between E' - E_u

$$\boldsymbol{E'} = E_u \frac{1 + \nu'}{1 + \nu_u}$$

Where: E'=Young Modulus; E_u*=Undrained Young Modulus;* ν'*=Poisson's ratio=0.2 and* ν_u*=Undrained Poisson's ratio=0.5.*

HS2	E' (MPa) vs. Depth (mbgl)				
Project ID:	**10039367**	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment**
Client:	**HS2**	Geology :	**E' RTD C Z**	Figure:	**G11**



	E'
Number of Tests	17
Minimum	1.80E+00
Maximum	1.57E+01
Offset	

Notes

Plot Date:	11/06/2021
Holebase database reference	**Data drop 10. Published 05/2021**

A High-Speed Design Partnership
ARCADIS COWI

Figure D-60. E' obtained from different lab tests within the River Terrace Deposits- (RTD-C Z)– Twyford Embankment and Routewide

Oedometer Modulus E_{oed} (or Coefficient of volume change $m_v=1/E_{oed}$) (G12)

Correlation with N from SPT

Eoed=1/mv=f2·N (Tomlinson and Woodward, 2008)

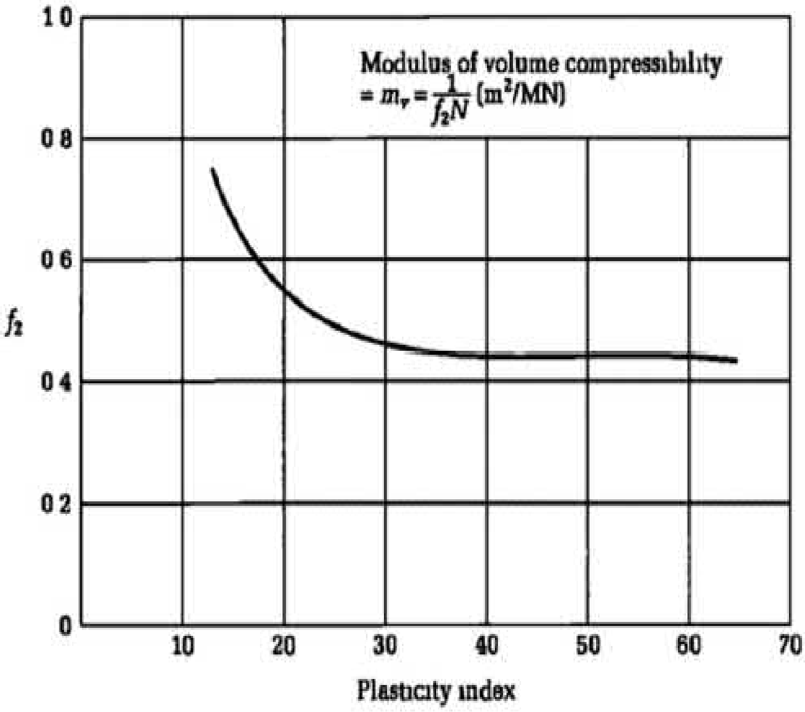


Figure D-61. coefficient f2 to correlate mv=1/Eoed from N SPT and PI within the Alluvium deposits – Routewide

Correlation of E' coming from N of SPT

$$E' = E_{oed}\frac{(1-2\cdot\nu')\cdot(1+\nu')}{1-\nu'}$$

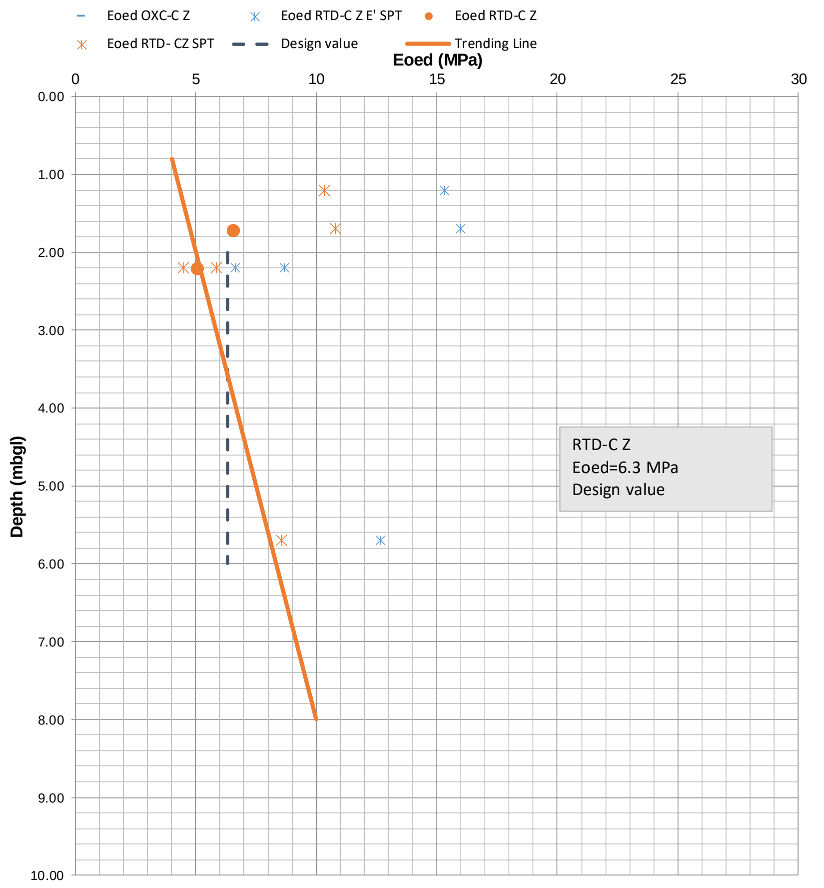
Where: E'=Young Modulus (see below); E_{oed}=Oedometer Modulus; and ν'=Poisson's ratio=0.2

E'=K·N

Where K=0.6 for slightly over-consolidated weathered clayey soils

Eoed (MPa) vs. Depth (mbgl)

Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North	Location:	Twyford Embankment
Client:	HS2	Geology :	Eoed RTD C Z	Figure:	G12



	Eoed
Number of Tests	17
Minimum	4.50E+00
Maximum	1.60E+01
Offset	

Notes

Plot Date:	11/06/2021
Holebase database reference	Data drop 10. Published 05/2021

Figure D-62. E_{oed} obtained from different lab tests within the River Terrace Deposits-(RTD-C Z)– Twyford Embankment

Oxford Clay Formation-(OXC C Z): OXC W, OXC U1, OXC U2 and (OXC MSDT): OXC U3

Four facies are defined for the Oxford Clay Formation (OXC):

- Upper weathered unit (OXC W): 4 m to 5 m bGL, thin, firm to very stiff, dark grey laminated clays with rare shell fragments.
- Three unweathered units (OXC U1, OXC U2 and OXC U3): OXC U1 and OXC U2 are described as very stiff to hard thin laminated clays; OXC U3 is composed by extremely weak to weak mudstones and siltstones (with a locally sandy gravelly clay unit) are encountered between 10 and 14 m depth.

The OXC formation may also contain sandy layers (or thin bands of limestone).

The table provides brief commentary on:

- the type and quantity of tests to prove the geotechnical design values,
- general trends of geotechnical values with depth,
- the plots used to determine the design values of each geotechnical parameter.

Reference to the plots and Section 8.2 (parameters in Table 8-24) of the GDR for confirmation of characteristic design values adopted in the geotechnical calculations.

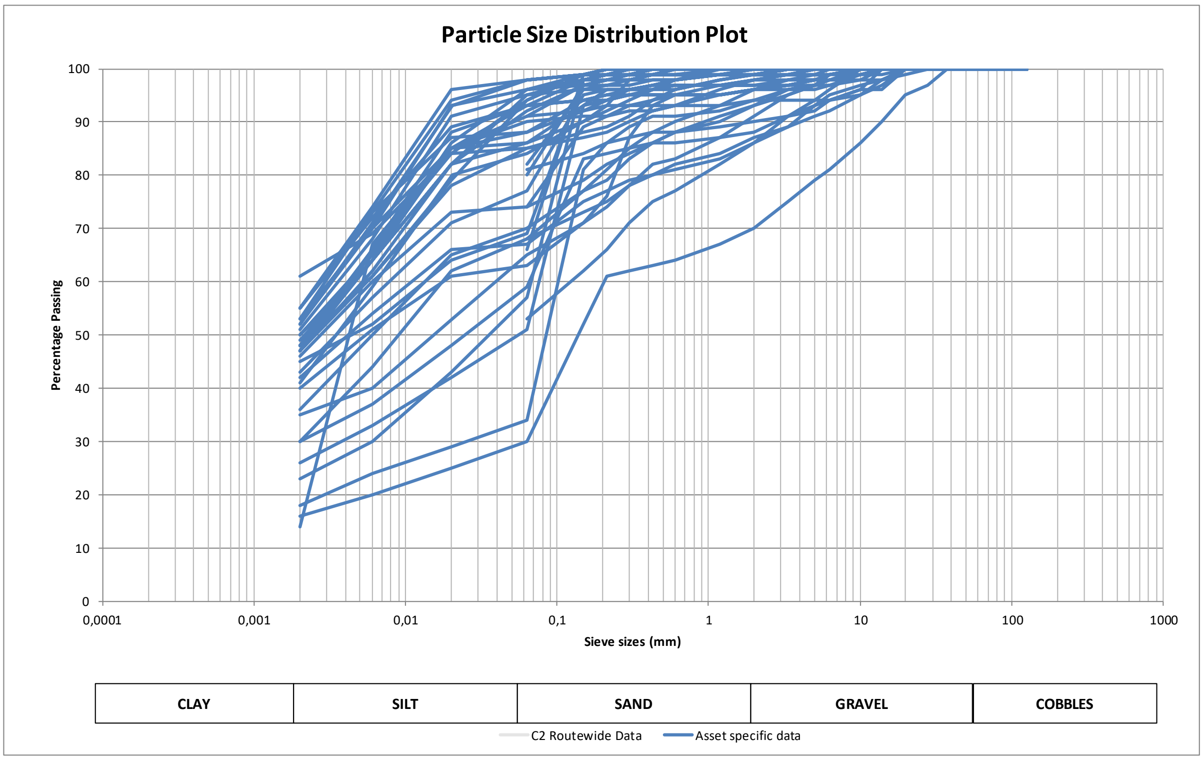
Table D- 5. Commentaries and justifications related to the design geotechnical parameters for OXC Formation

Fines content	#0.063	The results from the asset specific lab tests are represented on the reference plot The fines content is between 50% and 98% except for two (2) samples that yielded between 30% and 40% of particles passing the #0.063 mm sieve. based on them and on the borehole logs, the OXC Formation comprises firm to stiff silty clays, slightly sandy on top.	C1
Plasticity index	PI	• Asset specific results are consistent with results coming from routewide data • The design value within the OXC is 32% • The plot C3 reveals a slight decrease of plasticity with depth based on the routewide lab tests results	C2, C3
Liquid limit	LL	• Asset specific results are consistent with routewide results • The design value within the OXC is 55%	C2
Total Sulphur contents	TS	• The mean Total Potential Sulphate TPS (%) value is used in design • The value considered in the design within OXC is TS=1.43%, that gives a TPS=4.3%	C4
Bulk density	γ'	• Both asset specific data and routewide data are represented • The reference plot reveals a constant average value • The same design value is assumed for all the facies within OXC formation, γ'=2 Mg/m^3=20kN/m^3	C5
Blow N number from SPT, corrected to 60% test energy	N_{60}	• Both asset specific and routewide data are represented. • For OXC W and OXC U1 facies, which are less competent than the other layers, the average value N=12 and N=25, respectively, are designed as representative value • For OXC U2, which are more competent, the mean value N=34 is assumed as design value	C6

		• Reference plot reveals a general increase with depth (z) N=4+3.7·z which is consistent with the design values mentioned above • Design values indicate firm to stiff consistency for OXC W, very stiff consistency for OXC U1 and OXC U2, and very hard soil or weak rock, for OXC U3	
Cone resistance from CPT	q_c	• Only asset specific tests are considered to find the design value. • Design value of this parameter is used to differentiate OXC weathering profiles. • q_c–values increase with depth. Design values are consistent with the trend line q_c=-0.29+0.32·z evaluated at approximately the mid-point of each weathering profile/layers • the design value for OXC W is 1.7MPa, for OXC U1 is 2MPa and for OXC U2 is 3MPa form asset data. No value for OXC U3 is assigned as within rock CPT usually give refusal to penetration	C7
Undrained shear strength	c_u	• Both asset specific and routewide data are represented • In-situ Vane test, UU triaxial and both SPT and CPT derived c_u are used to find the design values of undrained shear strength • Vane tests give higher values of c_u than the other tests over the first deep meters; therefore, less weight is given to these tests derived results. • The laboratory analyses give higher values than the in-situ data and these are very dispersed. • Considering asset specific tests, a conservative value from the NSPT correlation has been used for the design • Considering both asset specific and routewide tests, design values are fixed, the present the average value • The design value for OXC w is 54 KPa up to depth 5m, design value for OXC u1 is 100 KPa and the design value for OXCu2 is 150 kPa	C8
Drained shear strength	c'	• The p'-q' plot shows a lower bound cohesion intercept of about 2 kPa, however, in line with guidance by Nowak and Gilbert (see general guidance at the start of Appendix D), long term drained values of c'=5 kPa for intact clays and of c'=2 kPa for fissured clays have been used in design	C9
	ϕ'	• Triaxial tests are considered more reliable in drained test conditions and consistently give values more representative of ϕ' than Shear box tests in drained conditions. • A good fit line in p-q' plot gives a value of ϕ' = 25° to OXC W. This value is consistent with the correlation with PI for normally consolidated or slightly over-consolidated clays (Ladd *et al*. 1977) • A good fit line in p-q' plot gives a value of ϕ' = 28° to OXC u	C9
	c', ϕ'	• Design failure lines are both more conservative than the one corresponding to the average line coming from the upper and lower boundaries (see lines in orange in the reference Plot)	C9
Coefficient of Permeability - coefficient of consolidation	k - c_v	• More importance is given to results within the specific asset. • Lab test results are multiplied by 10 to be compared with in-site test results. • In general, the design value is towards the lowest available data, which let the parametrisation on the safety side (lower permeability, longer period of consolidation) • The design value of k is used to obtain the design value of the coefficient of consolidation c_v.	C10

		• Plot reveals a slight decrease with depth of permeability from k=5E-10m/s between 0 and 4m depth, k=3.5E-10m/s between 2 and 7m, and k=2E-10m/s between 7 and 10m depth • Design values for c_v are, respectively, 3.8E-07m²/s for OXC W, 5.0E-07m²/s for OXC U1 and 4.2E-07m²/s for OXC U2. In absence of data, a design value for OXC U3 (mudstone and limestone), a very cautious value of c_v=1E-08m²/s	
Young/Effective Deformation Modulus	E’	• SPT and In-situ Vane tests results are used to find the representative values. Vane tests give too high and non-representative values	C11
		• E’ is correlated by N coming from SPT (CIRIA R143) Ref.[61], considering k=0.6 for OXC W and OXC U1 (slightly over-consolidated clays) and, k=0.9, for OXC U2 (over-consolidated clays)	C6, C11
		• Relationship between E’ and the Oedometer Deformation Modulus Eoed and the correction factor of 2 have been used (see General Design Methodology at the beginning of the Appendix D)	C11
		• Relationship between E’ and the Undrained Deformation Modulus Eu with E_u/c_u ratio - E_u/c_u (OXC W) =150, E_u/c_u (OXC U1) =300 and E_u/c_u (OXC U2) =500 - have been used. c_u values come from vane tests, SPT and UU triaxial tests	C8, C11
		• The design value for OXC w is 7 MPa up to depth 4m, the design value for OXC u1 is 12 MPa. • In the OXC u2, plot reveals an increase with depth z that it is considered a cautious fit: E'=-23+5·z, where z>7m.	C11
Oedometer Deformation Modulus	E_{oed}	• PI is used to obtain relationship between E_{oed}=1/mv and N coming from SPT	C6, C12
		• Relationship between the Oedometer Modulus E_{oed} and E’ coming from N of SPT (CIRIA R143) Ref.[61]. The correction factor in E_{oed} of 2 has been used (see General Design Methodology at the beginning of the Appendix D)	C8, C12
		• The design value for OXC w is 7.8 MPa up to depth 4m, the design value for OXC U1 is 13.9 MPa . • In the OXC U2, plot reveals an increase with depth z that it is considered a cautious fit: E'=-25.6+5.6·z, where z>7m.	C8, C12

Particle size distribution (C1)

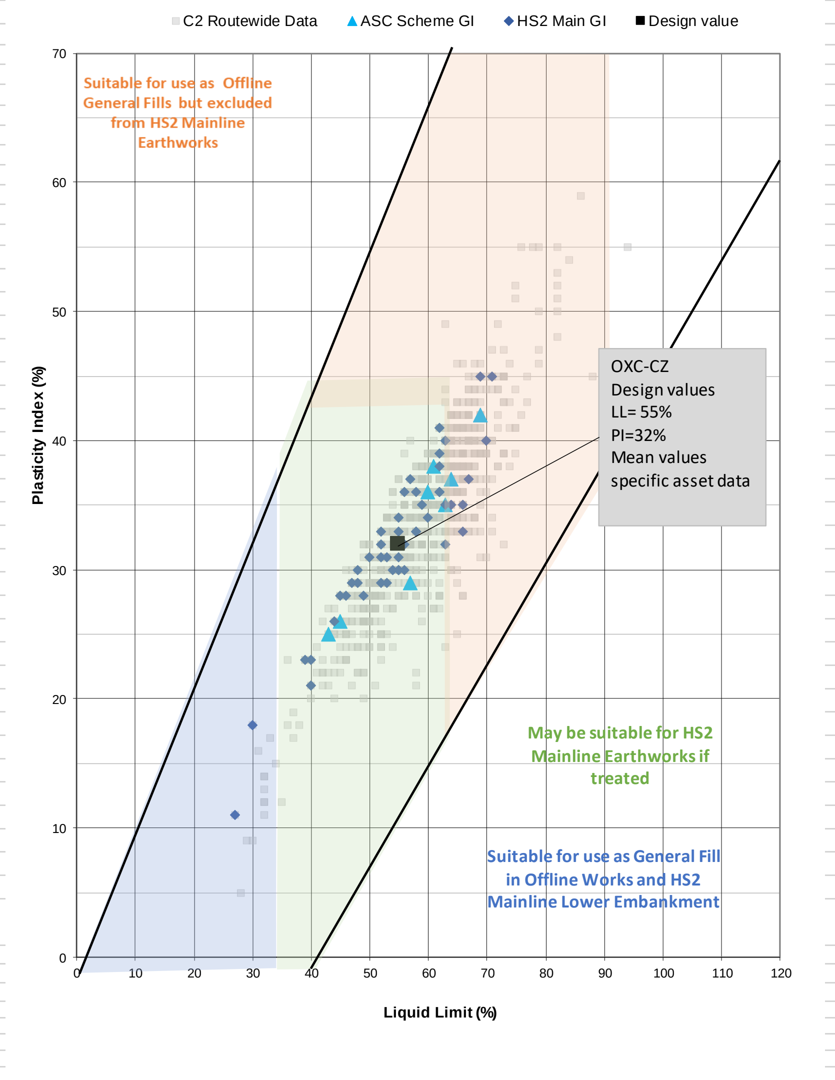


Notes	Client		Title			
Background C2 scheme wide parameters shown are based on holebase database geology codes dated 11/08/2020	HS2		: Particle Size Distribution for Oxford Clay Formation			
	Location	0	Project ID	10039367		
	Project Title	1MC07 - Stage One C3 -MWCC – Brackley to South Portal of Long Itchington Tunnel	Figure	C1	Date	19/07/2021

Figure D-63: Particles size distribution for Oxford Clay Formation OXC CZ – Twyfordl Embankment

Atterberg limits (C2 & C3)

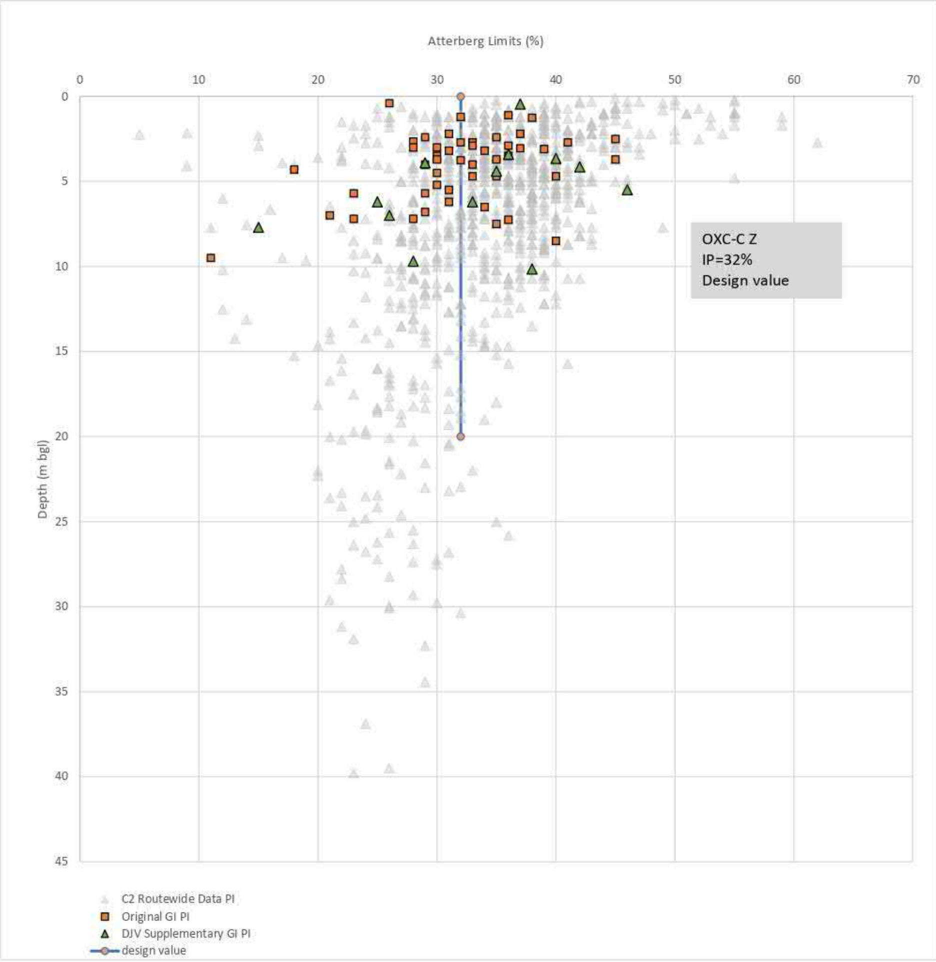
HS2	A-Line Plot - HS2 Suitability Overlay				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	OXC-C Z	Figure:	C2



Number of Tests:		Offset:		Plot Date:	19/07/2021
asc A High-Speed Design Partnership ARCADIS COWI		Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021		Holebase database reference	Datadrop 10. Published 05/2021

Figure D-64. Plasticity Index vs. Liquid Limit within the Oxford Clay Formation OXC-CZ – Twyford Embankment and Routewide

HS2	Liquid limit, Plastic limit and Plasticity Index with depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	OXC-C Z	Figure:	C3

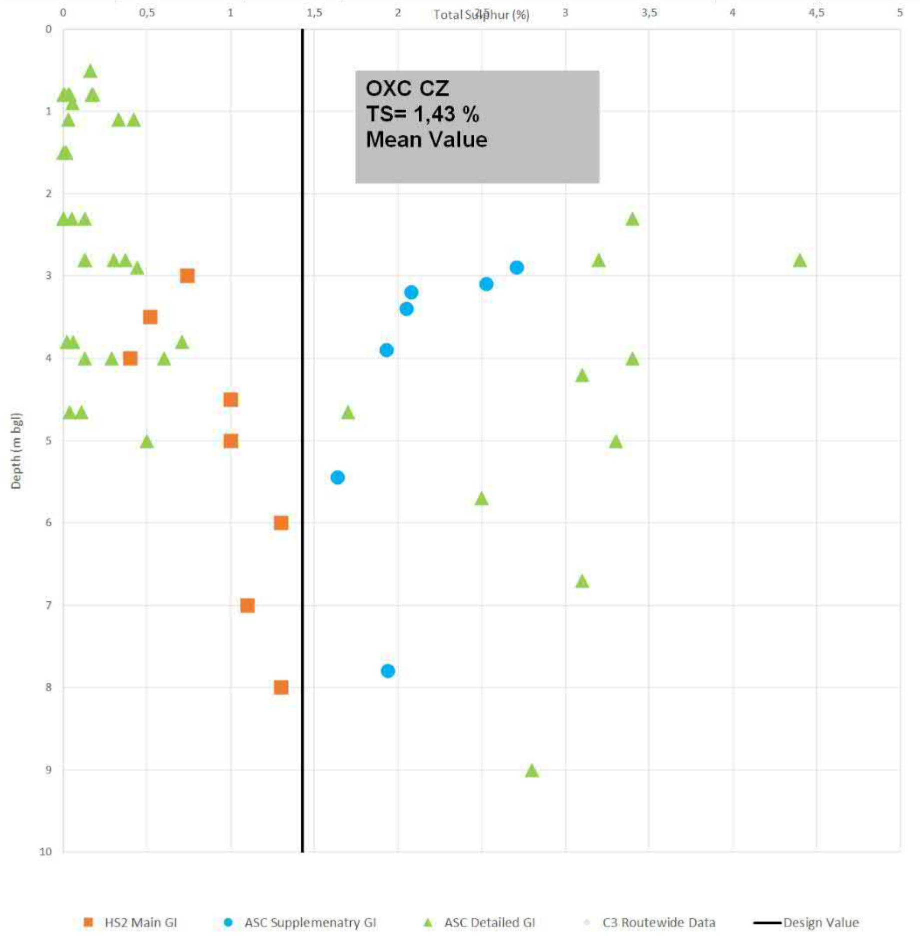


Number of test	181	Notes	Plot Date:	14/06/2021
		Background C2 Routewide data shown are based on Holebase database geology codes dated 29/05/2021	Offset:	
A High-Speed Design Partnership ARCADIS COWI			Holebase database reference	Datadrop 10. Published 05/2021

Figure D-65. Atterberg limits vs. depth within the Oxford Clay Formation OXC CZ - Twyford Embankment and Routewide

Sulphur content (C4)

HS2	Total Sulphur (as % S) vs Depth (m bgl)					
Project ID:	10039367	Project Title:	1MC07 - Stage One C3 -MWCC – Brackley to South Portal of Long Itchington Tunnel	Location:	Twyford embankmen
Client:	HS2	Geology :	OXC-C Z	Figure:	C4

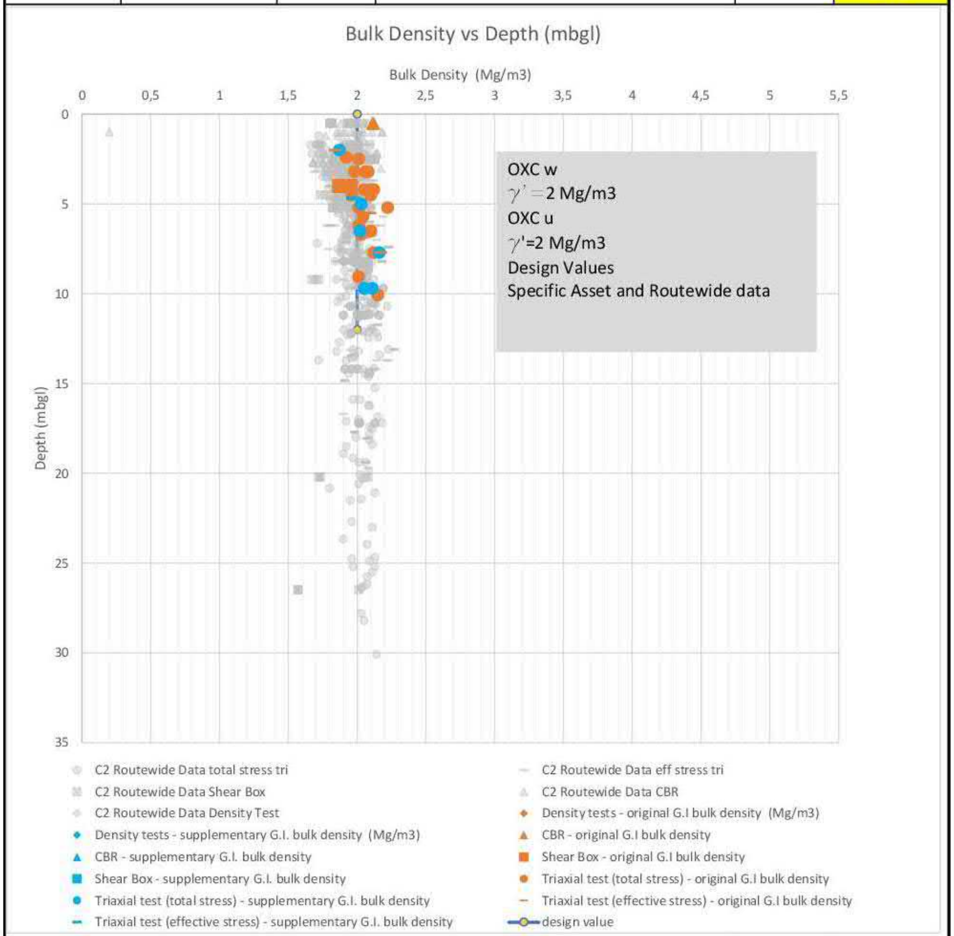


	TS %	Note		
Number of Tests	105	Background C3 scheme wide parameters shown are based on holebase database geology codes dated 29/10/2021.	Plot Date:	15/03/2022
Minimum	0,40			
Maximum	4,40		Database Reference	Data drop 17

Figure D-66. Total sulphur TS(%) within the Oxford Clay Formation OXC CZ – Twyford Embankment

Bulk density γ' (C5)

HS2	Bulk Density vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	OXC-C Z	Figure:	C5

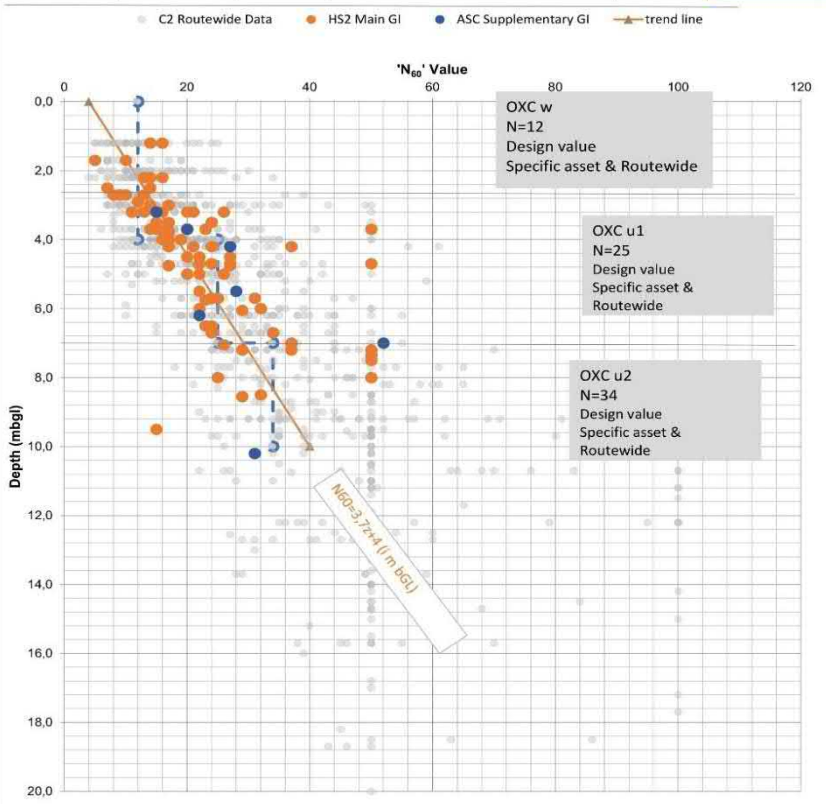


	Bulk Density	Notes	Plot Date:	14/06/2021
Number of Tests	42	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021		
Minimum	1,84			
Maximum	2,22			
asc A High-Speed Design Partnership ARCADIS setec COWI			Database reference number	Datadrop 10. Published 05/2021

Figure D-67. Bulk density obtained from different lab tests within the Oxford Clay Formation OXC CZ – Twyford Embankment and Routewide

Penetration resistance (C6)

HS2	SPT-N_{60} vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	OXC-C Z	Figure:	C6



	N Value	Notes		
Number of Tests	91	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	Plot Date:	06/07/2021
Minimum	5			
Maximum	52			
Offset				
asc A High-Speed Design Partnership ARCADIS COWI			Holebase Database Reference	Datadrop 10. Published 05/2021

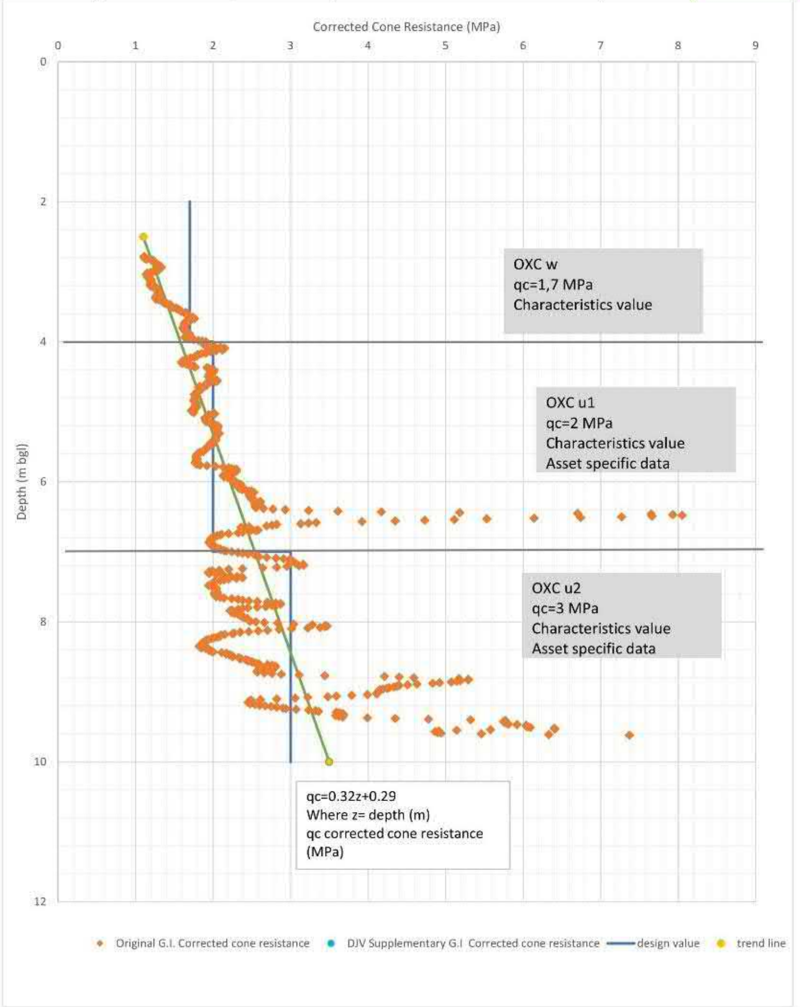
Figure D-68. SPT results within the Oxford Clay Formation OXC CZ –Twyford Embankment and Routewide

N value (blows/ 305mm)	Consistency	Field Indications	Approximate C_u (kPa)
0 to 2	Very Soft	Excludes between the fingers when squeezed in the fist	0 – 12.5
2 to 4	Soft	Easily moulded in the fingers	12.5 – 25
4 to 8	Medium (Firm)	Can be moulded in the fingers by strong pressure	25 – 50
8 to 15	Stiff	Cannot be moulded in the fingers	50 – 100
15 to 30	Very Stiff	Brittle or very tough	100 – 200
>30	Hard	-	>200

Figure D-70. Correlation C_u with N_{SPT} values Consistency and field descriptions (source: EPRI, 1990)

CPT Cone Resistance (C7)

HS2	CPT Cone Resistance vs Depth				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Figure:	C7
Client:	HS2	Location :	Twyford Embankment Group		



Notes:	Plot Date:	06/07/2021
	Holebase database reference	Datadrop 10. Published 05/2021

Figure D-69. CPT results within the Oxford Clay Formation OXC CZ – Twyford Embankment and Routewide

Undrained shear strength c_u (C8)

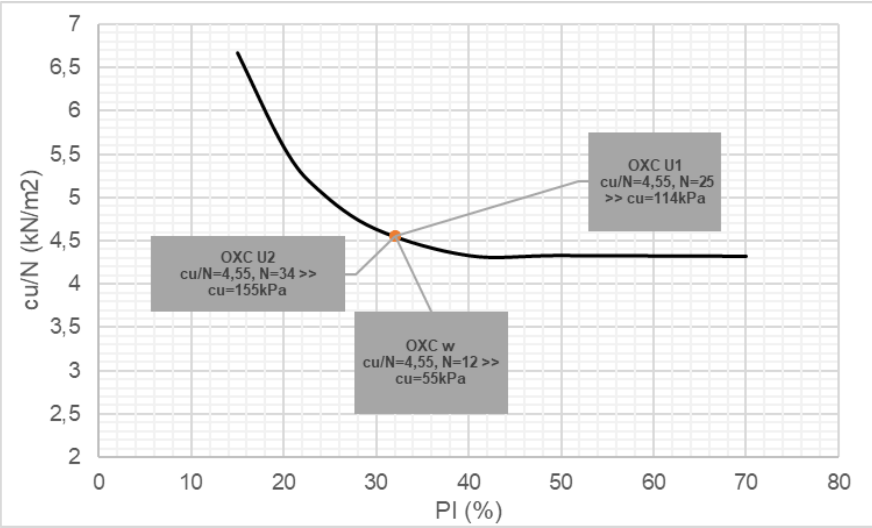
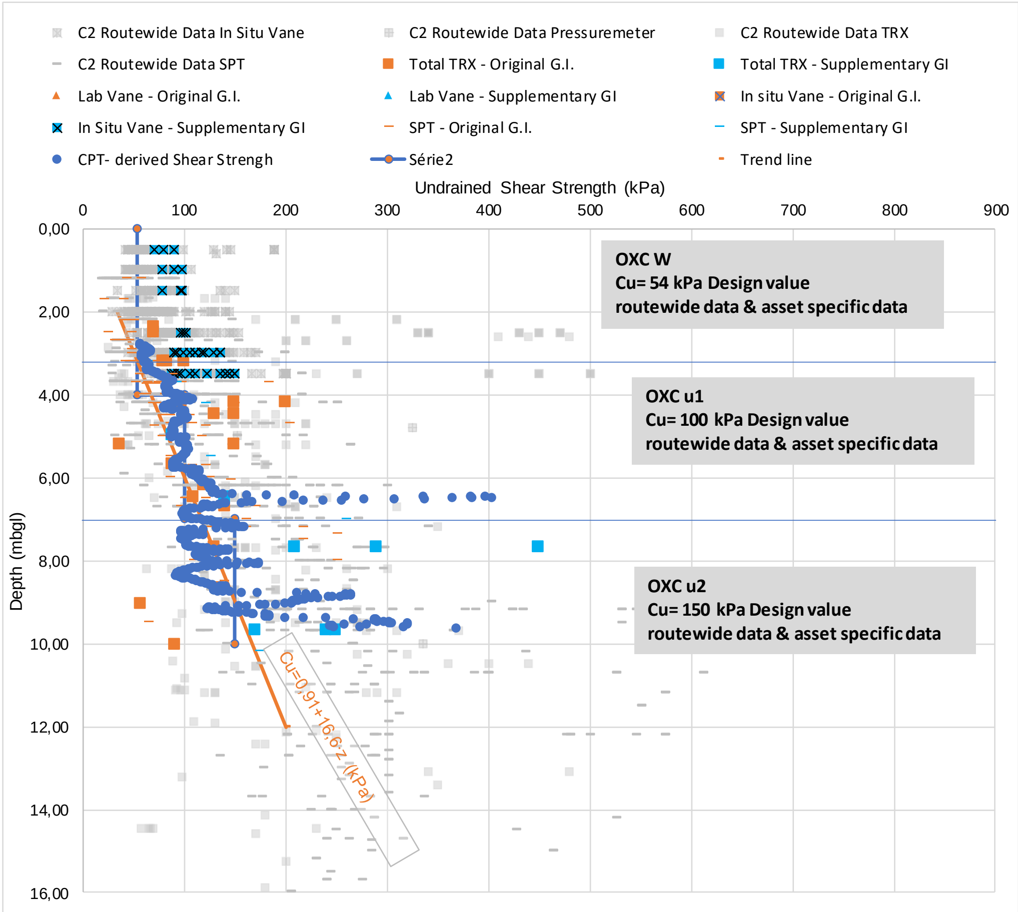


Figure D-71. Correlation between SPT N value and undrained shear strength cu, based on the Plasticity index PI Ladd et al. 1977 Ref. [60] (CIRIA R143) Ref [61]

HS2	Undrained Shear Strength vs. Depth (mbgl)				
Project ID:	**10039367**	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment Group**
Client:	**HS2**	Geology:	OXC-C Z	Figure:	**C8**



	Total	Notes	Plot Date:	19/07/2021
Number of Tests	230	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021		
Minimum	-			
Maximum	-			
Offset				
asc		Inferred ground conditions applied to CPT Cu profiles are based on review of exploratory hole information adjacent to the CPT position.	**Holebase database reference**	Datadrop 10. Published 05/2021

Figure D-72. Undrained shear strength obtained from different lab and in situ tests within the Oxford Clay Formation OXC CZ – Twyford Embankment and Routewide

Effective cohesion c' and effective friction angle ϕ'

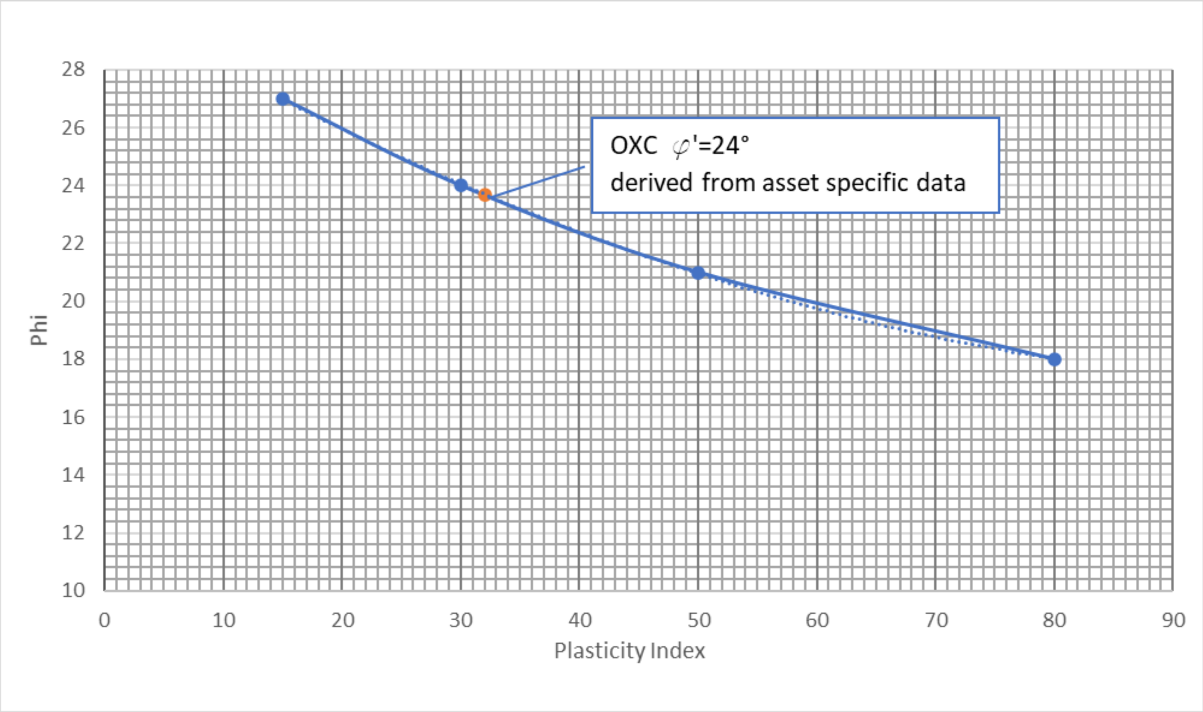
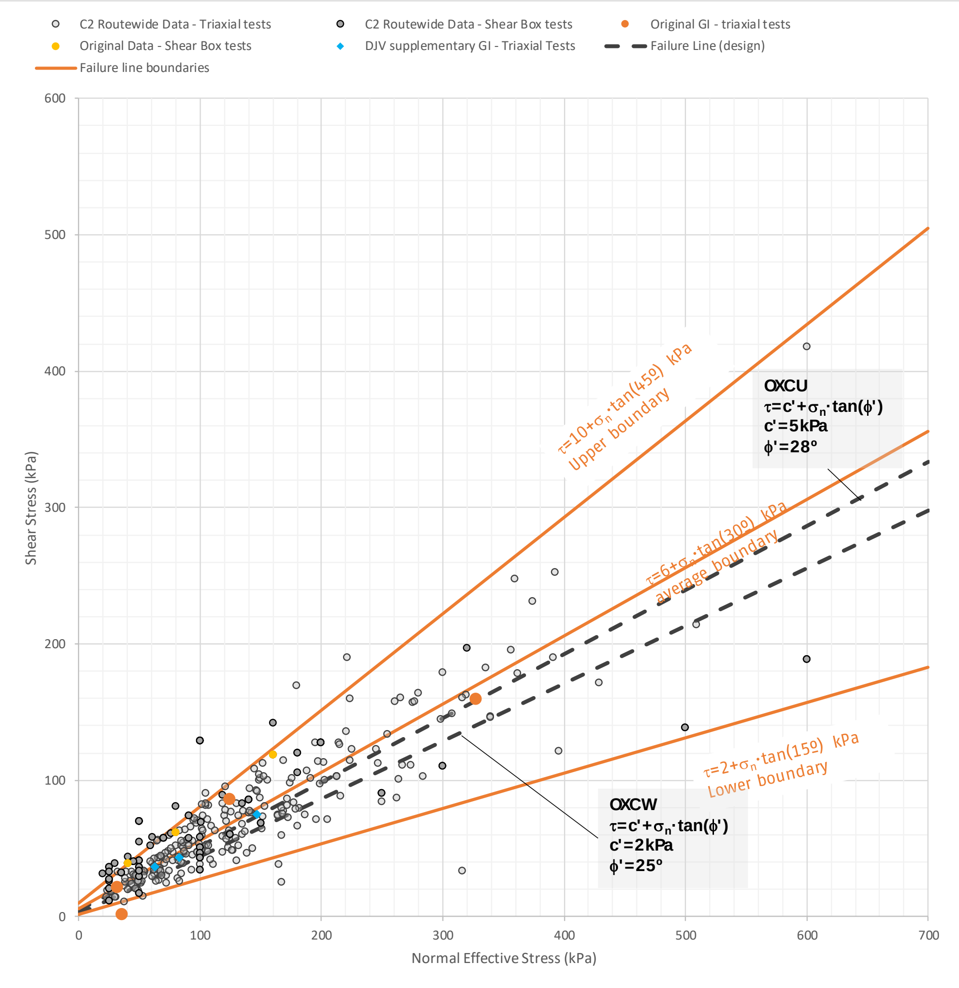


Figure D-73. Characteristic constant volume angle of shearing resistance ϕ'cv derivation (BS 8004:2015) Ref.[64] from routewide mean Plasticity Index within the Alluvium deposits

Shear Box Shear Stress Vs Normal Stress (C9)

HS2	p-q Plot				
Project ID:	**10039367**	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment Group**
Client:	**HS2**	Geology :	**OXC-C Z**	Figure:	**C9**



Notes:	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	**Plot Date:** 19/07/2021 **Offset**
Database reference	Datadrop 10. Published 05/2021	

Figure D-74. Shear stress vs. Normal Stress in the Oxford Clay Formation OXC CZ – Twyford Embankment and Routewide

Coefficient of consolidation c_v and coefficient of permeability k

Derivation from k obtained from lab consolidation tests and in situ permeability tests

$$c_v = \frac{k}{m_v \cdot \gamma_w}$$

Where:

c_v=coefficient of consolidation (m^2/s)

k=hydraulic conductivity (m/s),

m_v=coefficient of volume change (m^2/kN)

γ_w=unit weight of pore fluid/water (kN/m^3)

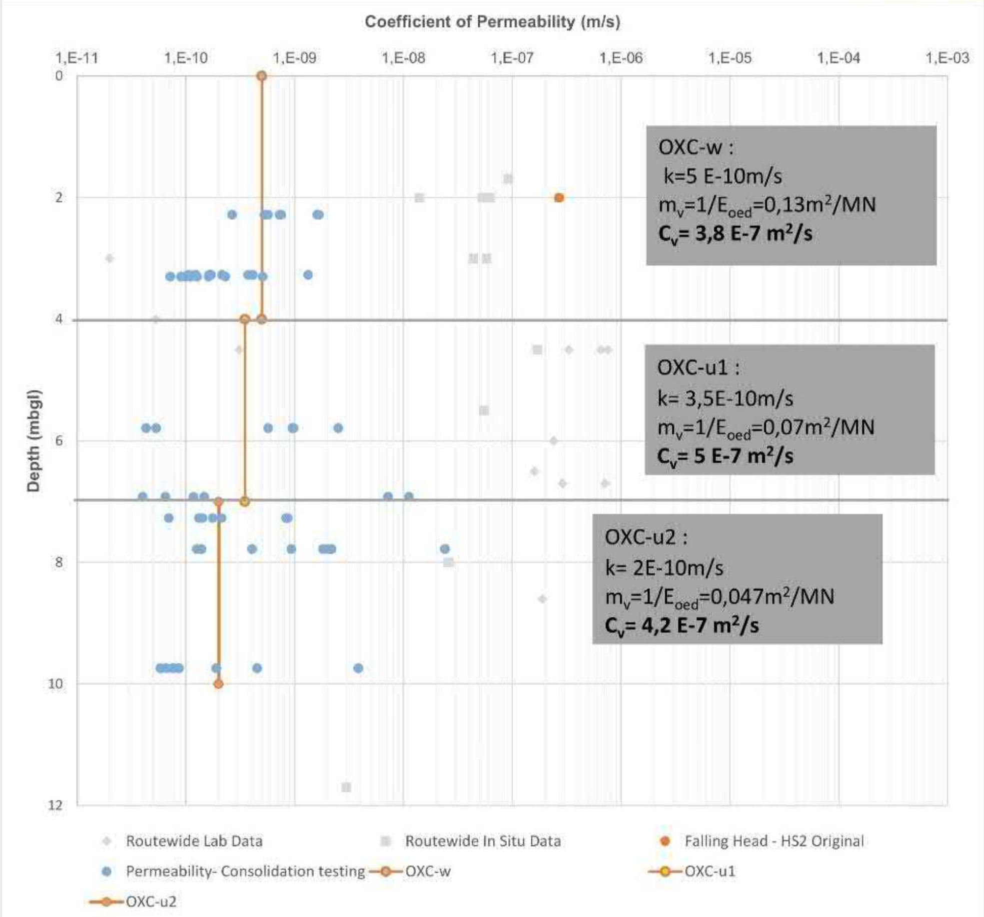
$c_{v\_insitu} = 10 \cdot c_{v\_lab} >> k_{\_insitu} = 10 \cdot k_{\_lab}$

$c_r = c_{v\_insitu}$

HS2

Permeability vs. Depth (mbgl)

Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	OXC-C Z	Figure:	C10



Notes	Plot Date:	07/07/2021
Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	Holebase database reference	Datadrop 10. Published 05/2021

Figure D-75. Shear stress vs. Normal Stress in the Oxford Clay Formation OXC CZ – Twyford Embankment and Routewide

Young Modulus E' (C11)

Correlation with N obtained from SPT

E'=K·N

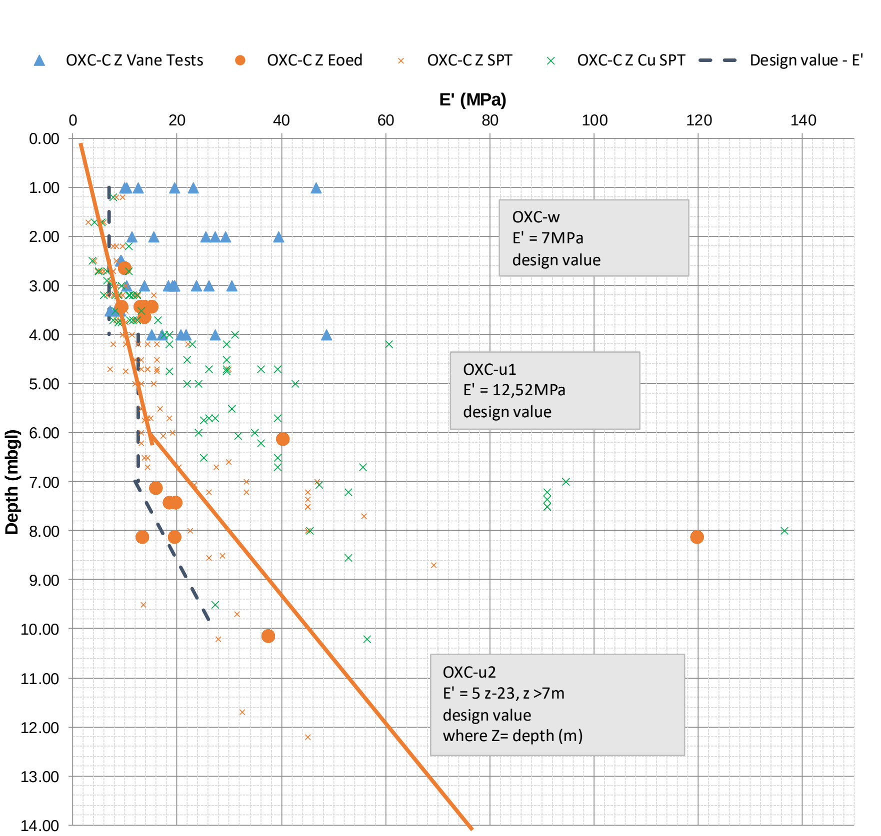
Where K=0.6-0.9(OXc-u2) for over-consolidated unweathered clayey soils; and K=0.6 (OXC-w & u1) for slightly over-consolidated weathered clayey soils (CIRIA R143) Ref.[61]

Relationship between E' - E_u

$$\boldsymbol{E'} = E_u \frac{1+\nu'}{1+\nu_u}$$

Where: E'=Young Modulus; E_u=Undrained Young Modulus; ν'=Poisson's ratio=0.2 and ν_u=Undrained Poisson's ratio=0.5.

HS2	E' (MPa) vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment
Client:	HS2	Geology :	E' OXC C Z	Figure:	C11



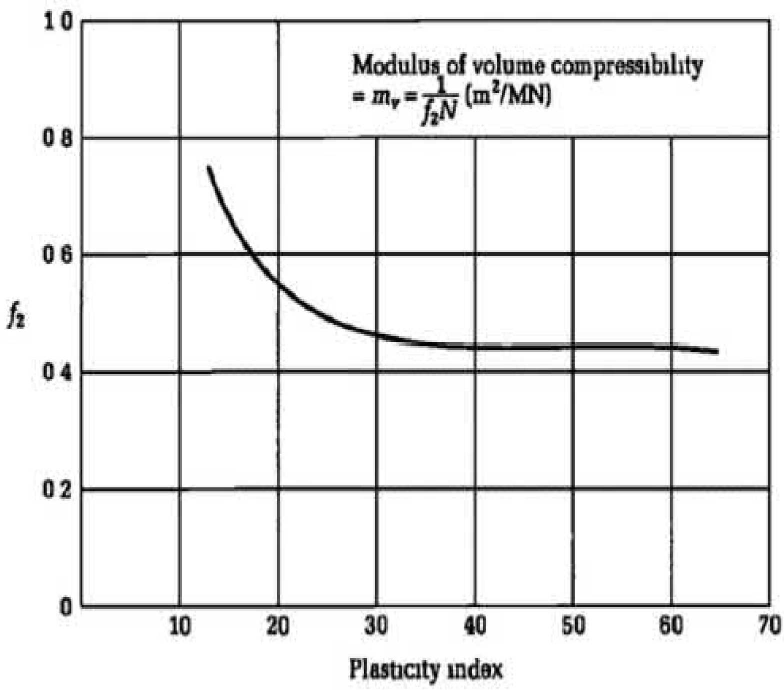
	E'	Notes	Plot Date:	11/06/2021
Number of Tests	110			
Minimum	4.74E+00			
Maximum	6.08E+01			
Offset				
			Holebase database reference	Data drop 10. Published 05/2021

Figure D-77. E' obtained from different lab tests within the Oxford Clay Formation OXC CZ – Twyford Embankment and Routewide

Oedometer Modulus E_{oed} (or Coefficient of volume change m_v=1/E_{oed})

Correlation with N from SPT

Eoed=1/mv=f2·N (Tomlinson and Woodward, 2008)



- Relationship between mv, SPT and plasticity index (Tomlinson and Woodward 2008)

Figure D-78. coefficient f2 to correlate mv=1/Eoed from N SPT and PI within the Alluvium deposits – Routewide

Correlation of E' coming from N of SPT

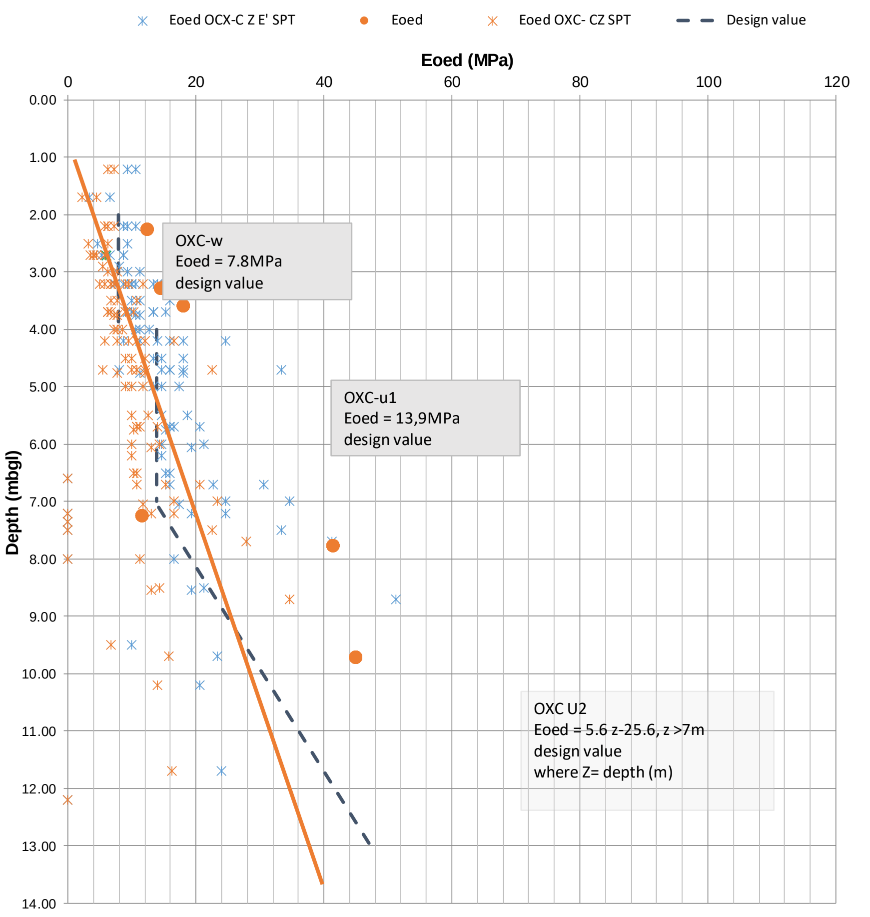
$$\boldsymbol{E}' = E_{oed}\frac{(1-2\cdot\nu')\cdot(1+\nu')}{1-\nu'}$$

Where: E'=Young Modulus (see below); E_{oed}=Oedometer Modulus; and ν'=Poisson's ratio=0.2

E'=K·N

Where K=0.6-0.9 for over-consolidated unweathered clayey soils; and K=0.6 for slightly over-consolidated weathered clayey soils

HS2	Eoed (MPa) vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment
Client:	HS2	Geology :	Eoed OXC C Z	Figure:	C12



	Eoed	Notes	Plot Date:	11/06/2021
Number of Tests	845			
Minimum	-			
Maximum	5.13E+01			
Offset				
			Holebase database reference	Data drop 10. Published 05/2021

Figure D-79. Eoed obtained from different lab tests within the Oxford Clay Formation OXC CZ – Twyford Embankment

Kellaways Formation – (KLB- S V SV)

The below table provides brief commentary on:

- the type and quantity of tests to prove the geotechnical design values,
- general trends of geotechnical values with depth,
- the plots used to determine the design values of each geotechnical parameter.

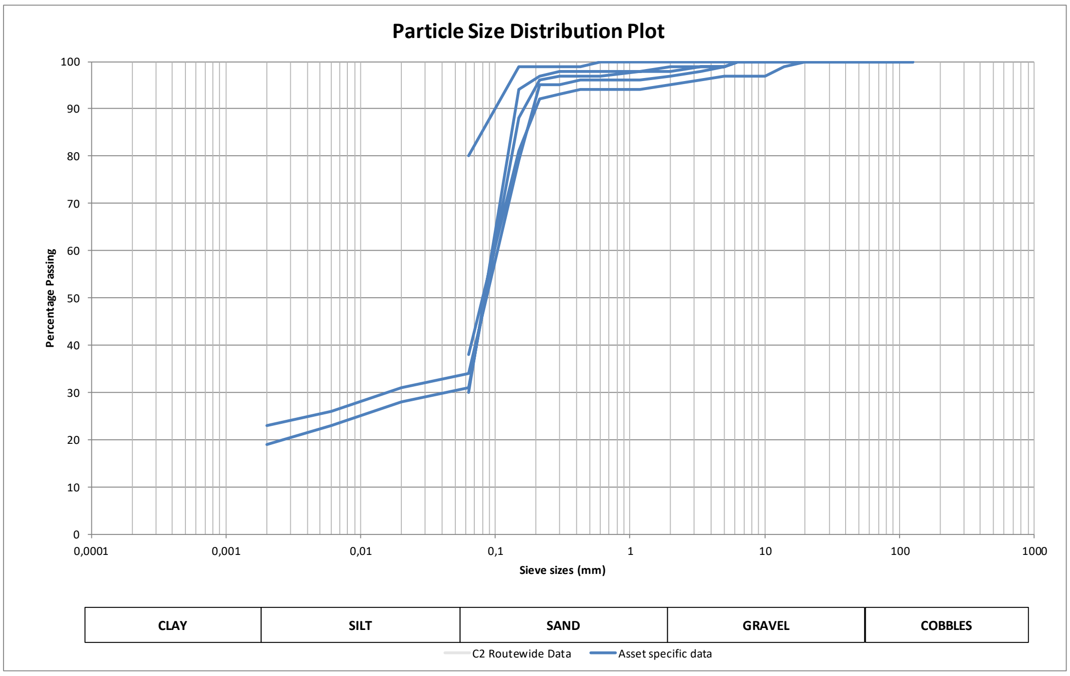
Reference should be made to the plots for the justification of the characteristic design values adopted in the geotechnical models and calculations (refer to Section 8.2).

Table D- 6. Commentary and justification of characteristic design values in KLB S V SV formation

Fines content	#0.063	only results from asset specific lab tests are considered based on the test results and on the borehole logs, KLB is described as locally soft and firm slightly **clayey fine to coarse SAND**.	D1
Plasticity index	PI	• asset specific results are consistent with routewide results. • the range of values around the mean specific asset in the KLB SV SV is 14% and it is assumed as design value.	D2, D3
Liquid limit	LL	• asset specific results are consistent with routewide results. • the design value specific asset in the KLB SV SV is 29% and it is assumed as design value	D2
Total Sulphur contents	TS	• No Total Sulphur test is available within this asset	NA
Bulk density	γ'	• only results from routewide data are considered. • the adopted design value for KLB SV SV is 2 Mg/m3	D5
Blow N number from SPT, corrected to 60% test energy	N_{60}	• seventeen one test results are available within this asset • a representative value is considered above 1m depth based in the asset specific data. • The design value within the KLB SV SV is 48 • the asset specific results indicate very dense consistency	D6
Cone resistance from CPT	q_c	• Only asset specific tests are considered to find the design value. • The design value within KLB SV SV is greater than 5MPa	D7
Undrained shear strength	c_u	• Both asset specific and routewide lab test results are represented • In-situ Vane test, UU triaxial and both SPT and CPT derived c_u are used to find the design values of undrained shear strength. • Considering both asset specific and routewide tests, the design value is 250 KPa	D8
Drained shear strength	c'	• No triaxial Cu+u and triaxial CD tests are available in this asset. • No Shear box tests are available in this asset. • In view of the absence of drained triaxial tests, a cautious long term drained value of c'=0kPa has been used in design	D9
	ϕ'	• No CD triaxial available in this asset. • A cautious value long term drained value of φ' =25° has been used in design.	D9

Coefficient of Permeability	K	• No Permeability test is available within this asset	N/A
Young/Effective Deformation Modulus	E’	• SPT results are used to find the representative values • Only In-situ Vane tests results with IP >30 results are used to find the representative values	D6
		• E’ is correlated by N coming from SPT (CIRIA R143) Ref.[61]	D11
		• The design value coming from the SPT.	D11
Oedometer Deformation Modulus	E_{oed}	SPT results are used to find the representative values	D6
		• PI is used to obtain relationship between Eoed=1/mv and N coming from SPT	D12
		• Relationship between the Oedometer Modulus Eoed and E’ coming from N of SPT (CIRIA R143) Ref.[61] • The design value is given by the average value coming from this three correlation	D8, D12

Particle size distribution (D1)

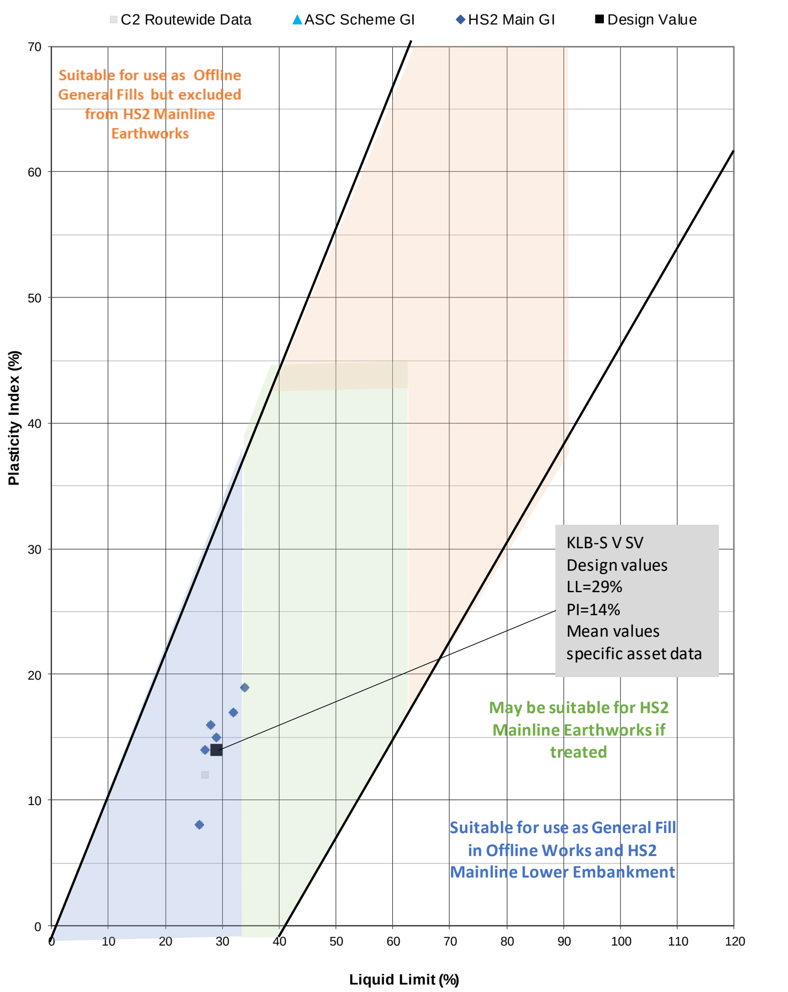


Notes	Client	Title				
Background C2 scheme wide parameters shown are based on holebase database geology codes dated 11/08/2020	HS2	: Particle Size Distribution for Kellaways Formation				
asc A High-Speed Design Partnership ARCADIS COWI	Location	0	Project ID	10039367		
	Project Title	1MC07 - Stage One C3 -MWCC – Brackley to South Portal of Long Itchington Tunnel	Figure	D1	Date	19/07/2021

Figure D-80. Particles size distribution within the Kellaways Formation – (KLB- S V SV) –Twyford Embankment

Atterberg limits (D2, D3)

HS2	A-Line Plot - HS2 Suitability Overlay				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	KLB-S V SV	Figure:	D2

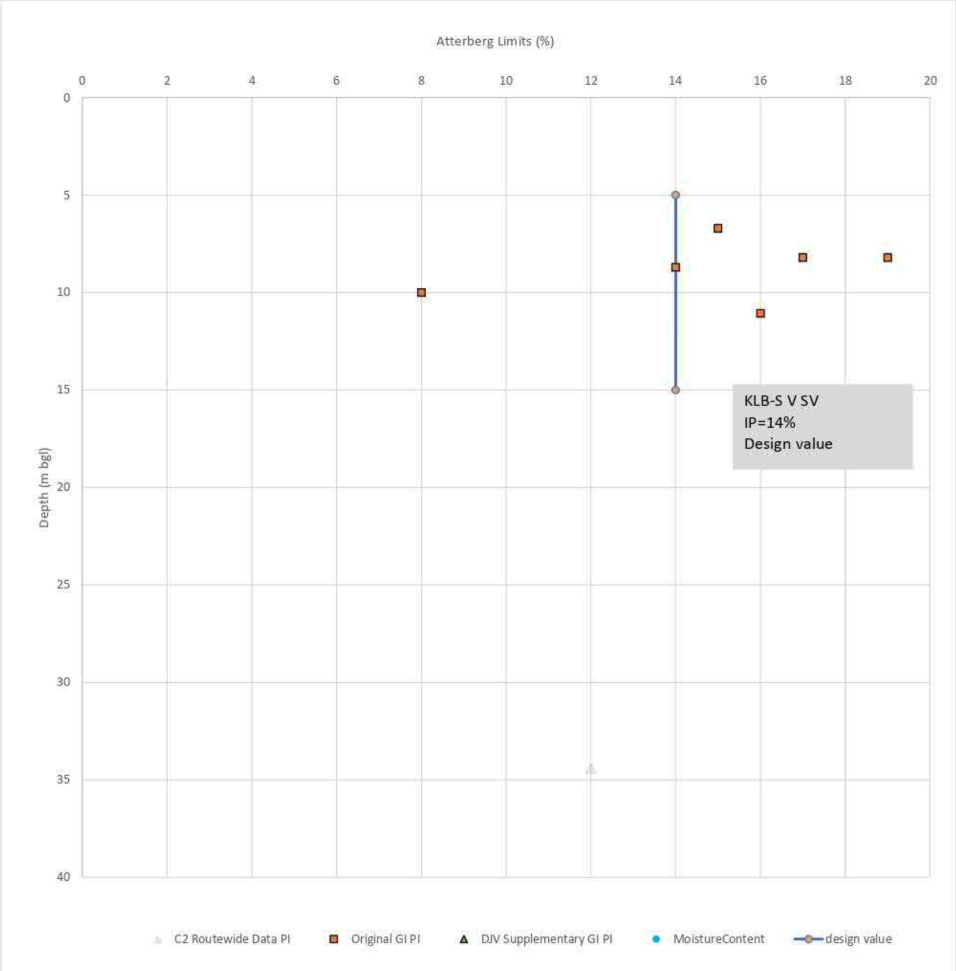


Number of Tests:	Offset:	Plot Date:	19/07/2021
	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	Holebase database reference	Datadrop 10. Published 05/2021

Figure D-81. Plasticity Index vs. Liquid Limit within the Kellaways Formation – (KLB- S V SV) – Twyford Embankment and routewide

HS2 — Liquid limit, Plastic limit and Plasticity Index with depth (mbgl)

Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client	HS2	Geology :	KLB-S V SV	Figure:	D3

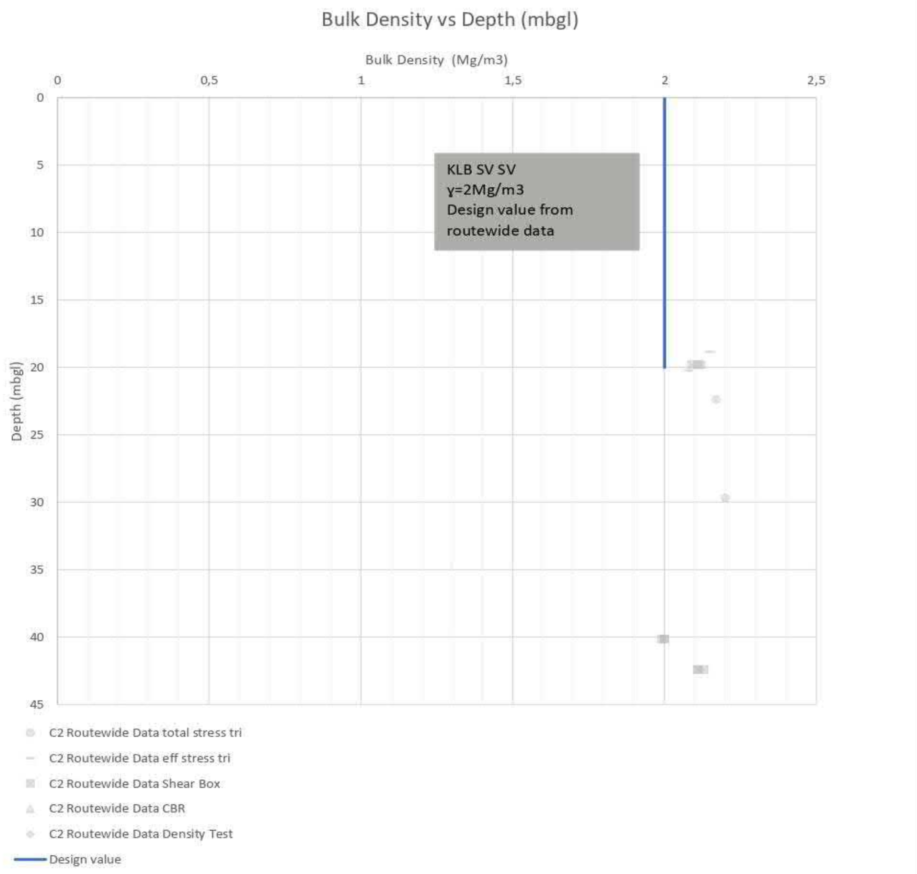


Number of test	18	Notes Background C2 Routewide data shown are based on Holebase database geology codes dated 29/05/2021	Plot Date:	14/06/2021
			Offset:	
			Holebase database reference	Datadrop 10. Published 05/2021

Figure D-82. Plasticity Index vs. depth within the Kellaways Formation – (KLB- S V SV)) – Twyford embankment and Routewide

Bulk density γ' (D5)

HS2	Bulk Density vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Routewide_ Calvert area
Client:	HS2	Geology :	KLB-S V SV	Figure:	D5



	Bulk Density
Number of Tests	7
Minimum	1,99
Maximum	2,20

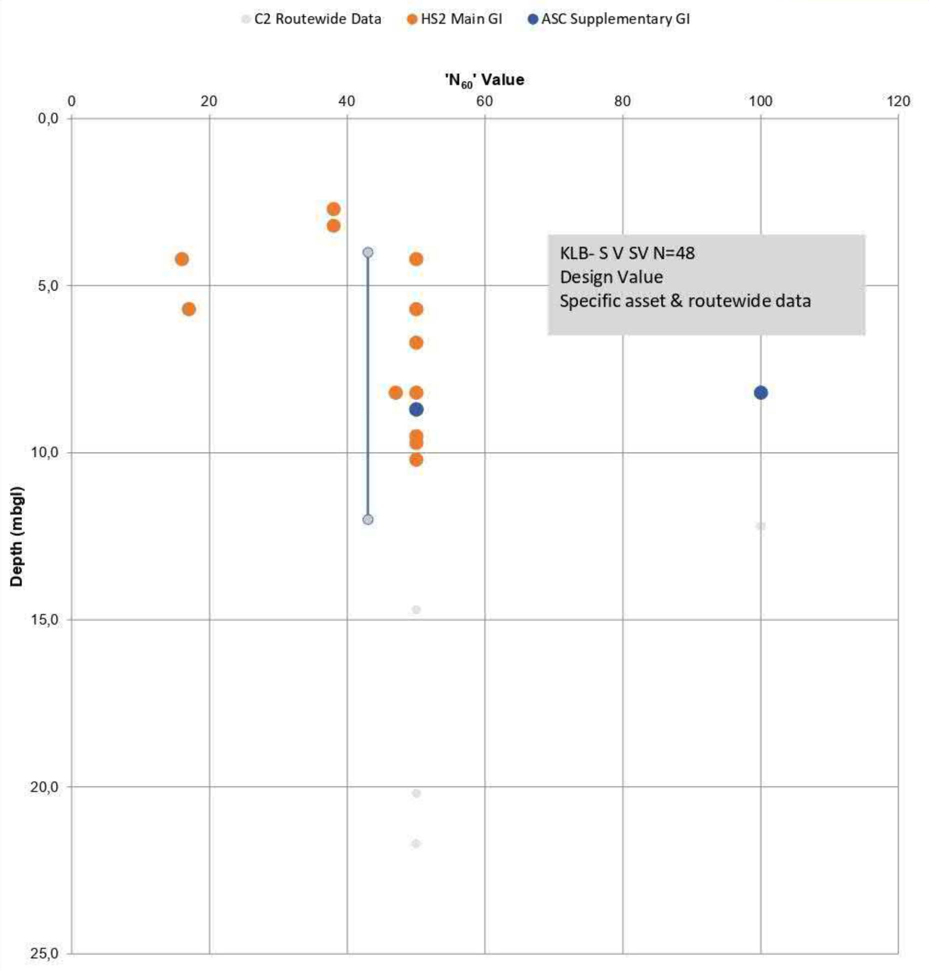
Notes
Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021

Plot Date:	01/07/2021
Database reference number	Datadrop 10. Published 05/2021

Figure D-84. Bulk density obtained from different lab tests within the Kellaways Formation - (KLB- S V SV)– Routewide

Penetration Resistance NSPT (D6)

HS2	SPT-N_{60} vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	KLB-S V SV	Figure:	D6

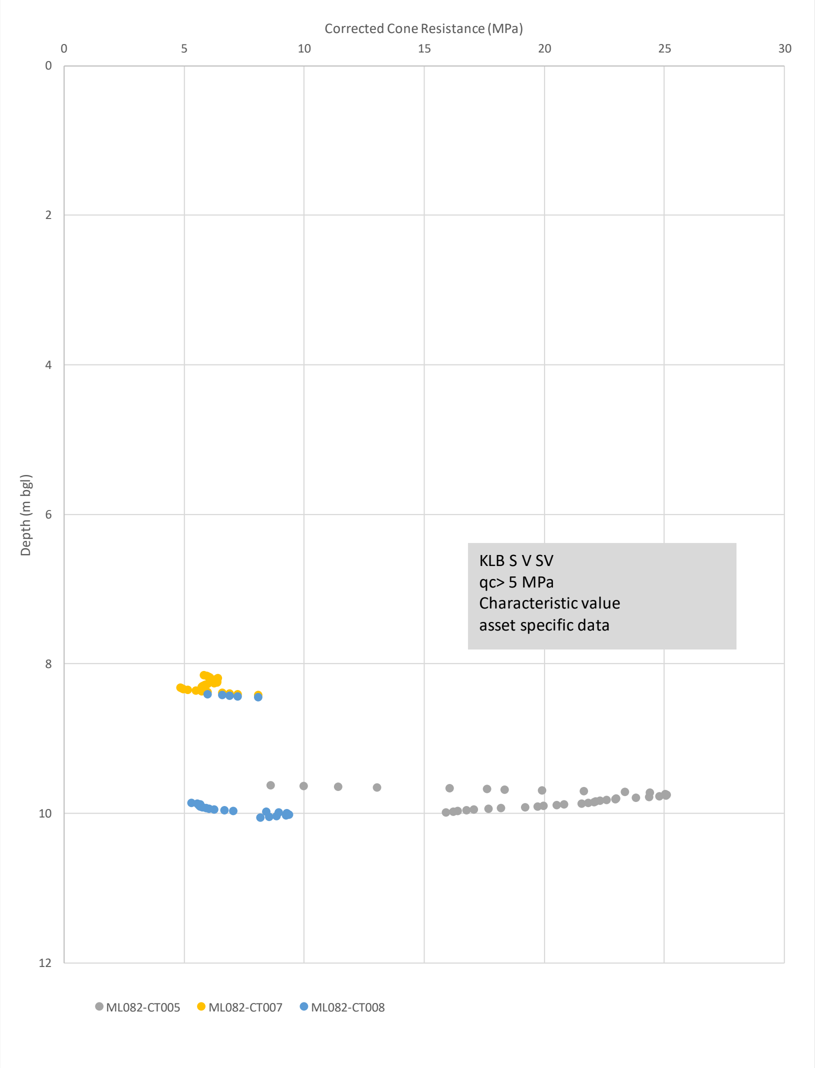


	N Value	Notes	Plot Date:	14/06/2021
Number of Tests	17	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021		
Minimum	16			
Maximum	100			
Offset				
			Holebase Database Reference	Datadrop 10. Published 05/2021

Figure D-85. SPT results within the Kellaways Formation - (KLB SV SV)– Twyford Embankment and routewide

CPT Cone Resistance vs Depth (D7)

HS2	CPT Cone Resistance vs Depth				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Figure:	D7
Client:	HS2	Location :	Twyford Embankment Group		



	Notes:	Plot Date:	11/03/2022
		Holebase database reference	Datadrop 10 Published 05/2021

Figure D-86. Bulk density obtained from different lab tests within the Kellaways Formation – (KLB- S V SV) – Routewide

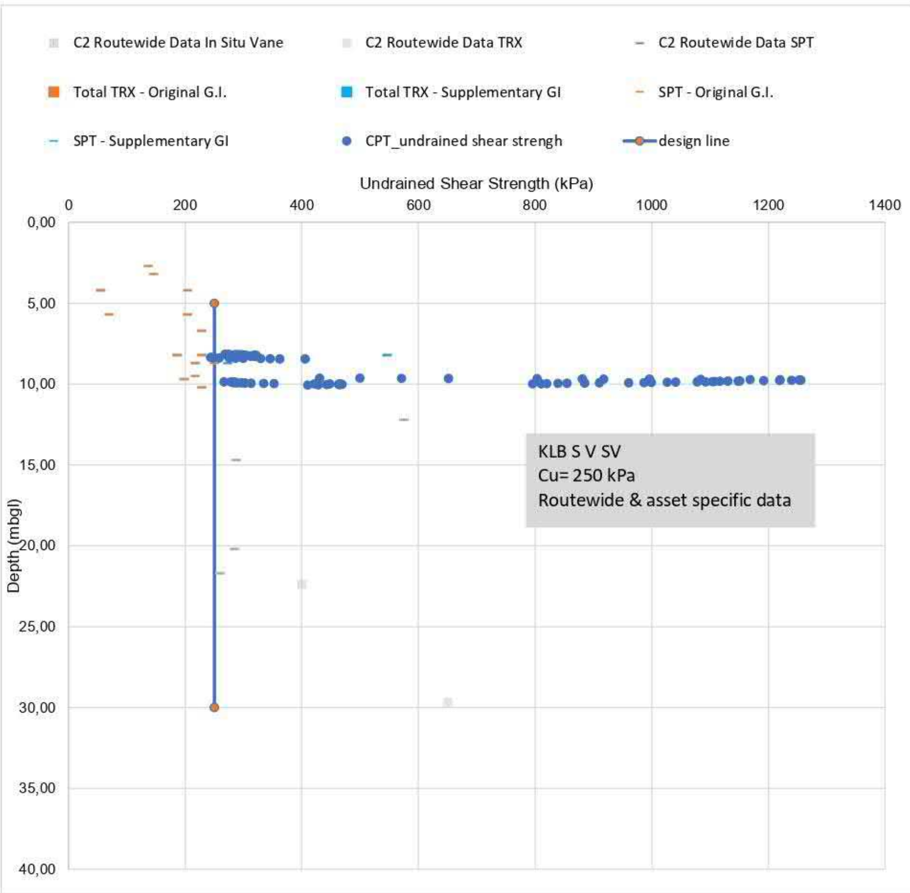
N value (blows/ 305mm)	Consistency	Field Indications	Approximate C_u (kPa)
0 to 2	Very Soft	Excludes between the fingers when squeezed in the fist	0 – 12.5
2 to 4	Soft	Easily moulded in the fingers	12.5 – 25
4 to 8	Medium (Firm)	Can be moulded in the fingers by strong pressure	25 – 50
8 to 15	Stiff	Cannot be moulded in the fingers	50 – 100
15 to 30	Very Stiff	Brittle or very tough	100 – 200
>30	Hard	-	>200

Figure D-87. Correlation C_u with N_{SPT} values Consistency and field descriptions (source: EPRI, 1990)

Undrained shear strength Cu (D8)

HS2 — Undrained Shear Strength vs. Depth (mbgl)

Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	KLB-S V SV	Figure:	D8



	Total
Number of Tests	35
Minimum	-
Maximum	-
Offset	

Notes

Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021

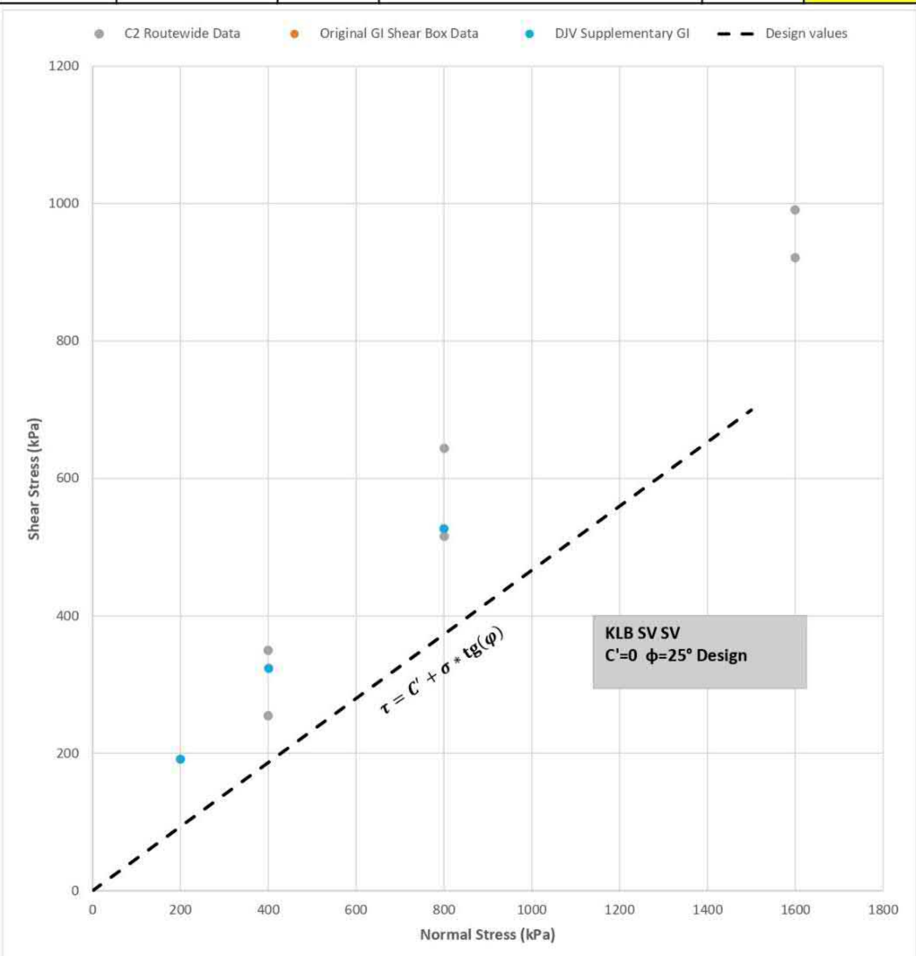
Inferred ground conditions applied to CPT Cu profiles are based on review of exploratory hole information adjacent to the CPT position.

Plot Date:	14/06/2021
Holebase database reference	Datadrop 10. Published 05/2021

Figure D-89. Undrained shear strength obtained from different lab and in situ tests within the Kellaways Formation – (KLB- S V SV)– Twyford Embankment and Routewide

Shear Box Shear Stress Vs Normal Stress (D9)

HS2	Shear Box Shear Stress vs. Normal Stress				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Routewide_ Calvert area
Client:	HS2	Geology :	KLB-S V SV	Figure:	D9



Notes:	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	Plot Date:	29/06/2021
Offset			
Holebase database reference	Datadrop 10. Published 05/2021		

Figure D-91. Shear stress vs. Normal Stress in the Kellaways Formation – (KLB- S V SV)–Routewide

Correlation with N obtained from SPT

$E' = K \cdot N$

Where K=0.6-0.9 for over-consolidated unweathered clayey soils; and K=0.6 for slightly over-consolidated weathered clayey soils (CIRIA R143) Ref.[61]

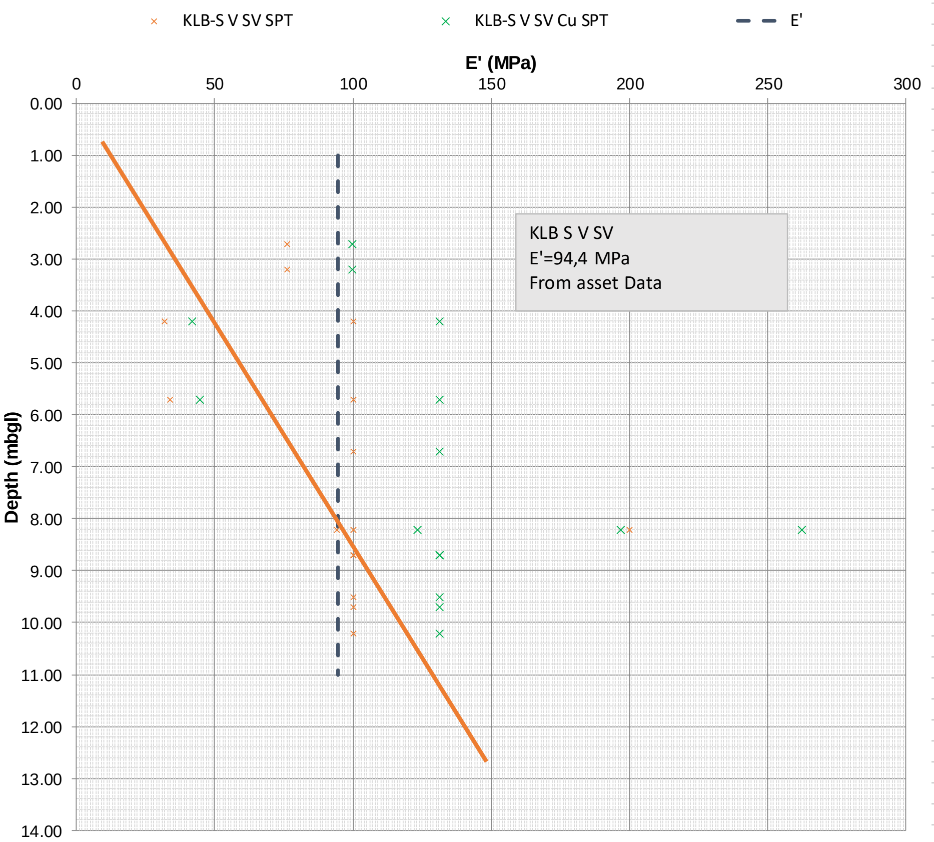
Relationship between E' - E_u

$$\boldsymbol{E'} = E_u \frac{1 + \nu'}{1 + \nu_u}$$

Where: E'=Young Modulus; E_u=Undrained Young Modulus; ν'=Poisson's ratio=0.2 and ν_u=Undrained Poisson's ratio=0.5.

Young Modulus E’ (D11)

HS2		E' (MPa) vs. Depth (mbgl)					
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment		
Client:	HS2	Geology :	E' KLB-S V SV	Figure:	D11		



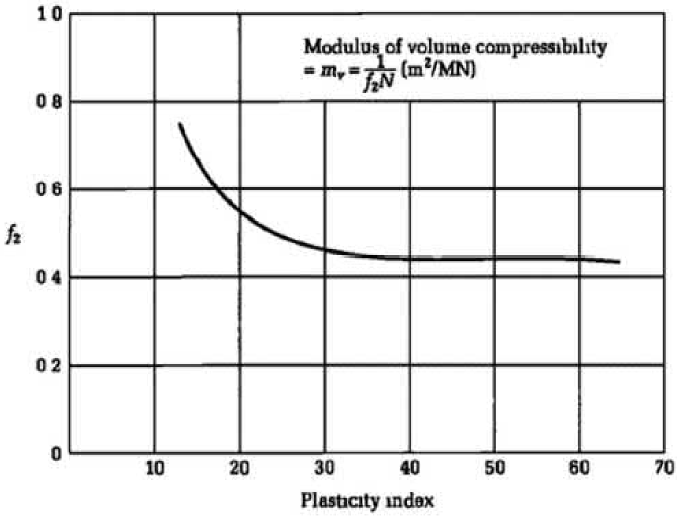
	E'	Notes		Plot Date:	11/06/2021
Number of Tests	35				
Minimum	3.20E+01				
Maximum	2.63E+02				
Offset					
				Holebase database reference	Data drop 10. Published 05/2021

Figure D-93. E’ obtained from different lab tests within the Kellaways Formation – (KLB- S V SV)– Twyford Embankment

Oedometer Modulus E_{oed} (or Coefficient of volume change m_v=1/E_{oed}) (B12)

Correlation with N from SPT

Eoed=1/mv=f2·N (Tomlinson and Woodward, 2008)



- Relationship between mv, SPT and plasticity index (Tomlinson and Woodward 2008)

Figure D-94. coefficient f2 to correlate mv=1/Eoed from N SPT and PI within the Alluvium deposits – Routewide

Correlation of E' coming from N of SPT

$$\boldsymbol{E}' = E_{oed}\frac{(1-2\cdot\nu')\cdot(1+\nu')}{1-\nu'}$$

Where: E'=Young Modulus (see below); E_{oed}=Oedometer Modulus; and ν'=Poisson's ratio=0.2

E'=K·N

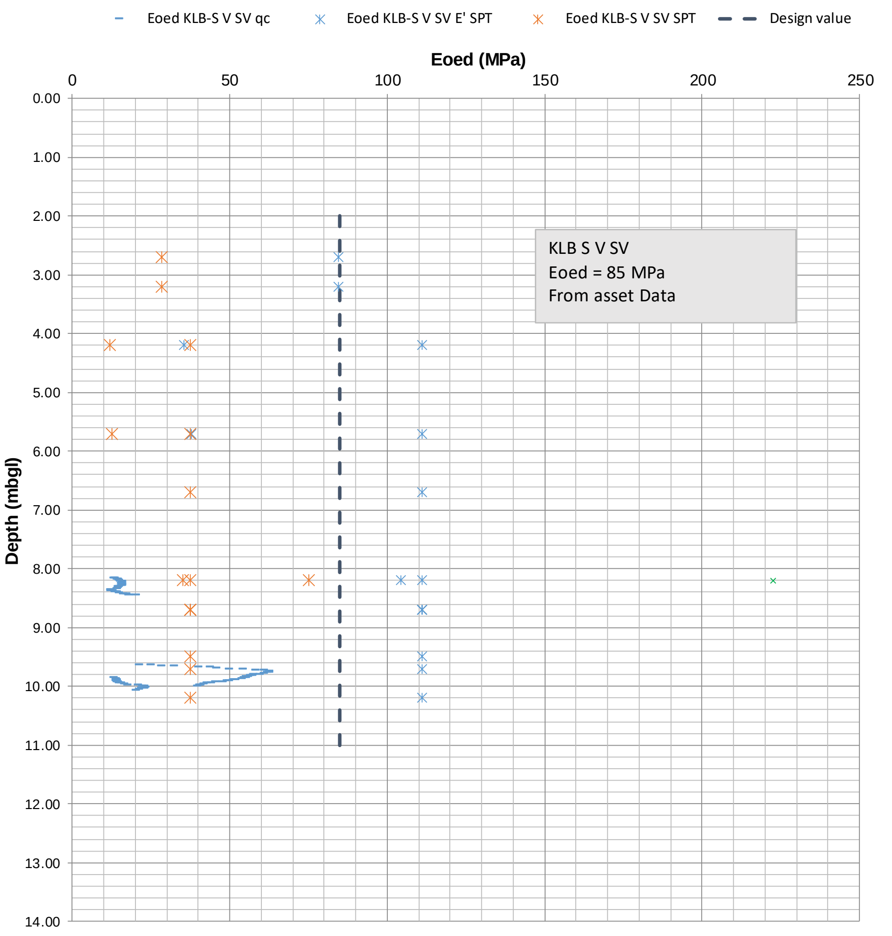
Where K=0.6-0.9 for over-consolidated unweathered clayey soils; and K=0.6 for slightly over-consolidated weathered clayey soils

Eoed (MPa) vs Depth (D12)

HS2

Eoed (MPa) vs. Depth (mbgl)

Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North	Location:	Twyford Embankment
Client:	HS2	Geology :	E' KLB-S V SV	Figure:	D12



Notes	Plot Date:	11/06/2021
	Holebase database reference	Data drop 10. Published 05/2021

Figure D-95. Eoed obtained from different lab tests within the Kellaways Formation – (KLB- S V SV)– Twyford Embankment

Kellaways Formation – (KLB- C Z)

The below table provides brief commentary on:

- the type and quantity of tests to prove the geotechnical design values,
- general trends of geotechnical values with depth,
- the plots used to determine the design values of each geotechnical parameter.

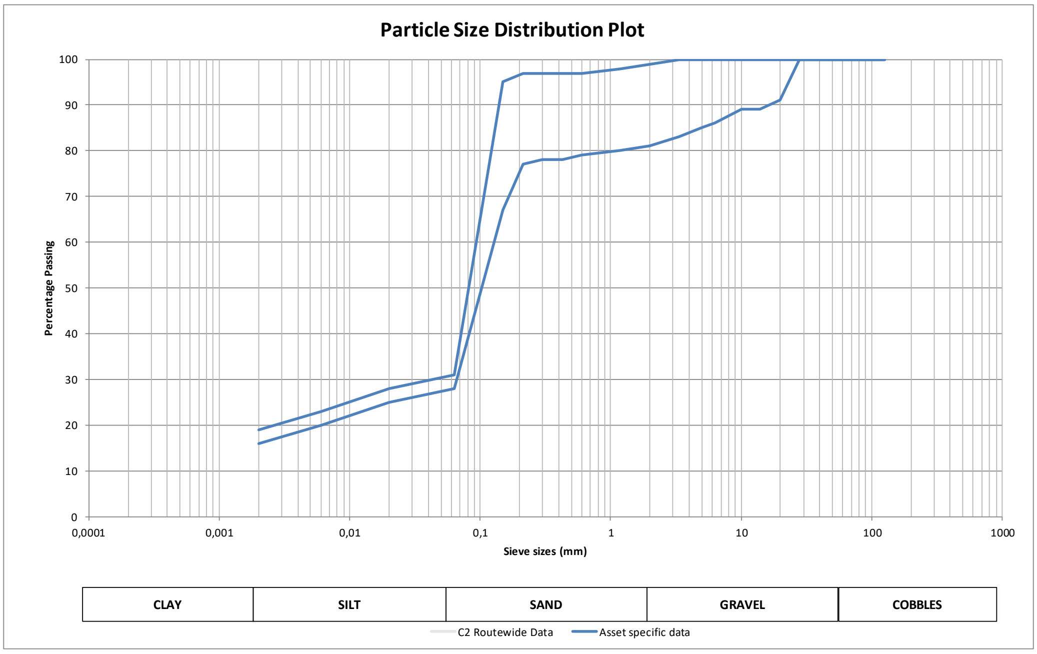
Reference should be made to the plots for the justification of the characteristic design values adopted in the geotechnical models and calculations (refer to Section 8.2).

Table D- 7. Commentary and justification of characteristic design values in ALV

Fines content	#0.063	only results from asset specific lab tests are considered based on the test results and on the borehole logs, KLB CZ is described as locally soft and firm slightly **sandy clay**	E1
Plasticity index	PI	• asset specific results are consistent with routewide results. • the range of values around the mean specific asset in the KLB CZ is 36% and it is assumed as design value.	E2, E3
Liquid limit	LL	• asset specific results are consistent with routewide results. • the design value specific asset in the KLB CZ is 29% and it is assumed as design value	E2
Total Sulphur contents	TS	• both asset specific and routewide lab test results are represented • asset specific mean value is used to obtain the design value of Total Potential Sulphate contents TPS (%) to assess its re-use • The design value within KLB CZ is 1.33%	E4
Bulk density	γ'	• only results from routewide data are considered. • the adopted design value for KLB CZ is 2 Mg/m3	E5
Blow N number from SPT, corrected to 60% test energy	N_{60}	• both asset specific and routewide in-situ test results are represented • the asset specific results indicate very stiff consistency. • the design value within KLB CZ is 47 which is consistent with the routewide	E6
Cone resistance from CPT	q_c	• no CPT are available within this asset and in the woutewide	N/A
Undrained shear strength	c_u	• SPT mean value are used to find the representative value	E6
		• Both asset specific and routewide lab test results are represented • In view of the lack of drained triaxial tests, a cautious Cu=207 kPa has been used in the design, this value coming from the correlation with NSPT.	E8
Drained shear strength	c'	• No triaxial Cu+u and triaxial CD tests are available in this asset. • No Shear box tests are available in this asset. • In view of the absence of drained triaxial tests, a cautious long term drained value of c'=2 kPa has been used in design	N/A

	ϕ'	• No CD triaxial available in this asset. • A cautious value of φ' is considered. This value is consistent with the correlation with PI for normally consolidated clays (Ladd et al. 1977) Ref. [60] (see Figure D-104)	
Coefficient of Permeability	k	• No permeability in situ tests is available in this asset.	N/A
Young/Effective Deformation Modulus	E'	• SPT results are used to find the representative values	E6
		• Oedometer results are used to find the representative values • E' is correlated by N coming from SPT (CIRIA R143) Ref.[61] • The design value coming from the SPT. Results coming from oedometer tests could give a less-estimation.	E11
Oedometer Deformation Modulus	E_{oed}	• Oedometer results are used to find the representative values	
		• SPT results are used to find the representative values	E6
		• PI is used to obtain relationship between Eoed=1/mv and N coming from SPT	E12
		• Relationship between the Oedometer Modulus Eoed and E' coming from N of SPT (CIRIA R143) Ref.[61] • The design value is given by the average value coming from this three correlation	E6, E12

Particle size distribution (E1)

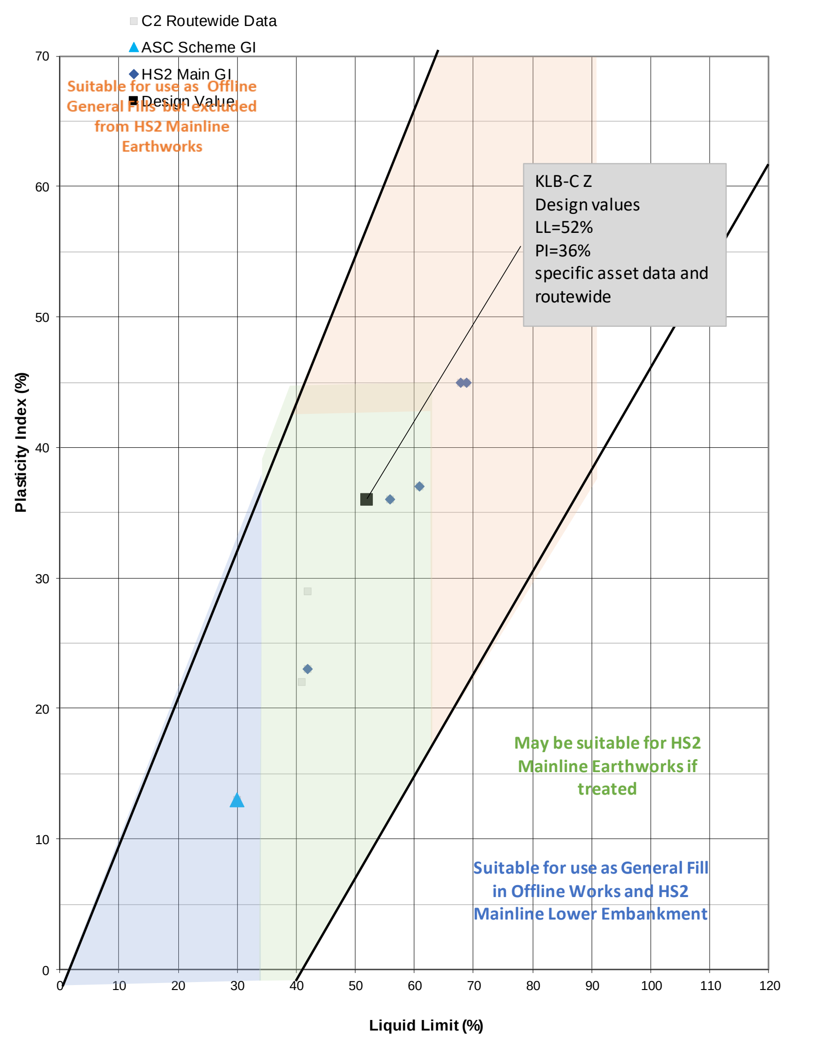


Notes Background C2 scheme wide parameters shown are based on holebase database geology codes dated 11/08/2020	Client HS2		Title : Particle Size Distribution for Kellaways Formation		
	Location	0	Project ID	10039367	
	Project Title	1MC07 - Stage One C3 -MWCC – Brackley to South Portal of Long Itchington Tunnel	Figure	C1	Date 19/07/2021

Figure D-96. Particles size distribution within the Kellaways Formation – (KLB- C Z) – Twyford Embankment

Atterberg limits (E2, E3)

HS2	A-Line Plot - HS2 Suitability Overlay				
Project ID:	**10039367**	Project Title:	**1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley**	Location:	**Twyford Embankment Group**
Client:	**HS2**	Geology :	**KLB-C Z**	Figure:	**E2**

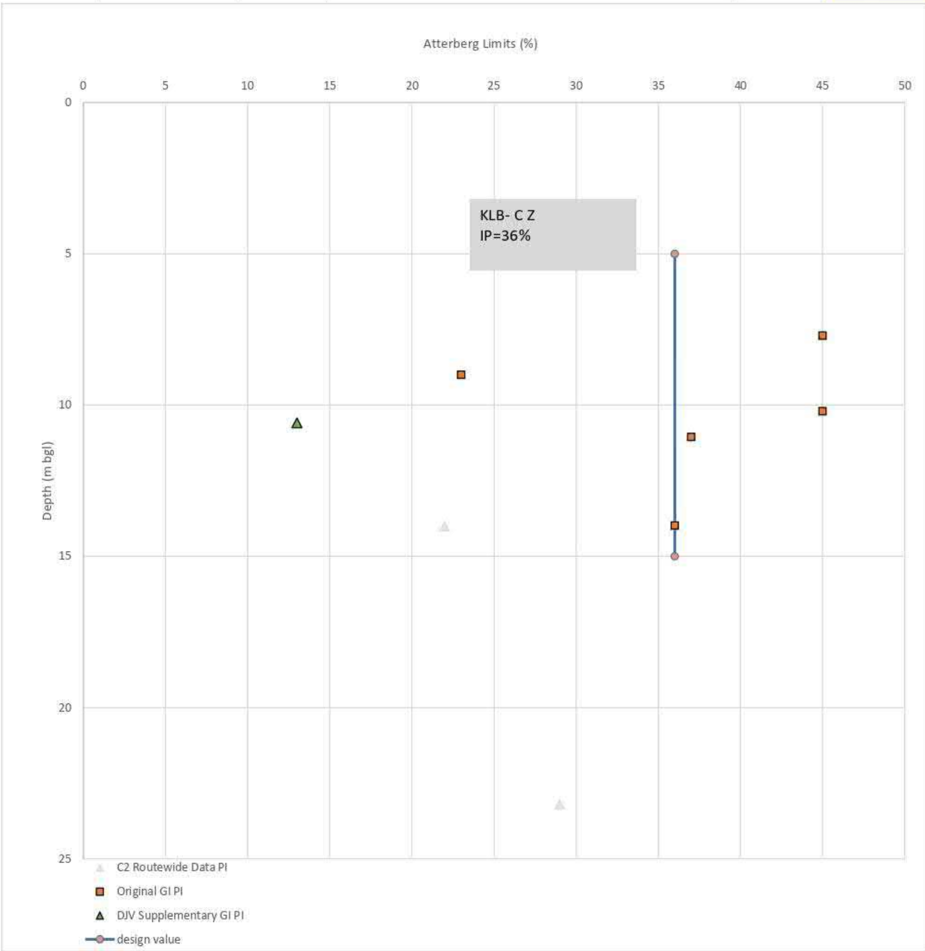


Number of Tests:	Offset:	Plot Date:	19/07/2021
asc A High-Speed Design Partnership ARCADIS COWI	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	Holebase database reference	Datadrop 10. Published 05/2021

Figure D-97. Plasticity Index vs. Liquid Limit within the Kellaways Formation – (KLB- C Z)

HS2 Liquid limit, Plastic limit and Plasticity Index with depth (mbgl)

Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	KLB-C Z	Figure:	E3

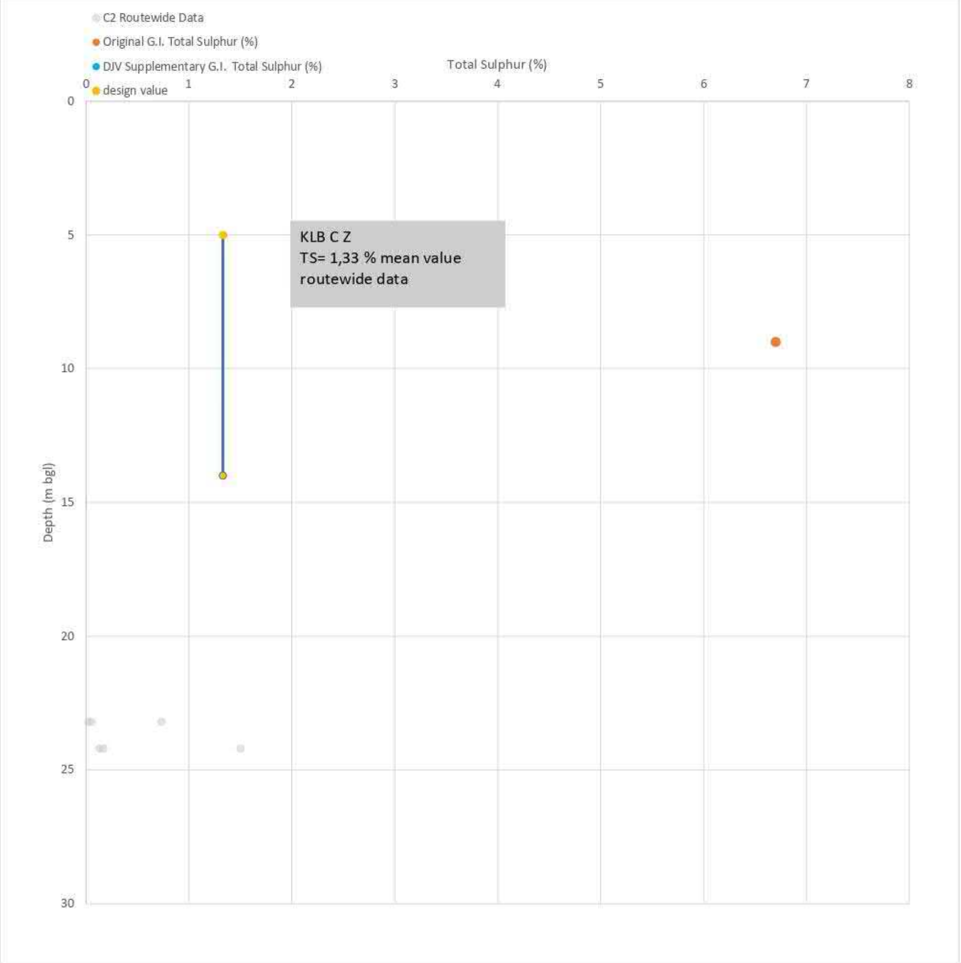


Number of test	20	Notes: Background C2 Routewide data shown are based on Holebase database geology codes dated 29/05/2021		Plot Date:	14/06/2021
				Offset:	
				Holebase database reference	Datadrop 10. Published 05/202[illegible]

Figure D-98. Plasticity Index vs. depth within the Kellaways Formation – (KLB- C Z)– Twyforf embankment and Routewide

Sulphur content (E4)

HS2	Total Sulphur (as % S) vs Depth (mbgl)				
Project ID: 10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley		Location:	Twyford Embankment Group
Client: HS2	Geology:	KLB-C Z		Figure:	E4

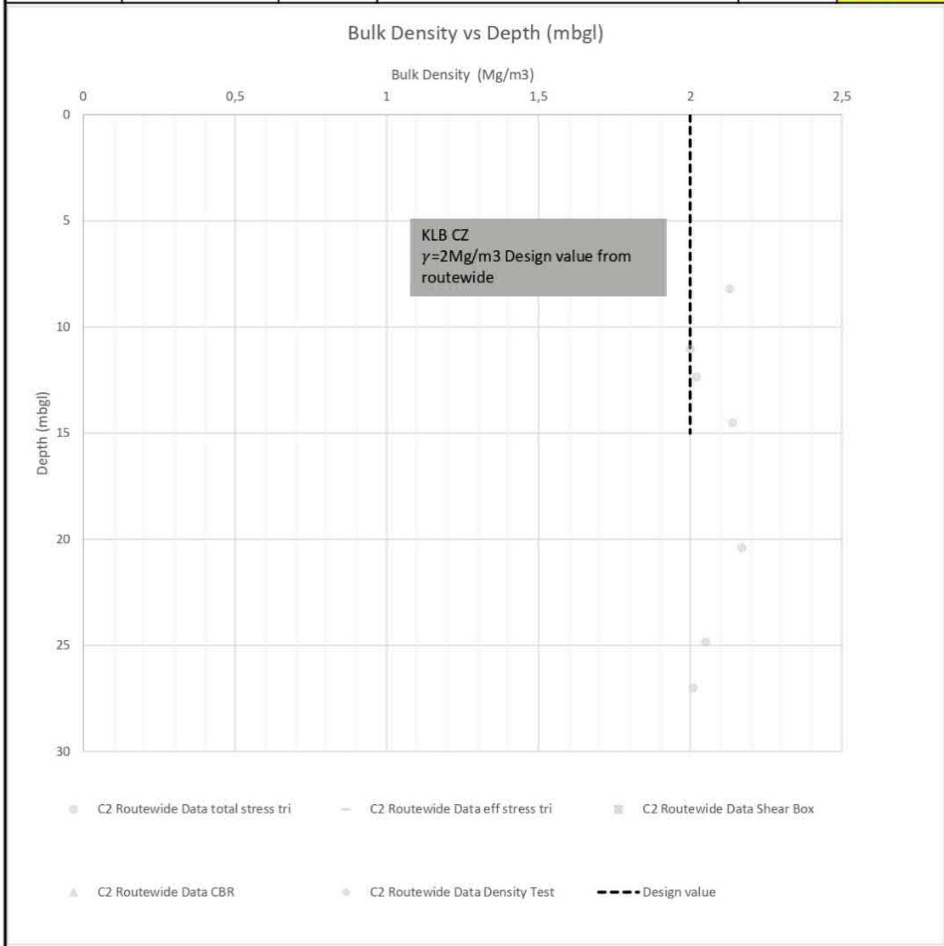


	TS %	Note	Plot Date:	21/06/2021
Number of Tests	7,00	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021		
Minimum	0,02			
Maximum	6,70			
asc A High-Speed Design Partnership ARCADIS COWI			Holebase database reference	Datadrop 70 Published 05/2021

Figure D-99. Total sulphur TS (%) within the Kellaways Formation – (KLB- C Z) – Twyford Embankment and Routewide

Bulk density ɣ'' (E5)

HS2	Bulk Density vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group
Client:	HS2	Geology :	KLB-C Z	Figure:	E5

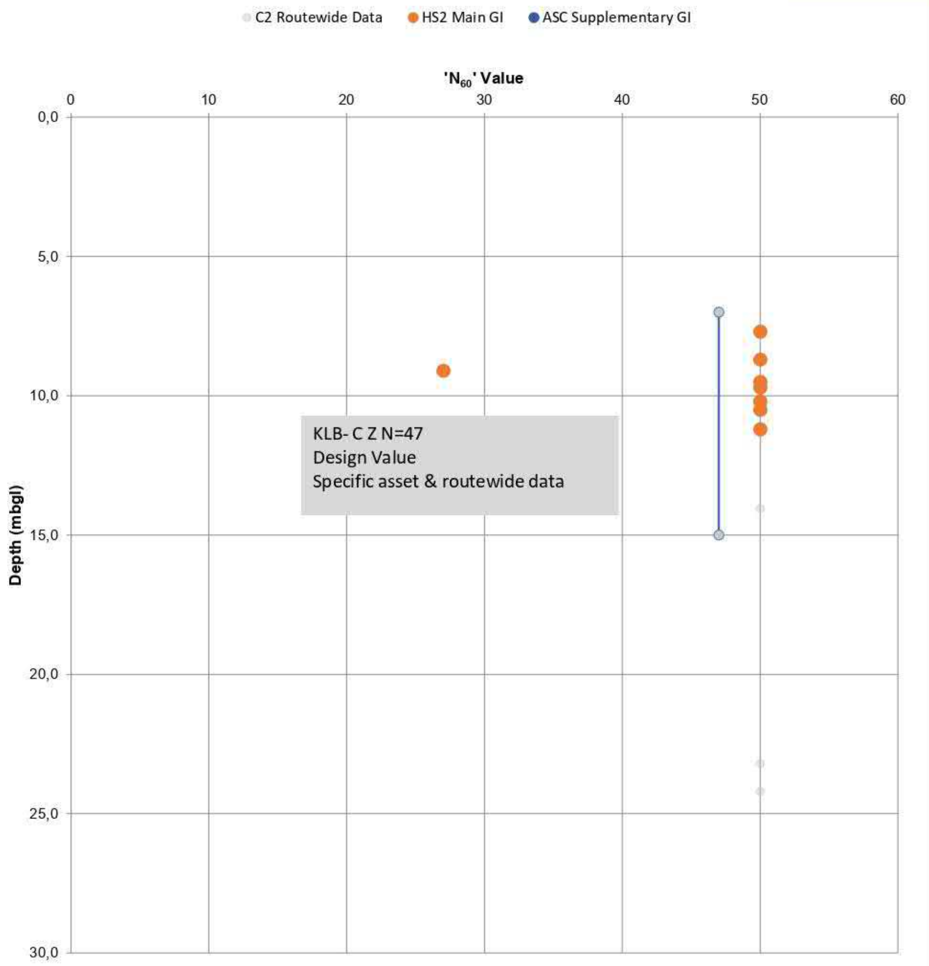


	Bulk Density	Notes	Plot Date:	29/06/2021
Number of Tests	3	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021		
Minimum	2,00			
Maximum	2,13			
			Database reference number	Datadrop 10. Published 05/2021

Figure D-100. Bulk density obtained from different lab tests within the Kellaways Formation – (KLB- C Z) – Twyford Embankment and Routewide

Standard Penetration Test resistance NSPT (E6)

HS2	SPT-N_{60} vs. Depth (mbgl)				
Project ID: 10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment Group	
Client: HS2	Geology :	KLB-C Z	Figure:	E6	



	N Value	Notes		
Number of Tests	8	Background C2 Routewide data shown are based on Holebase database geology codes dated 26/05/2021	Plot Date:	14/06/2021
Minimum	27			
Maximum	50		Holebase Database Reference	Datadrop 10. Published 05/2021
Offset				

Figure D-101. SPT results within the Kellaways Formation – (KLB- C Z) – Twyford Embankment and routewide

N value (blows/ 305mm)	Consistency	Field Indications	Approximate C_u (kPa)
0 to 2	Very Soft	Excludes between the fingers when squeezed in the fist	0 – 12.5
2 to 4	Soft	Easily moulded in the fingers	12.5 – 25
4 to 8	Medium (Firm)	Can be moulded in the fingers by strong pressure	25 – 50
8 to 15	Stiff	Cannot be moulded in the fingers	50 – 100
15 to 30	Very Stiff	Brittle or very tough	100 – 200
>30	Hard	-	>200

Figure D-102..Correlation C_u with N_{SPT} values Consistency and field descriptions (source: EPRI, 1990)

Undrained shear strength Cu (E8)

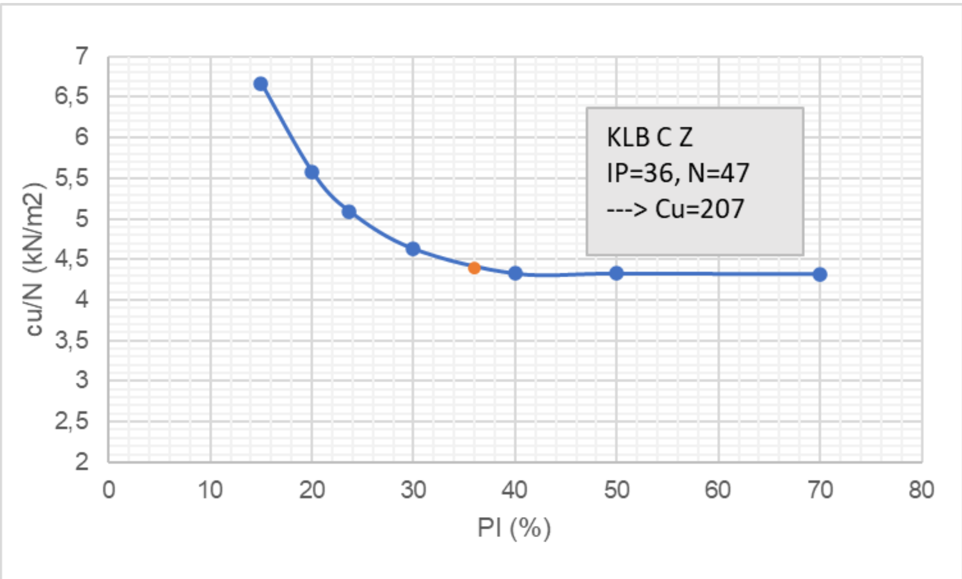


Figure D-103. Correlation between SPT N value and undrained shear strength cu, based on the Plasticity index PI Ladd et al. 1977 Ref. [60] (CIRIA R143) Ref [61]

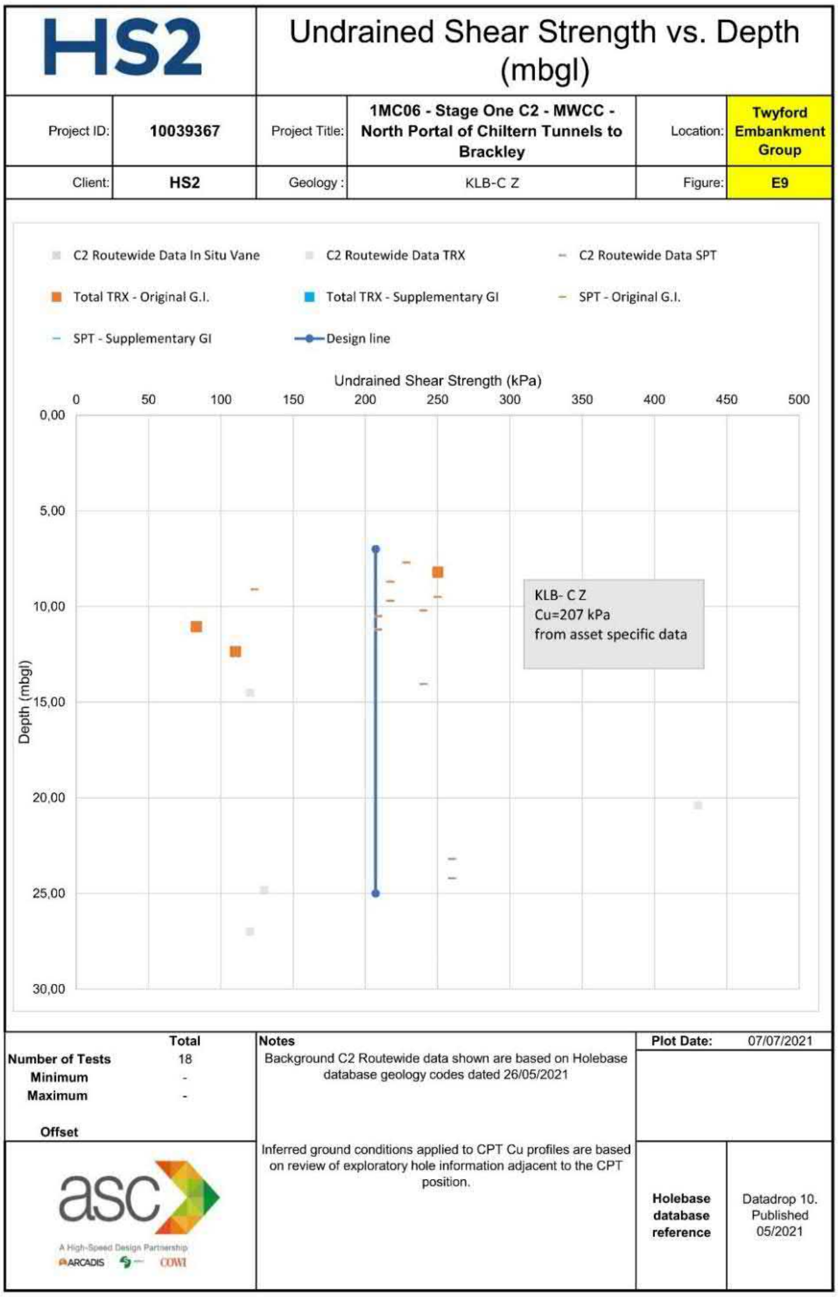


Figure D-105. Undrained shear strength obtained from different lab and in situ tests within the Kellaways Formation – (KLB- C Z) – Twyford Embankment

Effective cohesion c' and effective friction angle ϕ'

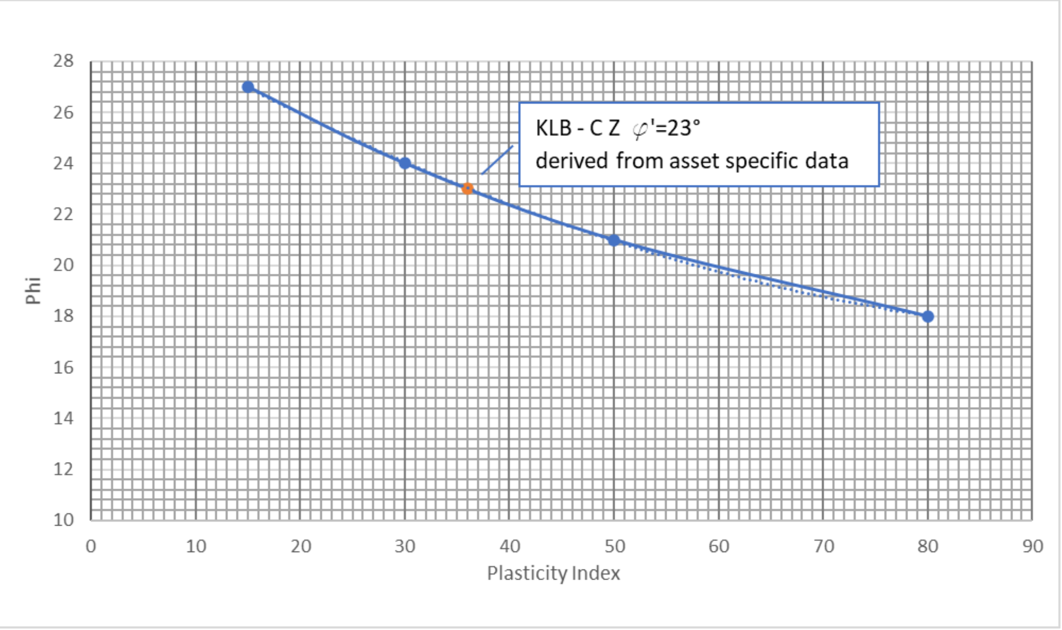


Figure D-104. Characteristic constant volume angle of shearing resistance ϕ'cv derivation (BS 8004:2015) Ref.[64] from asset specific mean Plasticity Index within the KLB -C Z

Coefficient of consolidation c_v

Derivation from k obtained from lab consolidation tests and in situ permeability tests

$$c_v = \frac{k}{m_v \cdot \gamma_w}$$

Where:

c_v=coefficient of consolidation (m^2/s)

k=hydraulic conductivity (m/s),

m_v=coefficient of volume change (m^2/kN)

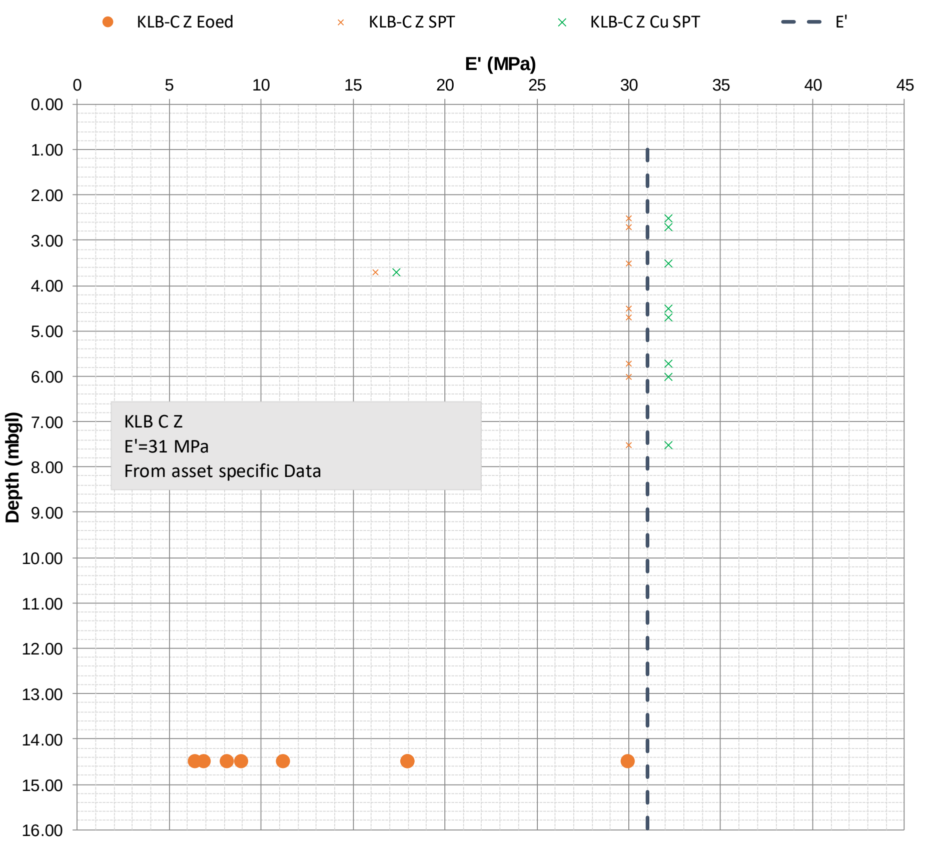
γ_w=unit weight of pore fluid/water (kN/m^3)

$c_{v\_insitu} = 10 \cdot c_{v\_lab} >> k_{\_insitu} = 10 \cdot k_{\_lab}$

$c_r = c_{v\_insitu}$

Young Modulus E' (E11)

HS2	E' (MPa) vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North Portal of Chiltern Tunnels to Brackley	Location:	Twyford Embankment
Client:	HS2	Geology :	E' KLB C Z	Figure:	E11



	E'	Notes	Plot Date:	11/06/2021
Number of Tests	26			
Minimum	6.43E+00			
Maximum	3.22E+01			
Offset				
			Holebase database reference	Data drop 10. Published 05/2021

Figure D-108. E' obtained from different lab tests within the Kellaways Formation – (KLB- C Z) – Twyford Embankment

Correlation with N obtained from SPT

E'=K·N

Where K=0.6-0.9 for over-consolidated unweathered clayey soils; and K=0.6 for slightly over-consolidated weathered clayey soils (CIRIA R143) Ref.[61]

Relationship between E' - E_u

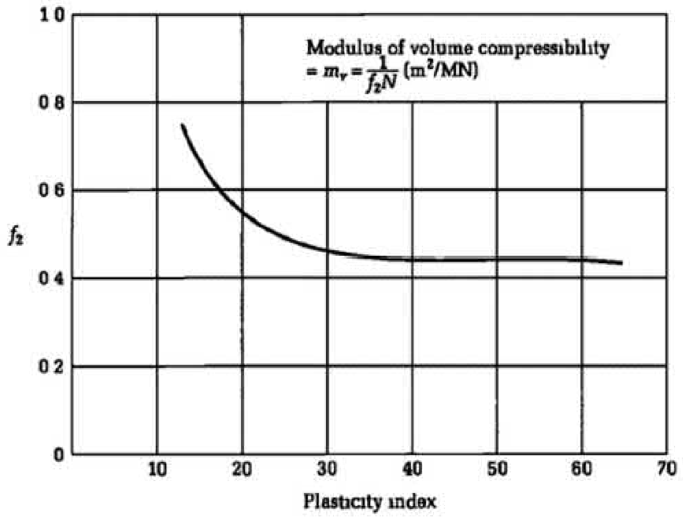
$$\boldsymbol{E'} = E_u \frac{1+\nu'}{1+\nu_u}$$

Where: E'=Young Modulus; E_u=Undrained Young Modulus; ν'=Poisson's ratio=0.2 and ν_u=Undrained Poisson's ratio=0.5.

Oedometer Modulus E_{oed} (or Coefficient of volume change $m_v=1/E_{oed}$) (E12)

Correlation with N from SPT

Eoed=1/mv=f2·N (Tomlinson and Woodward, 2008)



- Relationship between mv, SPT and plasticity index (Tomlinson and Woodward 2008)

Figure D-109. coefficient f2 to correlate mv=1/Eoed from N SPT and PI within the Alluvium deposits – Routewide

Correlation of E' coming from N of SPT

$$\boldsymbol{E'} = E_{oed}\frac{(1-2\cdot\nu')\cdot(1+\nu')}{1-\nu'}$$

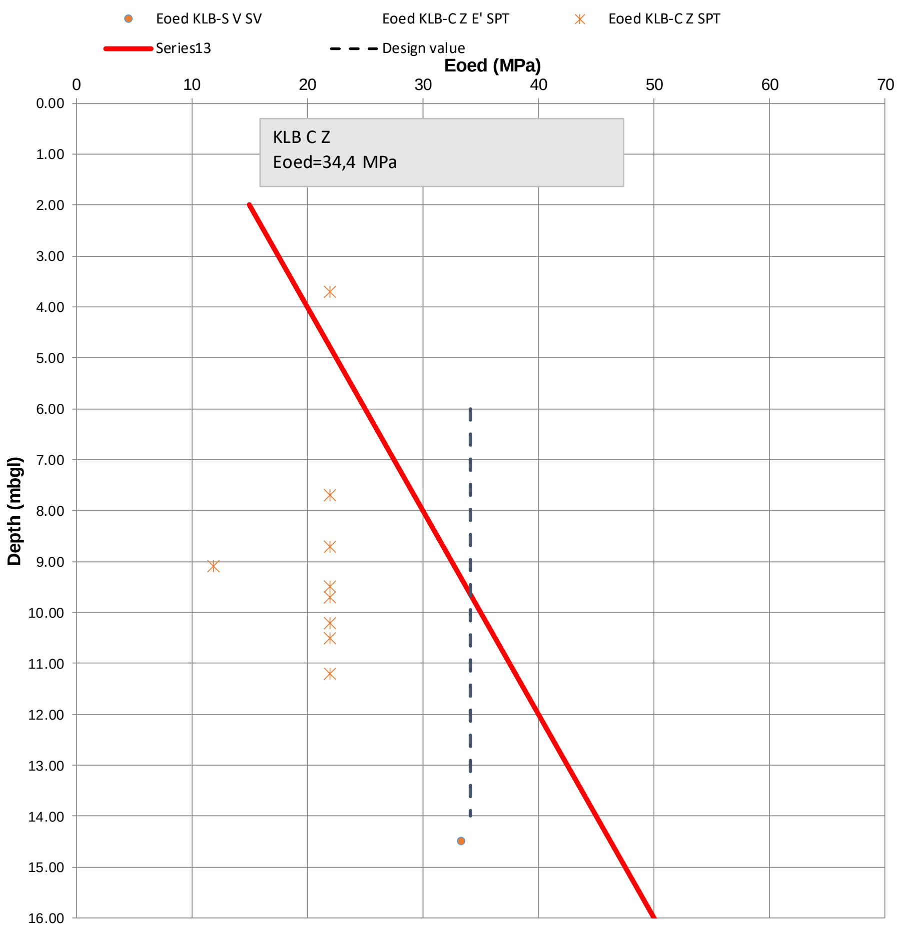
Where: E'=Young Modulus (see below); E_{oed}=Oedometer Modulus; and ν'=Poisson's ratio=0.2

E'=K·N

Where K=0.6-0.9 for over-consolidated unweathered clayey soils; and K=0.6 for slightly over-consolidated weathered clayey soils

Eoed (MPa) vs Depth (E12)

HS2	Eoed (MPa) vs. Depth (mbgl)				
Project ID:	10039367	Project Title:	1MC06 - Stage One C2 - MWCC - North	Location:	Twyford Embankment
Client:	HS2	Geology :	E' KLB-C Z	Figure:	E12



	Eoed	Notes	Plot Date:	11/06/2021
Number of Tests	19			
Minimum	-			
Maximum	3.33E+01			
Offset				
			Holebase database reference	Data drop 10. Published 05/2021

Figure D-110. Eoed obtained from different lab tests within the Kellaways Formation – (KLB- C Z) – Twyford Embankment

Appendix E Geotechnical Calculation

Number of Pages: 281

Project data

Project reference : HS2

Calculation title : 080-L1 Twyford Embankment- Profil 1

Location : H = 3.1 m - Ch. 80+940 - Ground model 1-A

Comments : N/A

Units : kN, kPa, kN/m3

γw : 10.0

Soil layers

	Name	Colour	γ	φ	c	Δc	qs nails	pl	KsB	Anisotropy	Favorable	Specific safety factors
1	ALV CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No
2	KLB-SV SV		20,0	25,00	0,0	0,0	-	-	-	No	No	No
3	KLB-CZ		20,0	28,00	3,0	0,0	-	-	-	No	No	No
4	GOG (CB, PMB, WHL)		20,0	25,00	3,0	0,0	-	-	-	No	No	No
5	Fill		20,0	26,00	5,0	0,0	-	-	-	No	No	No
6	ALV CZ_Cu		20,0	0,00	49,0	0,0	-	-	-	No	No	No
7	KLB-CZ_Cu		20,0	0,00	207,0	0,0	-	-	-	No	No	No
8	E&R Class A-1		20,0	35,00	0,0	0,0	-	-	-	No	No	No
9	OXC- w		20,0	25,00	2,0	0,0	-	-	-	No	No	No
10	OXC-u1		20,0	28,00	5,0	0,0	-	-	-	No	No	No
11	OXCw_Cu		20,0	0,00	54,0	0,0	-	-	-	No	No	No
12	OXCu1_Cu		20,0	0,00	100,0	0,0	-	-	-	No	No	No
13	OXC_u2		20,0	28,00	5,0	0,0	-	-	-	No	No	No
14	OXCu2_Cu		20,0	0,00	150,0	0,0	-	-	-	No	No	No
15	KLB SV SV_Cu		20,0	0,00	250,0	0,0	-	-	-	No	No	No

Soil layers (cont.)

	Name	Colour	Γγ	Γc	Γtan(φ)	Cohesion type	Curve
1	ALV CZ		-	-	-	Effective	Linear
2	KLB-SV SV		-	-	-	Effective	Linear
3	KLB-CZ		-	-	-	Effective	Linear
4	GOG (CB, PMB, WHL)		-	-	-	Effective	Linear
5	Fill		-	-	-	Effective	Linear
6	ALV CZ_Cu		-	-	-	Undrained	Linear
7	KLB-CZ_Cu		-	-	-	Undrained	Linear
8	E&R Class A-1		-	-	-	Effective	Linear
9	OXC- w		-	-	-	Effective	Linear
10	OXC-u1		-	-	-	Effective	Linear
11	OXCw_Cu		-	-	-	Undrained	Linear
12	OXCu1_Cu		-	-	-	Undrained	Linear
13	OXC_u2		-	-	-	Effective	Linear
14	OXCu2_Cu		-	-	-	Undrained	Linear
15	KLB SV SV_Cu		-	-	-	Undrained	Linear

Points

	X	Y		X	Y		X	Y		X	Y		X	Y		X	Y
2	60,000	0,000	3	0,000	-4,000	4	60,000	-4,500	11	0,000	3,100	13	28,200	0,000	32	60,000	-2,700
43	22,000	3,100	50	0,000	-2,700	63	0,000	0,000	64	0,000	-7,000	65	60,000	-7,000	68	0,000	-9,000
69	60,000	-9,000	70	0,000	-12,000	71	60,000	-12,000	73	0,000	-14,000	74	60,000	-14,000	75	0,000	-2,000
76	60,000	-2,000															

Segments

	Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2
51	4	3	107	32	50	126	43	13	128	13	63	132	65	64	142	2	13	144	68	69
145	71	70	147	74	73	148	43	11	149	76	75									

Distributed loads (1/2)

	Name	X left	Y left	q left	X right	Y right	q right	Ang/horizontal
1	10 kPa	19,352	3,100	10,0	21,500	3,100	10,0	90,00
2	57 kPa	0,000	3,100	57,0	19,341	3,100	57,0	90,00
3	20 kPa	0,000	3,100	20,0	21,500	3,100	20,0	90,00

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 12:22:18
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 1

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH80+940 GM1-A Profil 1 with E&R.t5p

Project data

Distributed loads (2/2)

	Name	X left	Y left	q left	X right	Y right	q right	Ang/horizontal
4	30 kPa Seismic	0,000	3,100	30,0	19,341	3,100	30,0	90,00

Data of the situation 1

Stage name : Short term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 21,500

Search type : Imposed passage point

Imposed passage point : X= 25,165; Y= 0,125

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in E&R Class A-1

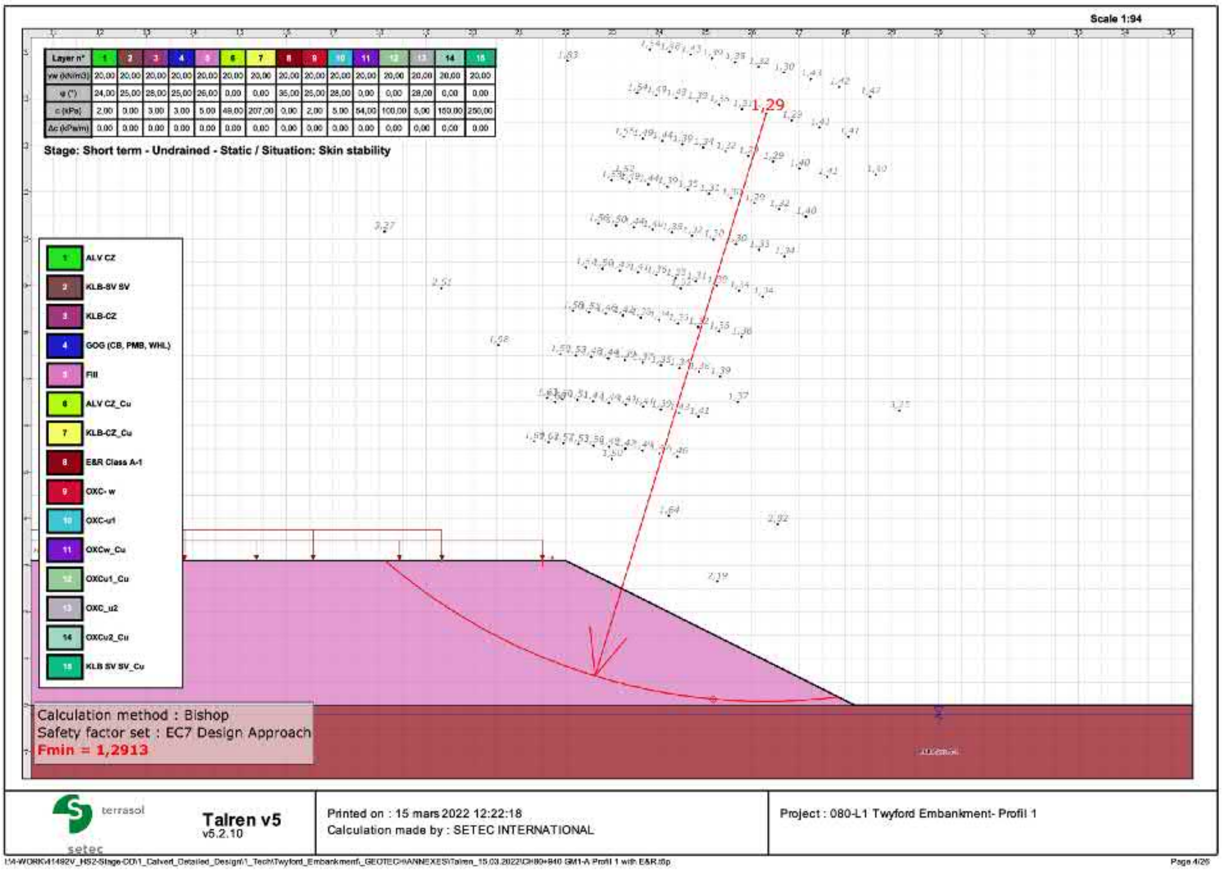
Results

Minimum safety factor : 1,2913

Coordinates of the critical centre and radius of the critical circle : N°= 537; X0= 26,30; Y0= 12,68; R= 12,60

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 12:22:18
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 1



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0.00	0,00	36,00	26,00	28,00	0,00	0,00	28,00	0,00	0.00
c (kPa)	2.00	0.00	3.00	3.00	5.00	48,00	207,00	0,00	2,00	5.00	54,00	100,00	5,00	150.00	250,00
Δc (kPa/m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0,00	0,00	0.00	0.00	0,00	0,00	0,00	0.00

Data of the situation 2

Stage name : Short term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 12,500

Search type : Imposed passage point

Imposed passage point : X= 25,112; Y= 0,109

Number of slices : 100

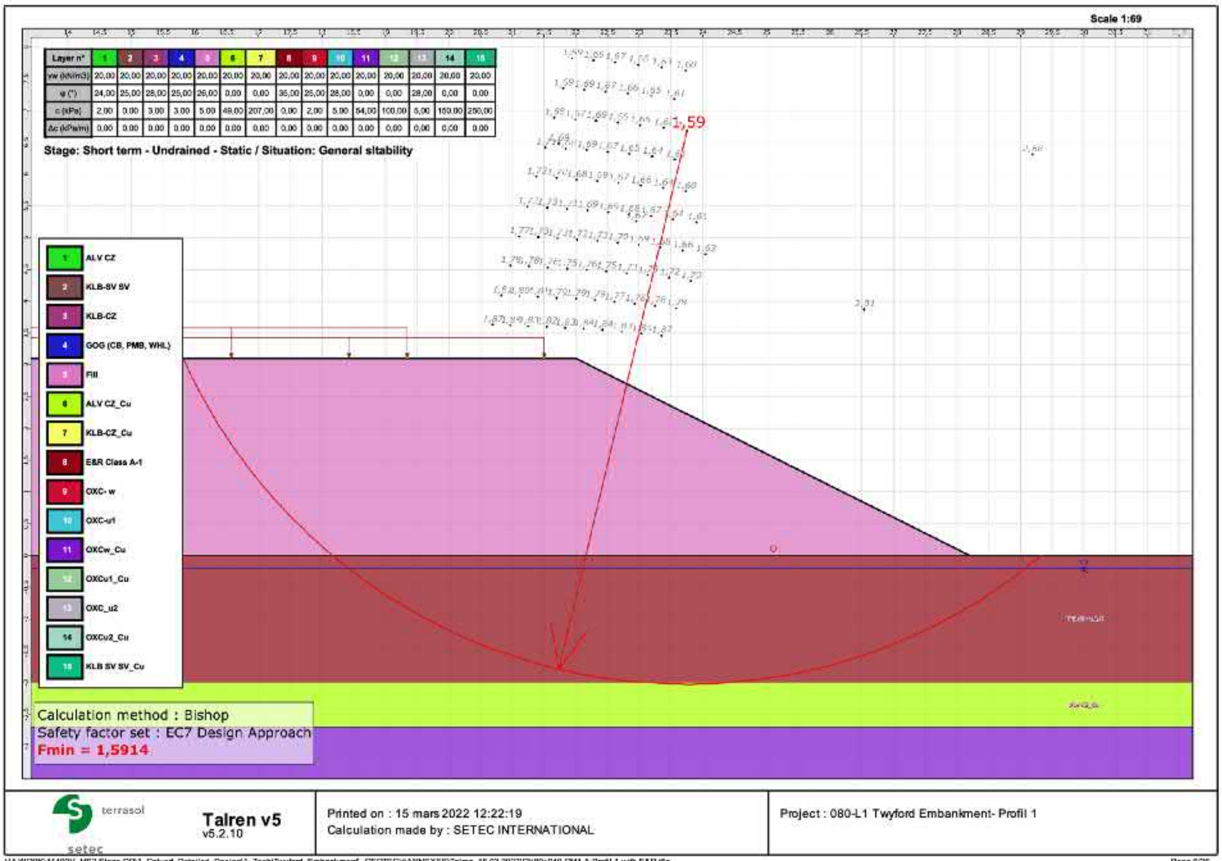
Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,5914

Coordinates of the critical centre and radius of the critical circle : N°= 171; X0= 23,75; Y0= 6,68; R= 8,70



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	35,00	25,00	28,00	0,00	0,00	28,00	0,00	0.00
c (kPa)	2,00	0.00	3.00	3.00	5.00	49,00	207,00	0,00	2,00	5.00	54,00	100,00	5,00	150.00	250,00
Δc (kPa/m)	0.00	0.00	0.00	0.00	0.00	0.00	0,00	0,00	0,00	0.00	0.00	0,00	0,00	0,00	0.00

Data of the situation 1

Stage name : Short term - Drained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 16,755

Search type : Imposed passage point

Imposed passage point : X= 25,500; Y= 0,000

Number of slices : 100

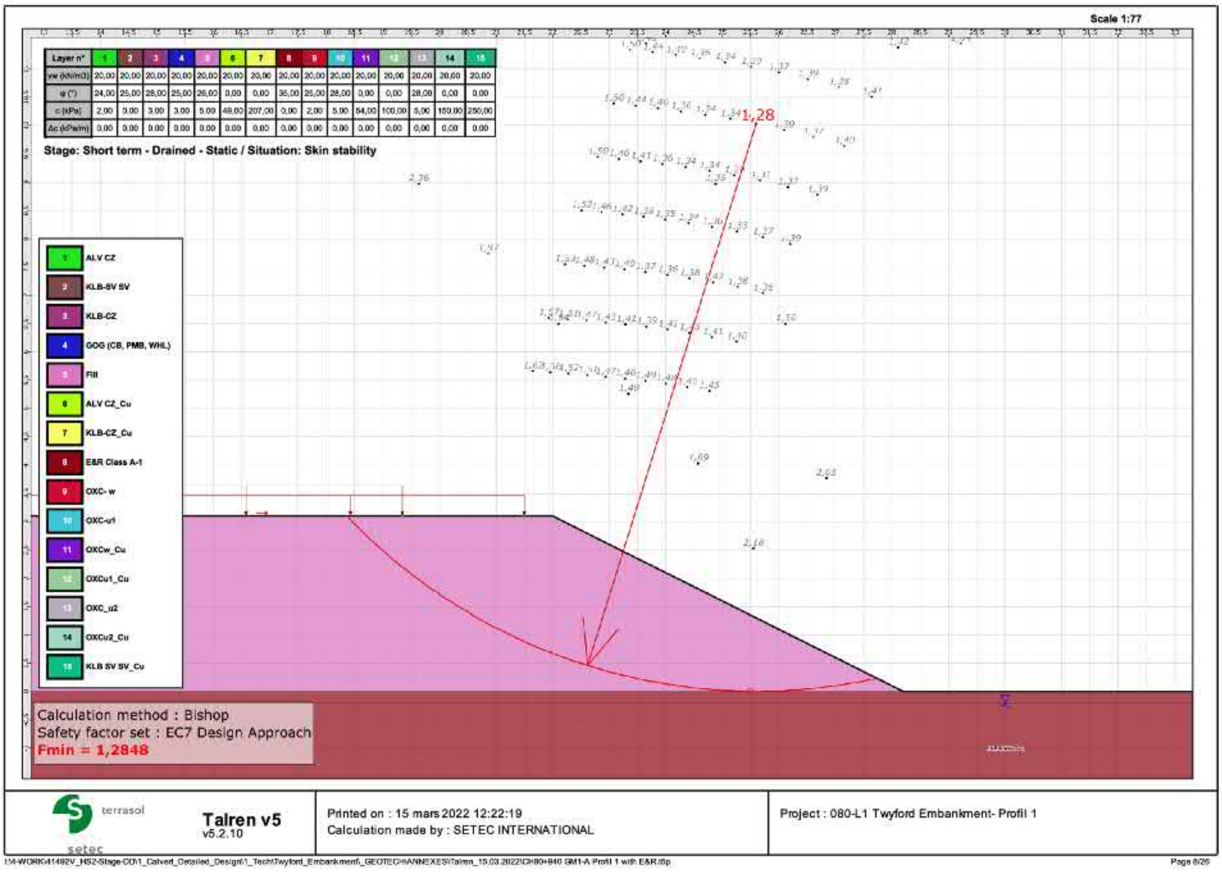
Seismic properties : No

Passage conditions through soil layers : Must pass out in E&R Class A-1

Results

Minimum safety factor : 1,2848

Coordinates of the critical centre and radius of the critical circle : N°= 472; X0= 25,60; Y0= 10,03; R= 10,03


Scale 1:77
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 24,00 25,00 28,00 25,00 26,00 0,00 0,00 36,00 25,00 28,00 0,00 0,00 28,00 0,00 0,00
c (kPa) 2,00 0,00 3,00 3,00 5,00 48,00 207,00 0,00 2,00 5,00 54,00 100,00 5,00 150,00 250,00
Δc (kPa/m) 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
Stage: Short term - Drained - Static / Situation: Skin stability
ALV CZ
KLB-SV SV
KLB-CZ
GOG (CB, PMB, WHL)
Fill
ALV CZ_Cu
KLB-CZ_Cu
E&R Class A-1
OXC- w
OXC-u1
OXCw_Cu
OXCu1_Cu
OXC_u2
OXCu2_Cu
KLB SV SV_Cu
1,28
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,2848
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 12:22:19
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 1

Data of the situation 2

Stage name : Short term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 26,000

Search type : Imposed passage point

Imposed passage point : X= 25,381; Y= 0,095

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ

Results

Minimum safety factor : 1,3836

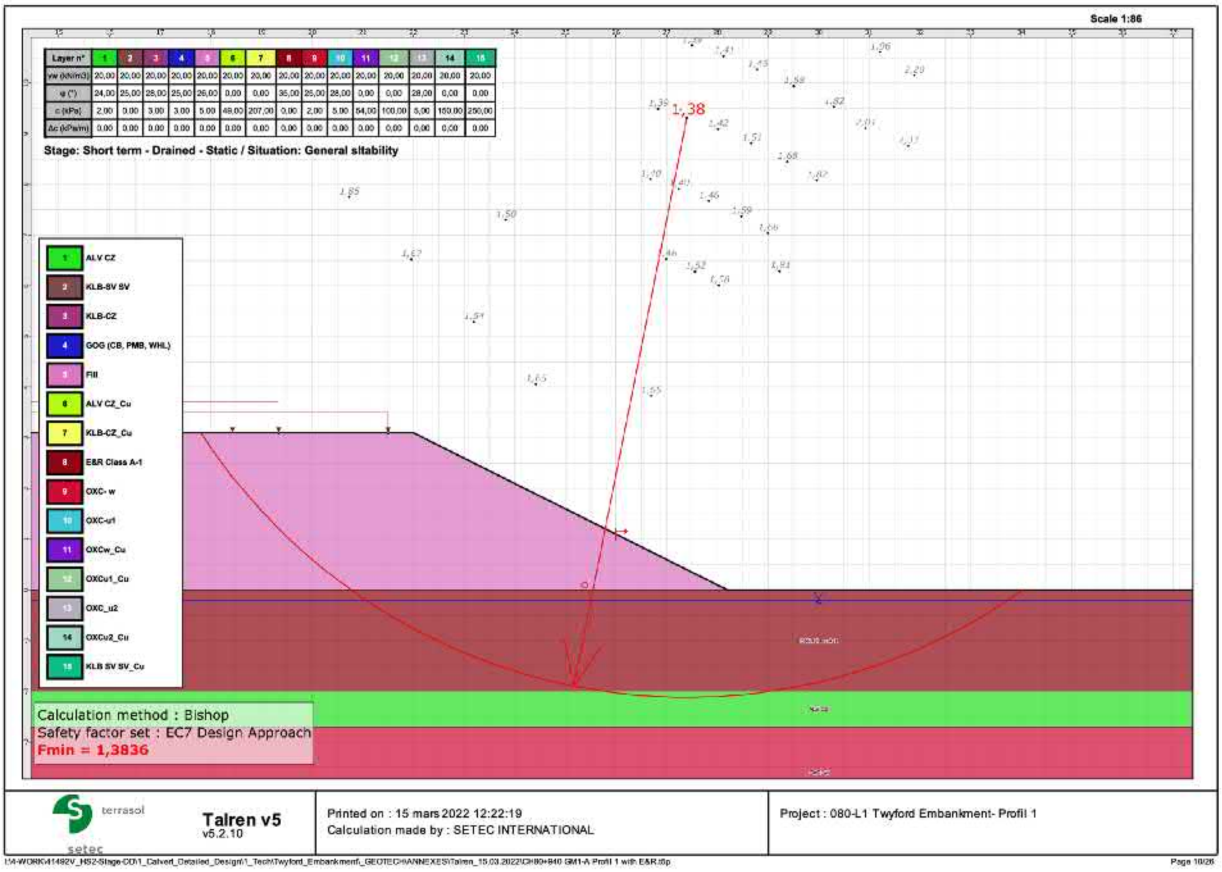
Coordinates of the critical centre and radius of the critical circle : N°= 273; X0= 27,40; Y0= 9,31; R= 11,43

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 12:22:19
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 1

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH80+940 GM1-A Profil 1 with E&R.t5p Page 9/26


Scale 1:86
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 24,00 25,00 28,00 25,00 26,00 0,00 0,00 36,00 25,00 28,00 0,00 0,00 28,00 0,00 0,00
c (kPa) 2,00 0,00 3,00 3,00 5,00 49,00 207,00 0,00 2,00 5,00 54,00 100,00 5,00 150,00 250,00
Δc (kPa/m) 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
Stage: Short term - Drained - Static / Situation: General sitability
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 ALV CZ_Cu
7 KLB-CZ_Cu
8 E&R Class A-1
9 OXC- w
10 OXC-u1
11 OXCw_Cu
12 OXCu1_Cu
13 OXC_u2
14 OXCu2_Cu
15 KLB SV SV_Cu
1,38
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3836
Talren v5
v5.2.10
Printed on : 15 mars 2022 12:22:19
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 1
Page 10/26

Data of the situation 1

Stage name : Long term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 21,500

Search type : Imposed passage point

Imposed passage point : X= 25,165; Y= 0,125

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in E&R Class A-1

Results

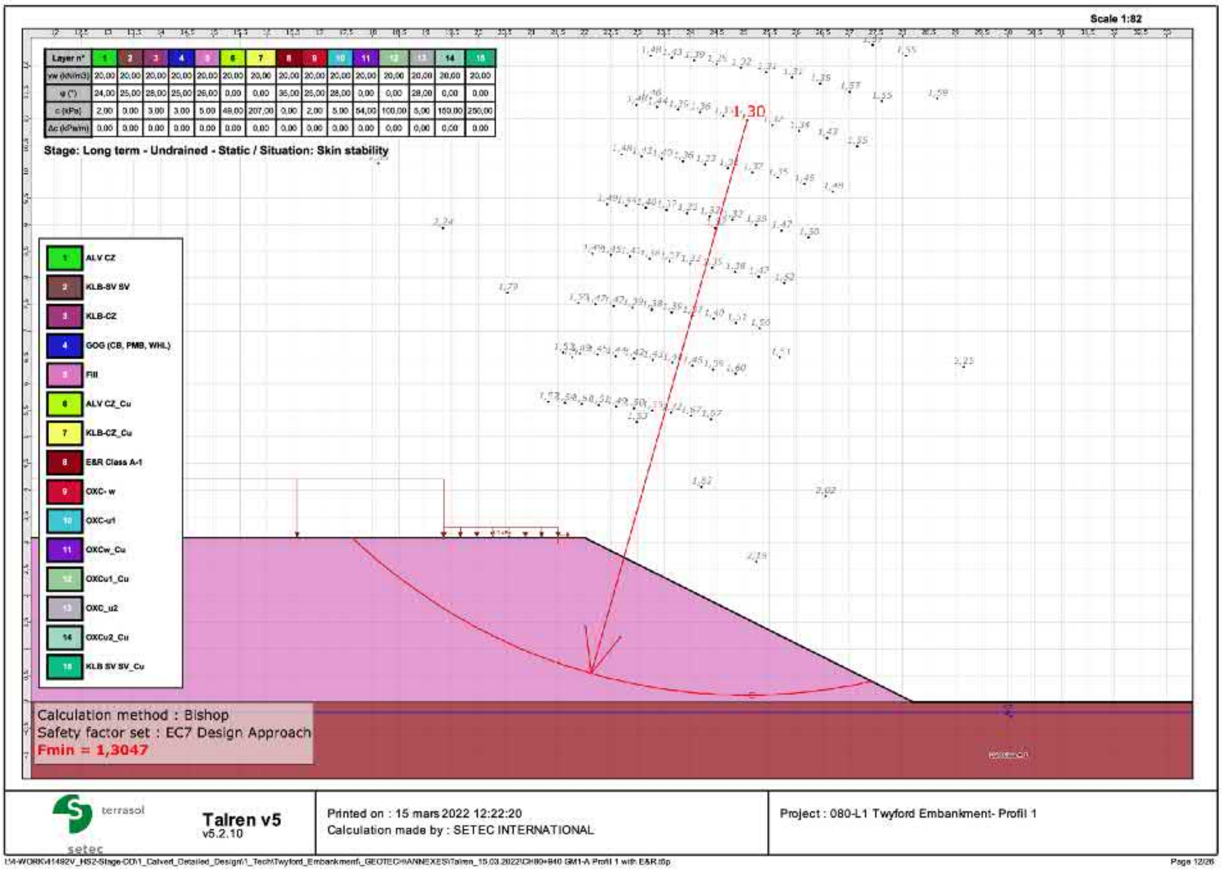
Minimum safety factor : 1,3047

Coordinates of the critical centre and radius of the critical circle : N°= 579; X0= 25,07; Y0= 10,97; R= 10,84

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 12:22:19
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 1

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH80+940 GM1-A Profil 1 with E&R.t5p Page 11/26



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	36,00	26,00	28,00	0,00	0,00	28,00	0,00	0,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	0,00	2,00	5,00	54,00	100,00	5,00	150,00	250,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Long term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 12,500

Search type : Imposed passage point

Imposed passage point : X= 25,112; Y= 0,109

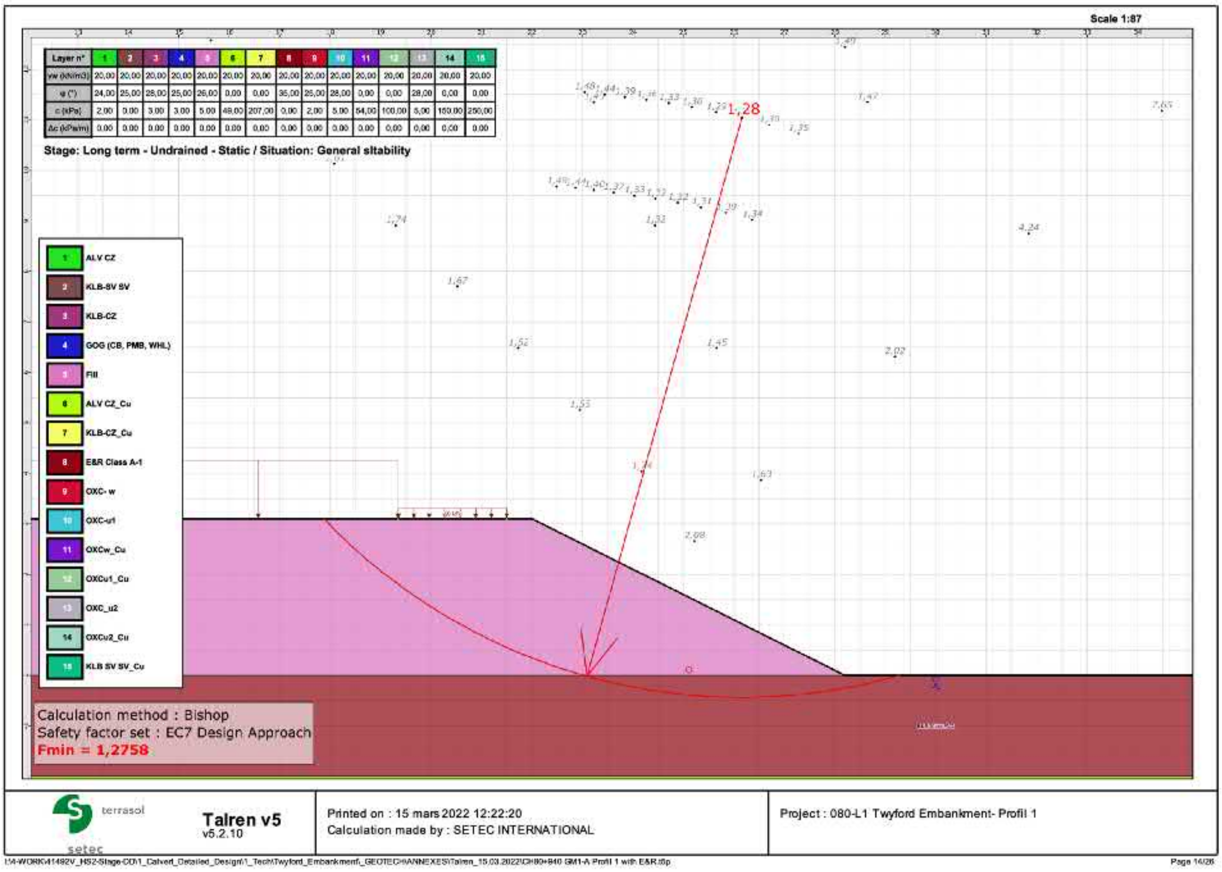
Number of slices : 100

Seismic properties : No

Results

Minimum safety factor : 1,2758

Coordinates of the critical centre and radius of the critical circle : N°= 931; X0= 26,16; Y0= 11,04; R= 11,47



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	36,00	25,00	28,00	0,00	0,00	28,00	0,00	0,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	0,00	2,00	5,00	54,00	100,00	5,00	150,00	250,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Long term - Drained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 16,755

Search type : Imposed passage point

Imposed passage point : X= 25,500; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in E&R Class A-1

Results

Minimum safety factor : 1,3013

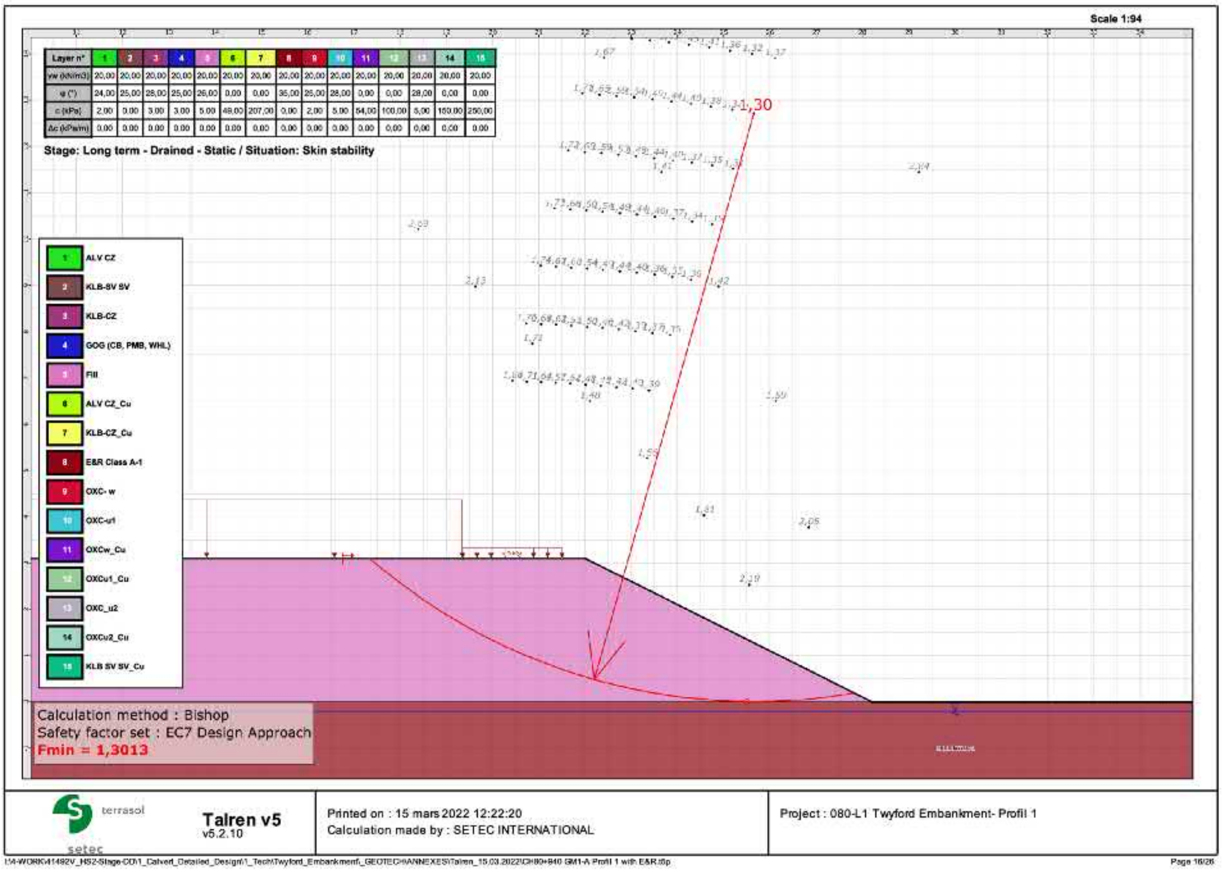
Coordinates of the critical centre and radius of the critical circle : N°= 370; X0= 25,65; Y0= 12,71; R= 12,71

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 12:22:20
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 1

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH80+940 GM1-A Profil 1 with E&R.t5p Page 15/26


Scale 1:94
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 0,00 | 0,00 | 35,00 | 25,00 | 28,00 | 0,00 | 0,00 | 28,00 | 0,00 | 0,00
c (kPa) | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 48,00 | 207,00 | 0,00 | 2,00 | 5,00 | 54,00 | 100,00 | 5,00 | 150,00 | 250,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Long term - Drained - Static / Situation: Skin stability
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 ALV CZ_Cu
7 KLB-CZ_Cu
8 E&R Class A-1
9 OXC- w
10 OXC-u1
11 OXCw_Cu
12 OXCu1_Cu
13 OXC_u2
14 OXCu2_Cu
15 KLB SV SV_Cu
1,30
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3013
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 12:22:20
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 1

Data of the situation 2

Stage name : Long term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 26,000

Search type : Imposed passage point

Imposed passage point : X= 25,381; Y= 0,095

Number of slices : 100

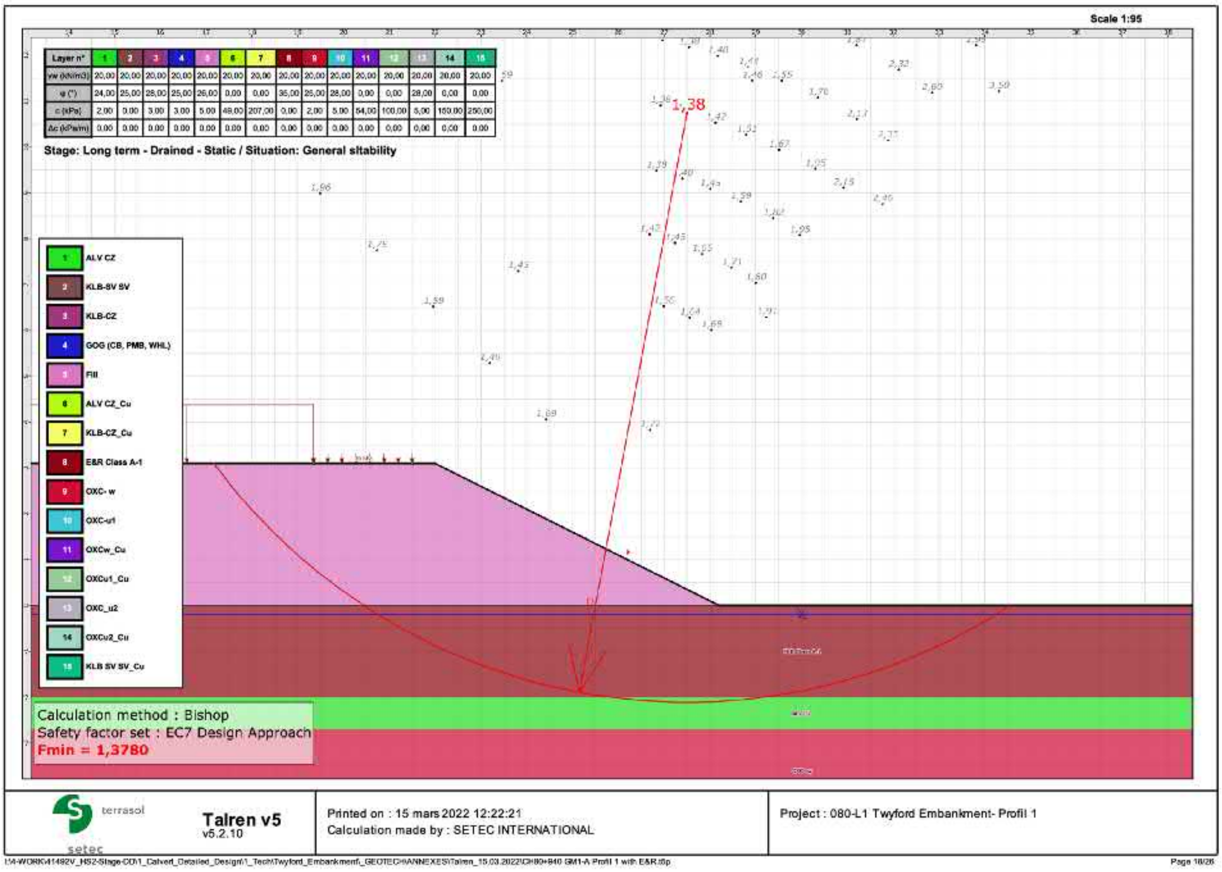
Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ

Results

Minimum safety factor : 1,3780

Coordinates of the critical centre and radius of the critical circle : N°= 289; X0= 27,50; Y0= 10,74; R= 12,85



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	35,00	25,00	28,00	0,00	0,00	28,00	0,00	0,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	0,00	2,00	5,00	54,00	100,00	5,00	150,00	250,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Seismic + 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 18,500

Search type : Imposed passage point

Imposed passage point : X= 25,568; Y= 0,074

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass out in E&R Class A-1

Results

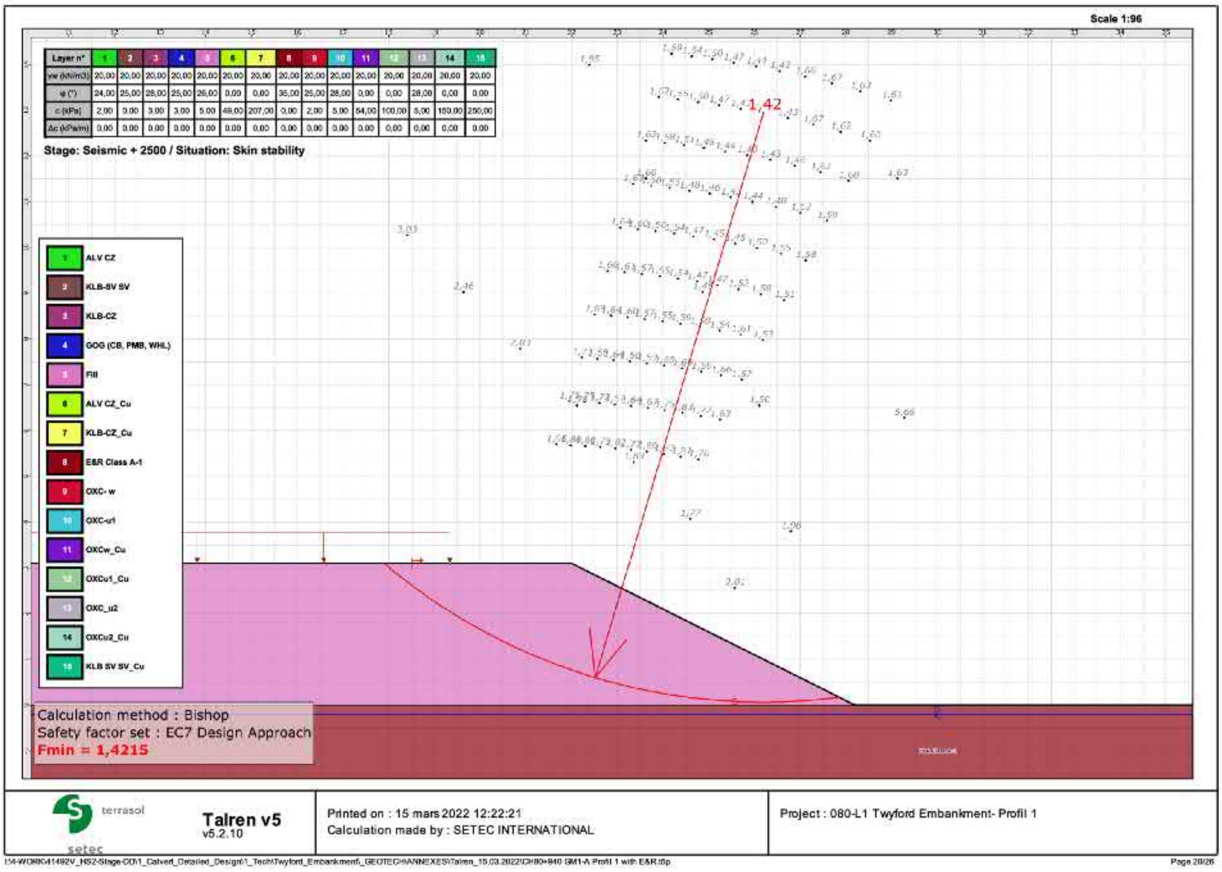
Minimum safety factor : 1,4215

Coordinates of the critical centre and radius of the critical circle : N°= 559; X0= 26,20; Y0= 12,94; R= 12,87

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 12:22:21
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 1



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	36,00	25,00	28,00	0,00	0,00	28,00	0,00	0,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	0,00	2,00	5,00	54,00	100,00	5,00	150,00	250,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Seismic + 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 26,000

Search type : Imposed passage point

Imposed passage point : X= 24,259; Y= 0,089

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : 0,012

Results

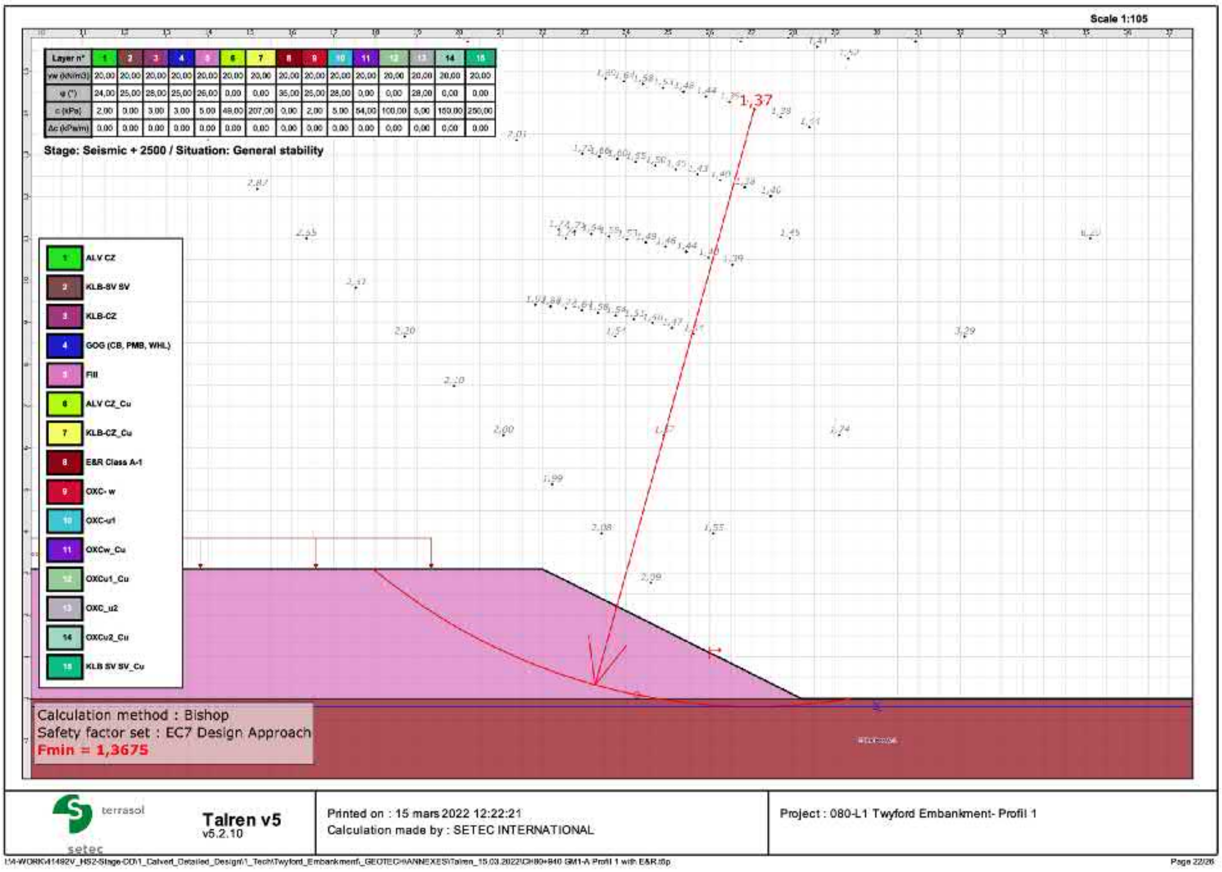
Minimum safety factor : 1,3675

Coordinates of the critical centre and radius of the critical circle : N°= 669; X0= 27,07; Y0= 14,10; R= 14,29

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 12:22:21
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 1

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH80+940 GM1-A Profil 1 with E&R.t5p Page 21/26


Scale 1:105
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 0.00 | 0,00 | 36,00 | 25,00 | 28,00 | 0,00 | 0,00 | 28,00 | 0,00 | 0.00
c (kPa) | 2.00 | 0.00 | 3.00 | 3.00 | 5.00 | 48,00 | 207,00 | 0,00 | 2,00 | 5.00 | 54,00 | 100,00 | 5,00 | 150.00 | 250,00
Δc (kPa/m) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0,00 | 0,00 | 0,00 | 0.00 | 0.00 | 0,00 | 0,00 | 0,00 | 0.00
Stage: Seismic + 2500 / Situation: General stability
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 ALV CZ_Cu
7 KLB-CZ_Cu
8 E&R Class A-1
9 OXC- w
10 OXC-u1
11 OXCw_Cu
12 OXCu1_Cu
13 OXC_u2
14 OXCu2_Cu
15 KLB SV SV_Cu
1,37
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3675
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 12:22:21
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 1

Data of the situation 1

Stage name : Seismic - 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 18,500

Search type : Imposed passage point

Imposed passage point : X= 25,500; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : -0,012

Passage conditions through soil layers : Must pass out in E&R Class A-1

Results

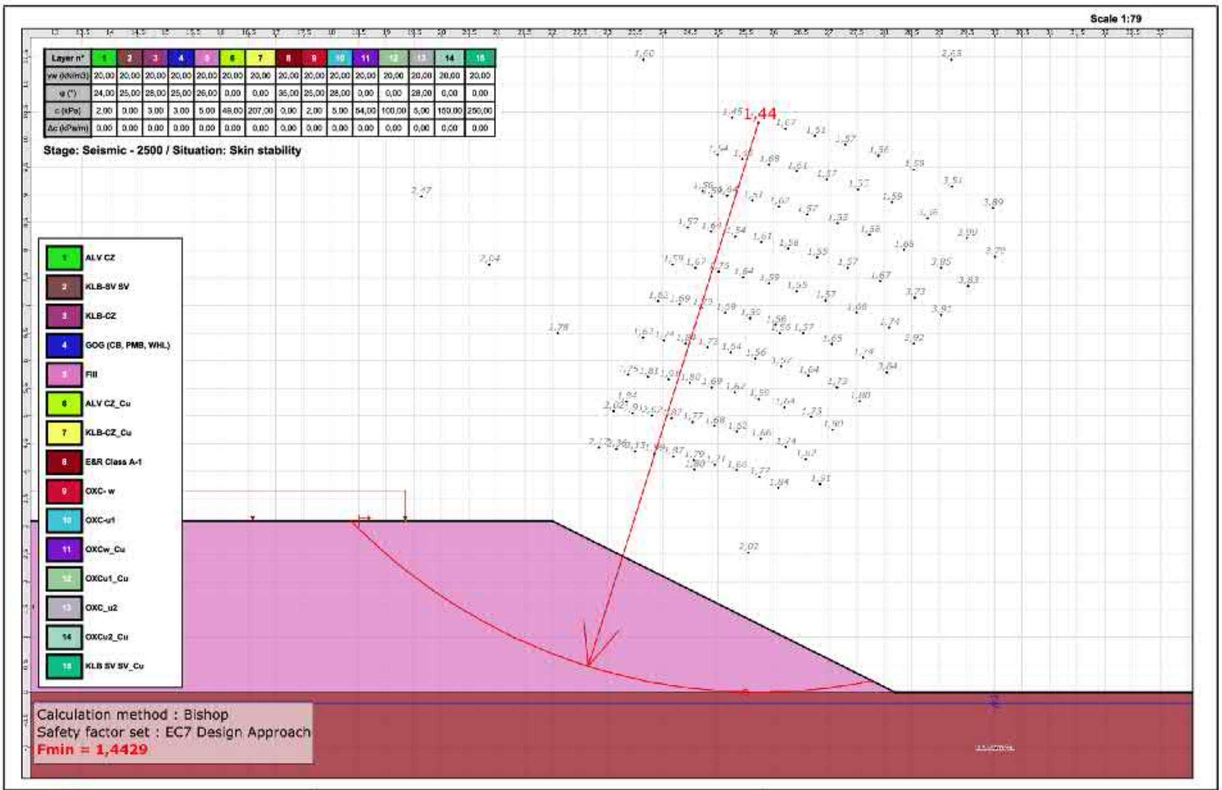
Minimum safety factor : 1,4429

Coordinates of the critical centre and radius of the critical circle : N°= 611; X0= 25,73; Y0= 10,31; R= 10,31

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 12:22:22
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 1

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH80+940 GM1-A Profil 1 with E&R.t5p Page 23/26



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	35,00	25,00	28,00	0,00	0,00	28,00	0,00	0,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	49,00	207,00	0,00	2,00	5,00	54,00	100,00	5,00	150,00	250,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

terrasol setec Talren v5 v5.2.10

Printed on : 15 mars 2022 12:22:22
Calculation made by : SETEC INTERNATIONAL

Project : 080-L1 Twyford Embankment- Profil 1

Data of the situation 2

Stage name : Seismic - 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 26,000

Search type : Imposed passage point

Imposed passage point : X= 24,500; Y= 0,097

Number of slices : 100

Seismic properties : Yes

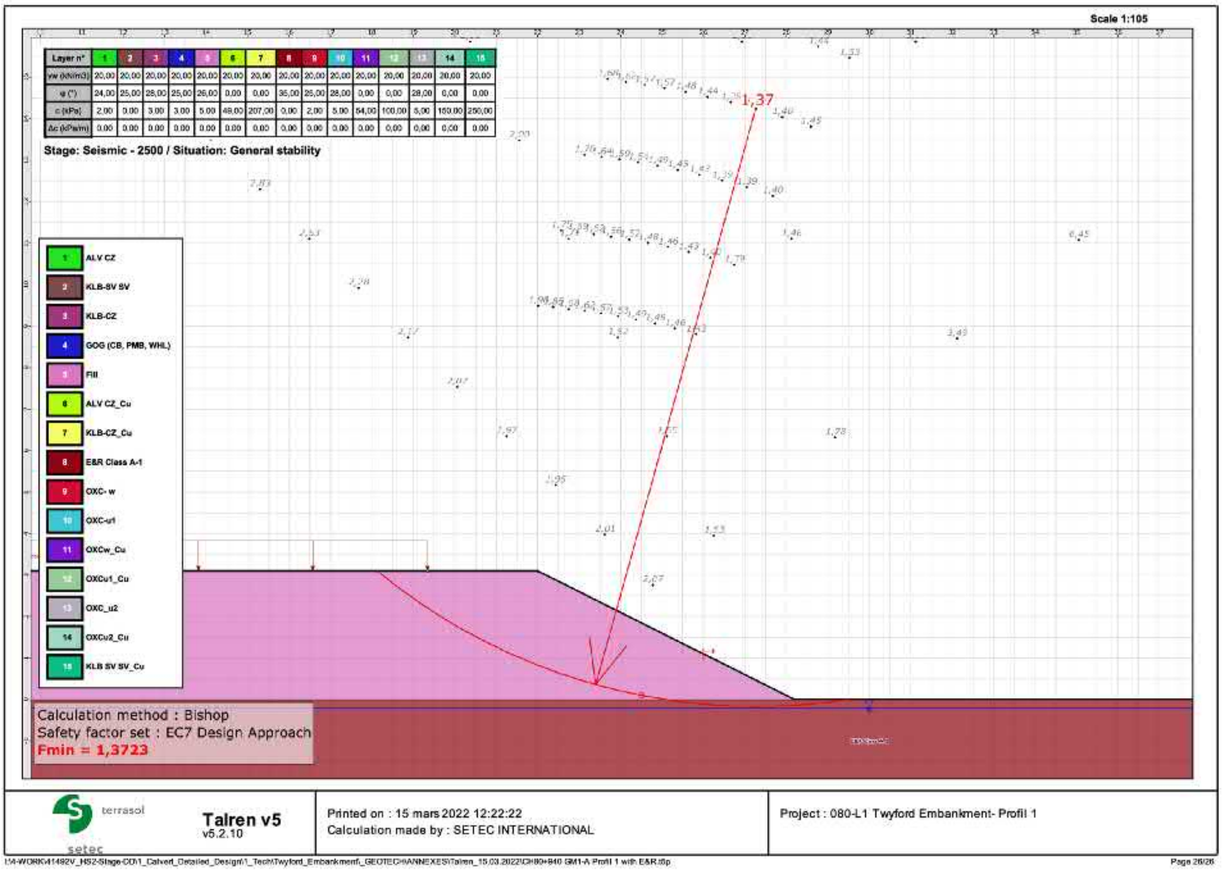
ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : -0,012

Results

Minimum safety factor : 1,3723

Coordinates of the critical centre and radius of the critical circle : N°= 668; X0= 27,26; Y0= 14,24; R= 14,40


Scale 1:105
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 0,00 | 0,00 | 36,00 | 25,00 | 28,00 | 0,00 | 0,00 | 28,00 | 0,00 | 0,00
c (kPa) | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 48,00 | 207,00 | 0,00 | 2,00 | 5,00 | 54,00 | 100,00 | 5,00 | 150,00 | 250,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Seismic - 2500 / Situation: General stability
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 ALV CZ_Cu
7 KLB-CZ_Cu
8 E&R Class A-1
9 OXC- w
10 OXC-u1
11 OXCw_Cu
12 OXCu1_Cu
13 OXC_u2
14 OXCu2_Cu
15 KLB SV SV_Cu
1,37
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3723
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 12:22:22
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 1
Page 26/26

Project data

Project reference : HS2
Calculation title : 080-L1 Twyford Embankment- Profil 2
Location : H = 2.7m - Ch. 81+225 - Ground model 1-C
Comments : N/A
Units : kN, kPa, kN/m3
γw : 10.0

Soil layers

	Name	Colour	γ	φ	c	Δc	qs nails	pl	KsB	Anisotropy	Favorable	Specific safety factors
1	ALV CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No
2	KLB-SV SV		20,0	25,00	0,0	0,0	-	-	-	No	No	No
3	KLB-CZ		20,0	28,00	3,0	0,0	-	-	-	No	No	No
4	GOG (CB, PMB, WHL)		20,0	25,00	3,0	0,0	-	-	-	No	No	No
5	Fill		20,0	26,00	5,0	0,0	-	-	-	No	No	No
6	OXC- w		20,0	25,00	2,0	0,0	-	-	-	No	No	No
7	OXC-u1		20,0	28,00	5,0	0,0	-	-	-	No	No	No
8	ALV CZ_Cu		20,0	0,00	49,0	0,0	-	-	-	No	No	No
9	OXCw_cu		20,0	0,00	54,0	0,0	-	-	-	No	No	No
10	OXCu1_Cu		20,0	0,00	100,0	0,0	-	-	-	No	No	No
11	KLB-CZ_Cu		20,0	0,00	207,0	0,0	-	-	-	No	No	No
12	KLB-SV SV_Cu		20,0	0,00	250,0	0,0	-	-	-	No	No	No
13	E&R ClassA-1		20,0	35,00	0,0	0,0	-	-	-	No	No	No

Soil layers (cont.)

	Name	Colour	Γγ	Γc	Γtan(φ)	Cohesion type	Curve
1	ALV CZ		-	-	-	Effective	Linear
2	KLB-SV SV		-	-	-	Effective	Linear
3	KLB-CZ		-	-	-	Effective	Linear
4	GOG (CB, PMB, WHL)		-	-	-	Effective	Linear
5	Fill		-	-	-	Effective	Linear
6	OXC- w		-	-	-	Effective	Linear
7	OXC-u1		-	-	-	Effective	Linear
8	ALV CZ_Cu		-	-	-	Undrained	Linear
9	OXCw_cu		-	-	-	Undrained	Linear
10	OXCu1_Cu		-	-	-	Undrained	Linear
11	KLB-CZ_Cu		-	-	-	Undrained	Linear
12	KLB-SV SV_Cu		-	-	-	Undrained	Linear
13	E&R ClassA-1		-	-	-	Effective	Linear

Points

	X	Y		X	Y		X	Y		X	Y		X	Y		X	Y
2	60,000	0,000	3	0,000	-5,000	4	60,000	-5,000	11	0,000	2,700	13	27,400	0,000	32	60,000	-2,400
43	22,000	2,700	50	0,000	-2,400	63	0,000	0,000	64	0,000	-6,000	65	60,000	-6,000	68	0,000	-8,000
69	60,000	-8,000	70	0,000	-10,000	71	60,000	-10,000	73	0,000	-2,000	74	60,000	-2,000			

Segments

	Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2
51	4	3	107	32	50	126	43	13	128	13	63	132	65	64	142	2	13	144	68	69
145	71	70	147	43	11	149	74	73												

Distributed loads

	Name	X left	Y left	q left	X right	Y right	q right	Ang/horizontal
1	10 kPa	19,343	2,700	10,0	21,500	2,700	10,0	90,00
2	57 kPa	0,000	2,700	57,0	19,344	2,700	57,0	90,00
3	20 kPa	0,000	2,700	20,0	21,500	2,700	20,0	90,00
4	30 kPa Seismic	0,000	2,700	30,0	19,344	2,700	30,0	90,00

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 11:49:12
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2

Data of the situation 1

Stage name : Short term - Undraines - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 20,000

Search type : Imposed passage point

Imposed passage point : X= 24,891; Y= 0,071

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in E&R ClassA-1

Results

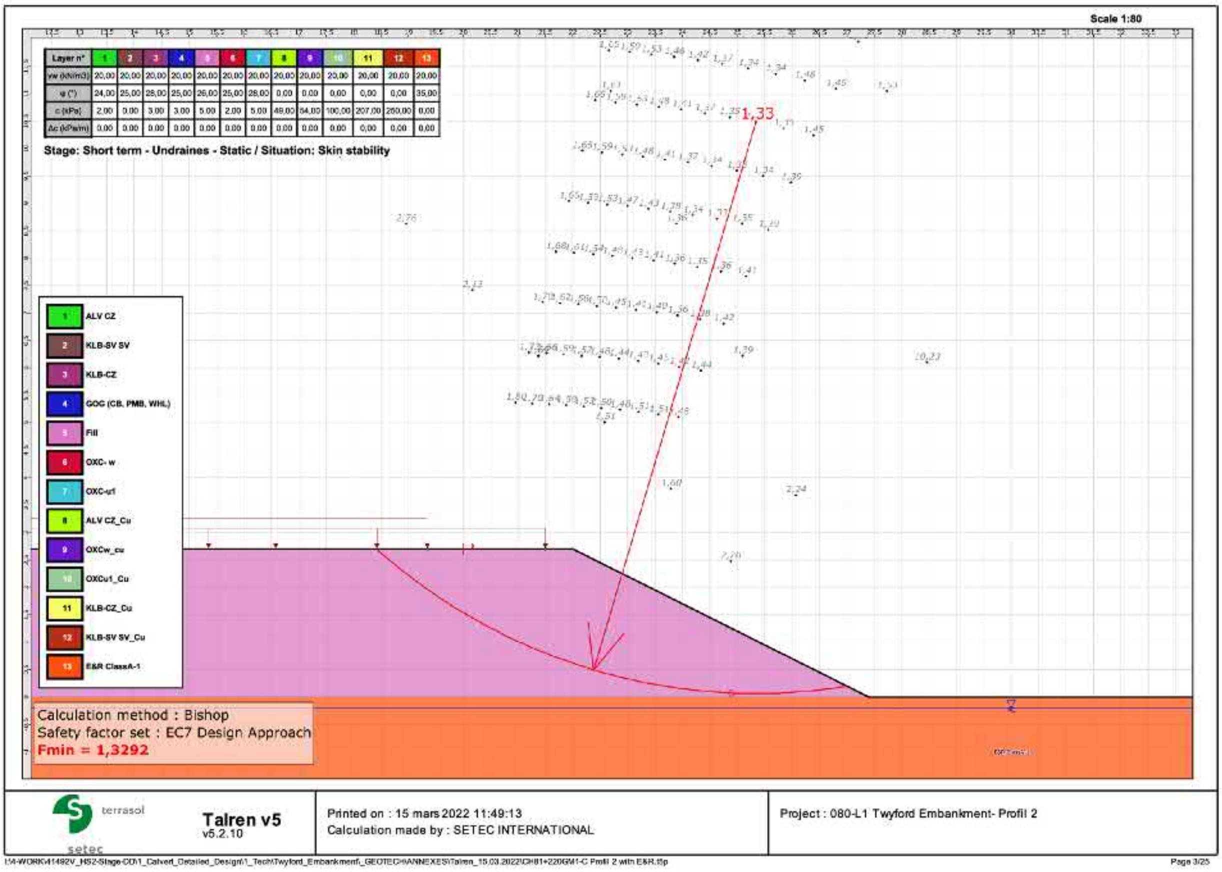
Minimum safety factor : 1,3292

Coordinates of the critical centre and radius of the critical circle : N°= 445; X0= 25,34; Y0= 10,48; R= 10,41

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 11:49:12
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+220GM1-C Profil 2 with E&R.t5p Page 2/25


Scale 1:80
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 25,00 | 28,00 | 0.00 | 0.00 | 0,00 | 0,00 | 0,00 | 35,00
c (kPa) | 2.00 | 0.00 | 3.00 | 3.00 | 5.00 | 2.00 | 5.00 | 49,00 | 54,00 | 100,00 | 207,00 | 260,00 | 0,00
Δc (kPa/m) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Short term - Undraines - Static / Situation: Skin stability
1,33
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 OXC- w
7 OXC-u1
8 ALV CZ_Cu
9 OXCw_cu
10 OXCu1_Cu
11 KLB-CZ_Cu
12 KLB-SV SV_Cu
13 E&R ClassA-1
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3292
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 11:49:13
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2

Data of the situation 2

Stage name : Short term - Undraines - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 25,564

Search type : Imposed passage point

Imposed passage point : X= 23,703; Y= 0,081

Number of slices : 100

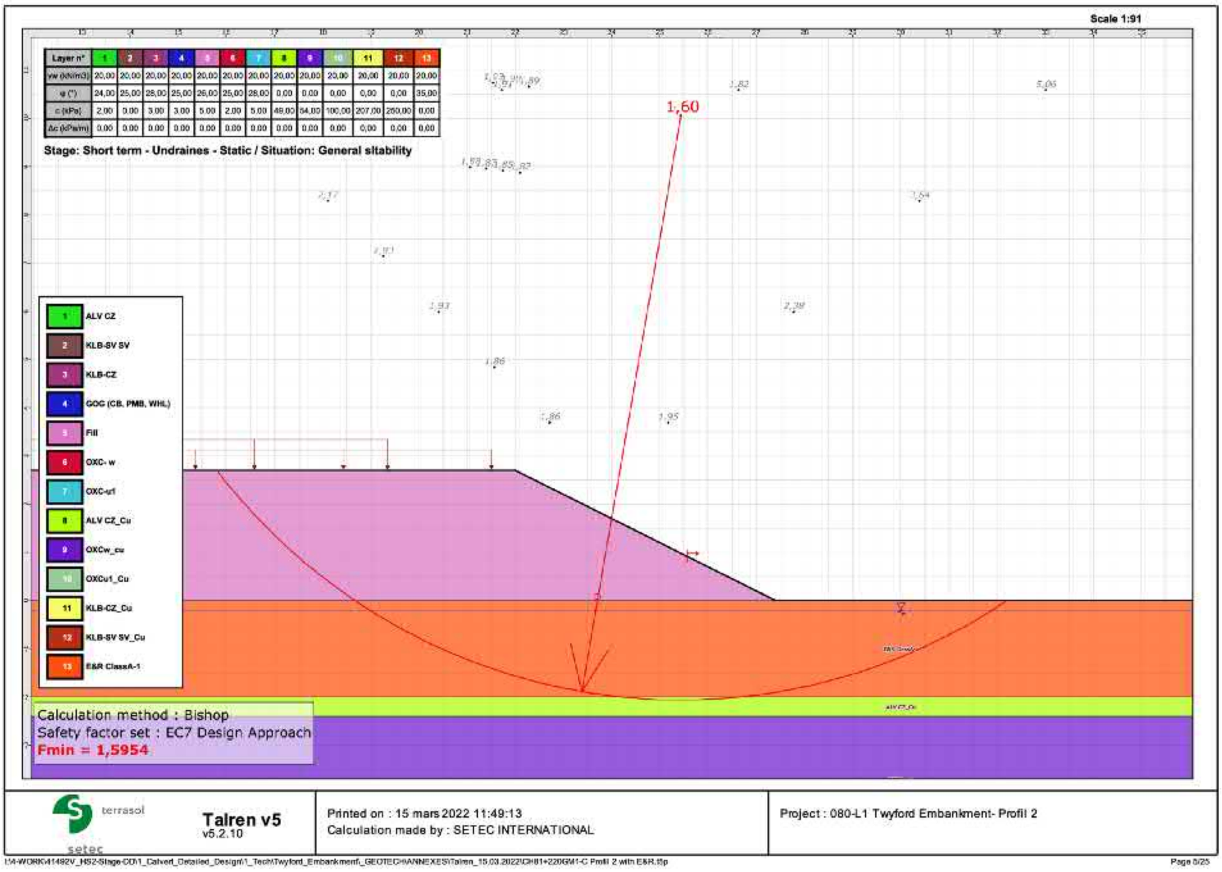
Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,5954

Coordinates of the critical centre and radius of the critical circle : N°= 151; X0= 25,44; Y0= 10,06; R= 12,12



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	25,00	28,00	0,00	0,00	0,00	0,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	2,00	5,00	48,00	54,00	100,00	207,00	260,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Short term - Drained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 20,000

Search type : Imposed passage point

Imposed passage point : X= 25,117; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in E&R ClassA-1

Results

Minimum safety factor : 1,3241

Coordinates of the critical centre and radius of the critical circle : N°= 415; X0= 25,27; Y0= 9,63; R= 9,63

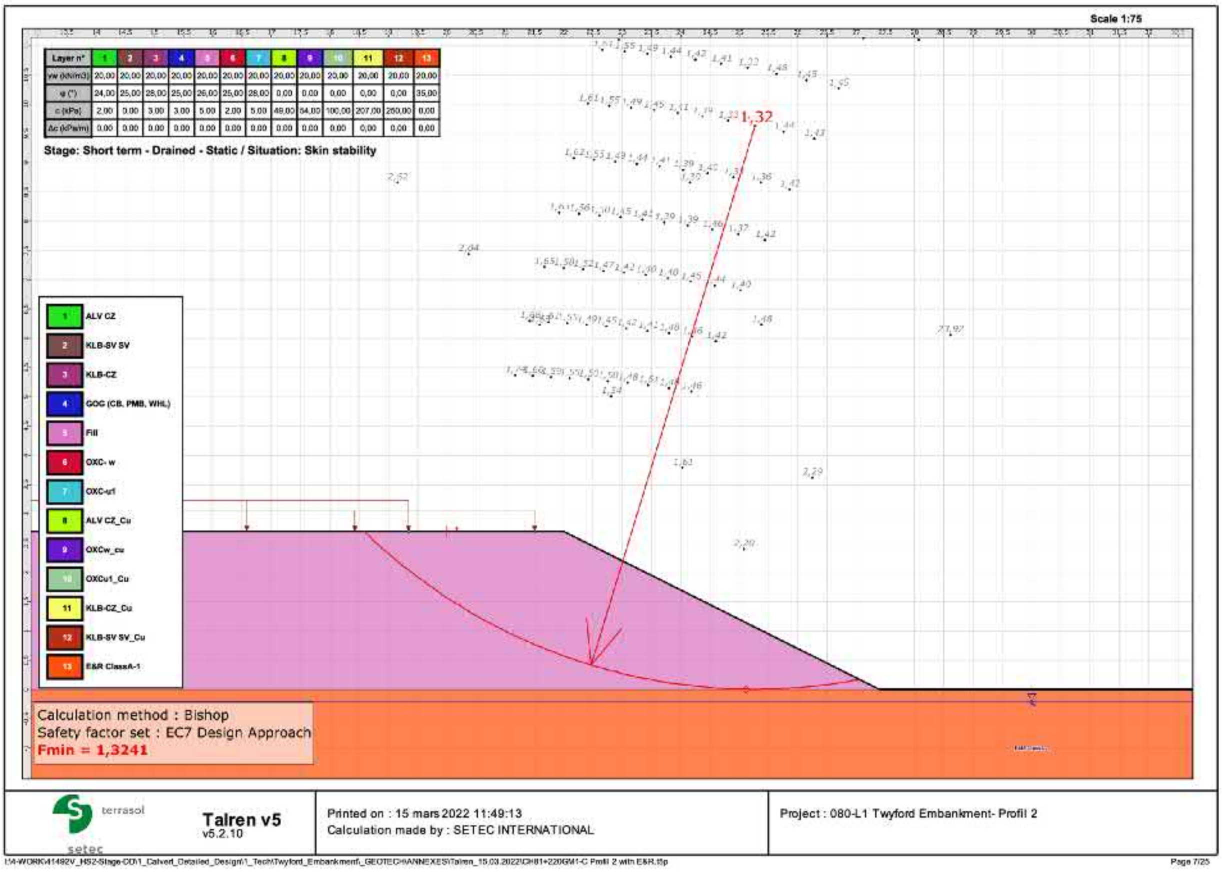
terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 11:49:13
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+220GM1-C Profil 2 with E&R.t5p

Page 6/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	25,00	28,00	0,00	0,00	0,00	0,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	2,00	5,00	48,00	54,00	100,00	207,00	250,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Short term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 25,613

Search type : Imposed passage point

Imposed passage point : X= 22,500; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ

Results

Minimum safety factor : 1,3504

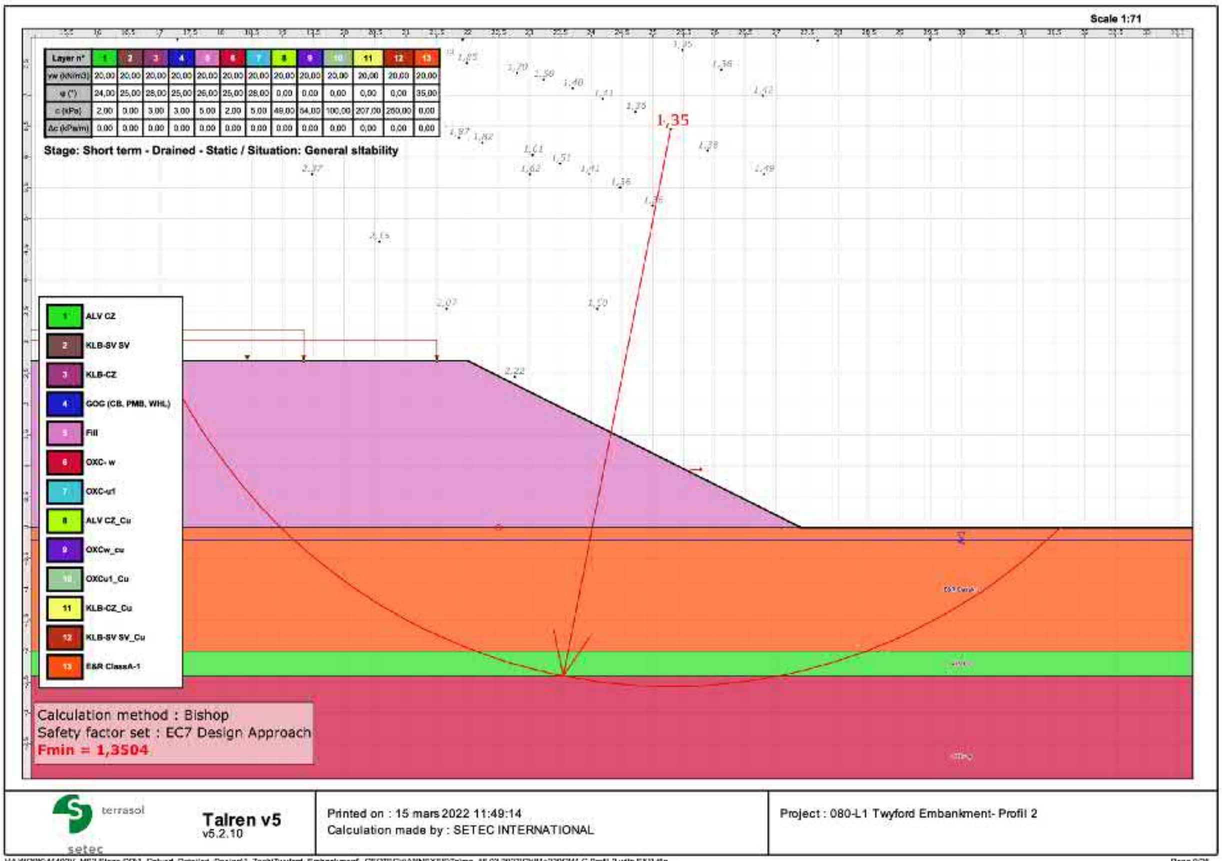
Coordinates of the critical centre and radius of the critical circle : N°= 217; X0= 25,29; Y0= 6,45; R= 9,02

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 11:49:14
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+220GM1-C Profil 2 with E&R.t5p Page 8/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	25,00	28,00	0,00	0,00	0,00	0,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	2,00	5,00	49,00	54,00	100,00	207,00	260,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

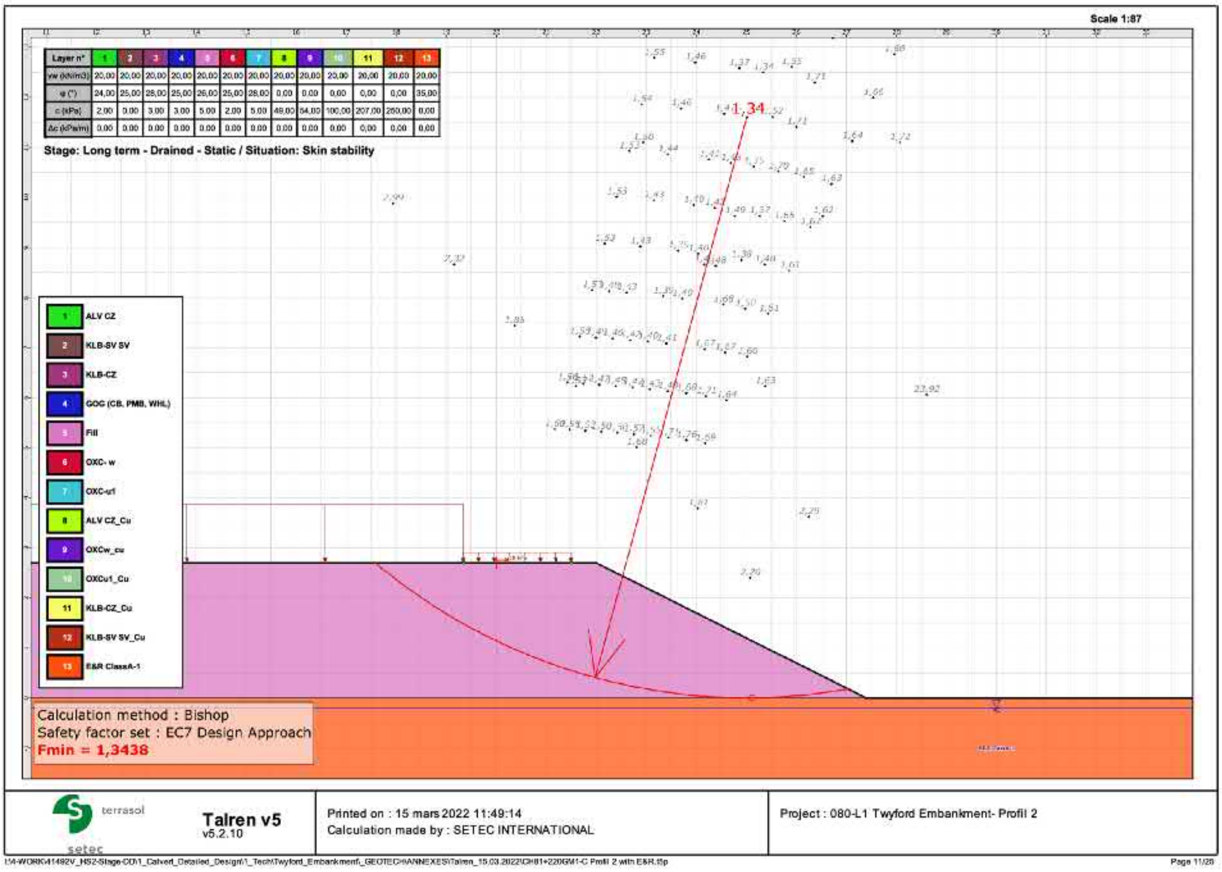
Stage name : Long term - Drained - Static
Situation name : Skin stability
Calculation method : Bishop
Safety factor set for this situation : EC7 Design Approach
Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular
Number of intervals : 10
Increment for circle radius : 0,500
Min abscissa of the circle emergence point : 20,000
Search type : Imposed passage point
Imposed passage point : X= 25,117; Y= 0,000
Number of slices : 100
Seismic properties : No
Passage conditions through soil layers : Must pass out in E&R ClassA-1
Results
Minimum safety factor : 1,3438
Coordinates of the critical centre and radius of the critical circle : N°= 480; X0= 25,01; Y0= 11,60; R= 11,59

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 11:49:14
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	25,00	28,00	0,00	0,00	0,00	0,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	2,00	5,00	49,00	54,00	100,00	207,00	250,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Long term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 25,613

Search type : Imposed passage point

Imposed passage point : X= 22,500; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ

Results

Minimum safety factor : 1,3187

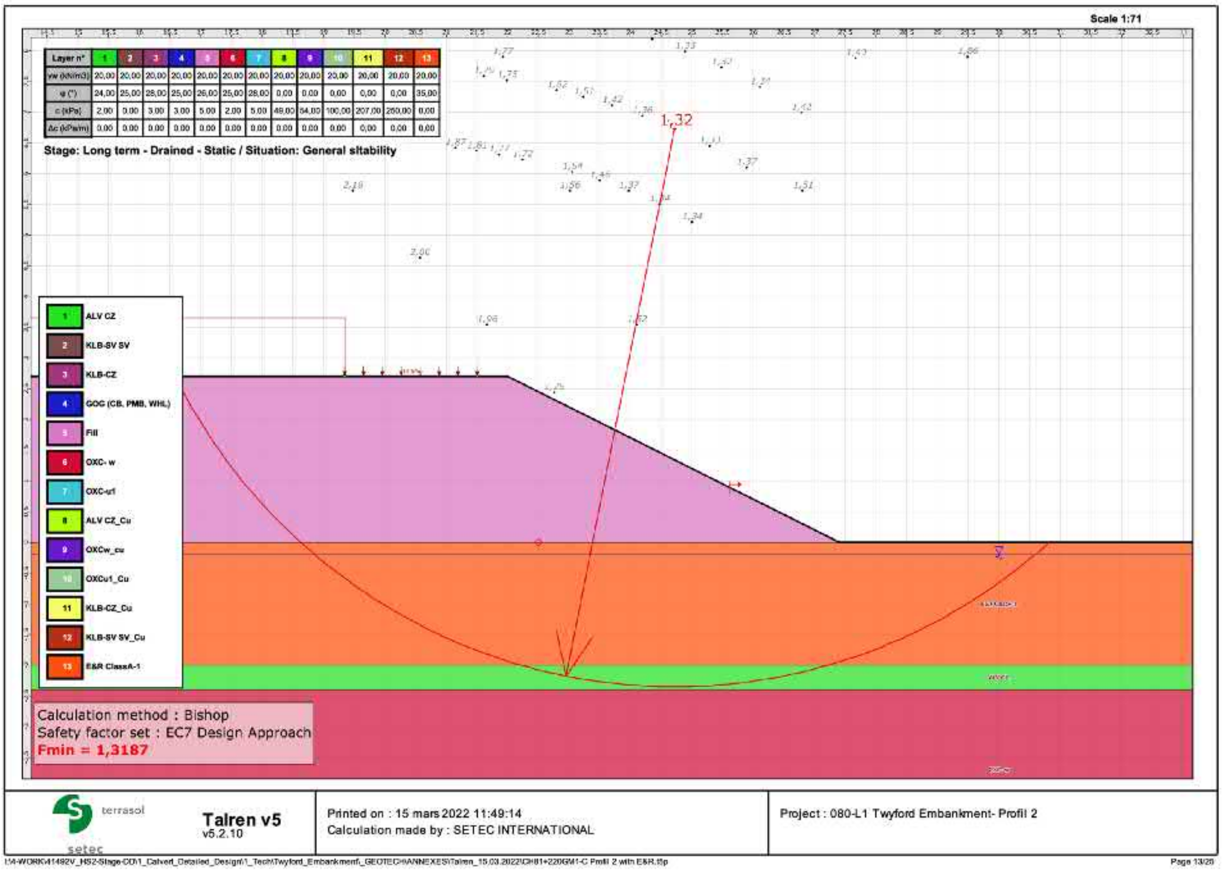
Coordinates of the critical centre and radius of the critical circle : N°= 254; X0= 24,72; Y0= 6,73; R= 9,08

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 11:49:14
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+220GM1-C Profil 2 with E&R.t5p
Page 12/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	25,00	28,00	0,00	0,00	0,00	0,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	2,00	5,00	49,00	54,00	100,00	207,00	260,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Long term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 20,000

Search type : Imposed passage point

Imposed passage point : X= 24,891; Y= 0,071

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in E&R ClassA-1

Results

Minimum safety factor : 1,3408

Coordinates of the critical centre and radius of the critical circle : N°= 467; X0= 24,19; Y0= 8,79; R= 8,74

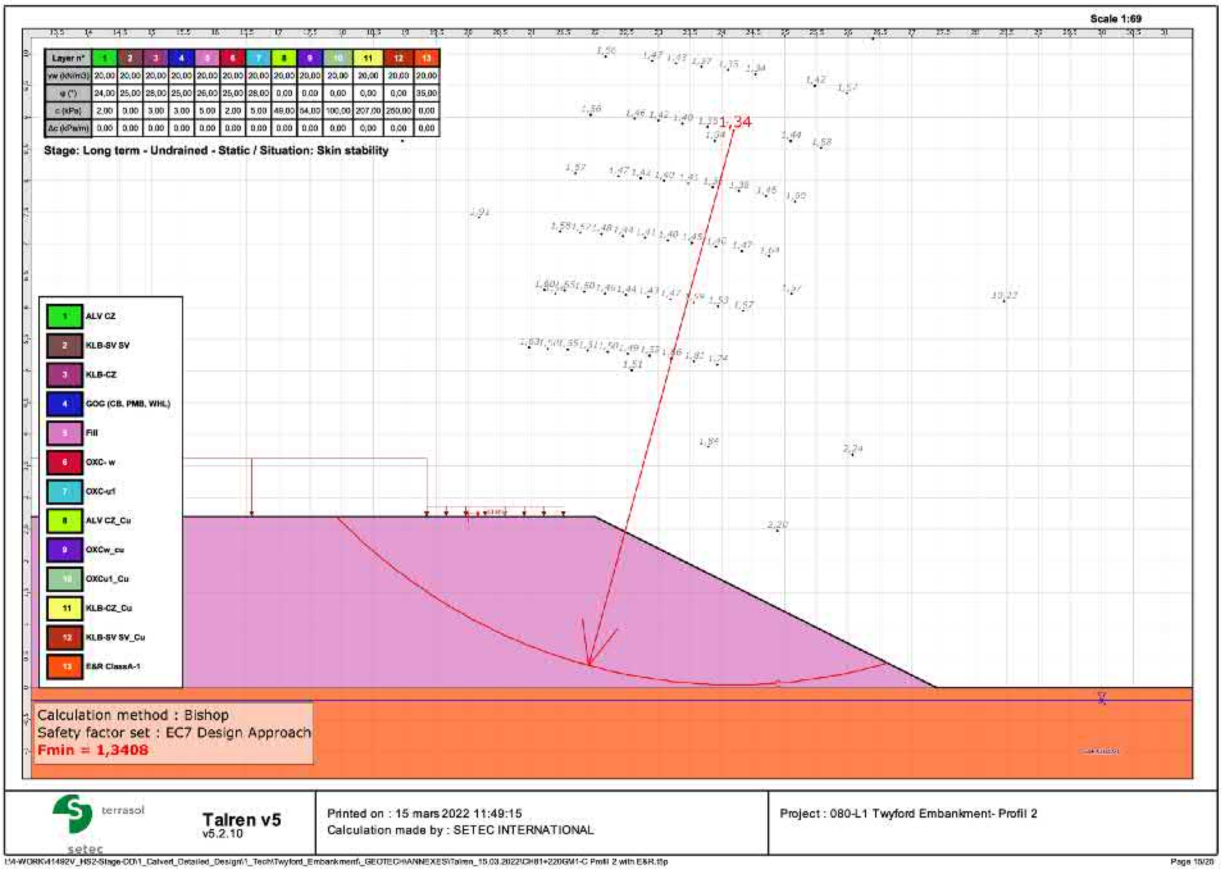
terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 11:49:15
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+220GM1-C Profil 2 with E&R.t5p

Page 14/25



Scale 1:69

Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	25,00	28,00	0,00	0,00	0,00	0,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	2,00	5,00	49,00	54,00	100,00	207,00	250,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Stage: Long term - Undrained - Static / Situation: Skin stability
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 OXC- w
7 OXC-u1
8 ALV CZ_Cu
9 OXCw_cu
10 OXCu1_Cu
11 KLB-CZ_Cu
12 KLB-SV SV_Cu
13 E&R ClassA-1
1,34
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3408
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 11:49:15
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2

Data of the situation 2

Stage name : Long term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 25,564

Search type : Imposed passage point

Imposed passage point : X= 23,703; Y= 0,081

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

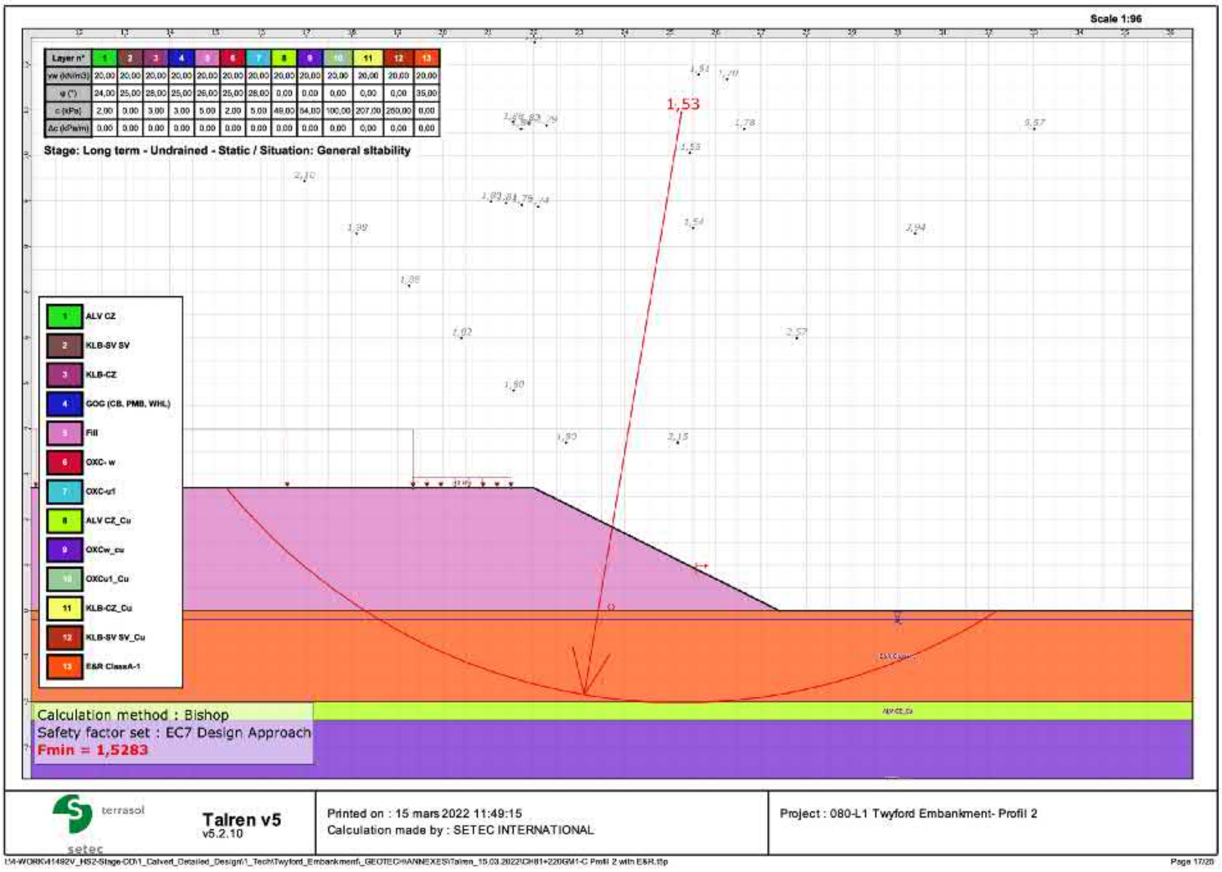
Results

Minimum safety factor : 1,5283

Coordinates of the critical centre and radius of the critical circle : N°= 171; X0= 25,25; Y0= 10,94; R= 12,96

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 11:49:15
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	25,00	28,00	0,00	0,00	0,00	0,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	2,00	5,00	48,00	54,00	100,00	207,00	260,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Seismic + 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 20,664

Search type : Imposed passage point

Imposed passage point : X= 25,358; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass out in E&R ClassA-1

Results

Minimum safety factor : 1,4998

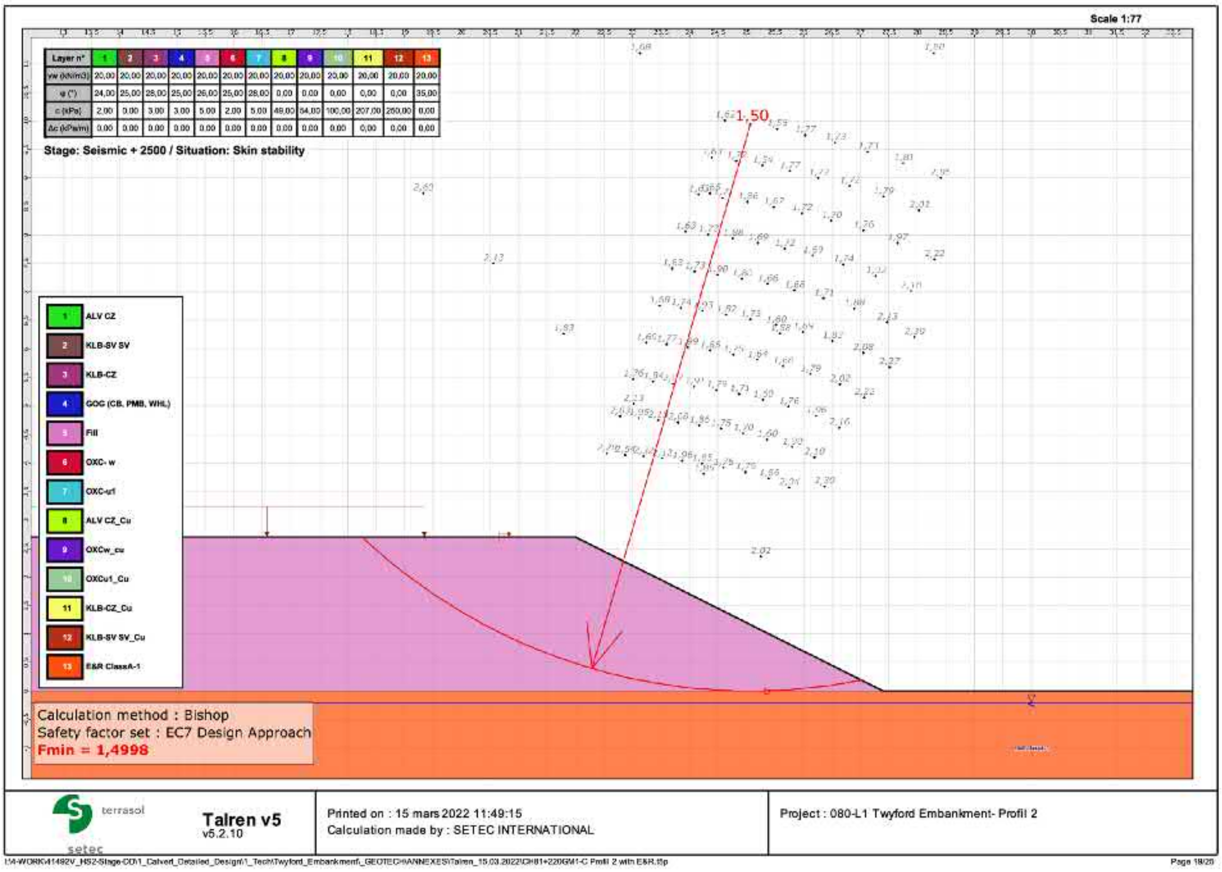
Coordinates of the critical centre and radius of the critical circle : N°= 561; X0= 25,07; Y0= 9,94; R= 9,94

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 11:49:15
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+220GM1-C Profil 2 with E&R.t5p


Scale 1:77
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 25,00 | 28,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 35,00
c (kPa) | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 2,00 | 5,00 | 48,00 | 54,00 | 100,00 | 207,00 | 250,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Seismic + 2500 / Situation: Skin stability
1,50
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 OXC- w
7 OXC-u1
8 ALV CZ_Cu
9 OXCw_cu
10 OXCu1_Cu
11 KLB-CZ_Cu
12 KLB-SV SV_Cu
13 E&R ClassA-1
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,4998
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 11:49:15
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2

Data of the situation 2

Stage name : Seismic + 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 25,613

Search type : Imposed passage point

Imposed passage point : X= 24,000; Y= 0,167

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

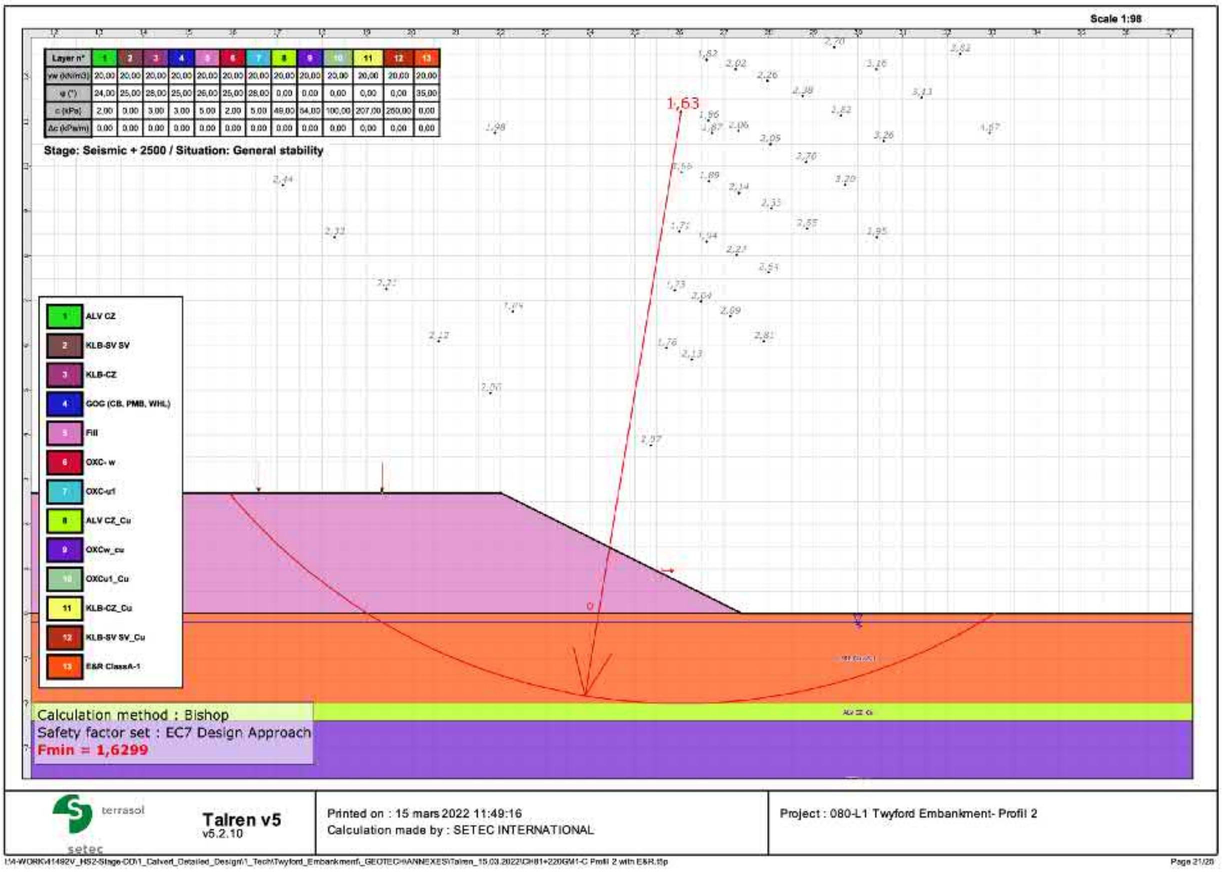
av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,6299

Coordinates of the critical centre and radius of the critical circle : N°= 244; X0= 26,04; Y0= 11,22; R= 13,23


Scale 1:98
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 24,00 25,00 28,00 25,00 26,00 25,00 28,00 0,00 0,00 0,00 0,00 0,00 35,00
c (kPa) 2,00 0,00 3,00 3,00 5,00 2,00 5,00 48,00 54,00 100,00 207,00 260,00 0,00
Δc (kPa/m) 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
Stage: Seismic + 2500 / Situation: General stability
1,63
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 OXC- w
7 OXC-u1
8 ALV CZ_Cu
9 OXCw_cu
10 OXCu1_Cu
11 KLB-CZ_Cu
12 KLB-SV SV_Cu
13 E&R ClassA-1
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,6299
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 11:49:16
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2
Page 21/28

Data of the situation 1

Stage name : Seismic - 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 17,500

Search type : Imposed passage point

Imposed passage point : X= 25,000; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

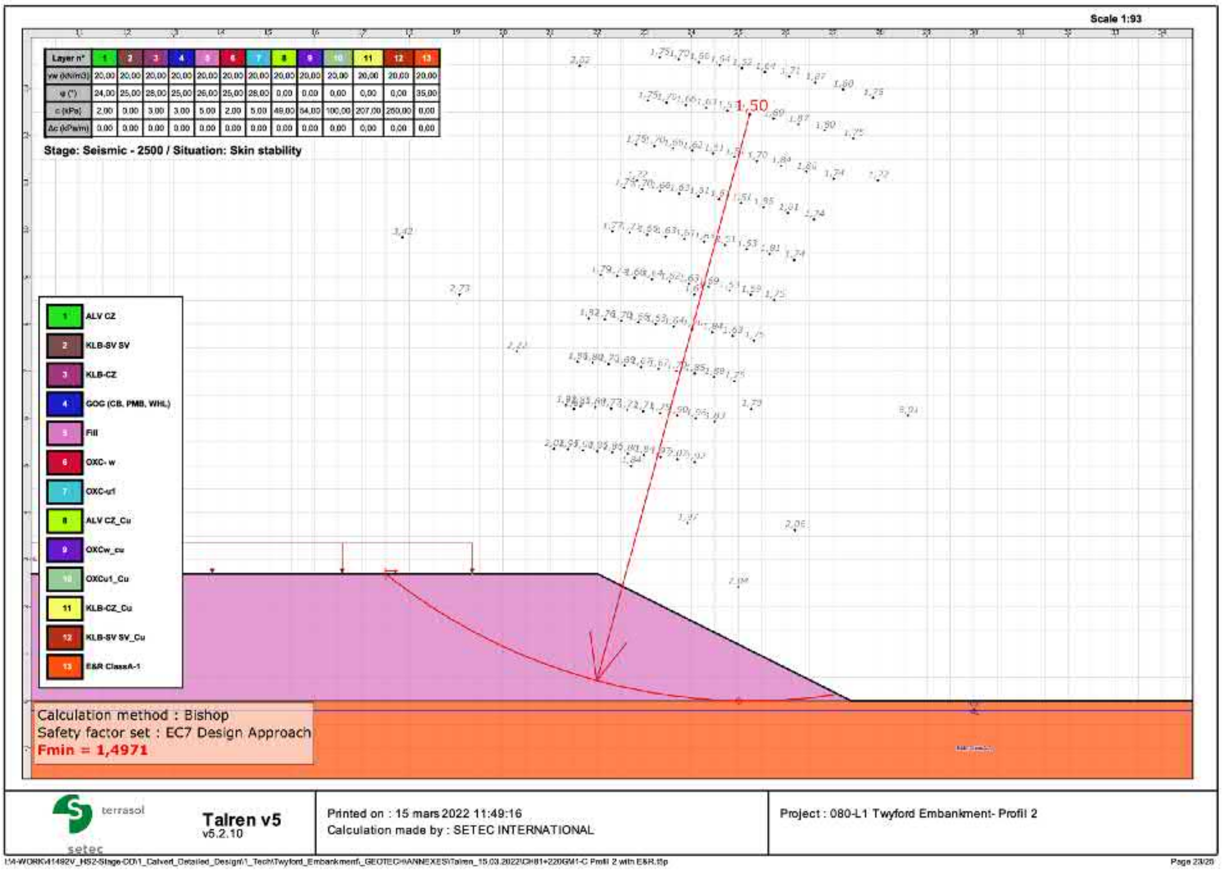
av/g coefficient (vertical acceleration) : -0,012

Passage conditions through soil layers : Must pass out in E&R ClassA-1

Results

Minimum safety factor : 1,4971

Coordinates of the critical centre and radius of the critical circle : N°= 518; X0= 25,24; Y0= 12,45; R= 12,45



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	25,00	28,00	0,00	0,00	0,00	0,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	2,00	5,00	48,00	54,00	100,00	207,00	250,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Seismic - 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 0,000

Search type : Imposed passage point

Imposed passage point : X= 25,000; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

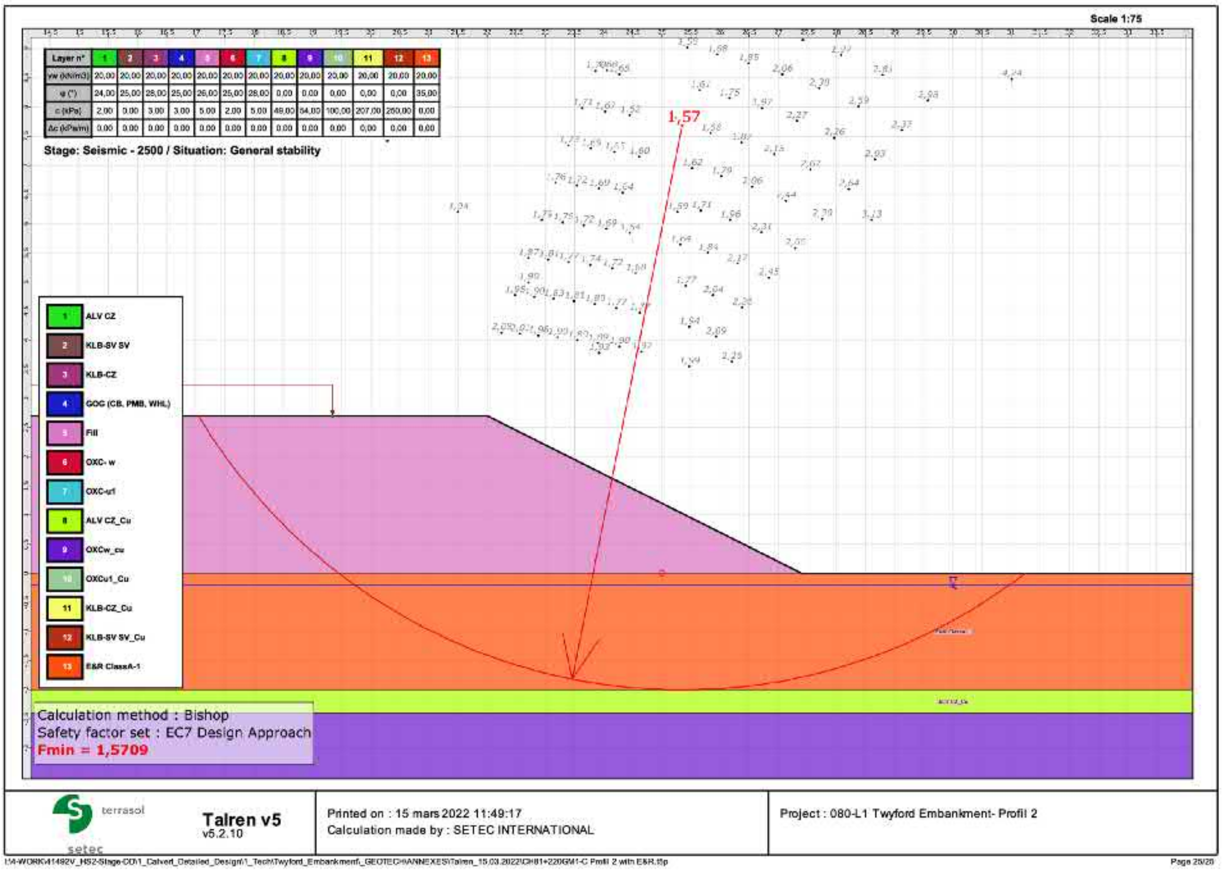
av/g coefficient (vertical acceleration) : -0,012

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,5709

Coordinates of the critical centre and radius of the critical circle : N°= 221; X0= 25,35; Y0= 7,68; R= 9,68


Scale 1:75
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 25,00 | 28,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 35,00
c (kPa) | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 2,00 | 5,00 | 49,00 | 54,00 | 100,00 | 207,00 | 250,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Seismic - 2500 / Situation: General stability
1,57
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 OXC- w
7 OXC-u1
8 ALV CZ_Cu
9 OXCw_cu
10 OXCu1_Cu
11 KLB-CZ_Cu
12 KLB-SV SV_Cu
13 E&R ClassA-1
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,5709
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 11:49:17
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 2

Project data

Project reference : HS2

Calculation title : 080-L1 Twyford Embankment- Profil 3

Location : H = 5.9m - Ch. 81+ 600 - Ground model 2

Comments : N/A

Units : kN, kPa, kN/m3

γw : 10.0

Soil layers

	Name	Colour	γ	φ	c	Δc	qs nails	pl	KsB	Anisotropy	Favorable	Specific safety factors
1	ALV CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No
2	KLB-SV SV		20,0	25,00	0,0	0,0	-	-	-	No	No	No
3	KLB-CZ		20,0	28,00	3,0	0,0	-	-	-	No	No	No
4	GOG (CB, PMB, WHL)		20,0	25,00	3,0	0,0	-	-	-	No	No	No
5	Fill		20,0	26,00	5,0	0,0	-	-	-	No	No	No
6	ALV CZ_Cu		20,0	0,00	49,0	0,0	-	-	-	No	No	No
7	KLB-CZ_Cu		20,0	0,00	207,0	0,0	-	-	-	No	No	No
8	KLB-SV SV_Cu		20,0	0,00	250,0	0,0	-	-	-	No	No	No
9	RTD SV SV		20,0	27,00	0,0	0,0	-	-	-	No	No	No
10	RTD SV SV_Cu		20,0	0,00	108,0	0,0	-	-	-	No	No	No
11	RTD CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No
12	RTD CZ_Cu		20,0	0,00	83,0	0,0	-	-	-	No	No	No
13	Starter Layer (Class 6c)		20,0	35,00	0,0	0,0	-	-	-	No	No	No

Soil layers (cont.)

	Name	Colour	Γγ	Γc	Γtan(φ)	Cohesion type	Curve
1	ALV CZ		-	-	-	Effective	Linear
2	KLB-SV SV		-	-	-	Effective	Linear
3	KLB-CZ		-	-	-	Effective	Linear
4	GOG (CB, PMB, WHL)		-	-	-	Effective	Linear
5	Fill		-	-	-	Effective	Linear
6	ALV CZ_Cu		-	-	-	Undrained	Linear
7	KLB-CZ_Cu		-	-	-	Undrained	Linear
8	KLB-SV SV_Cu		-	-	-	Effective	Linear
9	RTD SV SV		-	-	-	Effective	Linear
10	RTD SV SV_Cu		-	-	-	Undrained	Linear
11	RTD CZ		-	-	-	Effective	Linear
12	RTD CZ_Cu		-	-	-	Undrained	Linear
13	Starter Layer (Class 6c)		-	-	-	Effective	Linear

Points

	X	Y		X	Y		X	Y		X	Y		X	Y		X	Y
2	60,000	0,000	3	0,000	-2,800	4	60,000	-2,800	11	0,000	5,900	43	22,000	5,900	64	0,000	-4,000
65	60,000	-4,000	68	0,000	-6,000	69	60,000	-6,000	70	0,000	-8,500	71	60,000	-8,500	75	0,000	0,300
76	0,000	-0,300	80	33,284	0,219	83	34,337	-0,277	84	33,800	-0,000	85	0,000	-10,500	86	60,000	-10,500

Segments

	Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2
51	4	3	132	65	64	144	68	69	145	71	70	147	43	11	163	75	80	165	80	43
167	76	83	170	80	84	171	83	84	172	84	2	173	86	85						

Distributed loads

	Name	X left	Y left	q left	X right	Y right	q right	Ang/horizontal
1	10 kPa	19,343	5,900	10,0	21,500	5,900	10,0	90,00
2	57 kPa	0,000	5,900	57,0	19,344	5,900	57,0	90,00
3	20 kPa	0,000	5,900	20,0	21,500	5,900	20,0	90,00
4	30 kPa Seismic	0,000	5,900	30,0	19,344	5,900	30,0	90,00

Data of the situation 1

Stage name : Short term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 20,000

Search type : Imposed passage point

Imposed passage point : X= 32,500; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1497

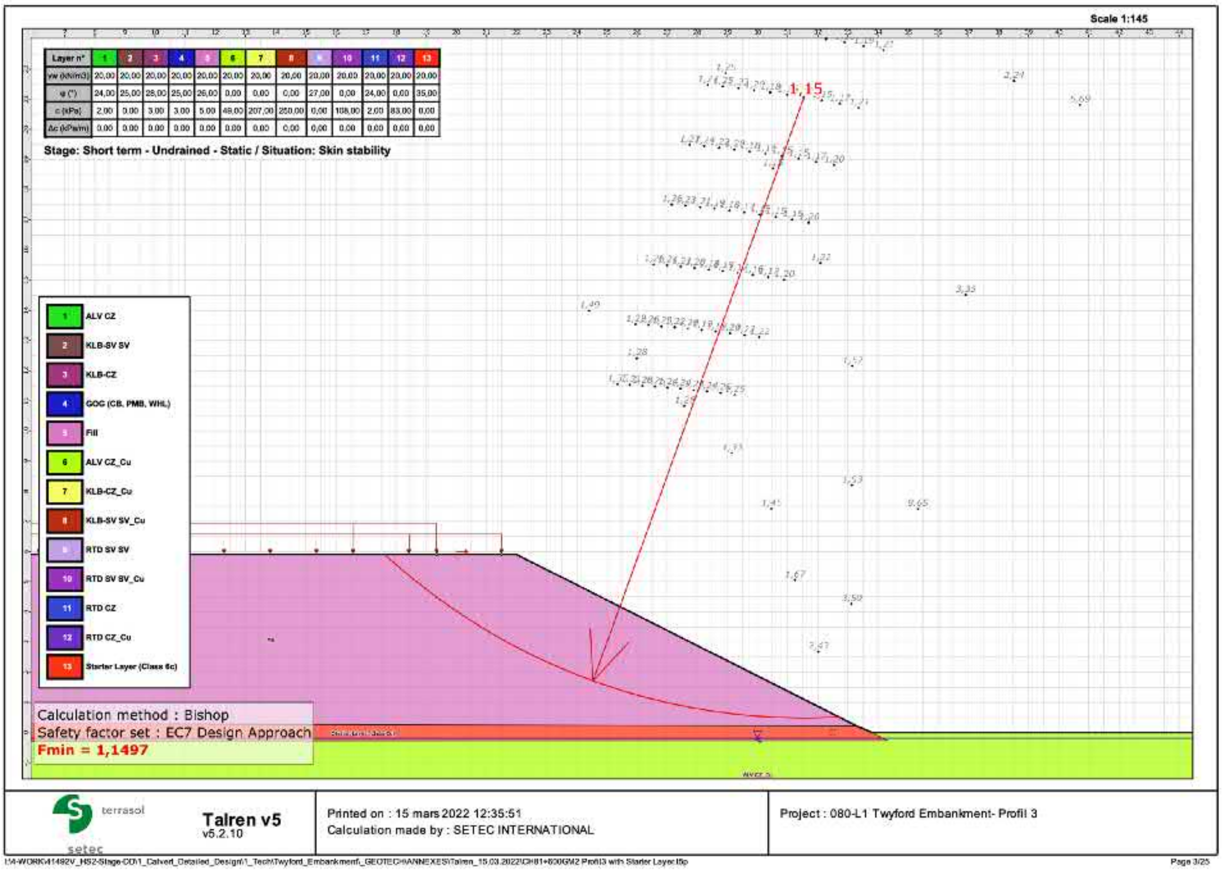
Coordinates of the critical centre and radius of the critical circle : N°= 496; X0= 31,54; Y0= 21,06; R= 20,58

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 12:35:51
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 3

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+600GM2 Profil3 with Starter Layer.t5p



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Short term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 31,000

Search type : Imposed passage point

Imposed passage point : X= 26,000; Y= 1,500

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

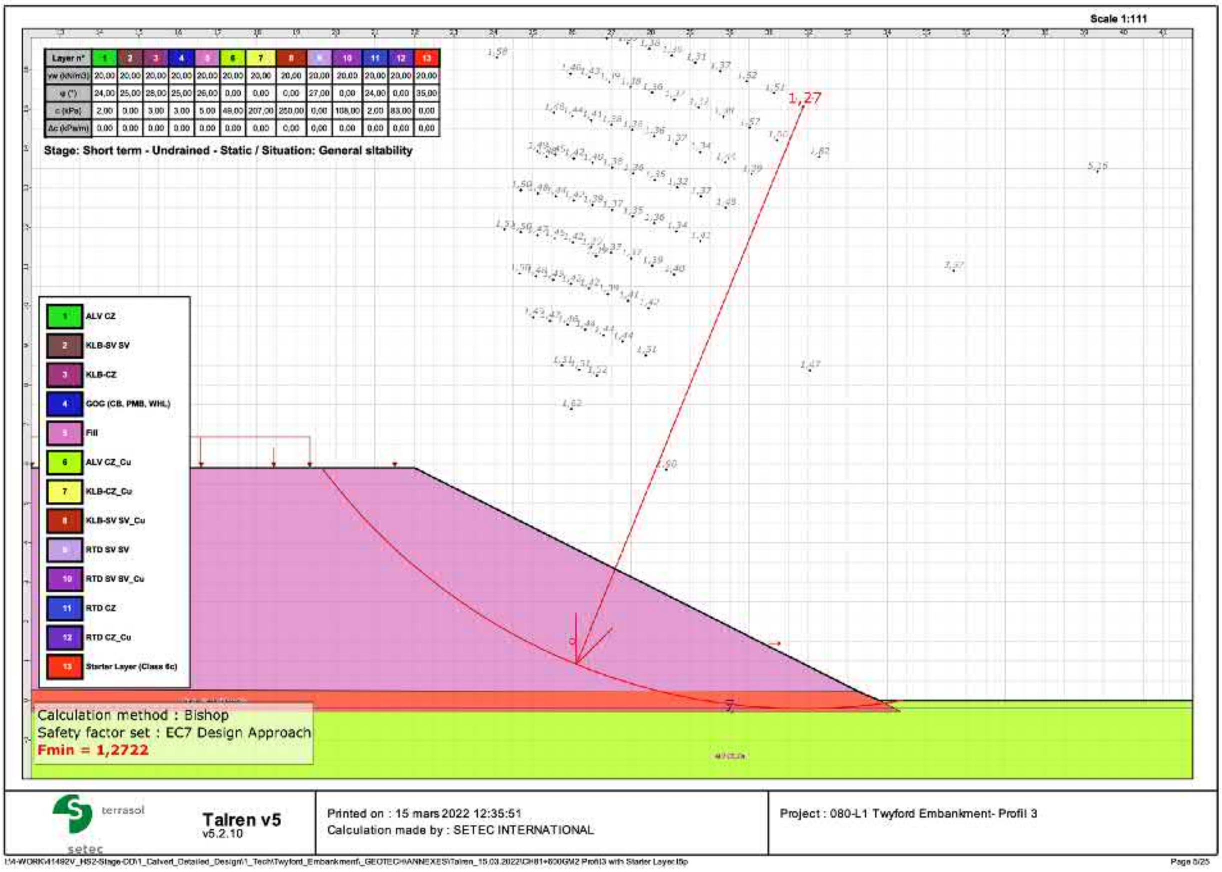
Minimum safety factor : 1,2722

Coordinates of the critical centre and radius of the critical circle : N°= 165; X0= 31,87; Y0= 15,06; R= 15,27

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 12:35:51
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 3


Scale 1:111
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 0,00 | 0,00 | 0,00 | 27,00 | 0,00 | 24,00 | 0,00 | 35,00
c (kPa) | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 48,00 | 207,00 | 250,00 | 0,00 | 108,00 | 2,00 | 83,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Short term - Undrained - Static / Situation: General sitability
1,27
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 ALV CZ_Cu
7 KLB-CZ_Cu
8 KLB-SV SV_Cu
9 RTD SV SV
10 RTD SV SV_Cu
11 RTD CZ
12 RTD CZ_Cu
13 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,2722
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 12:35:51
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 3

Data of the situation 1

Stage name : Short term - Drained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 17,000

Search type : Imposed passage point

Imposed passage point : X= 32,235; Y= 0,124

Number of slices : 100

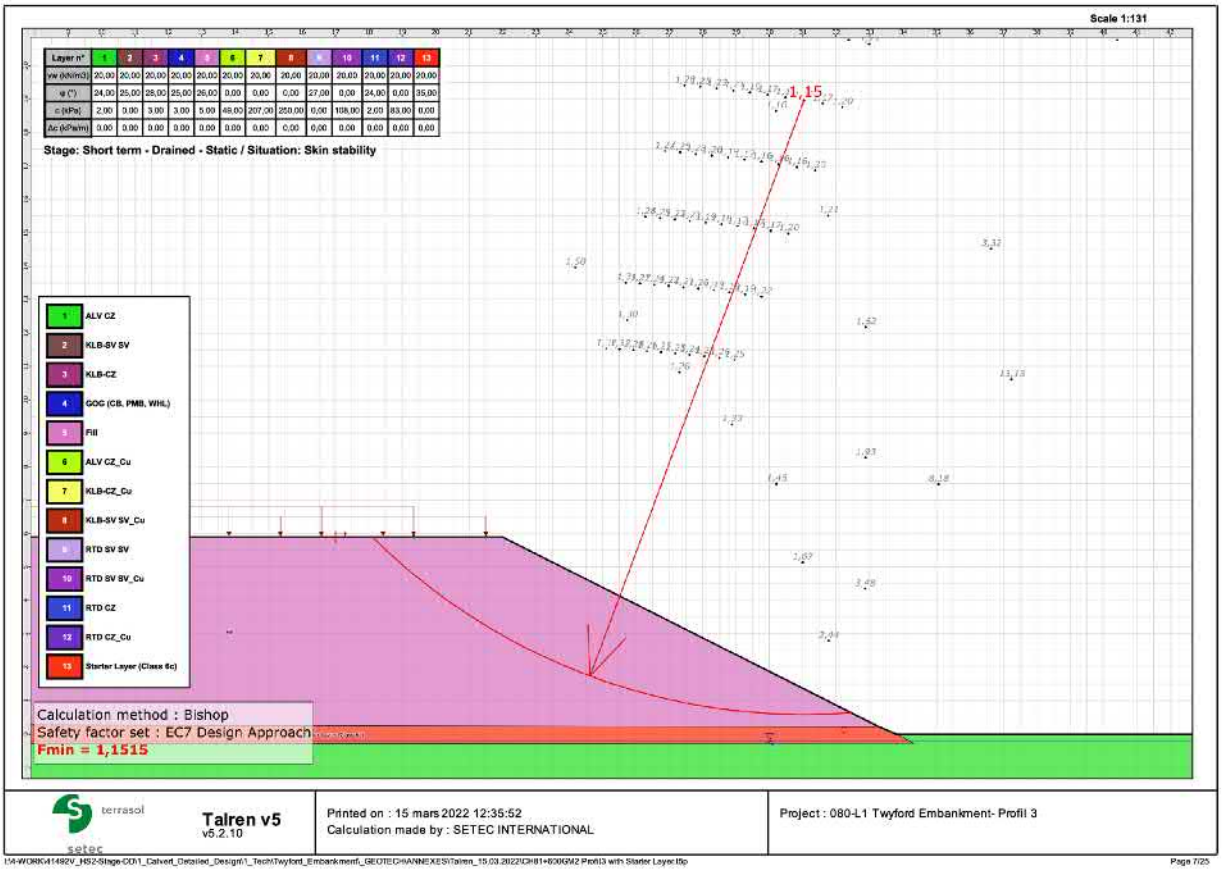
Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1515

Coordinates of the critical centre and radius of the critical circle : N°= 451; X0= 31,03; Y0= 18,96; R= 18,37



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Short term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 0,500

Search type : Imposed passage point

Imposed passage point : X= 32,500; Y= 0,000

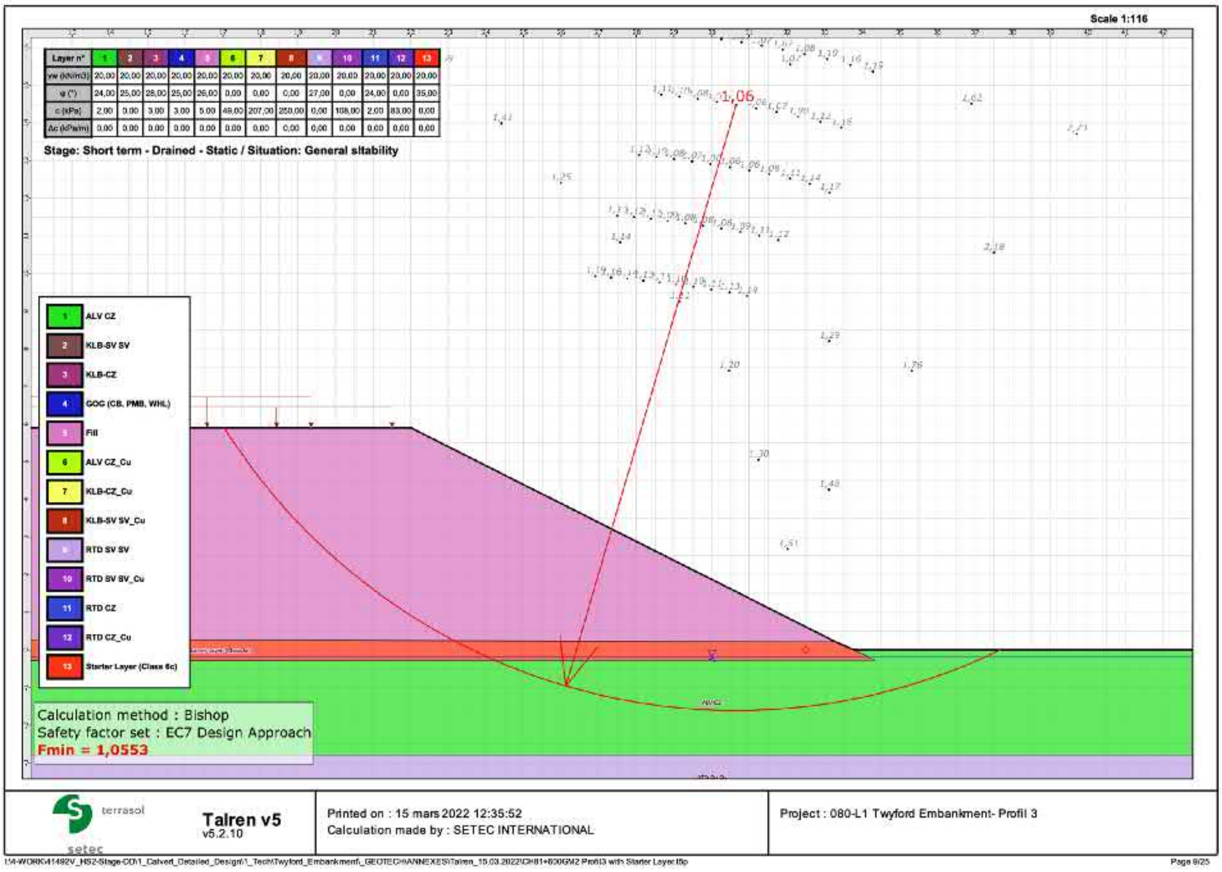
Number of slices : 100

Seismic properties : No

Results

Minimum safety factor : 1,0553

Coordinates of the critical centre and radius of the critical circle : N°= 1044; X0= 30,65; Y0= 14,48; R= 16,09


Scale 1:116
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 0,00 | 0,00 | 0,00 | 27,00 | 0,00 | 24,00 | 0,00 | 35,00
c (kPa) | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 48,00 | 207,00 | 250,00 | 0,00 | 108,00 | 2,00 | 83,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Short term - Drained - Static / Situation: General sitability
1,06
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 ALV CZ_Cu
7 KLB-CZ_Cu
8 KLB-SV SV_Cu
9 RTD SV SV
10 RTD SV SV_Cu
11 RTD CZ
12 RTD CZ_Cu
13 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,0553
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 12:35:52
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 3
Page 8/25

Data of the situation 1

Stage name : Long term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 20,000

Search type : Imposed passage point

Imposed passage point : X= 32,500; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

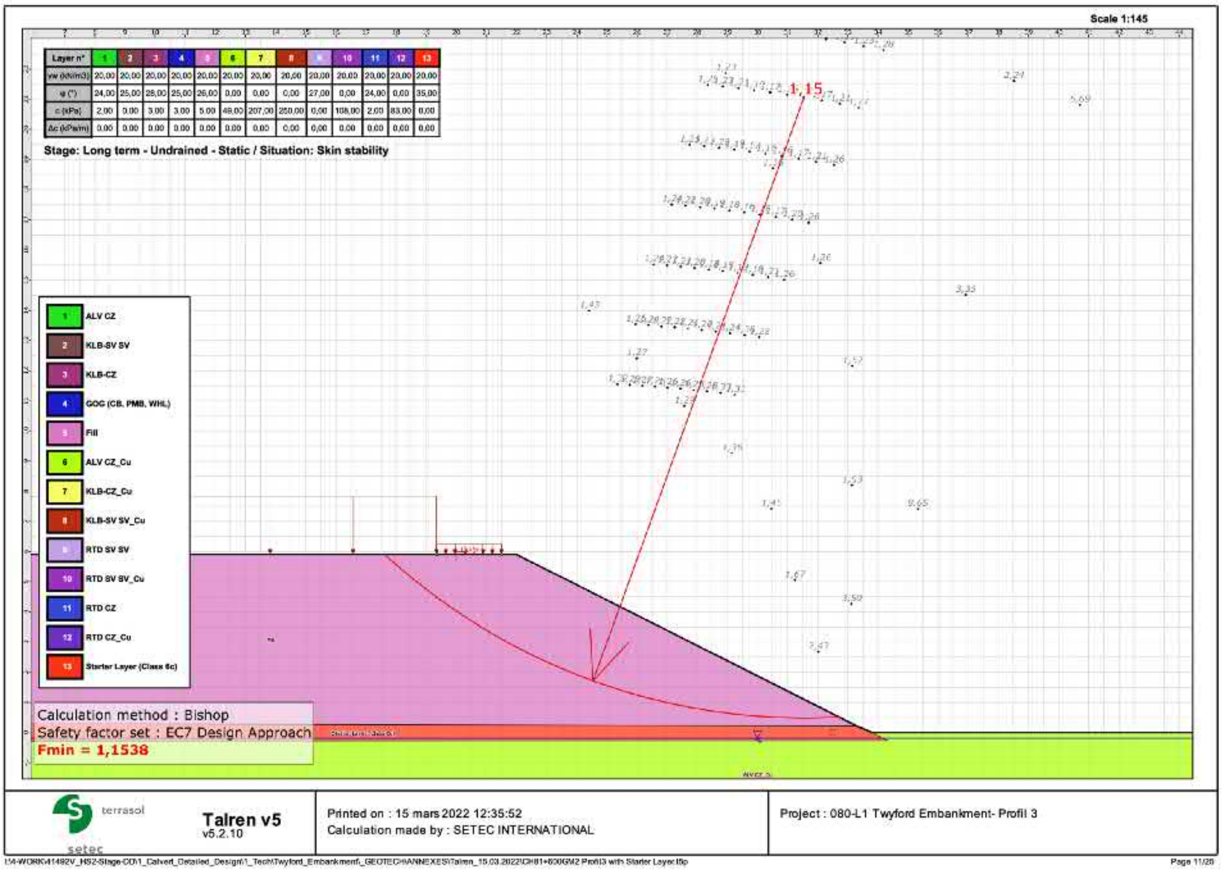
Minimum safety factor : 1,1538

Coordinates of the critical centre and radius of the critical circle : N°= 491; X0= 31,54; Y0= 21,06; R= 20,58

terrasol
setec
Talren v5
v5.2.10

Printed on : 15 mars 2022 12:35:52
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 3

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+600GM2 Profil3 with Starter Layer.t5p Page 10/25



Scale 1:145
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 0,00 | 0,00 | 0,00 | 27,00 | 0,00 | 24,00 | 0,00 | 35,00
c (kPa) | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 48,00 | 207,00 | 250,00 | 0,00 | 108,00 | 2,00 | 83,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Long term - Undrained - Static / Situation: Skin stability
1,15
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 ALV CZ_Cu
7 KLB-CZ_Cu
8 KLB-SV SV_Cu
9 RTD SV SV
10 RTD SV SV_Cu
11 RTD CZ
12 RTD CZ_Cu
13 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1538
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 12:35:52
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 3
Page 11/26

Data of the situation 2

Stage name : Long term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 31,000

Search type : Imposed passage point

Imposed passage point : X= 26,000; Y= 1,500

Number of slices : 100

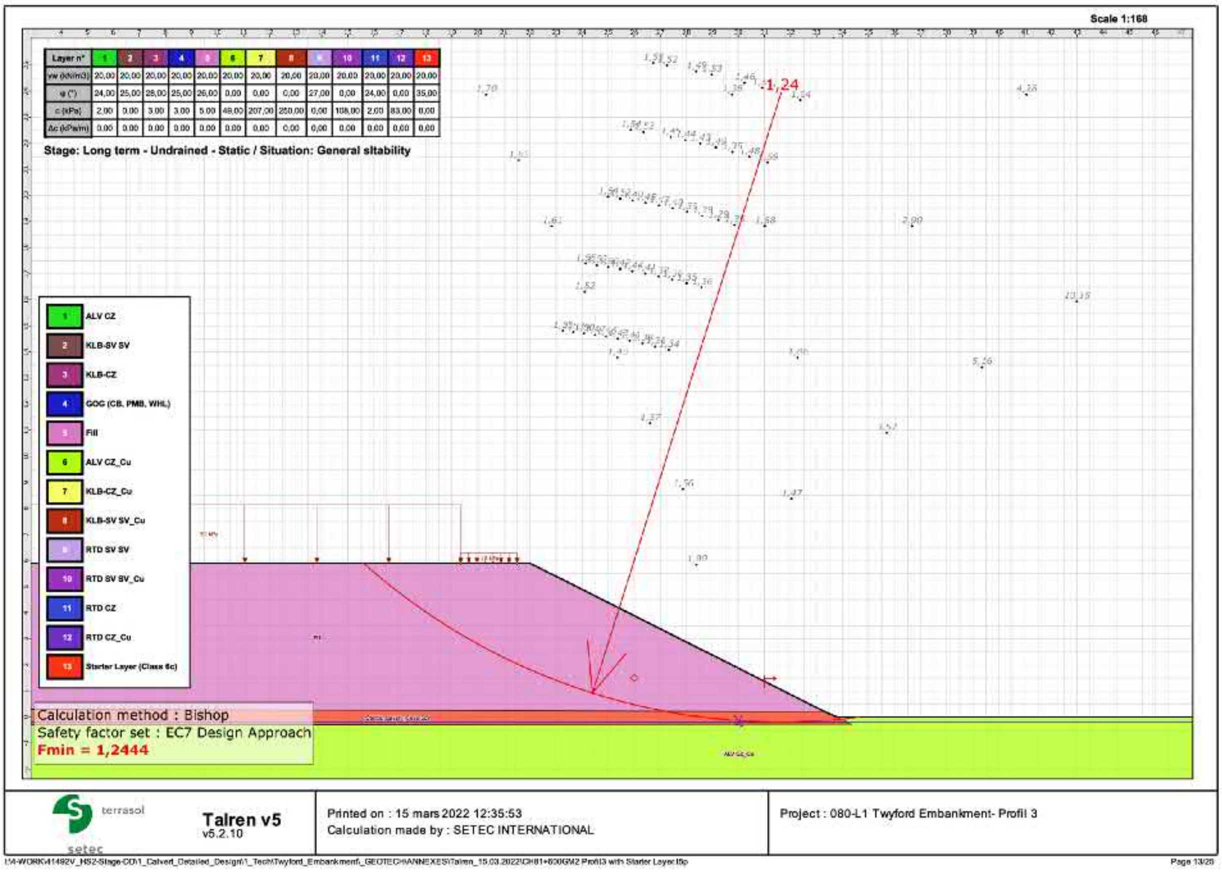
Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,2444

Coordinates of the critical centre and radius of the critical circle : N°= 187; X0= 31,63; Y0= 23,92; R= 24,11


Scale 1:168
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 0,00 | 0,00 | 0,00 | 27,00 | 0,00 | 24,00 | 0,00 | 35,00
c (kPa) | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 48,00 | 207,00 | 250,00 | 0,00 | 108,00 | 2,00 | 83,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Long term - Undrained - Static / Situation: General sltability
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 ALV CZ_Cu
7 KLB-CZ_Cu
8 KLB-SV SV_Cu
9 RTD SV SV
10 RTD SV SV_Cu
11 RTD CZ
12 RTD CZ_Cu
13 Starter Layer (Class 6c)
1,24
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,2444
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 12:35:53
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 3
Page 13/20

Data of the situation 1

Stage name : Long term - Drained -Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 17,000

Search type : Imposed passage point

Imposed passage point : X= 32,235; Y= 0,124

Number of slices : 100

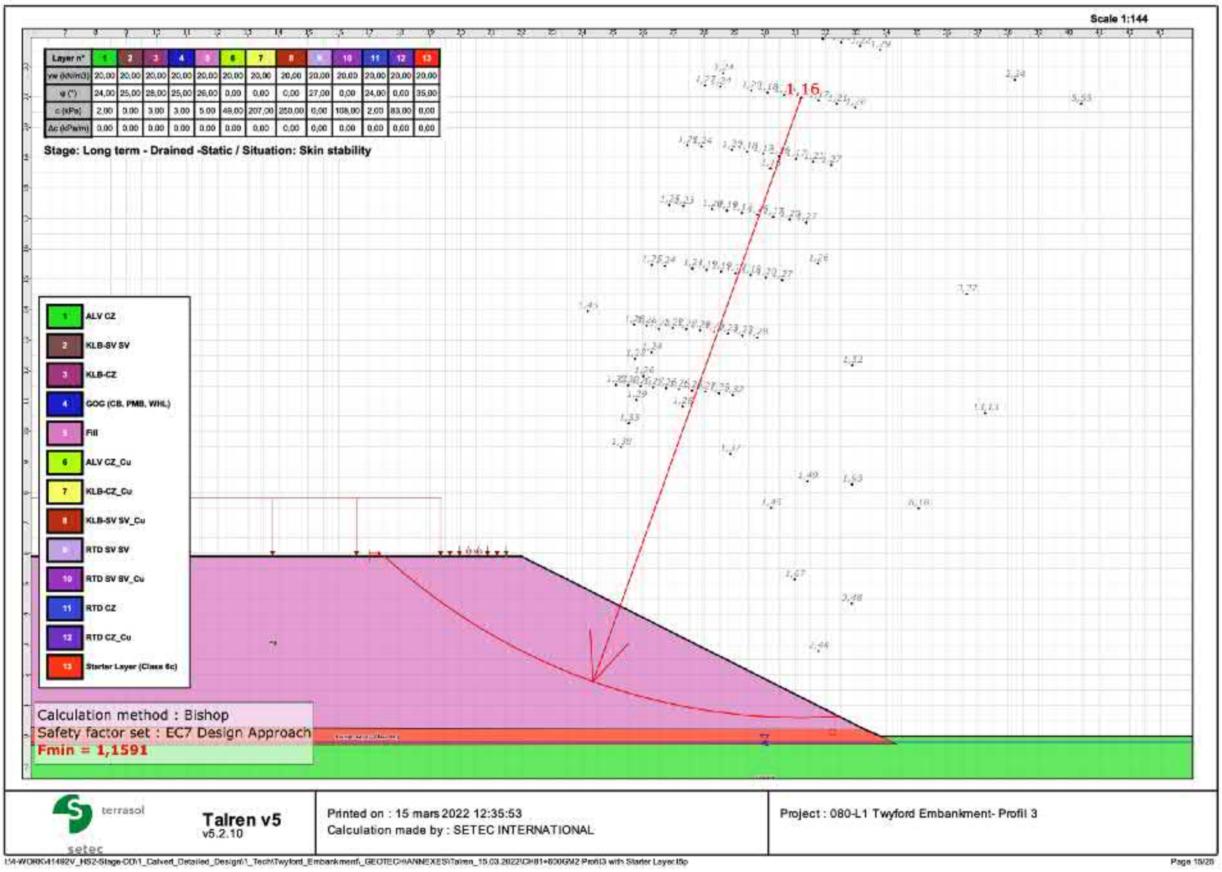
Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1591

Coordinates of the critical centre and radius of the critical circle : N°= 500; X0= 31,20; Y0= 20,97; R= 20,37



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Long term - Drained -Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 0,500

Search type : Imposed passage point

Imposed passage point : X= 32,500; Y= 0,000

Number of slices : 100

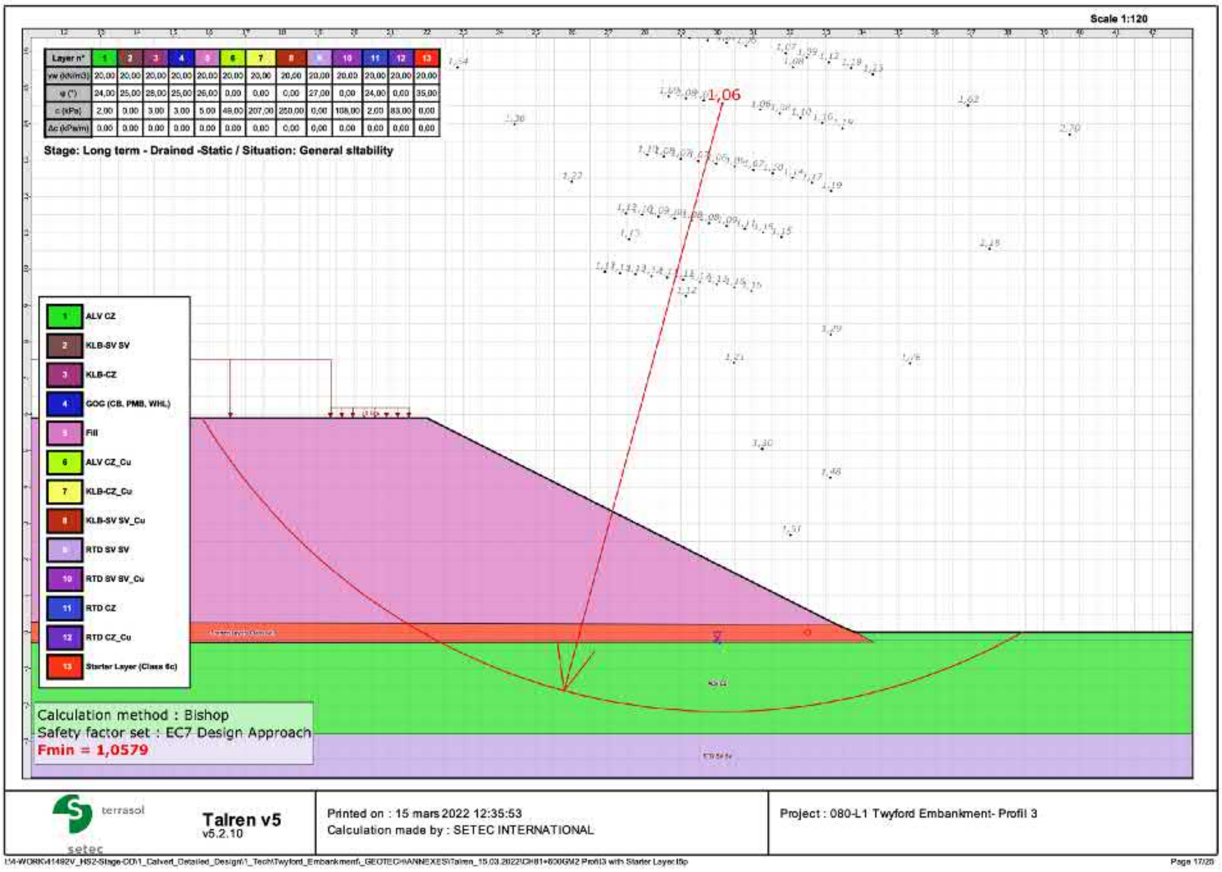
Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ

Results

Minimum safety factor : 1,0579

Coordinates of the critical centre and radius of the critical circle : N°= 554; X0= 30,14; Y0= 14,56; R= 16,75



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Seismic + 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 14,500

Search type : Imposed passage point

Imposed passage point : X= 32,500; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

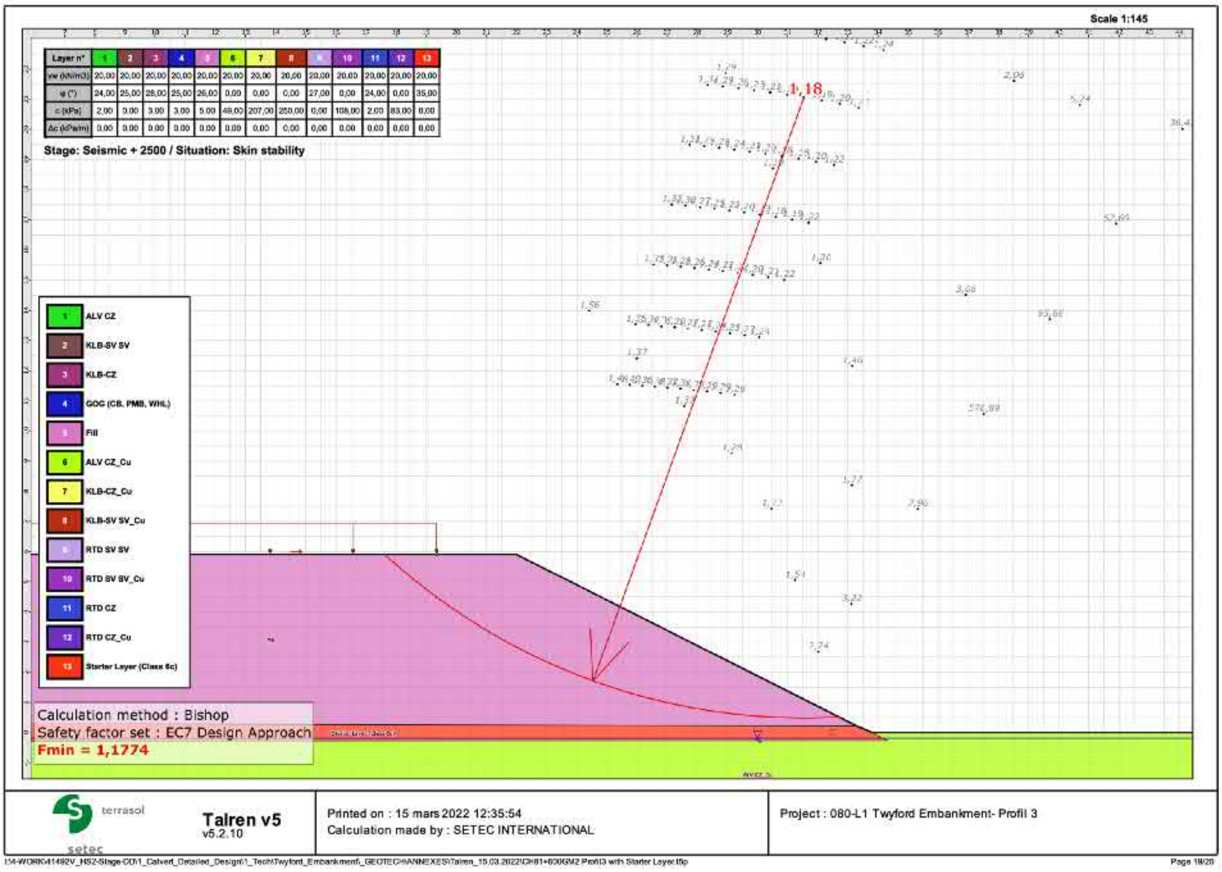
Results

Minimum safety factor : 1,1774

Coordinates of the critical centre and radius of the critical circle : N°= 496; X0= 31,54; Y0= 21,06; R= 20,58

terrasol setec | **Talren v5** v5.2.10 | Printed on : 15 mars 2022 12:35:54
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 3

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+600GM2 Profil3 with Starter Layer.t5p Page 18/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Seismic + 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 33,000

Search type : Imposed passage point

Imposed passage point : X= 26,000; Y= 1,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,2916

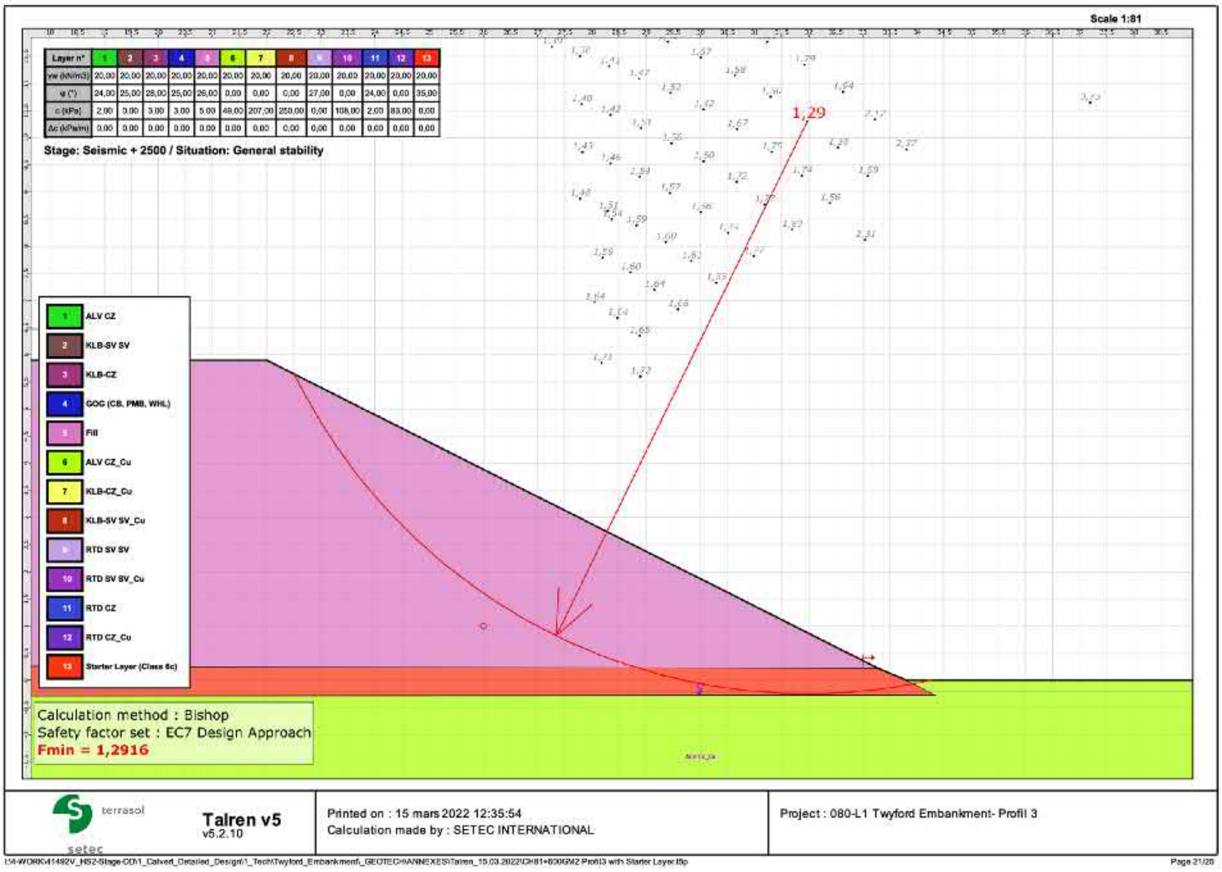
Coordinates of the critical centre and radius of the critical circle : N°= 268; X0= 31,97; Y0= 10,30; R= 10,54

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 12:35:54
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 3

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+600GM2 Profil3 with Starter Layer.t5p Page 20/25


Scale 1:81
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 0,00 | 0,00 | 0,00 | 27,00 | 0,00 | 24,00 | 0,00 | 35,00
c (kPa) | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 48,00 | 207,00 | 250,00 | 0,00 | 108,00 | 2,00 | 83,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Seismic + 2500 / Situation: General stability
1,29
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 ALV CZ_Cu
7 KLB-CZ_Cu
8 KLB-SV SV_Cu
9 RTD SV SV
10 RTD SV SV_Cu
11 RTD CZ
12 RTD CZ_Cu
13 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,2916
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 12:35:54
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 3
Page 21/28

Data of the situation 1

Stage name : Seismic - 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 16,000

Search type : Imposed passage point

Imposed passage point : X= 32,365; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : -0,012

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1837

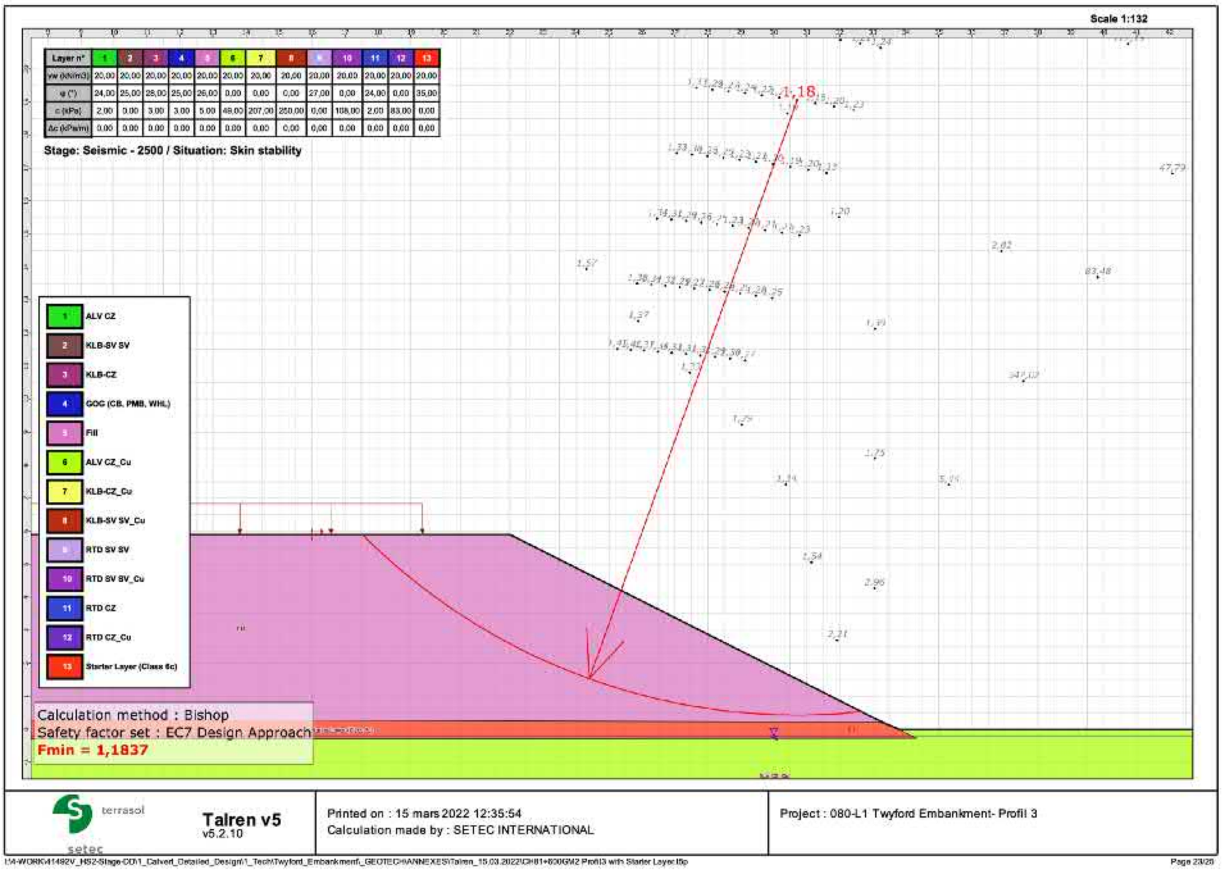
Coordinates of the critical centre and radius of the critical circle : N°= 486; X0= 30,71; Y0= 19,05; R= 18,62

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 12:35:54
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 3

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+600GM2 Profil3 with Starter Layer.t5p Page 22/25

Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00



Data of the situation 2

Stage name : Seismic - 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 33,000

Search type : Imposed passage point

Imposed passage point : X= 27,000; Y= 0,208

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : -0,012

Results

Minimum safety factor : 1,1689

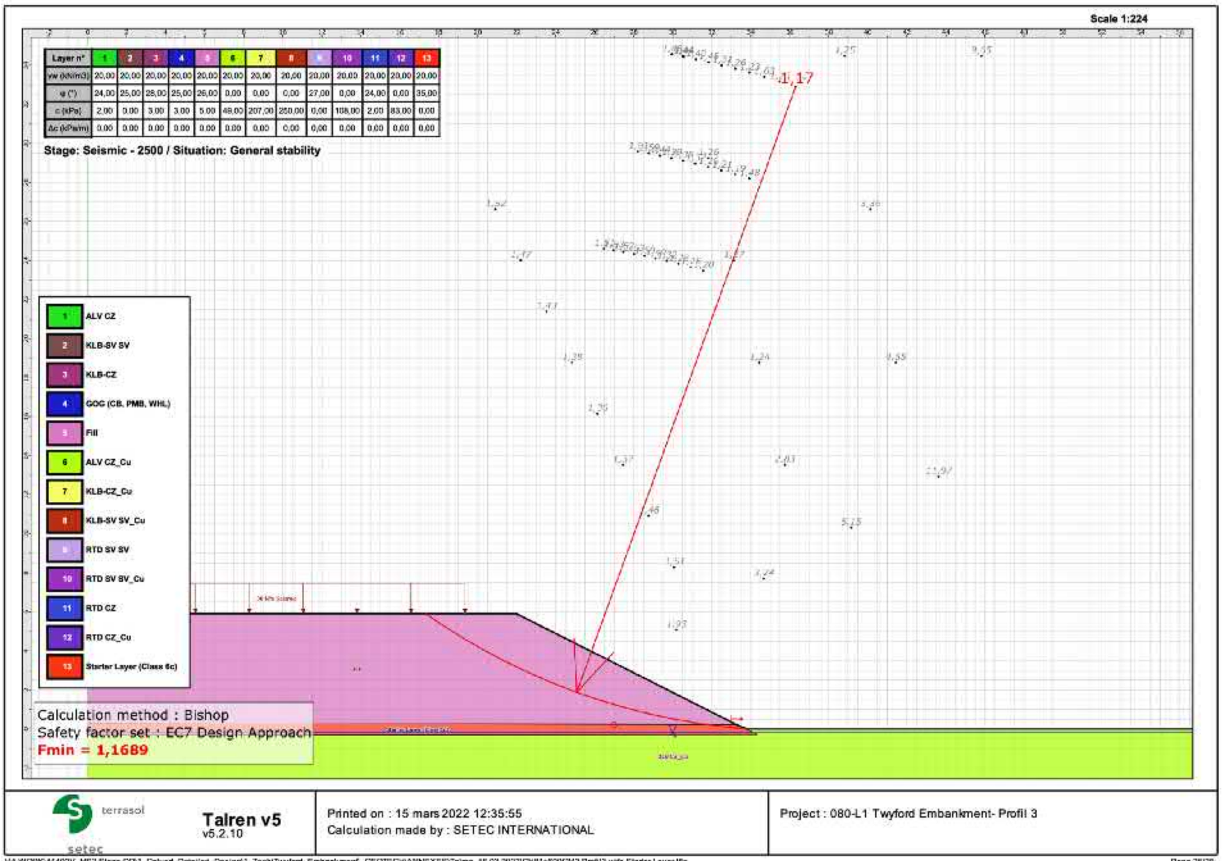
Coordinates of the critical centre and radius of the critical circle : N°= 226; X0= 36,30; Y0= 32,90; R= 32,99

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 12:35:55
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 3

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+600GM2 Profil3 with Starter Layer.t5p


Scale 1:224
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 0,00 | 0,00 | 0,00 | 27,00 | 0,00 | 24,00 | 0,00 | 35,00
c (kPa) | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 49,00 | 207,00 | 250,00 | 0,00 | 108,00 | 2,00 | 83,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Seismic - 2500 / Situation: General stability
1,17
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 ALV CZ_Cu
7 KLB-CZ_Cu
8 KLB-SV SV_Cu
9 RTD SV SV
10 RTD SV SV_Cu
11 RTD CZ
12 RTD CZ_Cu
13 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1689
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 12:35:55
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 3

Project data

Project reference : HS2
Calculation title : 080-L1 Twyford Embankment- Profil 4
Location : H = 5.80m - Ch. 81+ 687 - Ground model 4
Comments : N/A
Units : kN, kPa, kN/m3
γw : 10.0

Soil layers

	Name	Colour	γ	φ	c	Δc	qs nails	pl	KsB	Anisotropy	Favorable	Specific safety factors
1	ALV SV SV		20,0	25,00	0,0	0,0	-	-	-	No	No	No
2	ALV SV SV_Cu		20,0	0,00	40,0	0,0	-	-	-	No	No	No
3	ALV CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No
4	KLB-SV SV		20,0	25,00	0,0	0,0	-	-	-	No	No	No
5	KLB-CZ		20,0	28,00	3,0	0,0	-	-	-	No	No	No
6	GOG (CB, PMB, WHL)		20,0	25,00	3,0	0,0	-	-	-	No	No	No
7	Fill		20,0	26,00	5,0	0,0	-	-	-	No	No	No
8	ALV CZ_Cu		20,0	0,00	49,0	0,0	-	-	-	No	No	No
9	KLB-SV SV_Cu		20,0	0,00	250,0	0,0	-	-	-	No	No	No
10	KLB-CZ_Cu		20,0	0,00	207,0	0,0	-	-	-	No	No	No
11	Starter Layer (Class 6c)		20,0	35,00	0,0	0,0	-	-	-	No	No	No
12	ALV SV SV vadose		18,0	22,00	1,0	0,0	-	-	-	No	No	No

Soil layers (cont.)

	Name	Colour	Γγ	Γc	Γtan(φ)	Cohesion type	Curve
1	ALV SV SV		-	-	-	Effective	Linear
2	ALV SV SV_Cu		-	-	-	Undrained	Linear
3	ALV CZ		-	-	-	Effective	Linear
4	KLB-SV SV		-	-	-	Effective	Linear
5	KLB-CZ		-	-	-	Effective	Linear
6	GOG (CB, PMB, WHL)		-	-	-	Effective	Linear
7	Fill		-	-	-	Effective	Linear
8	ALV CZ_Cu		-	-	-	Undrained	Linear
9	KLB-SV SV_Cu		-	-	-	Undrained	Linear
10	KLB-CZ_Cu		-	-	-	Undrained	Linear
11	Starter Layer (Class 6c)		-	-	-	Effective	Linear
12	ALV SV SV vadose		-	-	-	Effective	Linear

Points

	X	Y		X	Y		X	Y		X	Y		X	Y		X	Y
3	0,000	-4,500	4	60,000	-4,500	11	0,000	5,800	12	16,000	5,800	13	27,600	0,000	26	30,600	0,000
27	35,000	-1,500	28	33,629	-1,500	64	0,000	-6,000	65	60,000	-6,000	66	0,000	-8,000	67	60,000	-8,000
71	60,000	-1,500	74	0,000	0,300	76	0,000	-0,300	77	60,000	0,000	78	27,000	0,300	79	38,000	-0,143
80	31,253	-0,309	81	25,235	-0,300	82	0,000	-2,700	83	60,000	-2,700						

Segments

	Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2
51	4	3	54	28	27	89	12	11	129	13	26	130	67	66	132	65	64	151	78	13
152	78	12	153	78	74	154	77	79	156	79	27	158	80	26	159	80	28	160	80	81
163	81	76	164	83	82															

Distributed loads

	Name	X left	Y left	q left	X right	Y right	q right	Ang/horizontal
1	10 kPa	13,300	5,800	10,0	15,500	5,800	10,0	90,00
2	57 kPa	0,000	5,800	57,0	13,300	5,800	57,0	90,00
3	20 kPa	0,000	5,800	20,0	15,500	5,800	20,0	90,00
4	30 kPa Seismic	0,000	5,800	30,0	13,300	5,800	30,0	90,00

Data of the situation 1

Stage name : Short term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 14,500

Search type : Imposed passage point

Imposed passage point : X= 25,627; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

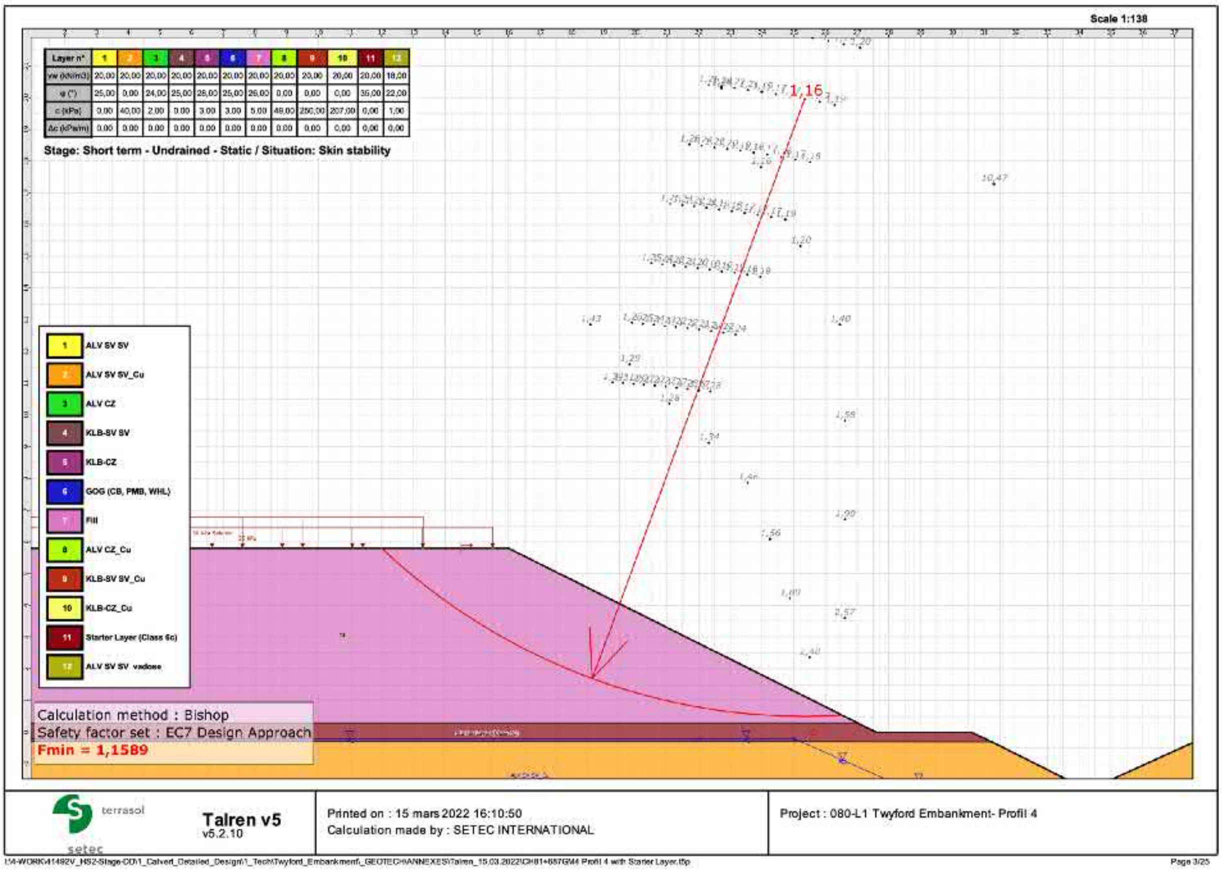
Minimum safety factor : 1,1589

Coordinates of the critical centre and radius of the critical circle : N°= 345; X0= 25,34; Y0= 19,96; R= 19,46

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 16:10:50
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 4

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+687GM4 Profil 4 with Starter Layer.t5p Page 2/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	18,00
φ (°)	25,00	0,00	24,00	25,00	26,00	25,00	26,00	0,00	0,00	0,00	35,00	22,00
c (kPa)	0,00	40,00	2,00	0,00	3,00	3,00	5,00	49,00	250,00	207,00	0,00	1,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Short term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 26,000

Search type : Imposed passage point

Imposed passage point : X= 24,500; Y= 0,000

Number of slices : 100

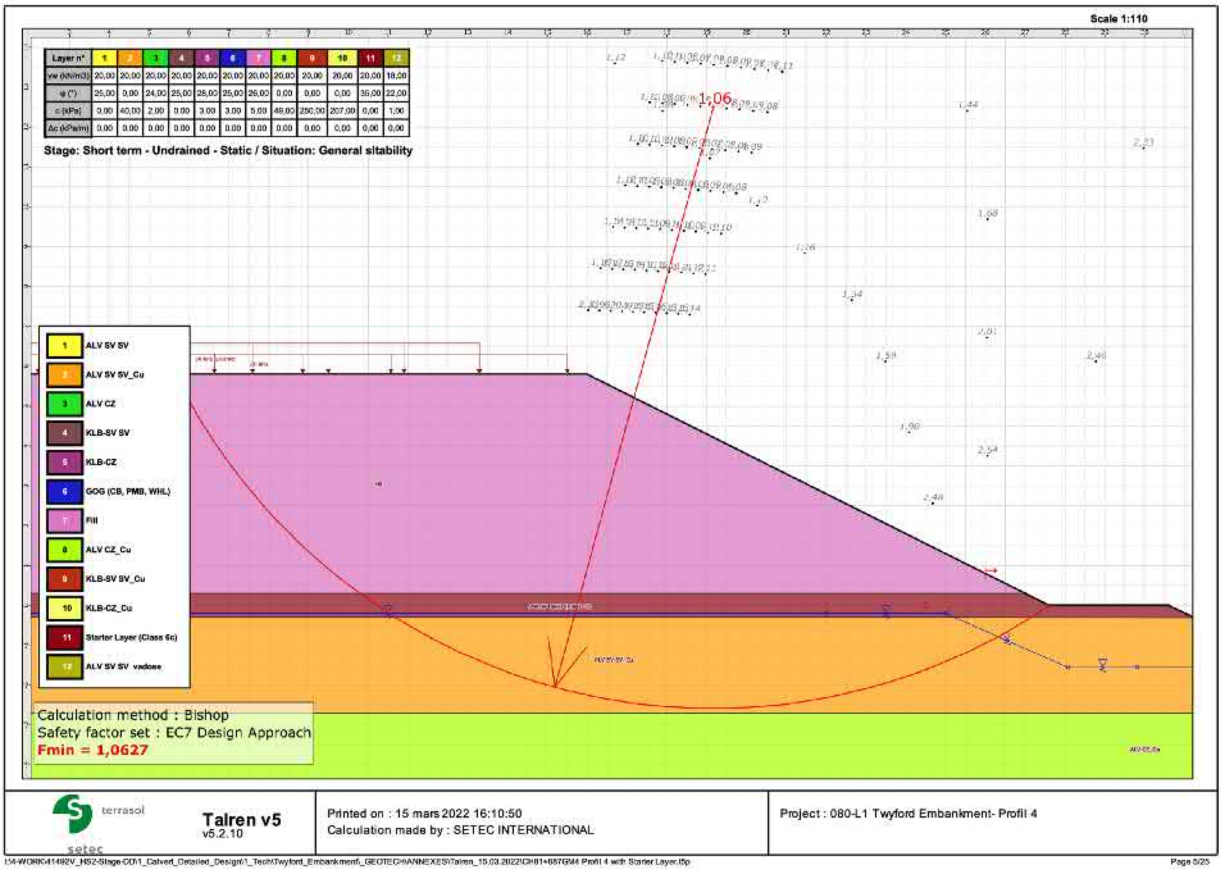
Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV SV SV_Cu

Results

Minimum safety factor : 1,0627

Coordinates of the critical centre and radius of the critical circle : N°= 513; X0= 19,17; Y0= 12,50; R= 15,09



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	18,00
φ (°)	25,00	0,00	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	35,00	22,00
c (kPa)	0,00	40,00	2,00	0,00	3,00	3,00	5,00	49,00	250,00	207,00	0,00	1,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Short term - Drained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 9,500

Search type : Imposed passage point

Imposed passage point : X= 25,305; Y= 0,126

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1622

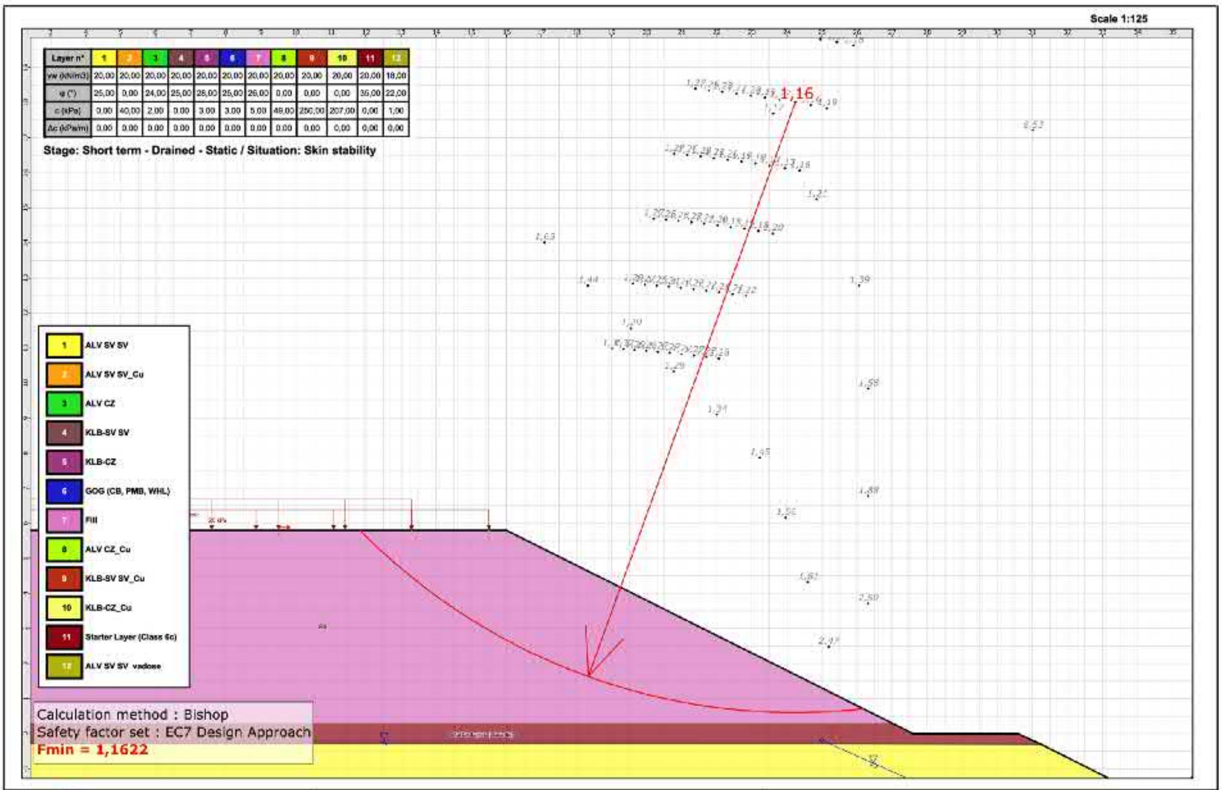
Coordinates of the critical centre and radius of the critical circle : N°= 365; X0= 24,24; Y0= 18,01; R= 17,41

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 16:10:51
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 4

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+687GM4 Profil 4 with Starter Layer.t5p

Page 6/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	18,00
φ (°)	25,00	0,00	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	35,00	22,00
c (kPa)	0,00	40,00	2,00	0,00	3,00	3,00	5,00	48,00	250,00	207,00	0,00	1,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

terrasol setec Talren v5 v5.2.10 | Printed on : 15 mars 2022 16:10:51 Calculation made by : SETEC INTERNATIONAL | Project : 080-L1 Twyford Embankment- Profil 4

Page 7/25

Data of the situation 2

Stage name : Short term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 1,500

Search type : Imposed passage point

Imposed passage point : X= 33,000; Y= -1,500

Number of slices : 100

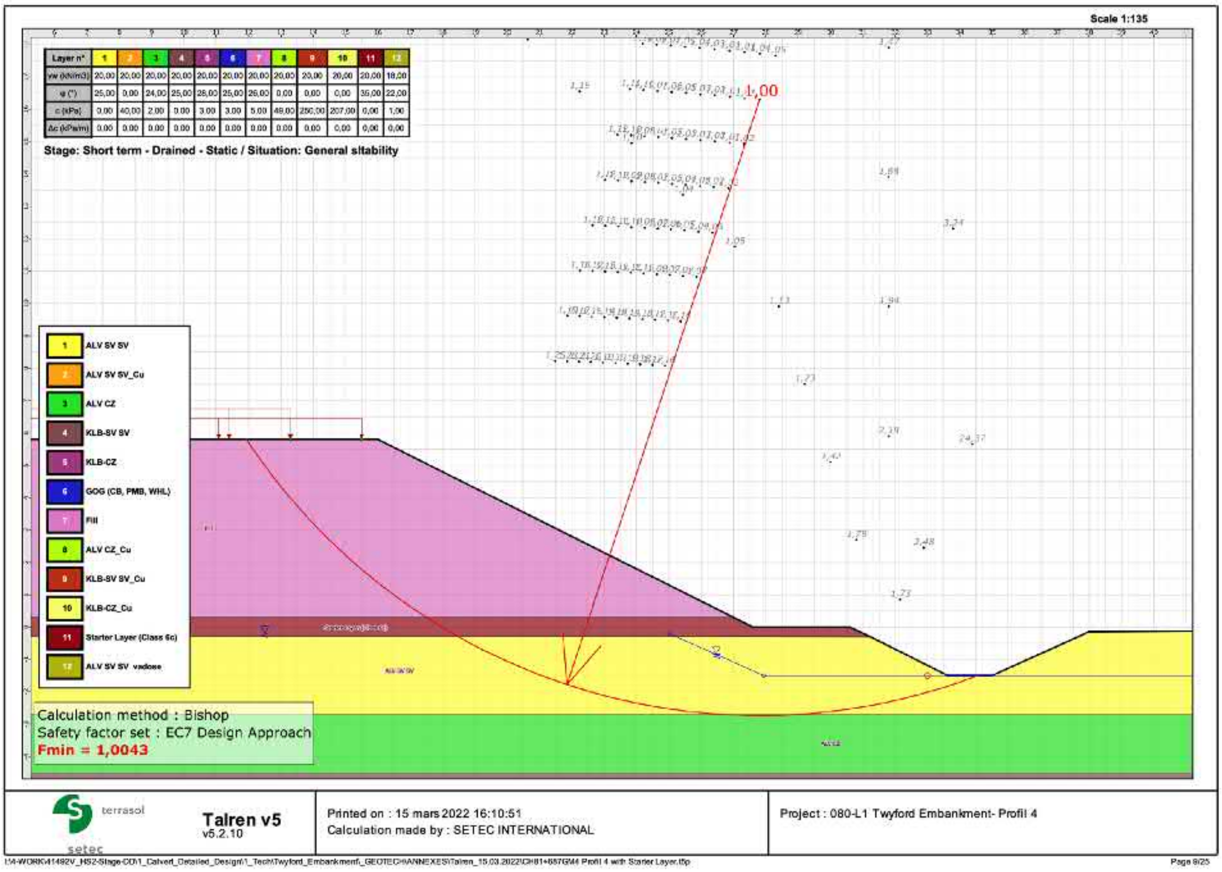
Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ

Results

Minimum safety factor : 1,0043

Coordinates of the critical centre and radius of the critical circle : N°= 174; X0= 27,81; Y0= 16,30; R= 19,03


Scale 1:135
Stage: Short term - Drained - Static / Situation: General sltability
ALV SV SV
ALV SV SV_Cu
ALV CZ
KLB-SV SV
KLB-CZ
GOG (CB, PMB, WHL)
Fill
ALV CZ_Cu
KLB-SV SV_Cu
KLB-CZ_Cu
Starter Layer (Class 6c)
ALV SV SV vadose
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,0043
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:10:51
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 4

Data of the situation 1

Stage name : Long term - Drained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 9,500

Search type : Imposed passage point

Imposed passage point : X= 25,305; Y= 0,126

Number of slices : 100

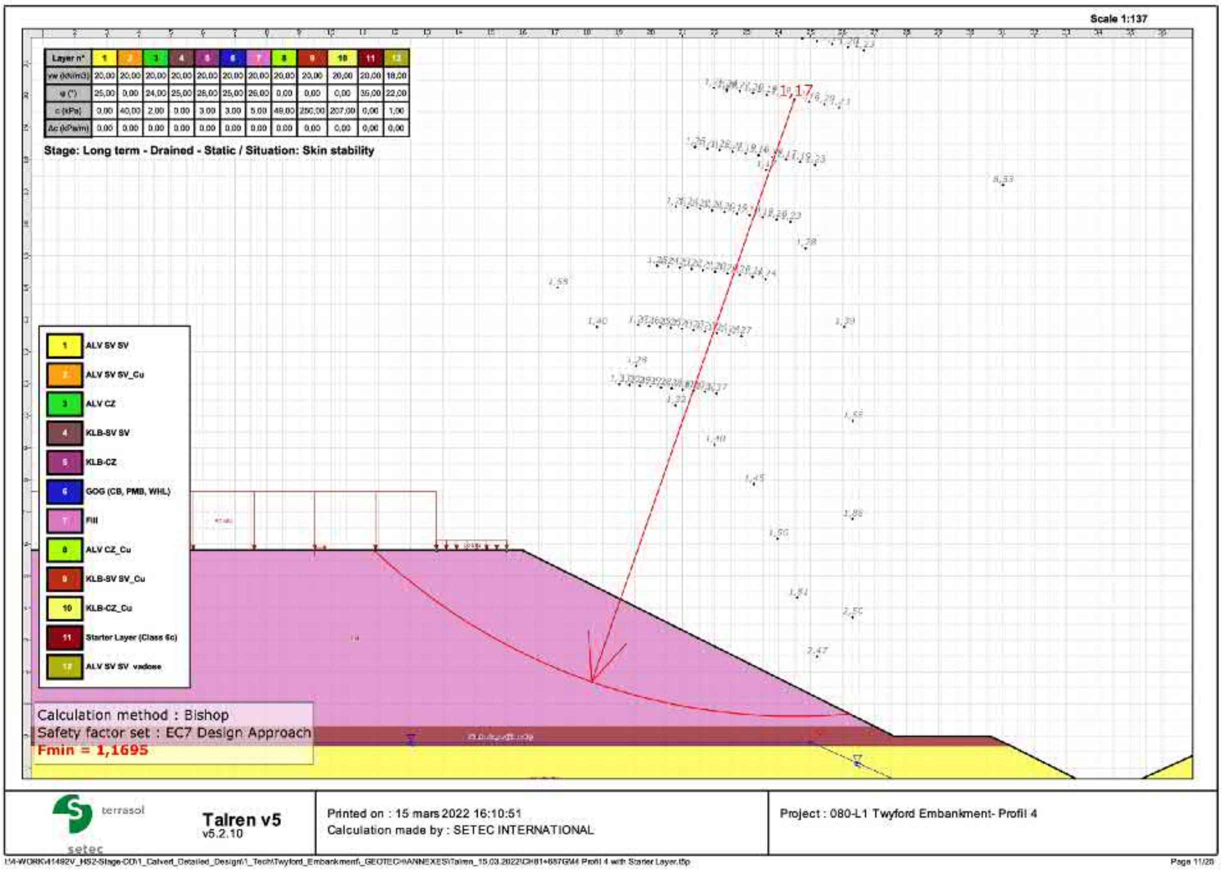
Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1695

Coordinates of the critical centre and radius of the critical circle : N°= 417; X0= 24,50; Y0= 19,89; R= 19,28



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	18,00
φ (°)	25,00	0,00	24,00	25,00	26,00	25,00	26,00	0,00	0,00	0,00	35,00	22,00
c (kPa)	0,00	40,00	2,00	0,00	3,00	3,00	5,00	49,00	250,00	207,00	0,00	1,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Long term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 26,000

Search type : Imposed passage point

Imposed passage point : X= 22,272; Y= 0,000

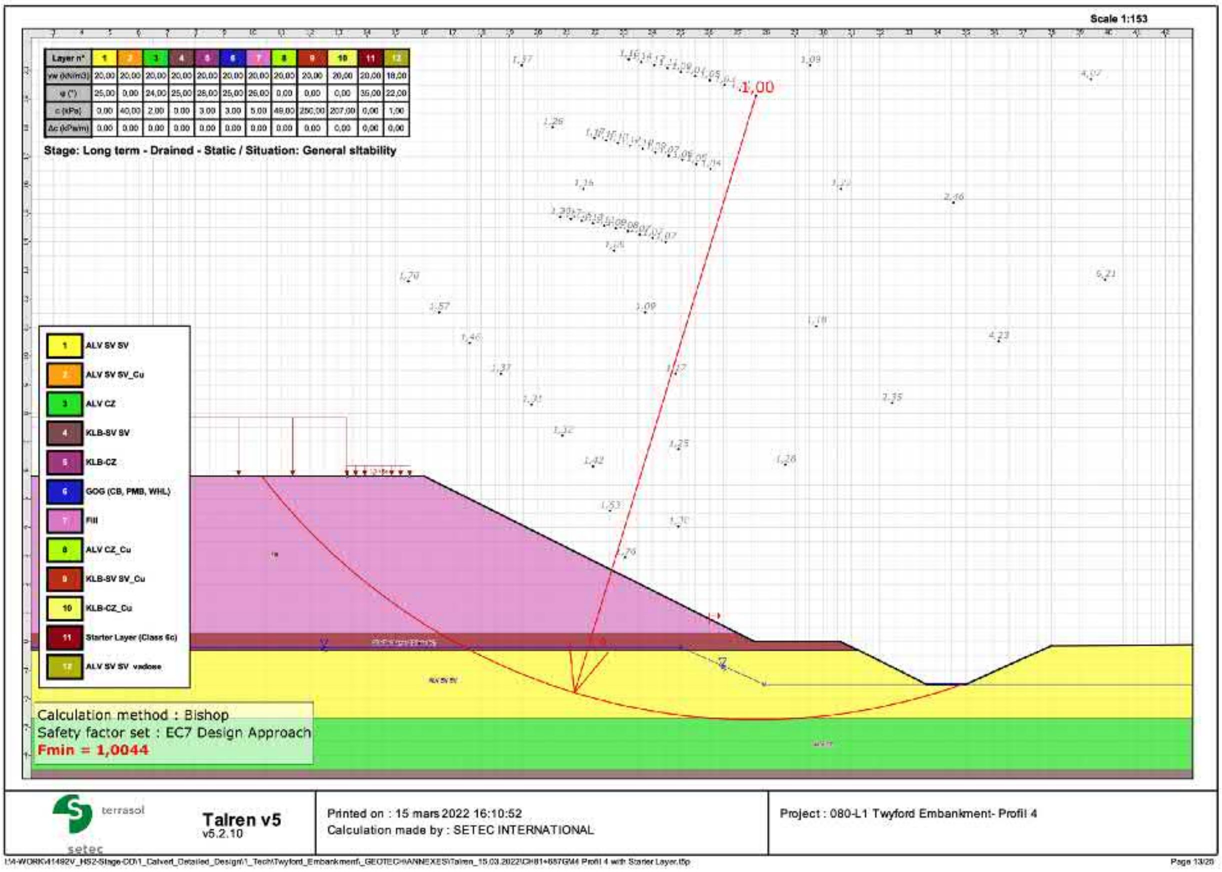
Number of slices : 100

Seismic properties : No

Results

Minimum safety factor : 1,0044

Coordinates of the critical centre and radius of the critical circle : N°= 370; X0= 27,64; Y0= 19,12; R= 21,85



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	18,00
φ (°)	25,00	0,00	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	35,00	22,00
c (kPa)	0,00	40,00	2,00	0,00	3,00	3,00	5,00	48,00	250,00	207,00	0,00	1,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Long term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 14,500

Search type : Imposed passage point

Imposed passage point : X= 25,627; Y= 0,000

Number of slices : 100

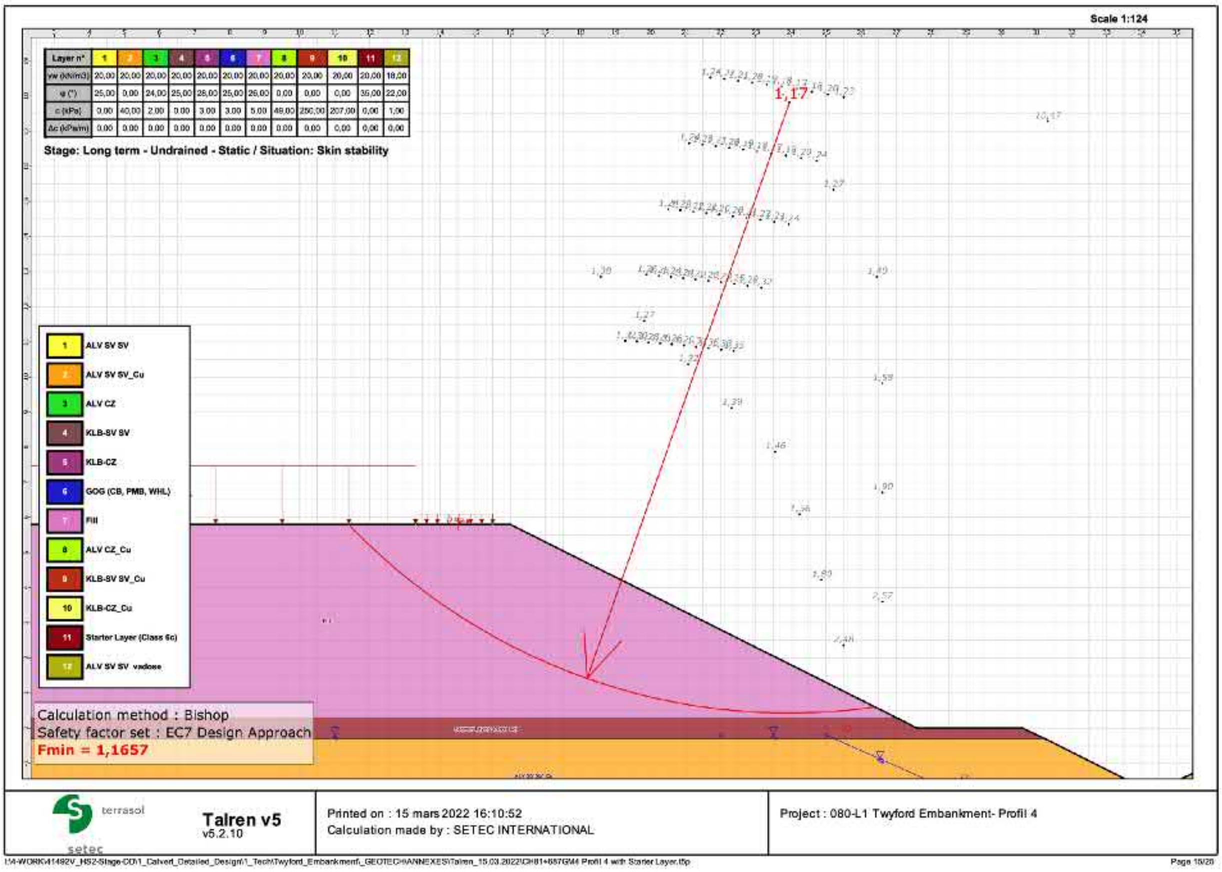
Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1657

Coordinates of the critical centre and radius of the critical circle : N°= 63; X0= 23,96; Y0= 17,82; R= 17,39



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	18,00
φ (°)	25,00	0,00	24,00	25,00	26,00	25,00	26,00	0,00	0,00	0,00	35,00	22,00
c (kPa)	0,00	40,00	2,00	0,00	3,00	3,00	5,00	48,00	250,00	207,00	0,00	1,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Long term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 26,000

Search type : Imposed passage point

Imposed passage point : X= 24,500; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV SV SV_Cu

Results

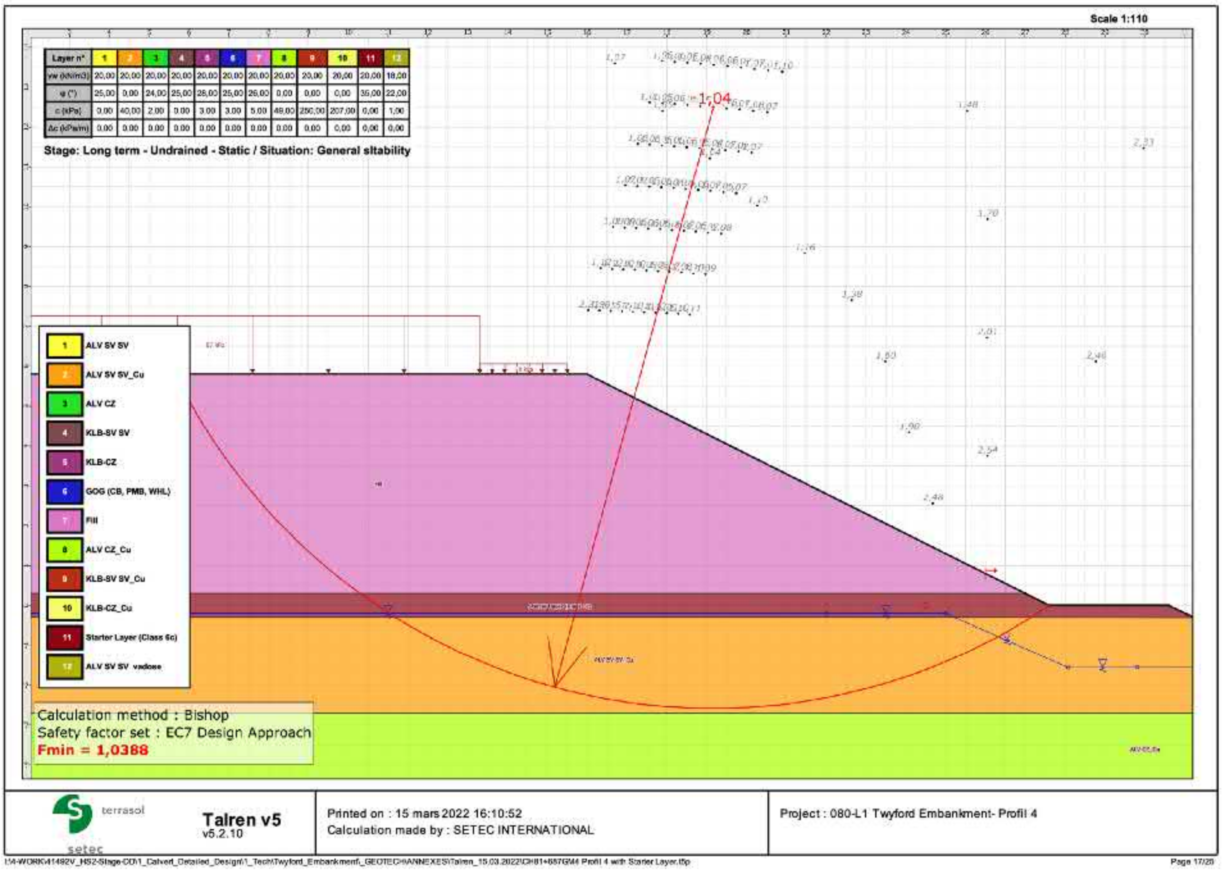
Minimum safety factor : 1,0388

Coordinates of the critical centre and radius of the critical circle : N°= 513; X0= 19,17; Y0= 12,50; R= 15,09

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 16:10:52
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 4

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+687GM4 Profil 4 with Starter Layer.t5p Page 16/25


Scale 1:110
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 18,00
φ (°) | 25,00 | 0,00 | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 0,00 | 0,00 | 0,00 | 35,00 | 22,00
c (kPa) | 0,00 | 40,00 | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 48,00 | 250,00 | 207,00 | 0,00 | 1,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Long term - Undrained - Static / Situation: General sltability
1 ALV SV SV
2 ALV SV SV_Cu
3 ALV CZ
4 KLB-SV SV
5 KLB-CZ
6 GOG (CB, PMB, WHL)
7 Fill
8 ALV CZ_Cu
9 KLB-SV SV_Cu
10 KLB-CZ_Cu
11 Starter Layer (Class 6c)
12 ALV SV SV vadose
1,04
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,0388
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:10:52
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 4
Page 17/20

Data of the situation 1

Stage name : Seismic + 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 9,000

Search type : Imposed passage point

Imposed passage point : X= 25,820; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

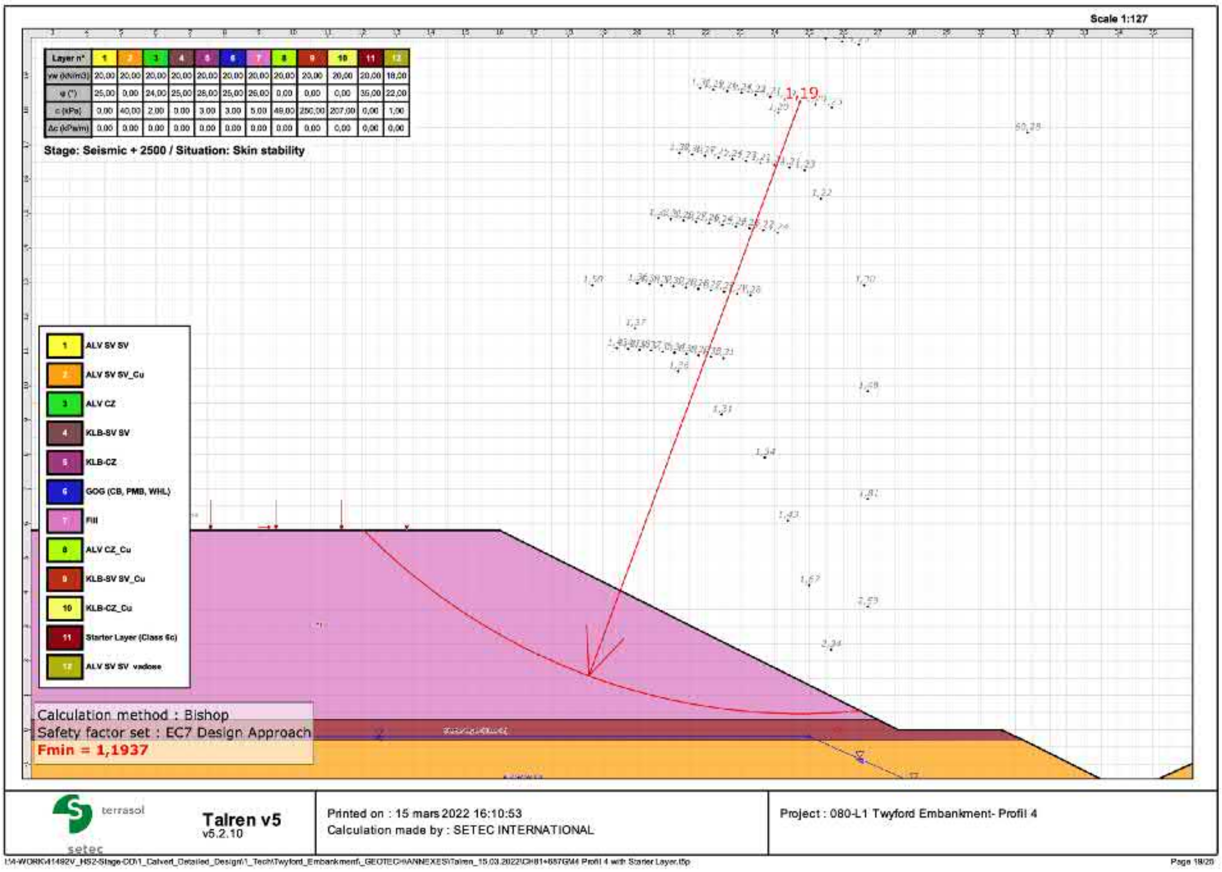
av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1937

Coordinates of the critical centre and radius of the critical circle : N°= 349; X0= 24,74; Y0= 18,25; R= 17,78



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	18,00
φ (°)	25,00	0,00	24,00	25,00	26,00	25,00	26,00	0,00	0,00	0,00	35,00	22,00
c (kPa)	0,00	40,00	2,00	0,00	3,00	3,00	5,00	49,00	250,00	207,00	0,00	1,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Seismic + 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 1,000

Search type : Imposed passage point

Imposed passage point : X= 30,255; Y= -1,000

Number of slices : 100

Seismic properties : Yes

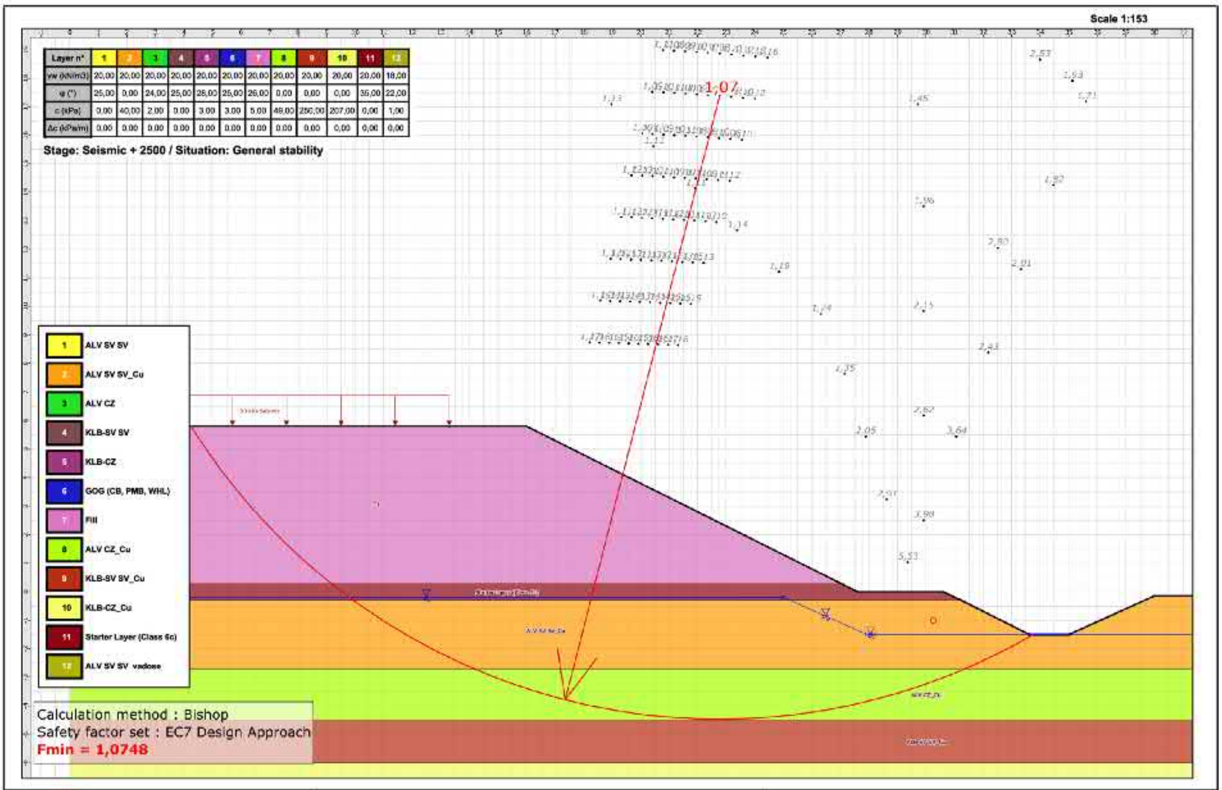
ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : 0,012

Results

Minimum safety factor : 1,0748

Coordinates of the critical centre and radius of the critical circle : N°= 946; X0= 22,77; Y0= 17,38; R= 21,84



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	18,00
φ (°)	25,00	0,00	24,00	25,00	26,00	25,00	26,00	0,00	0,00	0,00	35,00	22,00
c (kPa)	0,00	40,00	2,00	0,00	3,00	3,00	5,00	49,00	250,00	207,00	0,00	1,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

terrasol setec Talren v5 v5.2.10 | Printed on : 15 mars 2022 16:10:53 Calculation made by : SETEC INTERNATIONAL | Project : 080-L1 Twyford Embankment- Profil 4

I:\4-WORK\41492V_HS2-Stage-C0\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+687GM4 Profil 4 with Starter Layer.t5p Page 21/28

Data of the situation 1

Stage name : Seismic - 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 12,000

Search type : Imposed passage point

Imposed passage point : X= 25,603; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : -0,012

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1978

Coordinates of the critical centre and radius of the critical circle : N°= 391; X0= 24,86; Y0= 20,03; R= 19,54

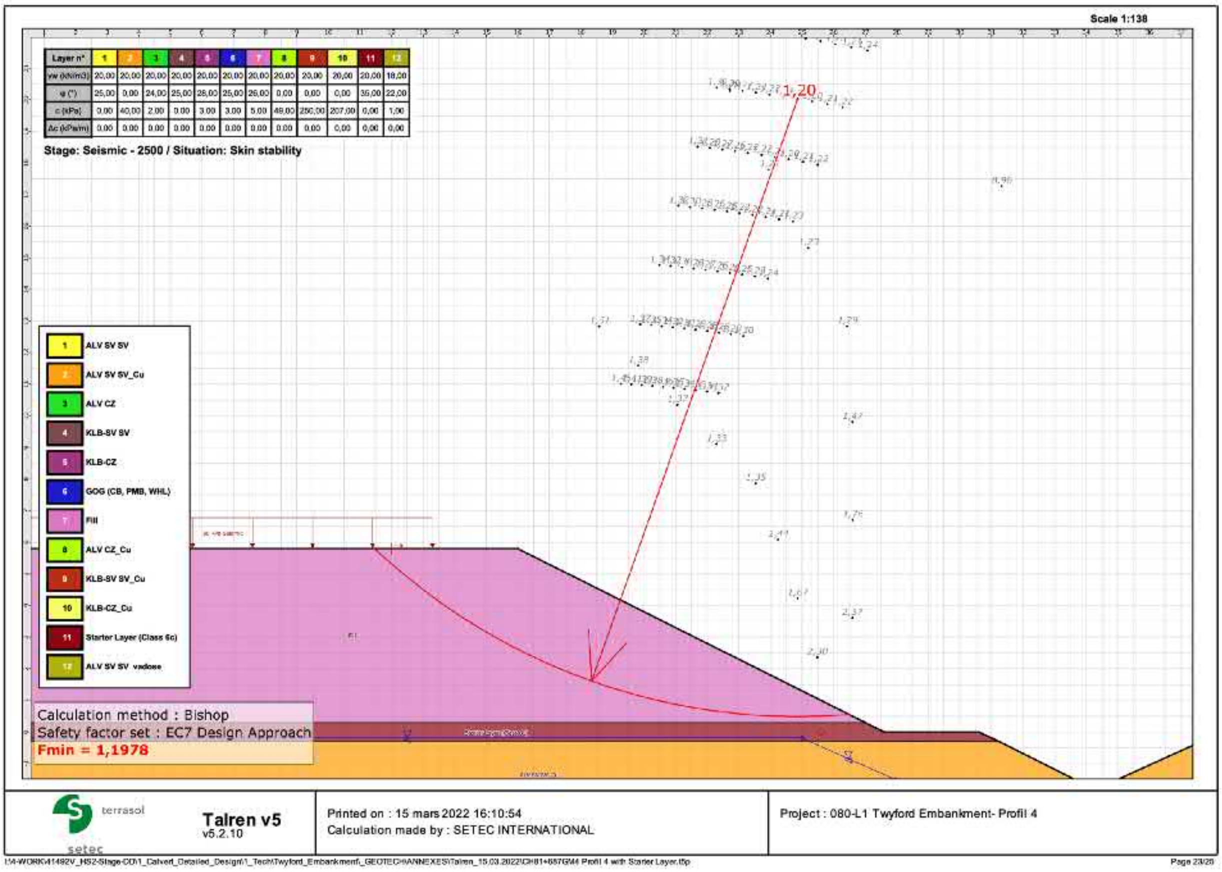
terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:10:53
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 4

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+687GM4 Profil 4 with Starter Layer.t5p

Page 22/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	18,00
φ (°)	25,00	0,00	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	35,00	22,00
c (kPa)	0,00	40,00	2,00	0,00	3,00	3,00	5,00	48,00	250,00	207,00	0,00	1,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Seismic - 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 9,000

Search type : Imposed passage point

Imposed passage point : X= 32,840; Y= -1,680

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

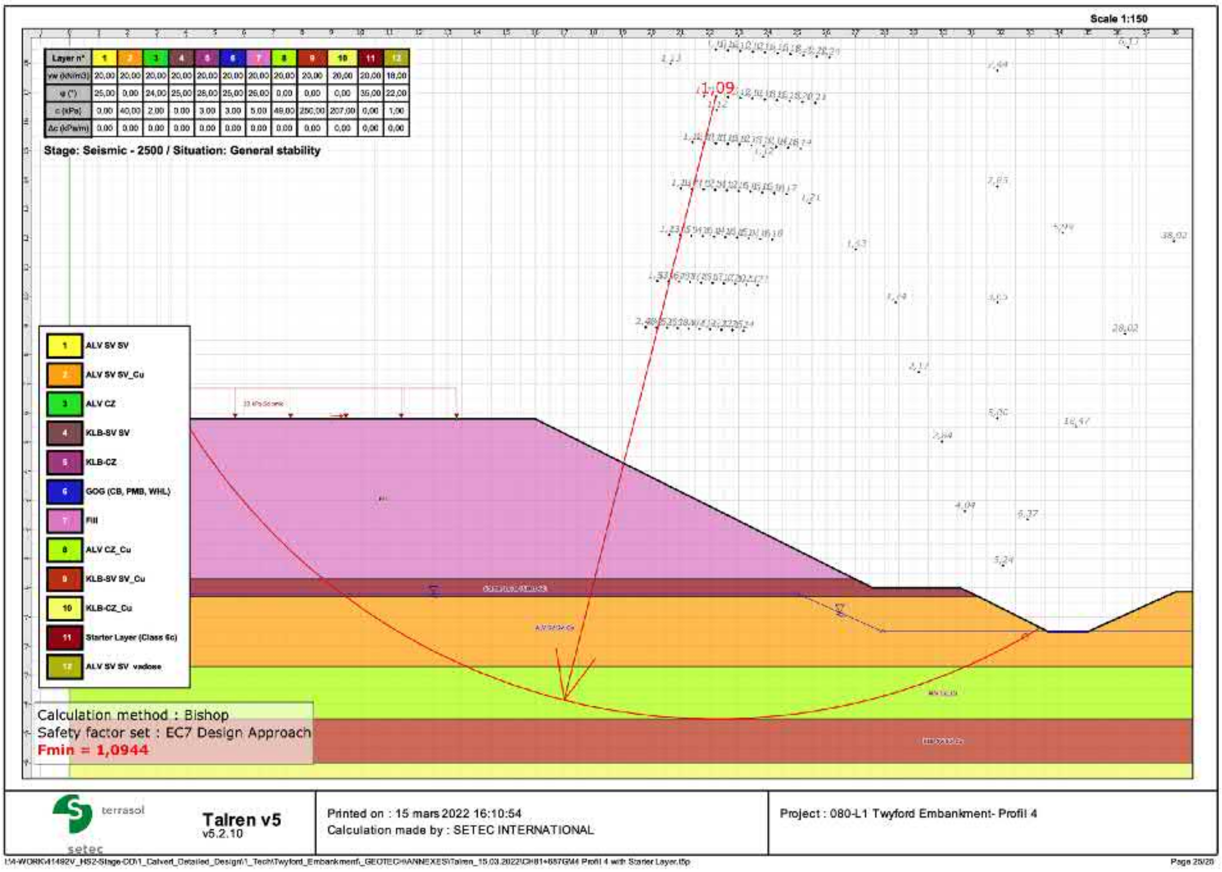
av/g coefficient (vertical acceleration) : -0,012

Passage conditions through soil layers : Must pass in in ALV SV SV_Cu

Results

Minimum safety factor : 1,0944

Coordinates of the critical centre and radius of the critical circle : N°= 1225; X0= 22,22; Y0= 16,87; R= 21,37


Scale 1:150
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 18,00
φ (°) | 25,00 | 0,00 | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 0,00 | 0,00 | 0,00 | 35,00 | 22,00
c (kPa) | 0,00 | 40,00 | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 49,00 | 250,00 | 207,00 | 0,00 | 1,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Seismic - 2500 / Situation: General stability
1,09
1 ALV SV SV
2 ALV SV SV_Cu
3 ALV CZ
4 KLB-SV SV
5 KLB-CZ
6 GOG (CB, PMB, WHL)
7 Fill
8 ALV CZ_Cu
9 KLB-SV SV_Cu
10 KLB-CZ_Cu
11 Starter Layer (Class 6c)
12 ALV SV SV vadose
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,0944
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:10:54
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 4

Project data

Project reference : HS2
Calculation title : 080-L1 Twyford Embankment- Profil 5
Location : H = 5.1m - Ch. 81+920 - Ground model 5
Comments : N/A
Units : kN, kPa, kN/m3
γw : 10.0

Soil layers

	Name	Colour	γ	φ	c	Δc	qs nails	pl	KsB	Anisotropy	Favorable	Specific safety factors
1	ALV SV SV		18,0	25,00	0,0	0,0	-	-	-	No	No	No
2	ALV CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No
3	KLB-SV SV		20,0	25,00	0,0	0,0	-	-	-	No	No	No
4	KLB-CZ		20,0	28,00	3,0	0,0	-	-	-	No	No	No
5	GOG (CB, PMB, WHL)		20,0	25,00	3,0	0,0	-	-	-	No	No	No
6	Fill		20,0	26,00	5,0	0,0	-	-	-	No	No	No
7	OXC- w		20,0	25,00	2,0	0,0	-	-	-	No	No	No
8	OXC-u1		20,0	28,00	5,0	0,0	-	-	-	No	No	No
9	ALV CZ_Cu		20,0	0,00	49,0	0,0	-	-	-	No	No	No
10	OXCw_cu		20,0	0,00	54,0	0,0	-	-	-	No	No	No
11	OXCu1_Cu		20,0	0,00	100,0	0,0	-	-	-	No	No	No
12	KLB-CZ_Cu		20,0	0,00	207,0	0,0	-	-	-	No	No	No
13	KLB-SV SV_Cu		20,0	0,00	250,0	0,0	-	-	-	No	No	No
14	Starter Layer (Class 6c)		20,0	35,00	0,0	0,0	-	-	-	No	No	No

Soil layers (cont.)

	Name	Colour	Γγ	Γc	Γtan(φ)	Cohesion type	Curve
1	ALV SV SV		-	-	-	Effective	Linear
2	ALV CZ		-	-	-	Effective	Linear
3	KLB-SV SV		-	-	-	Effective	Linear
4	KLB-CZ		-	-	-	Effective	Linear
5	GOG (CB, PMB, WHL)		-	-	-	Effective	Linear
6	Fill		-	-	-	Effective	Linear
7	OXC- w		-	-	-	Effective	Linear
8	OXC-u1		-	-	-	Effective	Linear
9	ALV CZ_Cu		-	-	-	Undrained	Linear
10	OXCw_cu		-	-	-	Undrained	Linear
11	OXCu1_Cu		-	-	-	Undrained	Linear
12	KLB-CZ_Cu		-	-	-	Undrained	Linear
13	KLB-SV SV_Cu		-	-	-	Undrained	Linear
14	Starter Layer (Class 6c)		-	-	-	Effective	Linear

Points

	X	Y		X	Y		X	Y		X	Y		X	Y		X	Y
2	60,000	0,000	3	0,000	-4,000	4	60,000	-4,000	11	0,000	5,100	13	32,200	0,000	32	60,000	-2,000
43	22,000	5,100	50	0,000	-2,000	55	0,000	-0,300	64	0,000	-5,700	65	60,000	-5,700	68	0,000	-9,200
69	60,000	-9,200	70	0,000	-10,600	71	60,000	-10,600	72	60,000	-0,200	74	0,000	0,300	76	60,000	-0,300
77	31,600	0,300	79	32,703	-0,300												

Segments

	Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2
51	4	3	107	32	50	132	65	64	142	2	13	144	68	69	145	71	70	147	43	11
150	74	77	151	77	43	152	77	13	157	79	13	158	79	55						

Distributed loads

	Name	X left	Y left	q left	X right	Y right	q right	Ang/horizontal
1	10 kPa	19,343	5,100	10,0	21,500	5,100	10,0	90,00
2	57 kPa	0,000	5,100	57,0	19,344	5,100	57,0	90,00
3	20 kPa	0,000	5,100	20,0	21,500	5,100	20,0	90,00
4	30 kPa Seismic	0,000	5,100	30,0	19,344	5,100	30,0	90,00

terrasol setec
Talren v5
v5.2.10

Printed on : 15 mars 2022 16:21:45
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+920 GM5 Profil 5 with starter Layer.t5p Page 1/25

Data of the situation 1

Stage name : Short term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 15,500

Search type : Imposed passage point

Imposed passage point : X= 32,102; Y= -0,145

Number of slices : 100

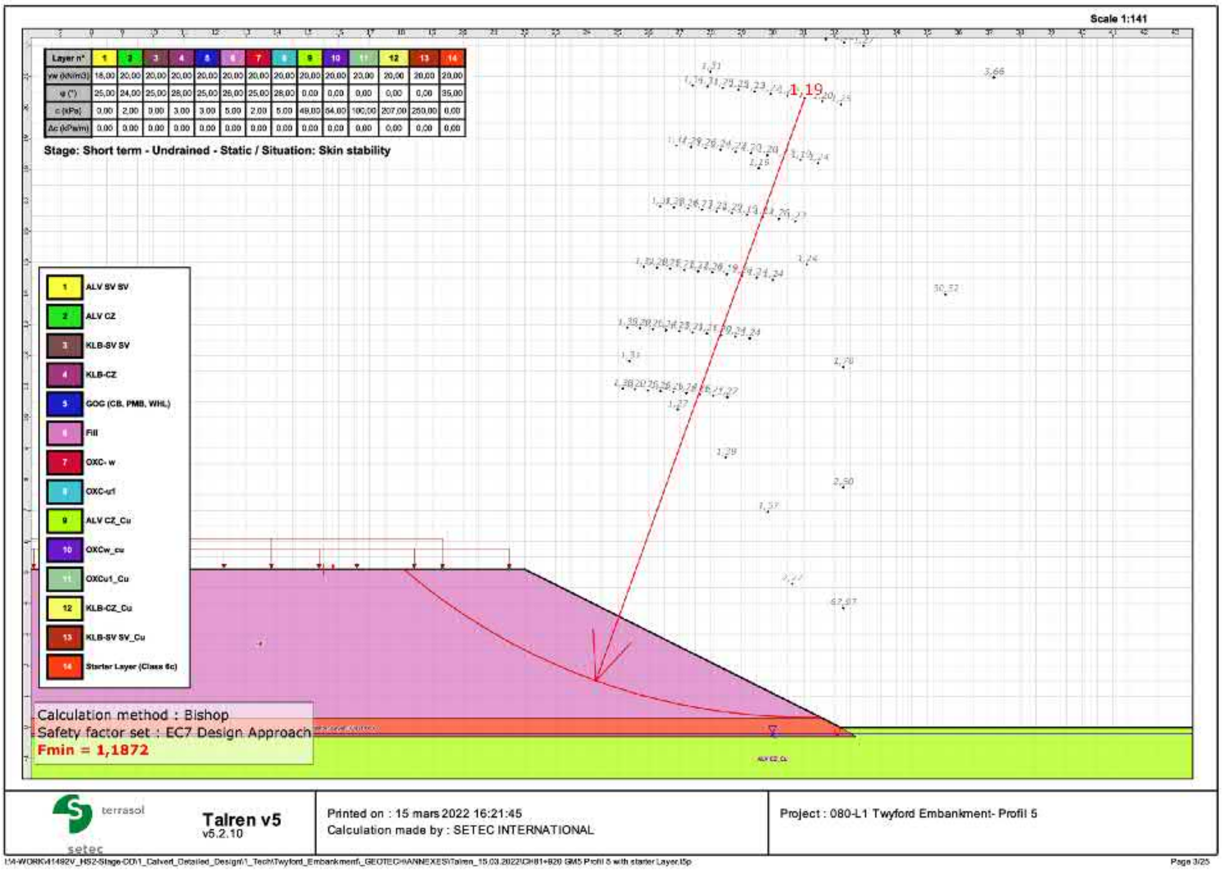
Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1872

Coordinates of the critical centre and radius of the critical circle : N°= 429; X0= 31,04; Y0= 20,30; R= 19,96



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14
γw (kN/m3)	18,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	24,00	25,00	28,00	25,00	26,00	25,00	28,00	0,00	0,00	0,00	0,00	0,00	35,00
c (kPa)	0,00	2,00	0,00	3,00	3,00	5,00	2,00	5,00	49,00	64,00	100,00	207,00	250,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Short term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 8,306

Search type : Imposed passage point

Imposed passage point : X= 32,500; Y= -0,265

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,3060

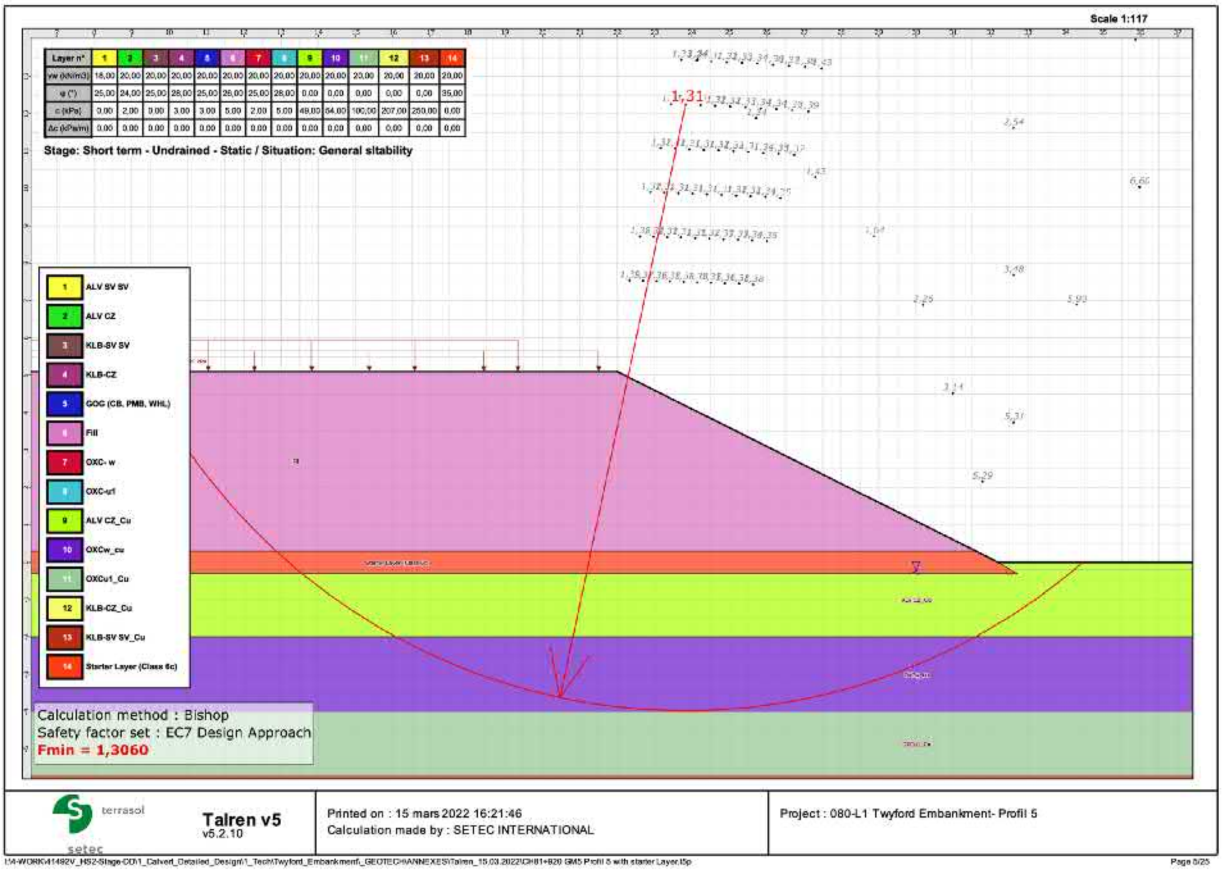
Coordinates of the critical centre and radius of the critical circle : N°= 976; X0= 23,83; Y0= 12,24; R= 16,21

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:21:46
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+920 GM5 Profil 5 with starter Layer.t5p


Scale 1:117
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14
γw (kN/m3) | 18,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 25,00 | 28,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 35,00
c (kPa) | 0,00 | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 2,00 | 5,00 | 49,00 | 54,00 | 100,00 | 207,00 | 250,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Short term - Undrained - Static / Situation: General sltability
1,31
1 ALV SV SV
2 ALV CZ
3 KLB-SV SV
4 KLB-CZ
5 GOG (CB, PMB, WHL)
6 Fill
7 OXC- w
8 OXC-u1
9 ALV CZ_Cu
10 OXCw_cu
11 OXCu1_Cu
12 KLB-CZ_Cu
13 KLB-SV SV_Cu
14 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3060
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:21:46
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5

Data of the situation 1

Stage name : Short term - Drained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 18,000

Search type : Imposed passage point

Imposed passage point : X= 31,000; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

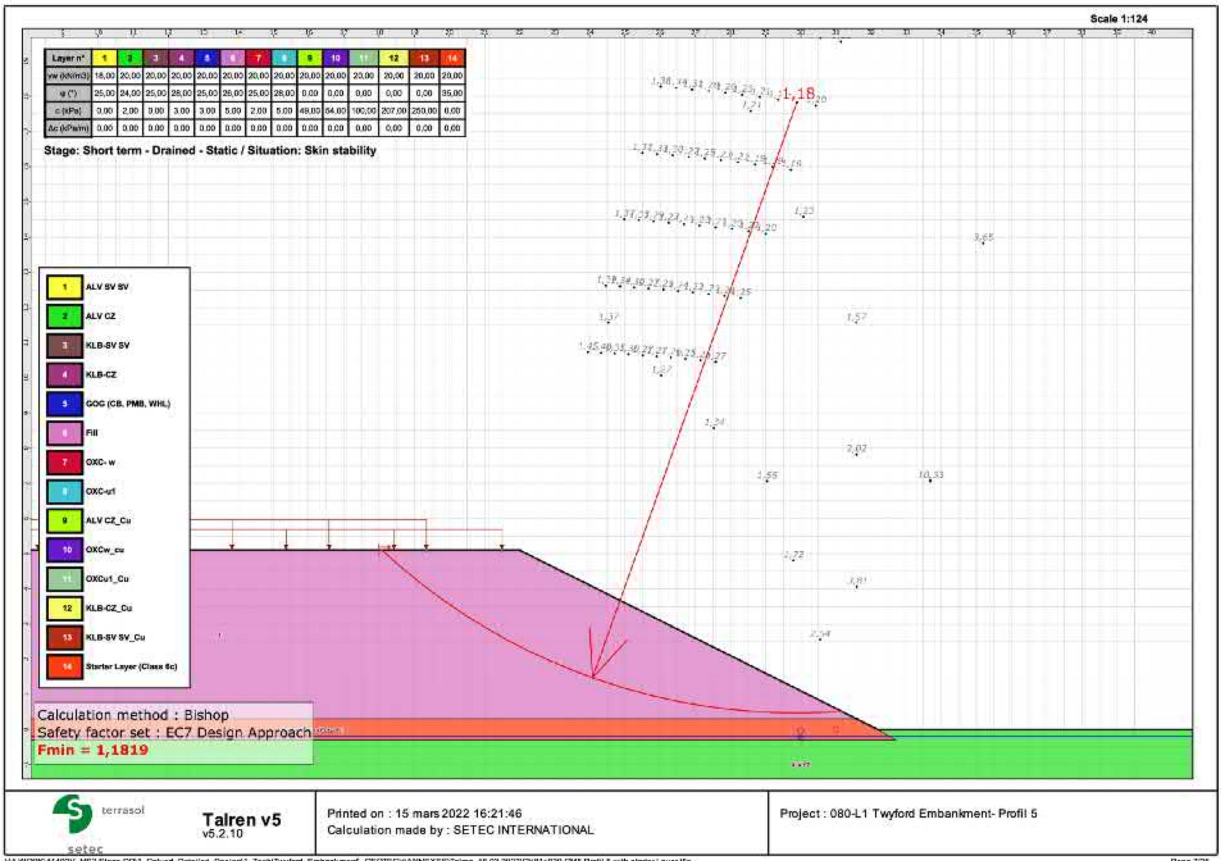
Minimum safety factor : 1,1819

Coordinates of the critical centre and radius of the critical circle : N°= 403; X0= 29,89; Y0= 17,83; R= 17,36

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 16:21:46
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+920 GM5 Profil 5 with starter Layer.t5p Page 6/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14
γw (kN/m3)	18,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	24,00	25,00	28,00	25,00	26,00	25,00	28,00	0,00	0,00	0,00	0,00	0,00	35,00
c (kPa)	0,00	2,00	0,00	3,00	3,00	5,00	2,00	5,00	49,00	54,00	100,00	207,00	250,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Short term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 31,500

Search type : Imposed passage point

Imposed passage point : X= 24,000; Y= 0,277

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ

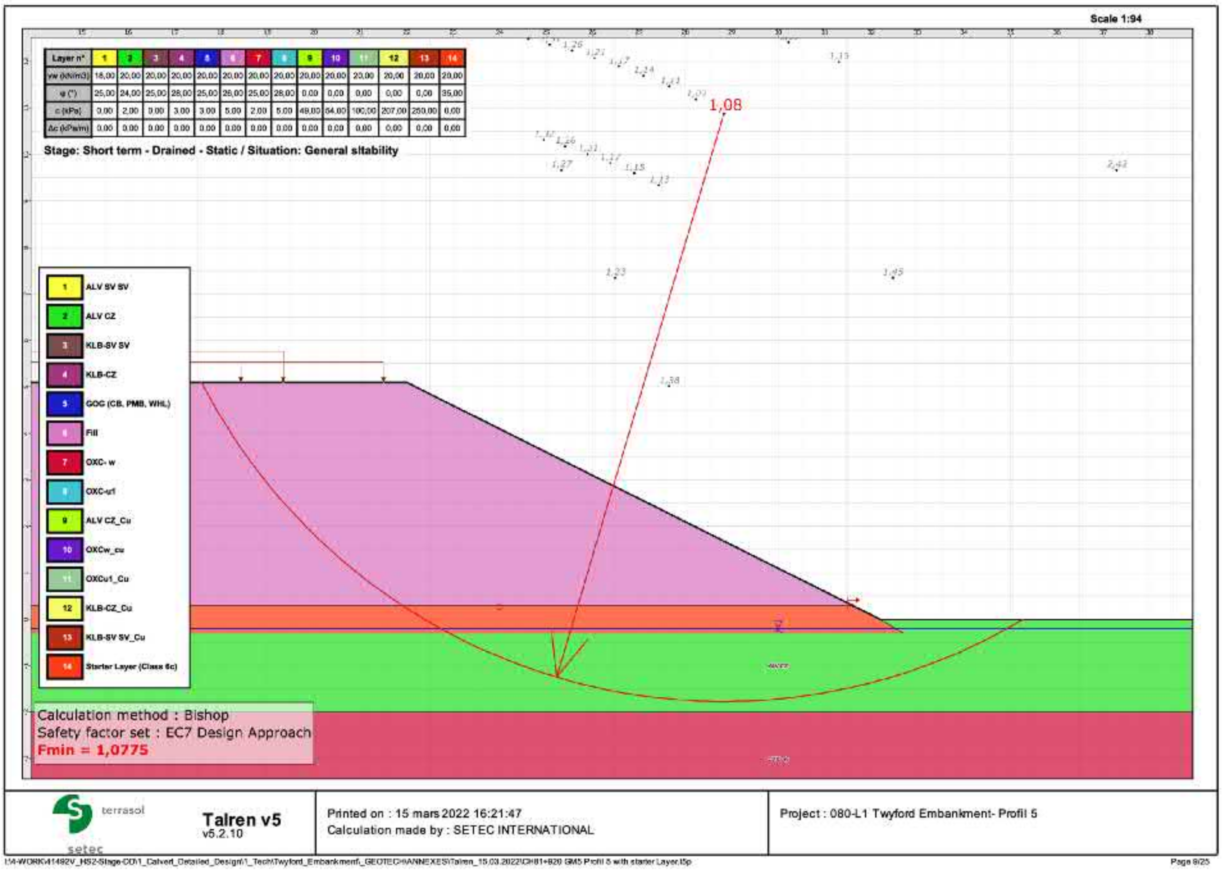
Results

Minimum safety factor : 1,0775

Coordinates of the critical centre and radius of the critical circle : N°= 219; X0= 28,83; Y0= 10,88; R= 12,65

terrasol setec | **Talren v5** v5.2.10 | Printed on : 15 mars 2022 16:21:46
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+920 GM5 Profil 5 with starter Layer.t5p Page 8/25


Scale 1:94
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14
γw (kN/m3) | 18,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 25,00 | 28,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 35,00
c (kPa) | 0,00 | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 2,00 | 5,00 | 49,00 | 54,00 | 100,00 | 207,00 | 250,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Short term - Drained - Static / Situation: General sltability
1,08
1 ALV SV SV
2 ALV CZ
3 KLB-SV SV
4 KLB-CZ
5 GOG (CB, PMB, WHL)
6 Fill
7 OXC- w
8 OXC-u1
9 ALV CZ_Cu
10 OXCw_cu
11 OXCu1_Cu
12 KLB-CZ_Cu
13 KLB-SV SV_Cu
14 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,0775
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:21:47
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5

Data of the situation 1

Stage name : Long term - Drained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 18,000

Search type : Imposed passage point

Imposed passage point : X= 31,000; Y= 0,000

Number of slices : 100

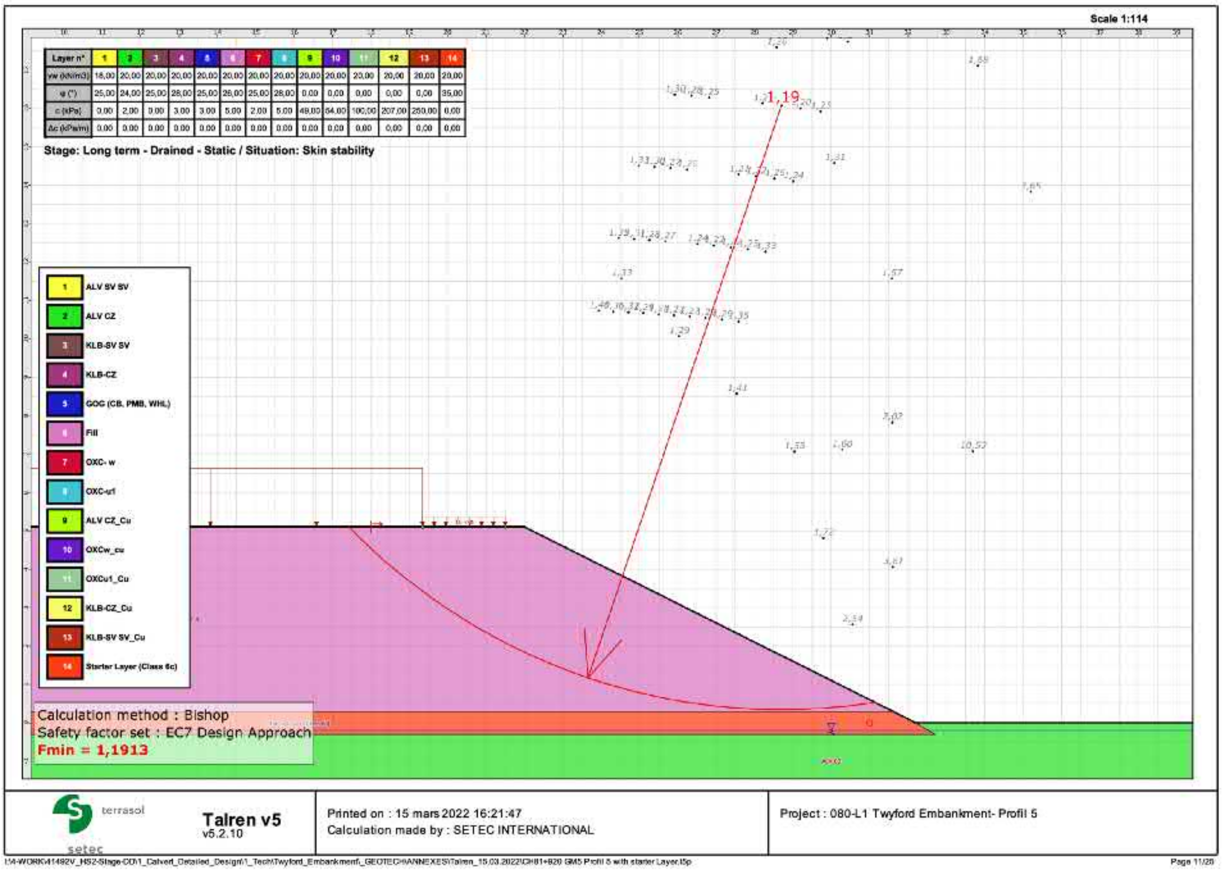
Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1913

Coordinates of the critical centre and radius of the critical circle : N°= 436; X0= 28,70; Y0= 16,07; R= 15,73


Scale 1:114
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14
γw (kN/m3) | 18,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 25,00 | 28,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 35,00
c (kPa) | 0,00 | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 2,00 | 5,00 | 49,00 | 54,00 | 100,00 | 207,00 | 250,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Long term - Drained - Static / Situation: Skin stability
1,19
1 ALV SV SV
2 ALV CZ
3 KLB-SV SV
4 KLB-CZ
5 GOG (CB, PMB, WHL)
6 Fill
7 OXC- w
8 OXC-u1
9 ALV CZ_Cu
10 OXCw_cu
11 OXCu1_Cu
12 KLB-CZ_Cu
13 KLB-SV SV_Cu
14 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1913
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:21:47
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5
Page 11/20

Data of the situation 2

Stage name : Long term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 31,500

Search type : Imposed passage point

Imposed passage point : X= 24,000; Y= 0,277

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ

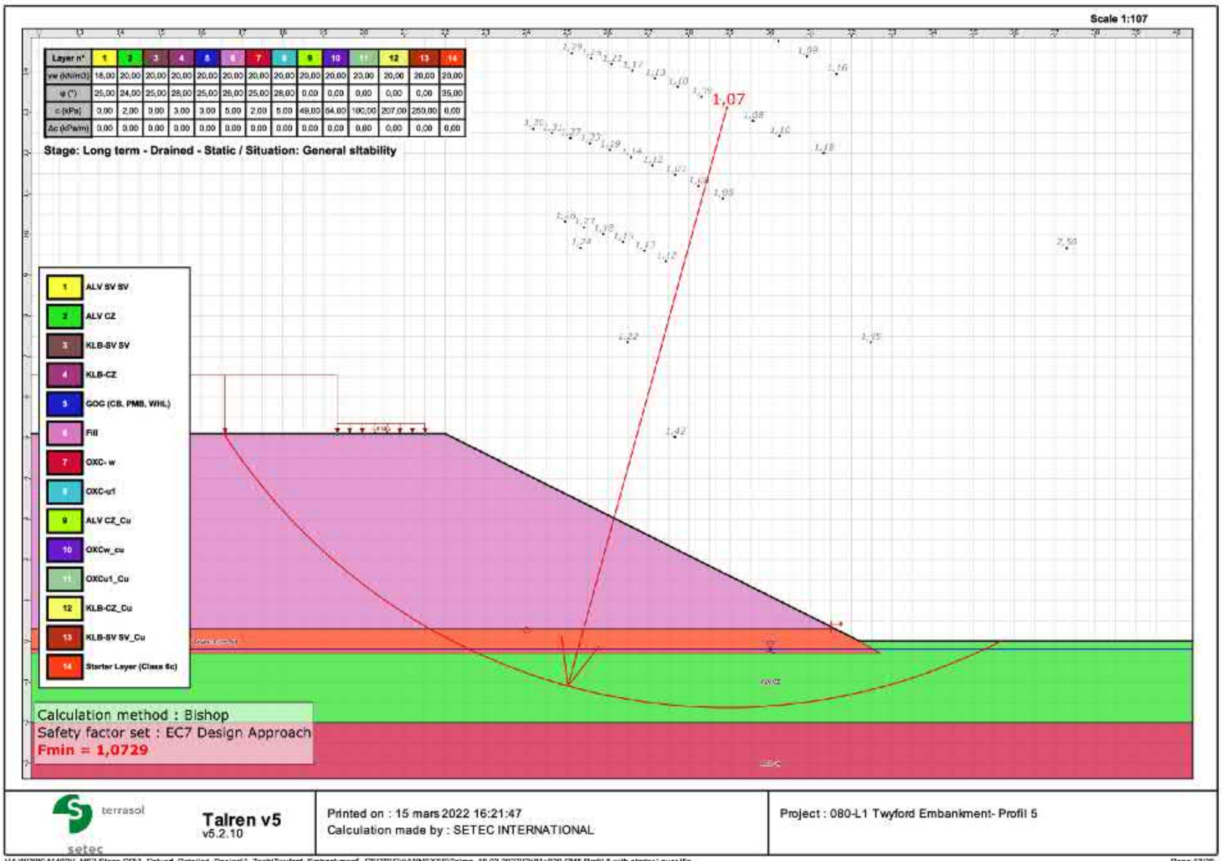
Results

Minimum safety factor : 1,0729

Coordinates of the critical centre and radius of the critical circle : N°= 344; X0= 28,93; Y0= 13,11; R= 14,74

terrasol setec | Talren v5 v5.2.10 | Printed on : 15 mars 2022 16:21:47
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+920 GM5 Profil 5 with starter Layer.t5p Page 12/25


Scale 1:107
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14
γw (kN/m3) 18,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 25,00 24,00 25,00 28,00 25,00 26,00 25,00 28,00 0,00 0,00 0,00 0,00 0,00 35,00
c (kPa) 0,00 2,00 0,00 3,00 3,00 5,00 2,00 5,00 49,00 54,00 100,00 207,00 250,00 0,00
Δc (kPa/m) 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
Stage: Long term - Drained - Static / Situation: General sltability
1,07
1 ALV SV SV
2 ALV CZ
3 KLB-SV SV
4 KLB-CZ
5 GOG (CB, PMB, WHL)
6 Fill
7 OXC- w
8 OXC-u1
9 ALV CZ_Cu
10 OXCw_cu
11 OXCu1_Cu
12 KLB-CZ_Cu
13 KLB-SV SV_Cu
14 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,0729
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:21:47
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5
Page 13/20

Data of the situation 1

Stage name : Long term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 15,500

Search type : Imposed passage point

Imposed passage point : X= 31,500; Y= 0,000

Number of slices : 100

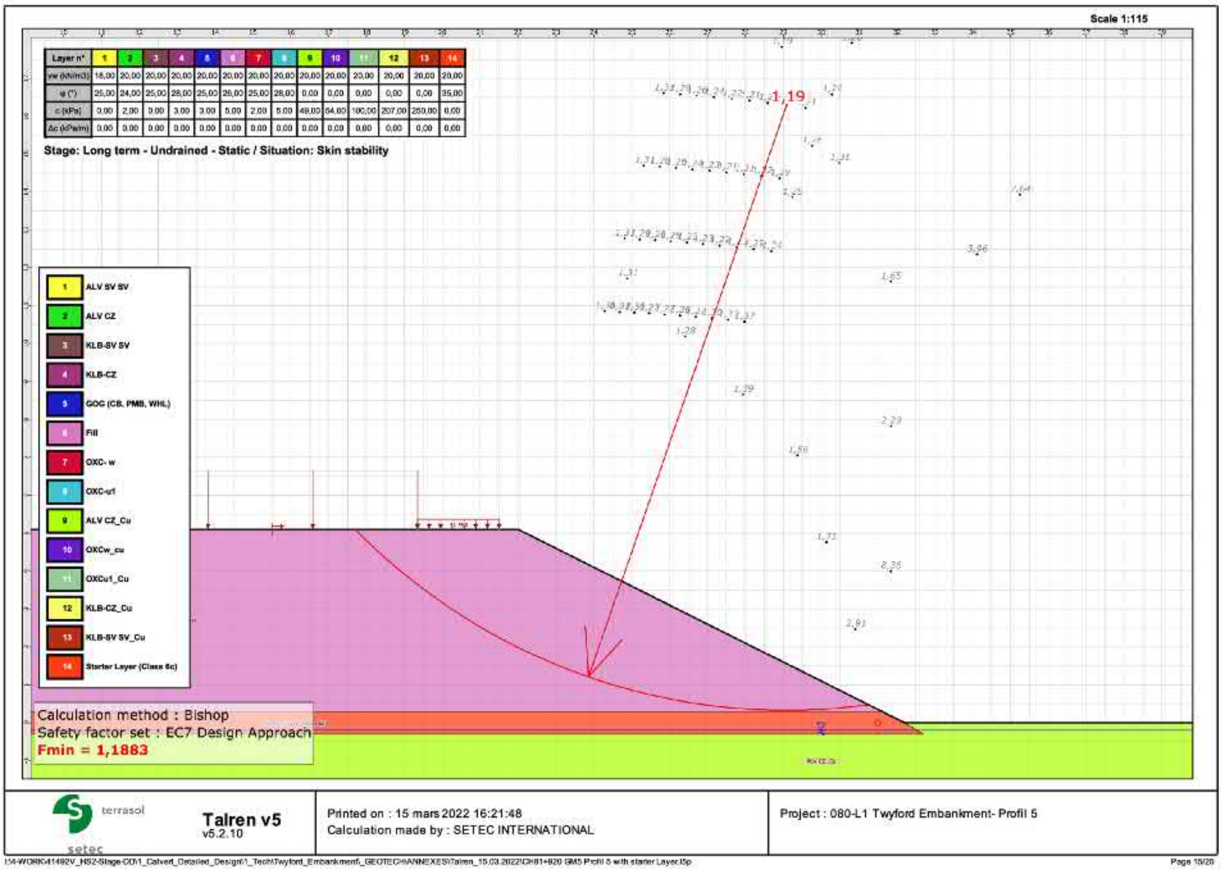
Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1883

Coordinates of the critical centre and radius of the critical circle : N°= 429; X0= 29,09; Y0= 16,29; R= 15,96


Scale 1:115
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14
γw (kN/m3) | 18,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 25,00 | 28,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 35,00
c (kPa) | 0,00 | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 2,00 | 5,00 | 49,00 | 54,00 | 100,00 | 207,00 | 250,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Long term - Undrained - Static / Situation: Skin stability
1 ALV SV SV
2 ALV CZ
3 KLB-SV SV
4 KLB-CZ
5 GOG (CB, PMB, WHL)
6 Fill
7 OXC- w
8 OXC-u1
9 ALV CZ_Cu
10 OXCw_cu
11 OXCu1_Cu
12 KLB-CZ_Cu
13 KLB-SV SV_Cu
14 Starter Layer (Class 6c)
1,19
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1883
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:21:48
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5

Data of the situation 2

Stage name : Long term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 15,500

Search type : Imposed passage point

Imposed passage point : X= 31,315; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,2553

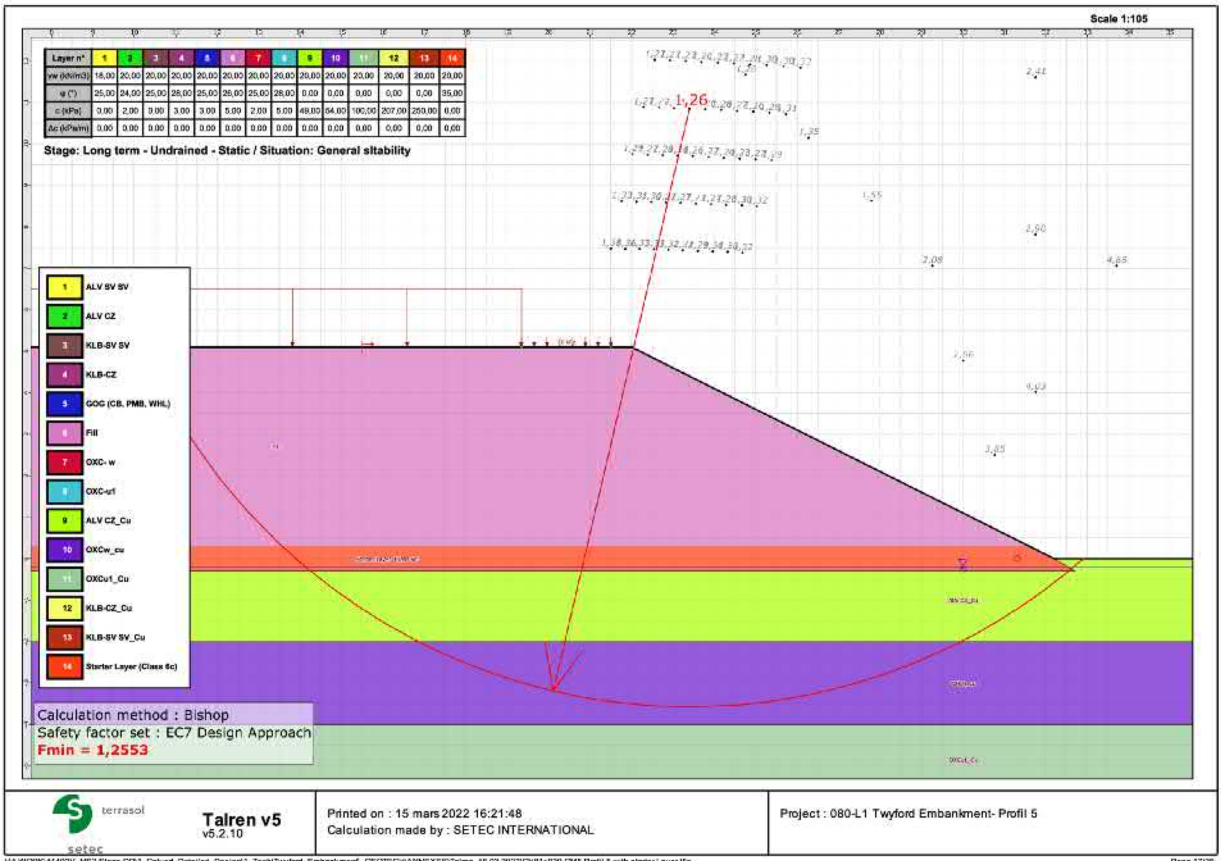
Coordinates of the critical centre and radius of the critical circle : N°= 739; X0= 23,40; Y0= 10,85; R= 14,42

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:21:48
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+920 GM5 Profil 5 with starter Layer.t5p Page 16/25


Scale 1:105
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14
γw (kN/m3) | 18,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 25,00 | 28,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 35,00
c (kPa) | 0,00 | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 2,00 | 5,00 | 49,00 | 54,00 | 100,00 | 207,00 | 250,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Long term - Undrained - Static / Situation: General sltability
1,26
1 ALV SV SV
2 ALV CZ
3 KLB-SV SV
4 KLB-CZ
5 GOG (CB, PMB, WHL)
6 Fill
7 OXC- w
8 OXC-u1
9 ALV CZ_Cu
10 OXCw_cu
11 OXCu1_Cu
12 KLB-CZ_Cu
13 KLB-SV SV_Cu
14 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,2553
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:21:48
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5
Page 17/20

Data of the situation 1

Stage name : Seismic + 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 31,600

Search type : Imposed passage point

Imposed passage point : X= 28,789; Y= 0,000

Number of slices : 100

Seismic properties : Yes

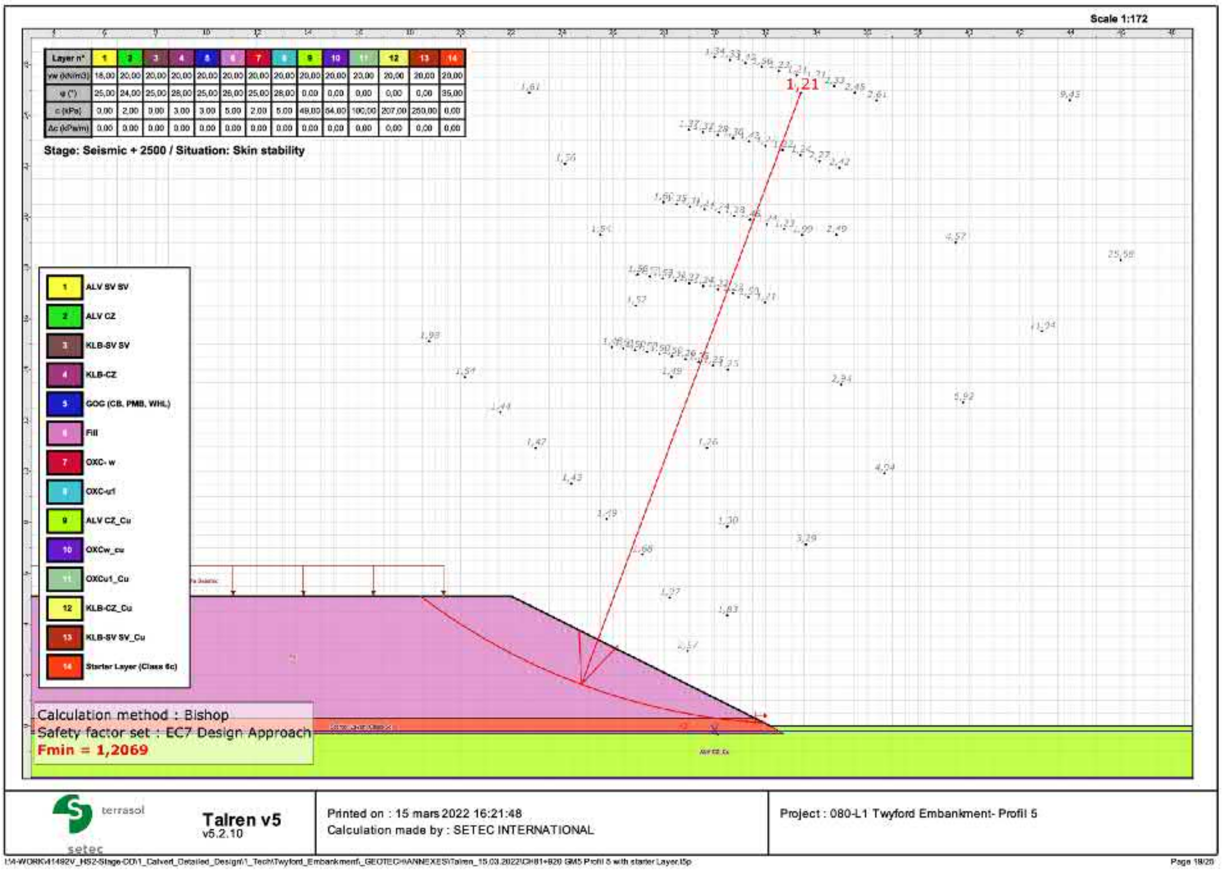
ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : 0,012

Results

Minimum safety factor : 1,2069

Coordinates of the critical centre and radius of the critical circle : N°= 118; X0= 33,39; Y0= 24,89; R= 24,81



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14
γw (kN/m3)	18,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	24,00	25,00	28,00	25,00	26,00	25,00	28,00	0,00	0,00	0,00	0,00	0,00	35,00
c (kPa)	0,00	2,00	0,00	3,00	3,00	5,00	2,00	5,00	49,00	54,00	100,00	207,00	250,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Seismic + 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 31,500

Search type : Imposed passage point

Imposed passage point : X= 21,112; Y= 2,364

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

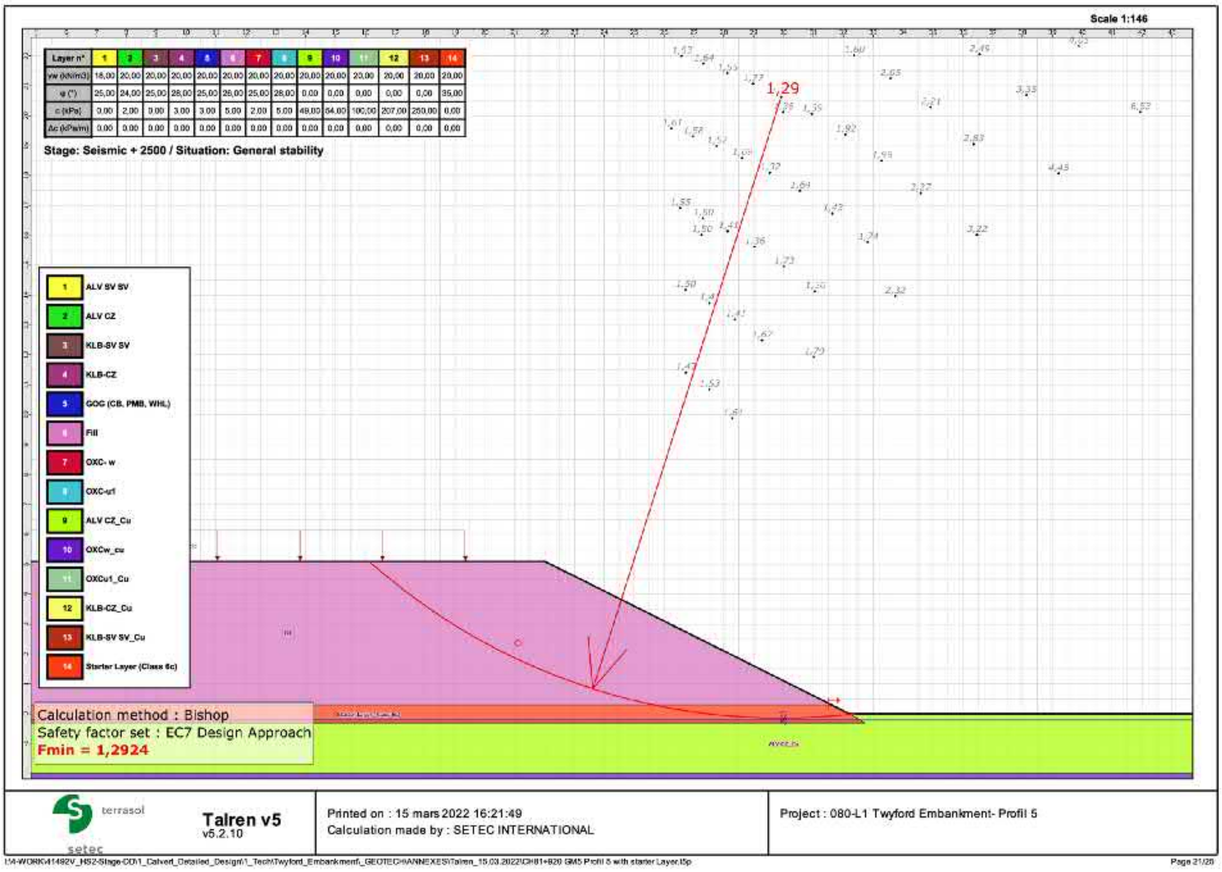
av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,2924

Coordinates of the critical centre and radius of the critical circle : N°= 411; X0= 29,92; Y0= 20,62; R= 20,76



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14
γw (kN/m3)	18,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	24,00	25,00	28,00	25,00	26,00	25,00	28,00	0,00	0,00	0,00	0,00	0,00	35,00
c (kPa)	0,00	2,00	0,00	3,00	3,00	5,00	2,00	5,00	49,00	64,00	100,00	207,00	250,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Seismic - 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 31,332

Search type : Imposed passage point

Imposed passage point : X= 29,113; Y= 0,166

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : -0,012

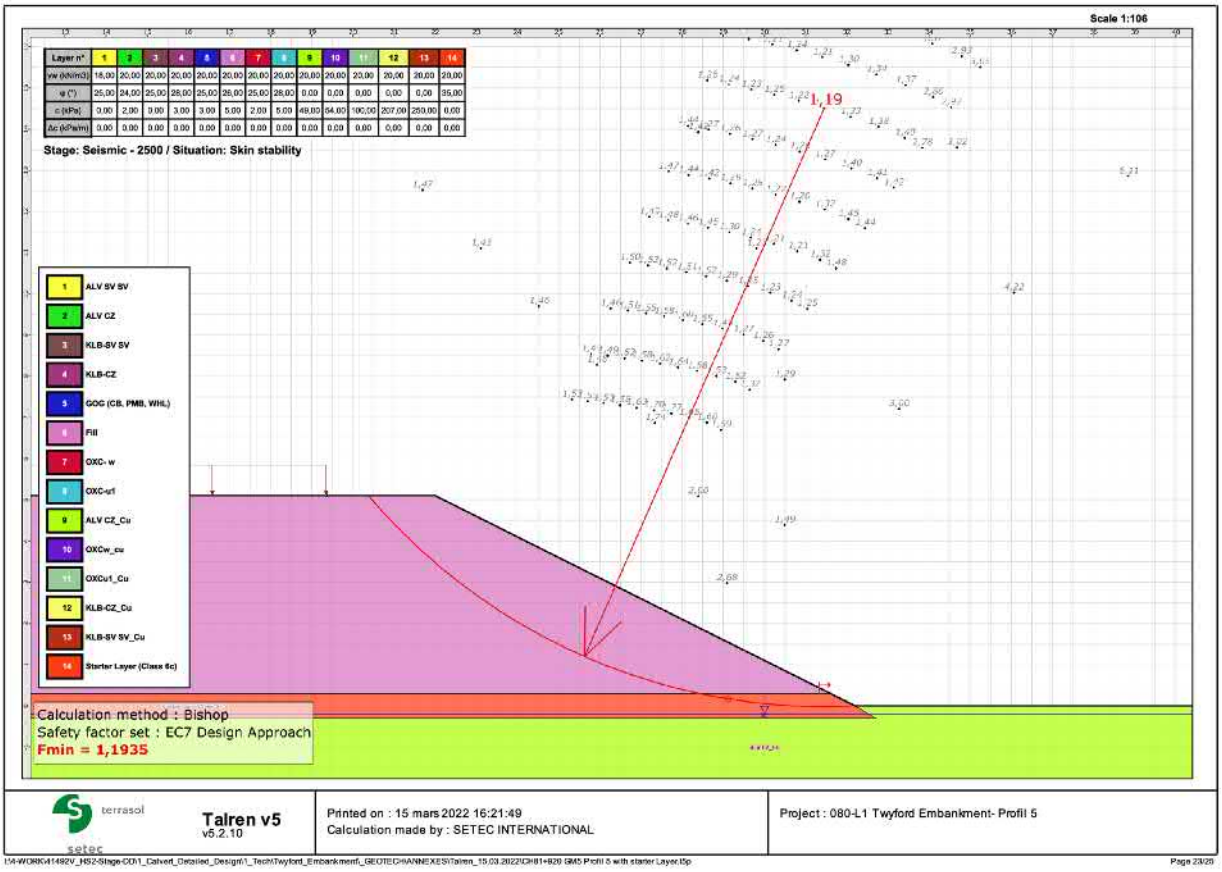
Results

Minimum safety factor : 1,1935

Coordinates of the critical centre and radius of the critical circle : N°= 526; X0= 31,45; Y0= 14,51; R= 14,53

terrasol setec | **Talren v5** v5.2.10 | Printed on : 15 mars 2022 16:21:49
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+920 GM5 Profil 5 with starter Layer.t5p Page 22/25


Scale 1:106
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14
γw (kN/m3) | 18,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 24,00 | 25,00 | 28,00 | 25,00 | 26,00 | 25,00 | 28,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 35,00
c (kPa) | 0,00 | 2,00 | 0,00 | 3,00 | 3,00 | 5,00 | 2,00 | 5,00 | 49,00 | 54,00 | 100,00 | 207,00 | 250,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Seismic - 2500 / Situation: Skin stability
1 ALV SV SV
2 ALV CZ
3 KLB-SV SV
4 KLB-CZ
5 GOG (CB, PMB, WHL)
6 Fill
7 OXC- w
8 OXC-u1
9 ALV CZ_Cu
10 OXCw_cu
11 OXCu1_Cu
12 KLB-CZ_Cu
13 KLB-SV SV_Cu
14 Starter Layer (Class 6c)
1,19
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1935
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:21:49
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5
Page 23/28

Data of the situation 2

Stage name : Seismic - 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 31,600

Search type : Imposed passage point

Imposed passage point : X= 21,500; Y= 3,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : -0,012

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

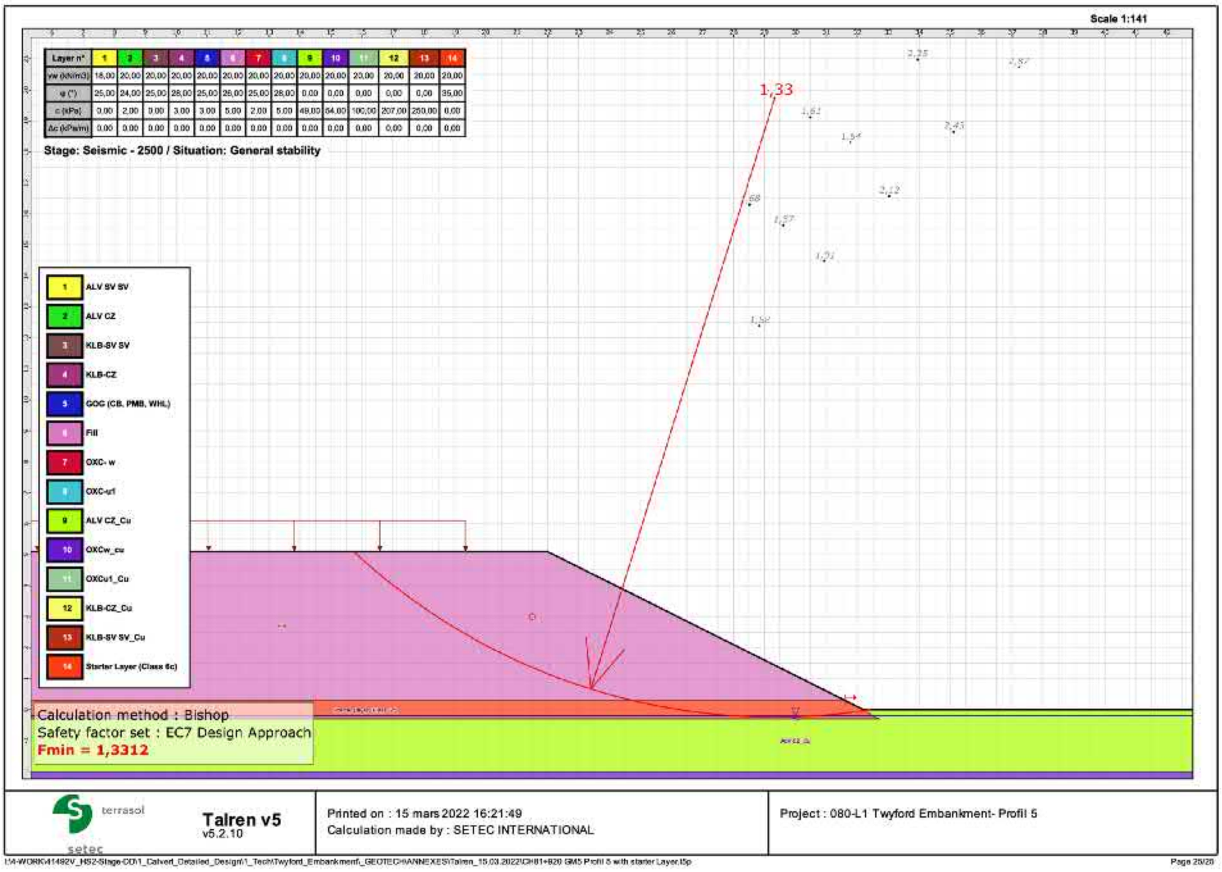
Minimum safety factor : 1,3312

Coordinates of the critical centre and radius of the critical circle : N°= 164; X0= 29,33; Y0= 19,73; R= 19,97

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:21:49
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 5



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14
γw (kN/m3)	18,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	24,00	25,00	28,00	25,00	26,00	25,00	28,00	0,00	0,00	0,00	0,00	0,00	35,00
c (kPa)	0,00	2,00	0,00	3,00	3,00	5,00	2,00	5,00	48,00	64,00	100,00	207,00	250,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Project data

Project reference : HS2

Calculation title : 080-L1 Twyford Embankment- Profil 6

Location : H = 4.3m - Ch. 82+100 - Ground model 6

Comments : N/A

Units : kN, kPa, kN/m3

γw : 10.0

Soil layers

	Name	Colour	γ	φ	c	Δc	qs nails	pl	KsB	Anisotropy	Favorable	Specific safety factors
1	KLB-SV SV		20,0	25,00	0,0	0,0	-	-	-	No	No	No
2	KLB-CZ		20,0	28,00	3,0	0,0	-	-	-	No	No	No
3	GOG (CB, PMB, WHL)		20,0	25,00	3,0	0,0	-	-	-	No	No	No
4	Fill		20,0	26,00	5,0	0,0	-	-	-	No	No	No
5	KLB-SV SV_Cu		20,0	0,00	250,0	0,0	-	-	-	No	No	No
6	KLB-CZ_Cu		20,0	0,00	207,0	0,0	-	-	-	No	No	No
7	Starter Layer (Class 6c)		20,0	35,00	0,0	0,0	-	-	-	No	No	No
8	OXC- w		20,0	25,00	2,0	0,0	-	-	-	No	No	No
9	OXC-u1		20,0	28,00	5,0	0,0	-	-	-	No	No	No
10	OXCw_Cu		20,0	0,00	54,0	0,0	-	-	-	No	No	No
11	OXCu1_Cu		19,0	0,00	100,0	0,0	-	-	-	No	No	No
12	RTD CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No
13	RTD CZ_Cu		20,0	0,00	80,0	0,0	-	-	-	No	No	No
14	RTD SV SV		20,0	27,00	0,0	0,0	-	-	-	No	No	No
15	RTD SV SV_Cu		20,0	0,00	108,0	0,0	-	-	-	No	No	No
16	OXC u2		20,0	28,00	5,0	0,0	-	-	-	No	No	No
17	OXC u2_Cu		20,0	0,00	150,0	0,0	-	-	-	No	No	No
18	ALV CZ_Cu		20,0	0,00	49,0	0,0	-	-	-	No	No	No
19	ALV CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No

Soil layers (cont.)

	Name	Colour	Γγ	Γc	Γtan(φ)	Cohesion type	Curve
1	KLB-SV SV		-	-	-	Effective	Linear
2	KLB-CZ		-	-	-	Effective	Linear
3	GOG (CB, PMB, WHL)		-	-	-	Effective	Linear
4	Fill		-	-	-	Effective	Linear
5	KLB-SV SV_Cu		-	-	-	Undrained	Linear
6	KLB-CZ_Cu		-	-	-	Undrained	Linear
7	Starter Layer (Class 6c)		-	-	-	Effective	Linear
8	OXC- w		-	-	-	Effective	Linear
9	OXC-u1		-	-	-	Effective	Linear
10	OXCw_Cu		-	-	-	Undrained	Linear
11	OXCu1_Cu		-	-	-	Undrained	Linear
12	RTD CZ		-	-	-	Effective	Linear
13	RTD CZ_Cu		-	-	-	Undrained	Linear
14	RTD SV SV		-	-	-	Effective	Linear
15	RTD SV SV_Cu		-	-	-	Undrained	Linear
16	OXC u2		-	-	-	Effective	Linear
17	OXC u2_Cu		-	-	-	Undrained	Linear
18	ALV CZ_Cu		-	-	-	Undrained	Linear
19	ALV CZ		-	-	-	Undrained	Linear

Points

	X	Y		X	Y		X	Y		X	Y		X	Y		X	Y
2	60,000	0,000	3	0,000	-3,000	4	60,000	-3,000	11	0,000	4,300	13	30,600	0,000	32	60,000	-2,000
43	22,000	4,300	50	0,000	-2,000	73	0,000	-7,000	76	60,000	-7,000	78	0,000	-9,000	79	60,000	-9,000
80	0,000	-10,500	81	60,000	-10,500	82	0,000	-2,500	83	60,000	-2,500	84	0,000	-5,000	85	60,000	-5,000
86	0,000	-14,000	87	60,000	-14,000	88	0,000	0,300	89	0,000	-0,300	91	60,000	-0,300	94	30,000	0,300
95	31,000	-0,300															

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:34:19
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+100 GM6 Profil 6 with starter Layer.t5p

Project data

Segments

	Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2
51	4	3	107	32	50	142	2	13	147	43	11	148	73	76	156	81	79	157	79	78
159	81	80	160	32	83	161	4	83	162	83	82	163	4	85	164	76	85	165	85	84
166	87	86	177	94	43	178	94	88	179	94	13	180	91	95	181	89	95	182	95	13

Distributed loads

	Name	X left	Y left	q left	X right	Y right	q right	Ang/horizontal
1	10 kPa	19,340	4,300	10,0	21,500	4,300	10,0	90,00
2	57 kPa	0,000	4,300	57,0	20,000	4,300	57,0	90,00
3	20 kPa	0,000	4,300	20,0	20,000	4,300	20,0	90,00
4	30 kPa Seismic	0,000	4,300	30,0	20,000	4,300	30,0	90,00

Data of the situation 1

Stage name : Short term - Undrained - Static
Situation name : Skin stability
Calculation method : Bishop
Safety factor set for this situation : EC7 Design Approach
Details of the safety factor set

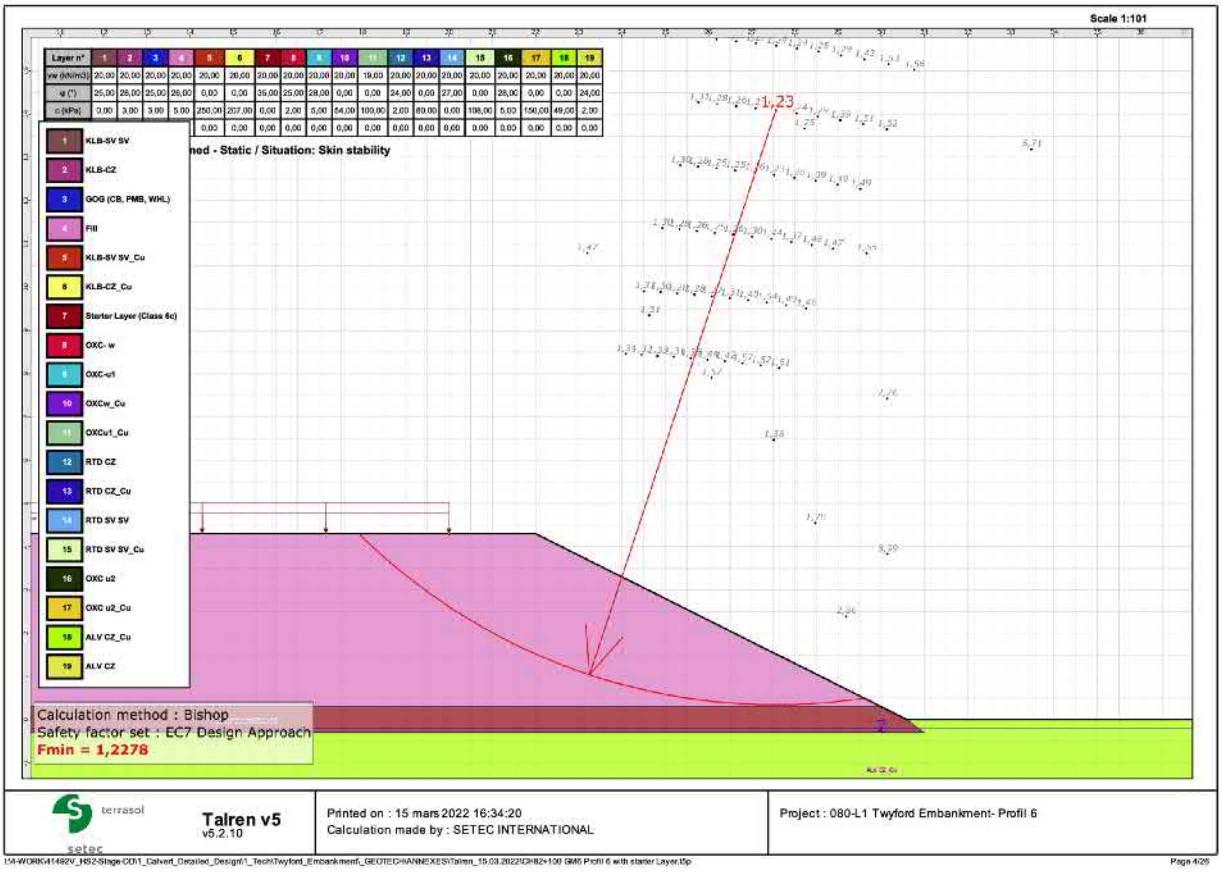
Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular
Number of intervals : 10
Increment for circle radius : 0,500
Min abscissa of the circle emergence point : 12,000
Search type : Imposed passage point
Imposed passage point : X= 29,681; Y= 0,000
Number of slices : 100
Seismic properties : No
Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)
Results
Minimum safety factor : 1,2278
Coordinates of the critical centre and radius of the critical circle : N°= 552; X0= 27,56; Y0= 14,09; R= 13,74

terrasol
setec
Talren v5
v5.2.10

Printed on : 15 mars 2022 16:34:19
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+100 GM6 Profil 6 with starter Layer.t5p Page 3/26


Scale 1:101
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 19,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 26,00 | 25,00 | 26,00 | 0,00 | 0,00 | 35,00 | 25,00 | 28,00 | 0,00 | 0,00 | 24,00 | 0,00 | 27,00 | 0,00 | 28,00 | 0,00 | 0,00 | 24,00
c (kPa) | 0,00 | 3,00 | 3,00 | 5,00 | 250,00 | 207,00 | 0,00 | 2,00 | 5,00 | 54,00 | 100,00 | 2,00 | 80,00 | 0,00 | 108,00 | 5,00 | 150,00 | 49,00 | 2,00
0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
ned - Static / Situation: Skin stability
1,23
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,2278
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:34:20
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6
Page 4/26

Data of the situation 2

Stage name : Short term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 30,000

Search type : Imposed passage point

Imposed passage point : X= 27,500; Y= 0,086

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

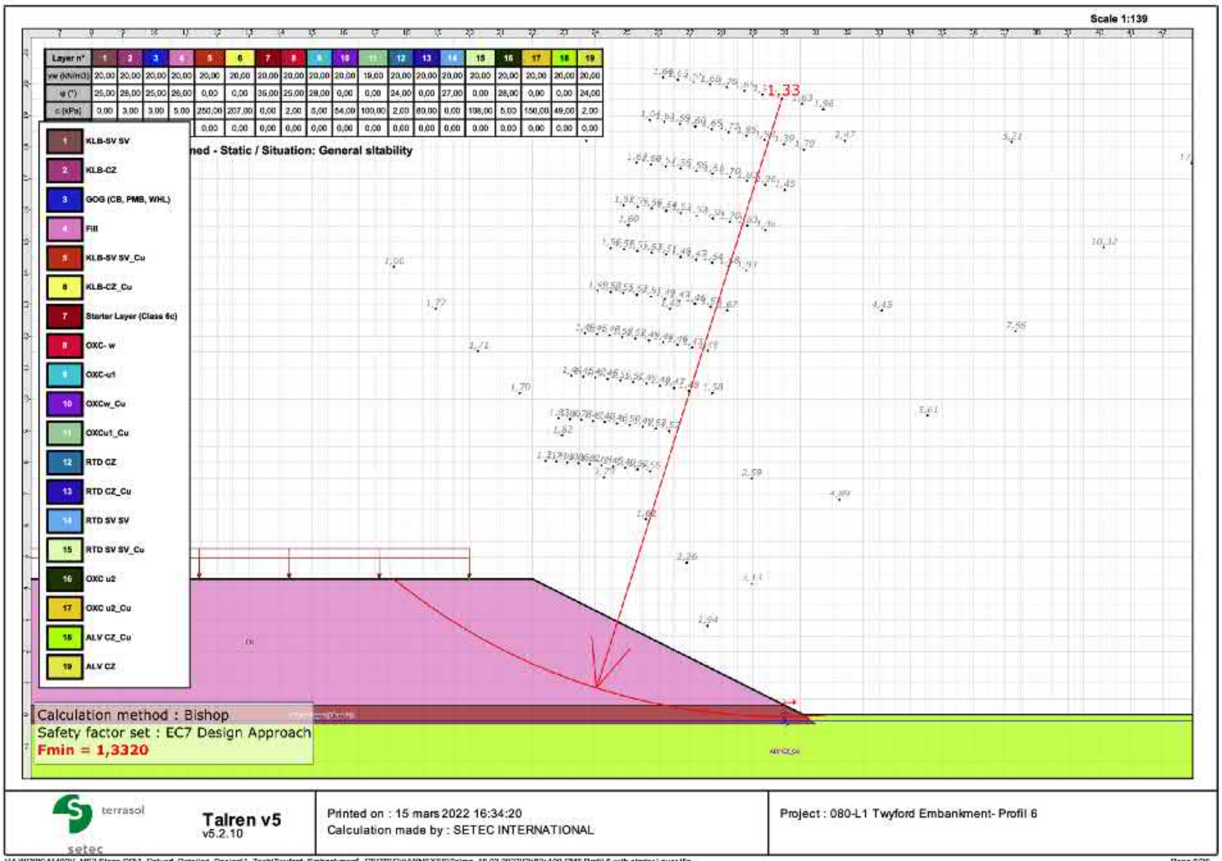
Minimum safety factor : 1,3320

Coordinates of the critical centre and radius of the critical circle : N°= 393; X0= 29,92; Y0= 19,53; R= 19,59

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 16:34:20
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+100 GM6 Profil 6 with starter Layer.t5p


Scale 1:139
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 19,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 25,00 26,00 25,00 26,00 0,00 0,00 35,00 25,00 28,00 0,00 0,00 24,00 0,00 27,00 0,00 28,00 0,00 0,00 24,00
c (kPa) 0,00 3,00 3,00 5,00 250,00 207,00 0,00 2,00 5,00 54,00 100,00 2,00 80,00 0,00 108,00 5,00 150,00 49,00 2,00
0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
ned - Static / Situation: General stability
1,33
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3320
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:34:20
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

Data of the situation 1

Stage name : Short term - Drained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 14,500

Search type : Imposed passage point

Imposed passage point : X= 29,702; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,2265

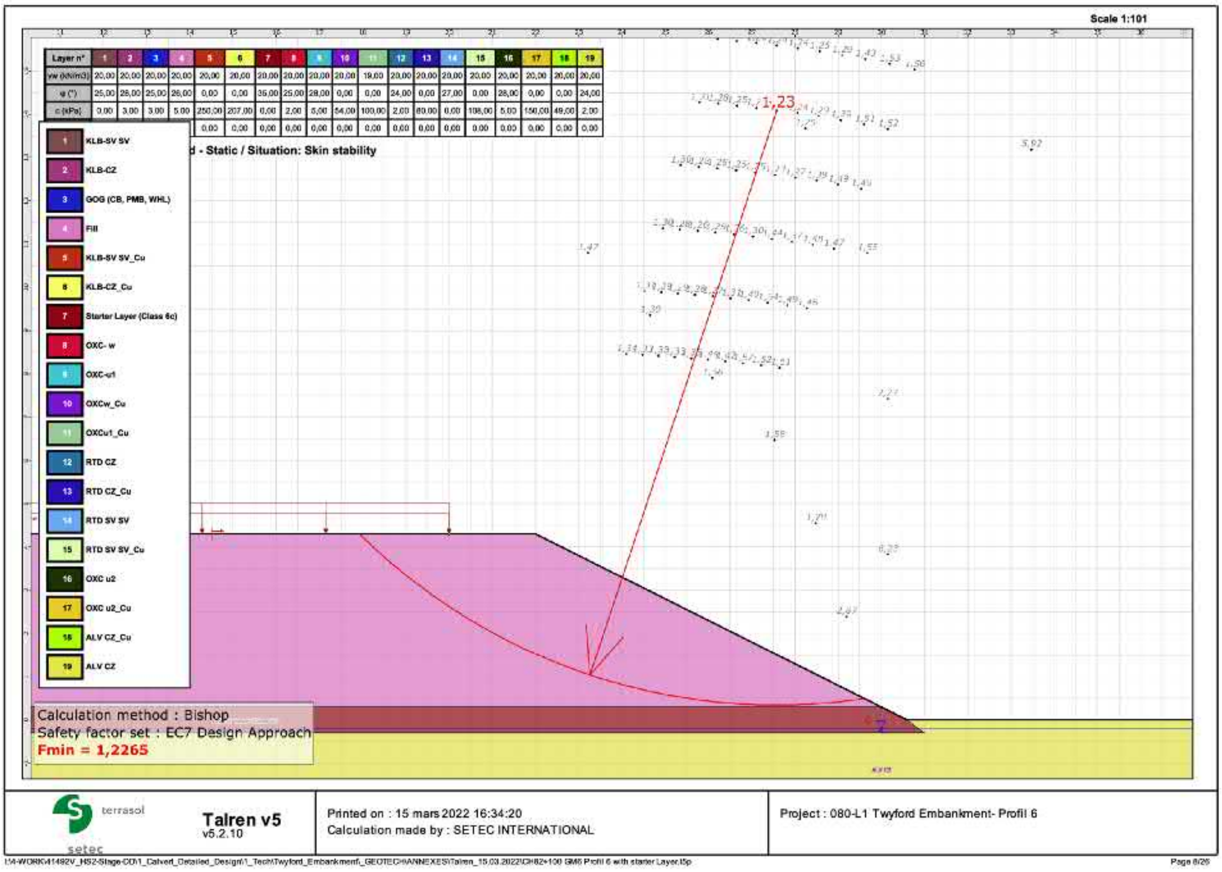
Coordinates of the critical centre and radius of the critical circle : N°= 550; X0= 27,58; Y0= 14,09; R= 13,75

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:34:20
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+100 GM6 Profil 6 with starter Layer.t5p


Scale 1:101
Layer n°
γw (kN/m3)
φ (°)
c (kPa)
d - Static / Situation: Skin stability
KLB-SV SV
KLB-CZ
GOG (CB, PMB, WHL)
Fill
KLB-SV SV_Cu
KLB-CZ_Cu
Starter Layer (Class 6c)
OXC- w
OXC-u1
OXCw_Cu
OXCu1_Cu
RTD CZ
RTD CZ_Cu
RTD SV SV
RTD SV SV_Cu
OXC u2
OXC u2_Cu
ALV CZ_Cu
ALV CZ
1,23
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,2265
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:34:20
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

Data of the situation 2

Stage name : Short term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 30,000

Search type : Imposed passage point

Imposed passage point : X= 26,376; Y= 0,135

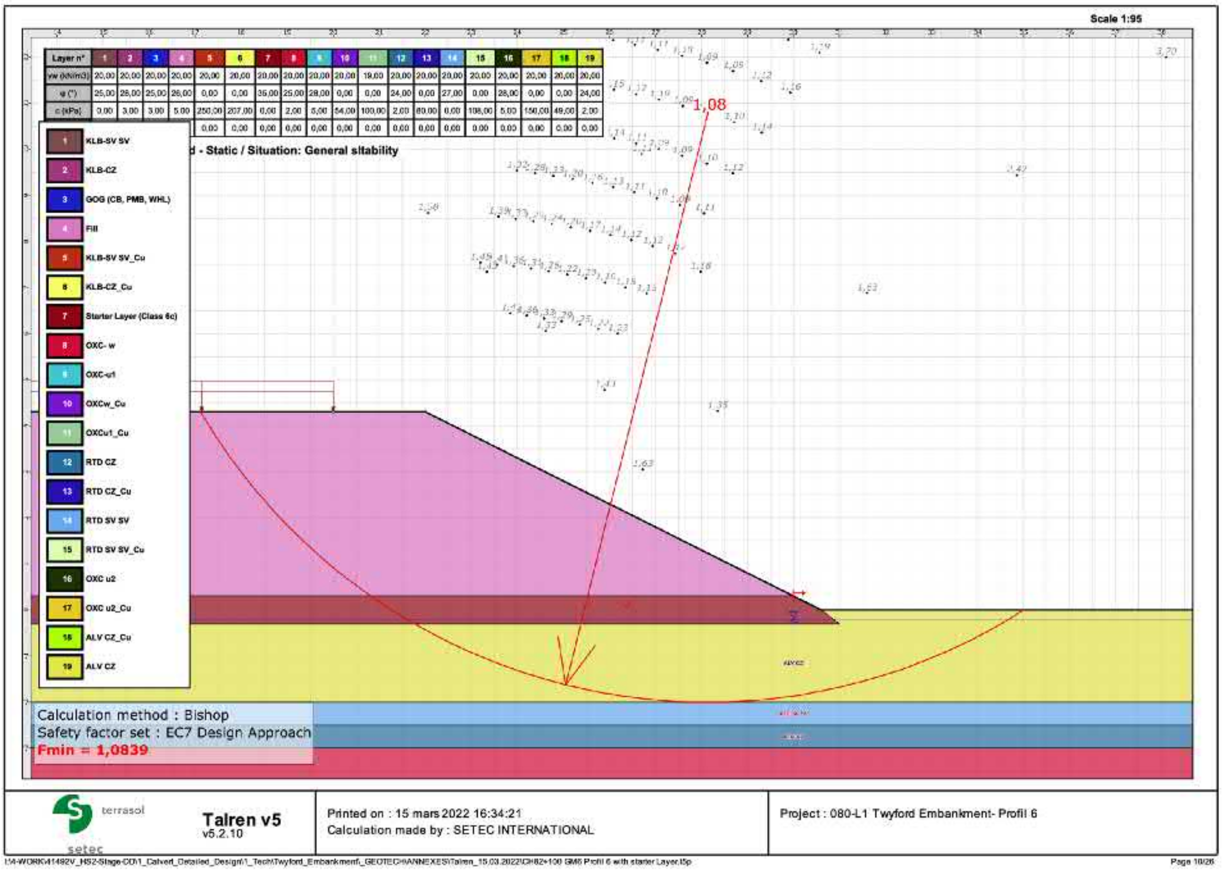
Number of slices : 100

Seismic properties : No

Results

Minimum safety factor : 1,0839

Coordinates of the critical centre and radius of the critical circle : N°= 411; X0= 28,14; Y0= 10,78; R= 12,78


Scale 1:95
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 19,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 25,00 26,00 25,00 26,00 0,00 0,00 35,00 25,00 28,00 0,00 0,00 24,00 0,00 27,00 0,00 28,00 0,00 0,00 24,00
c (kPa) 0,00 3,00 3,00 5,00 250,00 207,00 0,00 2,00 5,00 54,00 100,00 2,00 80,00 0,00 108,00 5,00 150,00 49,00 2,00
0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
d - Static / Situation: General stability
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
1,08
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,0839
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:34:21
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

Data of the situation 1

Stage name : Long term - Drained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 14,500

Search type : Imposed passage point

Imposed passage point : X= 29,702; Y= 0,000

Number of slices : 100

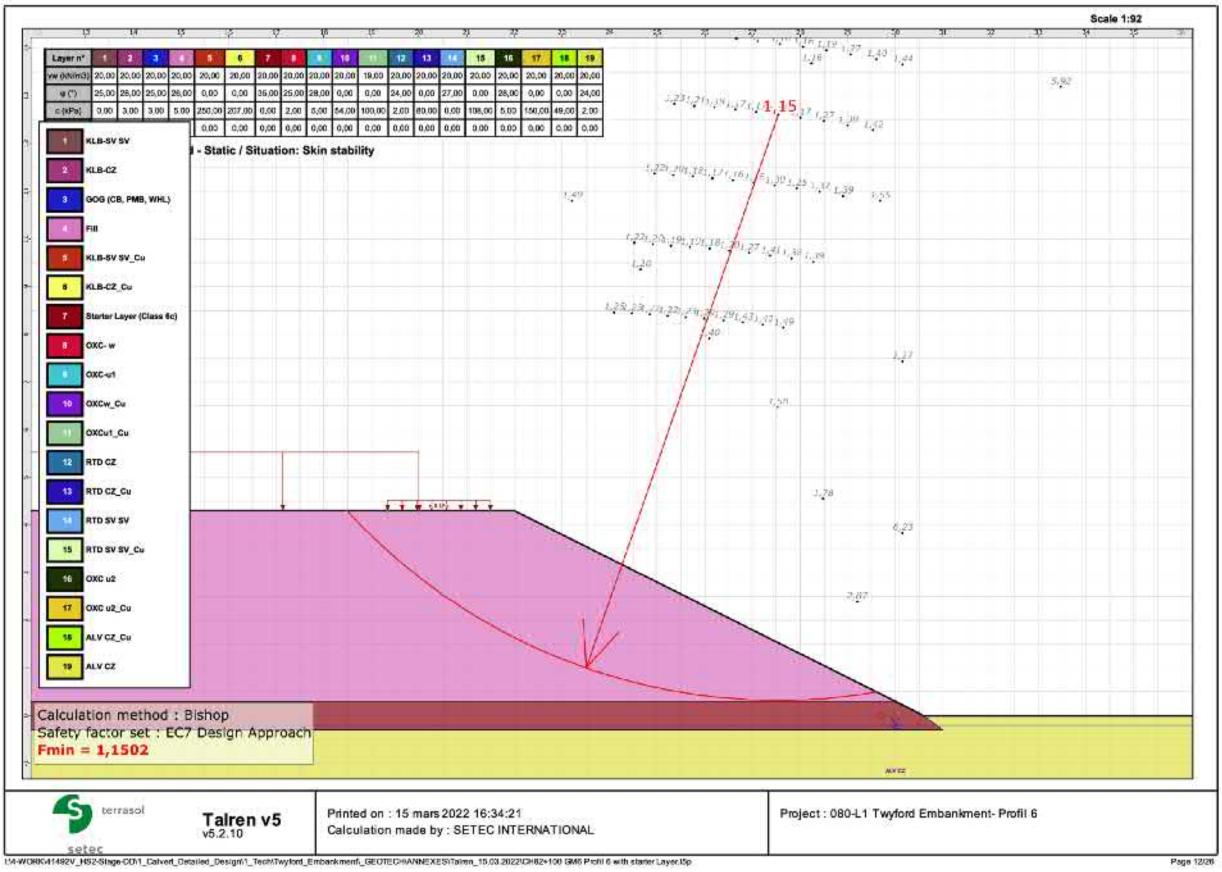
Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1502

Coordinates of the critical centre and radius of the critical circle : N°= 504; X0= 27,54; Y0= 12,60; R= 12,28


Scale 1:92
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 19,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 25,00 26,00 25,00 26,00 0,00 0,00 35,00 25,00 28,00 0,00 0,00 24,00 0,00 27,00 0,00 28,00 0,00 0,00 24,00
c (kPa) 0,00 3,00 3,00 5,00 250,00 207,00 0,00 2,00 5,00 54,00 100,00 2,00 60,00 0,00 108,00 5,00 150,00 49,00 2,00
0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
- Static / Situation: Skin stability
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
1,15
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1502
terrasol
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:34:21
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6
Page 12/26

Data of the situation 2

Stage name : Long term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 30,000

Search type : Imposed passage point

Imposed passage point : X= 26,376; Y= 0,135

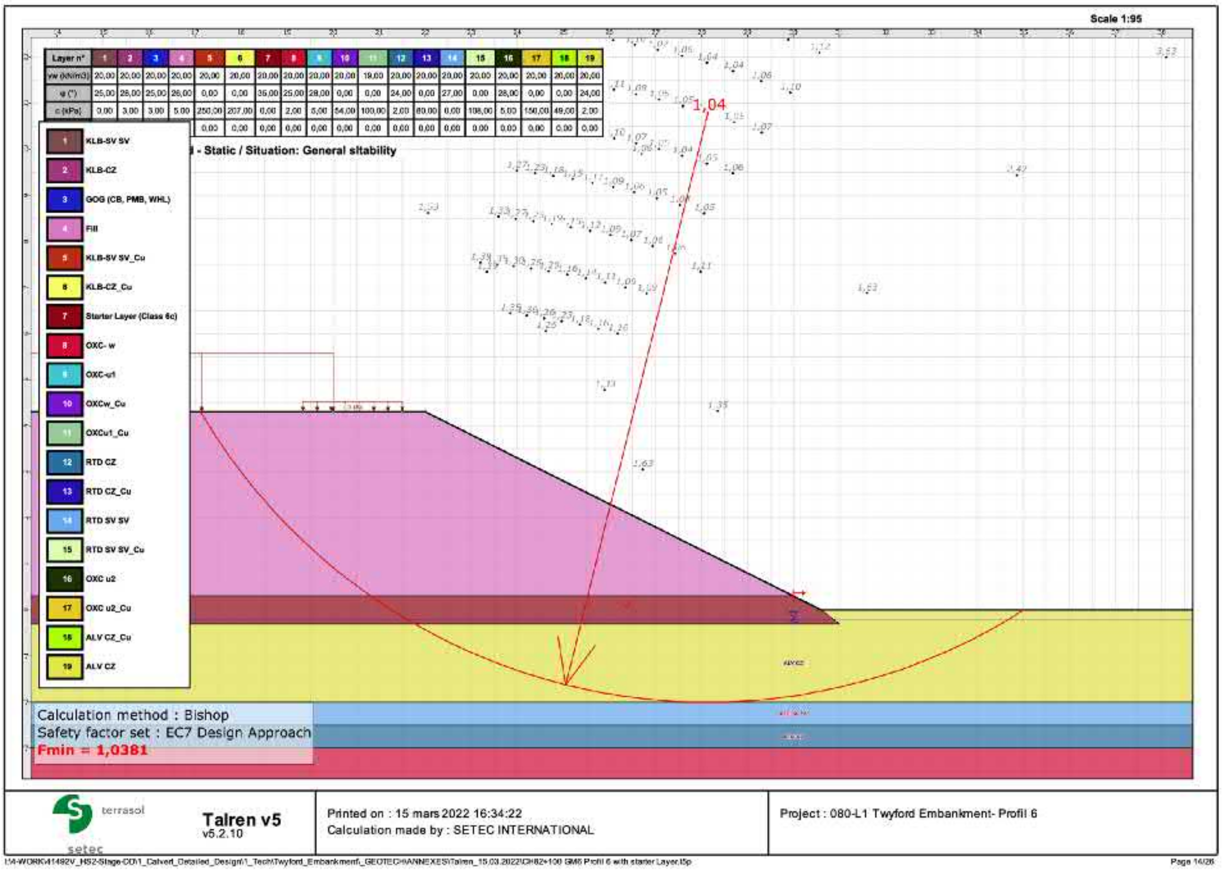
Number of slices : 100

Seismic properties : No

Results

Minimum safety factor : 1,0381

Coordinates of the critical centre and radius of the critical circle : N°= 411; X0= 28,14; Y0= 10,78; R= 12,78


Scale 1:95
- Static / Situation: General stability
KLB-SV SV
KLB-CZ
GOG (CB, PMB, WHL)
Fill
KLB-SV SV_Cu
KLB-CZ_Cu
Starter Layer (Class 6c)
OXC- w
OXC-u1
OXCw_Cu
OXCu1_Cu
RTD CZ
RTD CZ_Cu
RTD SV SV
RTD SV SV_Cu
OXC u2
OXC u2_Cu
ALV CZ_Cu
ALV CZ
1,04
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,0381
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:34:22
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

Data of the situation 1

Stage name : Long term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 12,000

Search type : Imposed passage point

Imposed passage point : X= 29,681; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

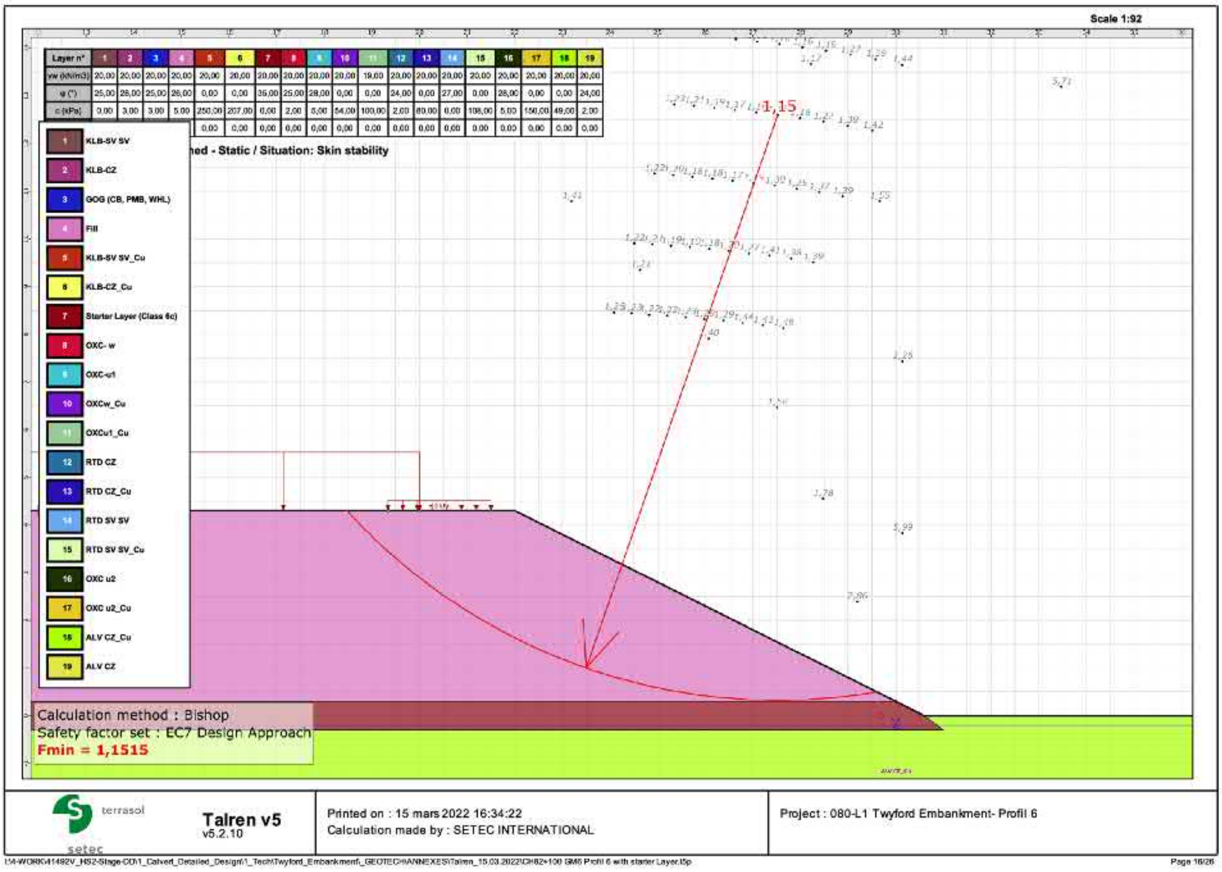
Minimum safety factor : 1,1515

Coordinates of the critical centre and radius of the critical circle : N°= 506; X0= 27,52; Y0= 12,60; R= 12,28

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:34:22
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6


Scale 1:92
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 19,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 25,00 28,00 25,00 26,00 0,00 0,00 35,00 25,00 28,00 0,00 0,00 24,00 0,00 27,00 0,00 28,00 0,00 0,00 24,00
c (kPa) 0,00 3,00 3,00 5,00 250,00 207,00 0,00 2,00 5,00 54,00 100,00 2,00 80,00 0,00 108,00 5,00 150,00 49,00 2,00
0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
...hed - Static / Situation: Skin stability
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
1,15
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1515
terrasol
Talren v5
v5.2.10
setec
Printed on : 15 mars 2022 16:34:22
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

Data of the situation 2

Stage name : Long term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 30,000

Search type : Imposed passage point

Imposed passage point : X= 27,500; Y= 0,086

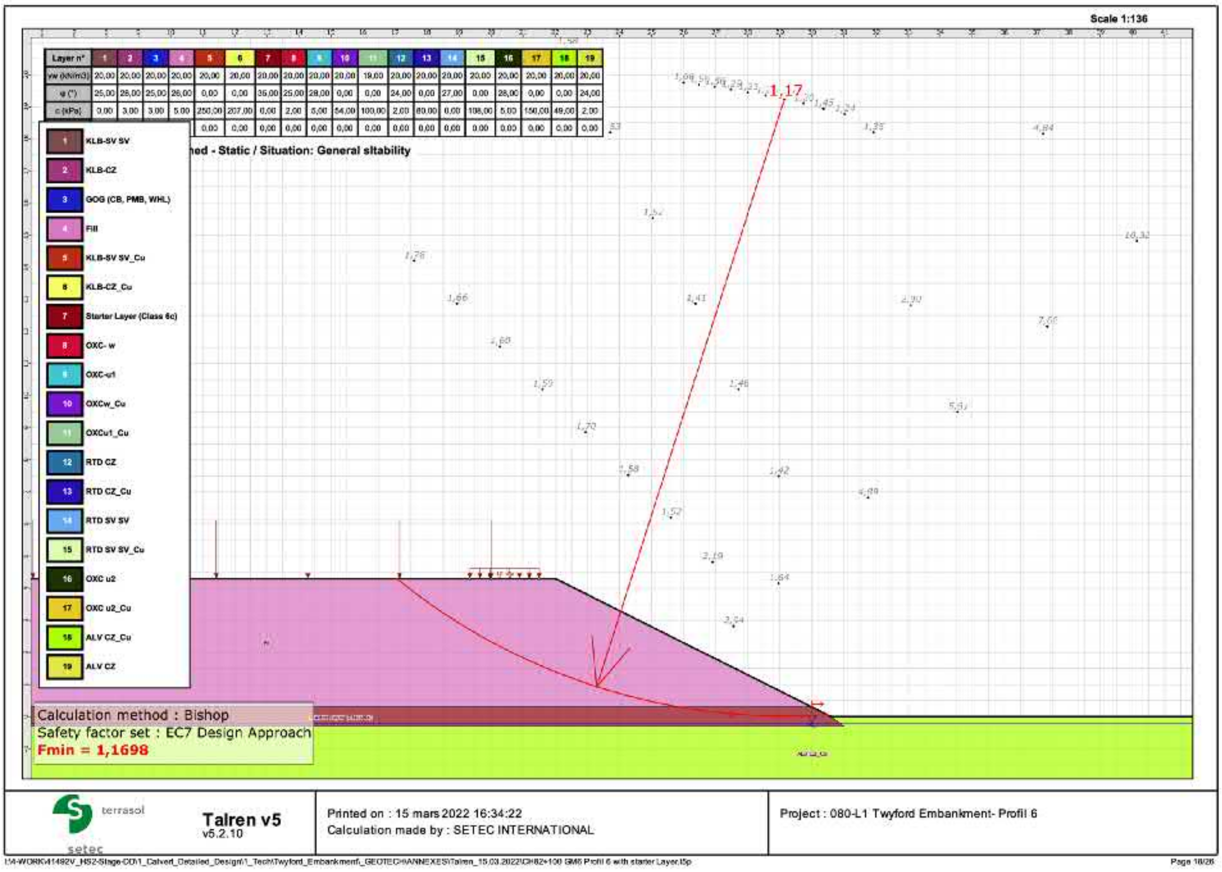
Number of slices : 100

Seismic properties : No

Results

Minimum safety factor : 1,1698

Coordinates of the critical centre and radius of the critical circle : N°= 487; X0= 29,14; Y0= 19,23; R= 19,21


Scale 1:136
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 19,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 26,00 | 25,00 | 26,00 | 0,00 | 0,00 | 35,00 | 25,00 | 28,00 | 0,00 | 0,00 | 24,00 | 0,00 | 27,00 | 0,00 | 28,00 | 0,00 | 0,00 | 24,00
c (kPa) | 0,00 | 3,00 | 3,00 | 5,00 | 250,00 | 207,00 | 0,00 | 2,00 | 5,00 | 54,00 | 100,00 | 2,00 | 60,00 | 0,00 | 108,00 | 5,00 | 150,00 | 49,00 | 2,00
0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
ned - Static / Situation: General sltability
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
1,17
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1698
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:34:22
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6
Page 18/26

Data of the situation 1

Stage name : Seismic + 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 16,500

Search type : Imposed passage point

Imposed passage point : X= 29,852; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

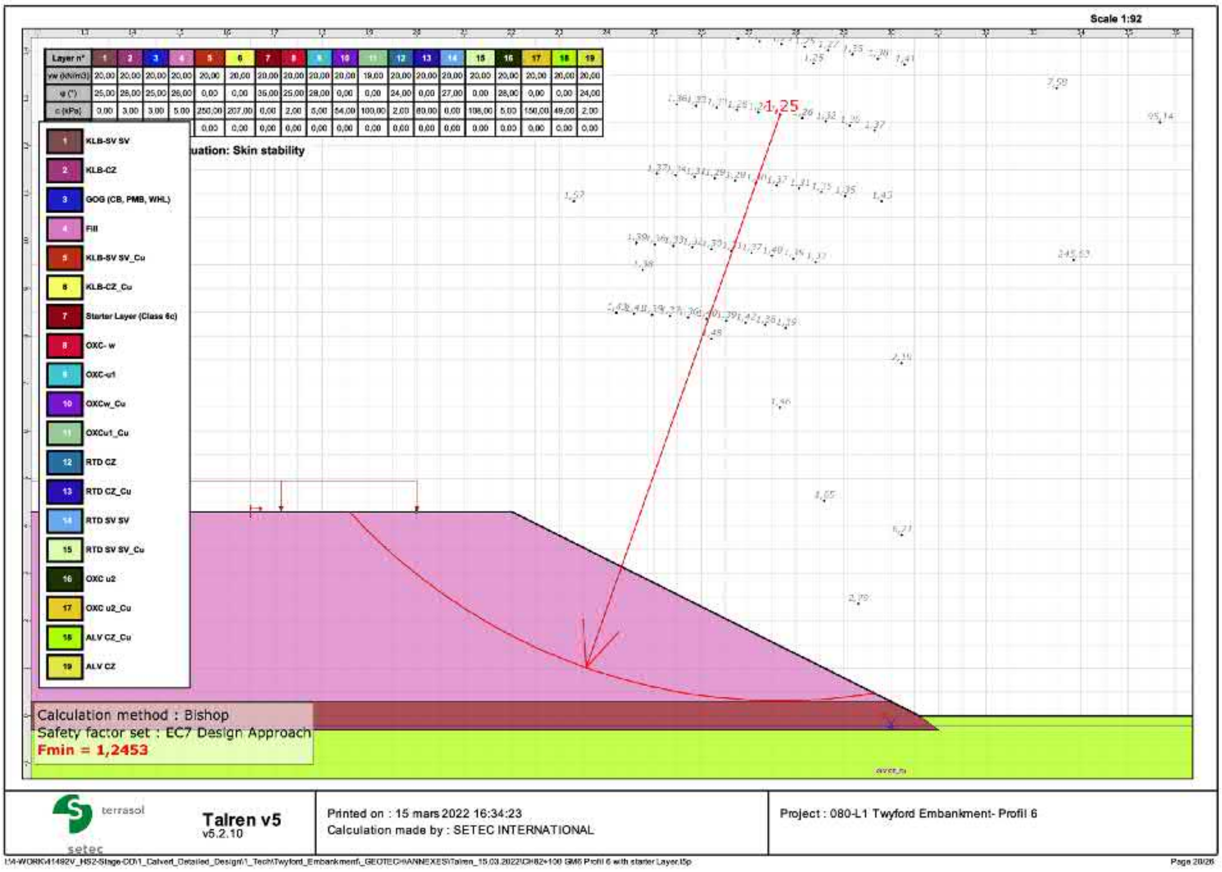
Minimum safety factor : 1,2453

Coordinates of the critical centre and radius of the critical circle : N°= 492; X0= 27,66; Y0= 12,66; R= 12,34

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 16:34:23
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+100 GM6 Profil 6 with starter Layer.t5p


Scale 1:92
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 19,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 25,00 26,00 25,00 26,00 0,00 0,00 35,00 25,00 28,00 0,00 0,00 24,00 0,00 27,00 0,00 28,00 0,00 0,00 24,00
c (kPa) 0,00 3,00 3,00 5,00 250,00 207,00 0,00 2,00 5,00 54,00 100,00 2,00 80,00 0,00 108,00 5,00 150,00 49,00 2,00
0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
uation: Skin stability
1,25
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,2453
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:34:23
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

Data of the situation 2

Stage name : Seismic + 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 15,000

Search type : Imposed passage point

Imposed passage point : X= 29,635; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

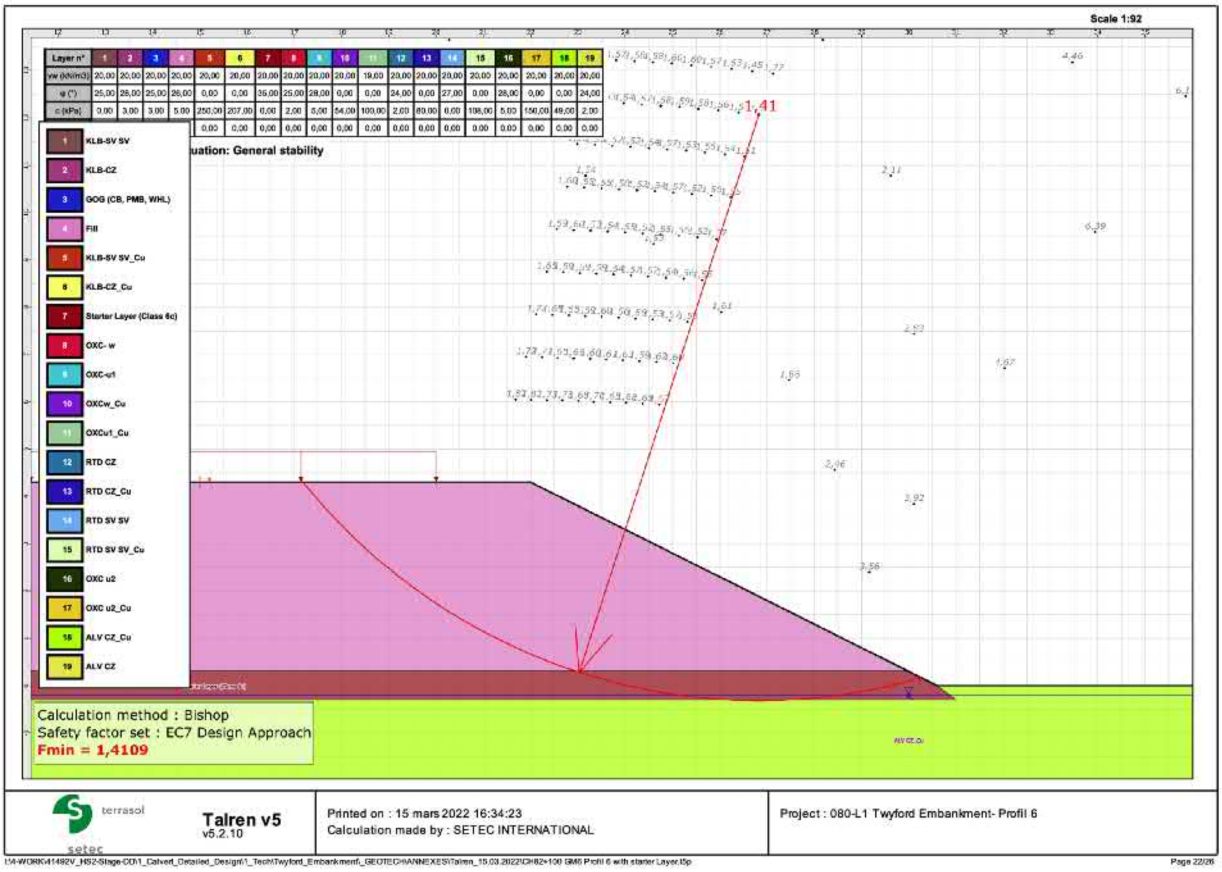
av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,4109

Coordinates of the critical centre and radius of the critical circle : N°= 365; X0= 26,83; Y0= 12,07; R= 12,38


Scale 1:92
uation: General stability
KLB-SV SV
KLB-CZ
GOG (CB, PMB, WHL)
Fill
KLB-SV SV_Cu
KLB-CZ_Cu
Starter Layer (Class 6c)
OXC- w
OXC-u1
OXCw_Cu
OXCu1_Cu
RTD CZ
RTD CZ_Cu
RTD SV SV
RTD SV SV_Cu
OXC u2
OXC u2_Cu
ALV CZ_Cu
ALV CZ
1,41
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,4109
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:34:23
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

Data of the situation 1

Stage name : Seismic - 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 18,000

Search type : Imposed passage point

Imposed passage point : X= 29,855; Y= 0,024

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : -0,012

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

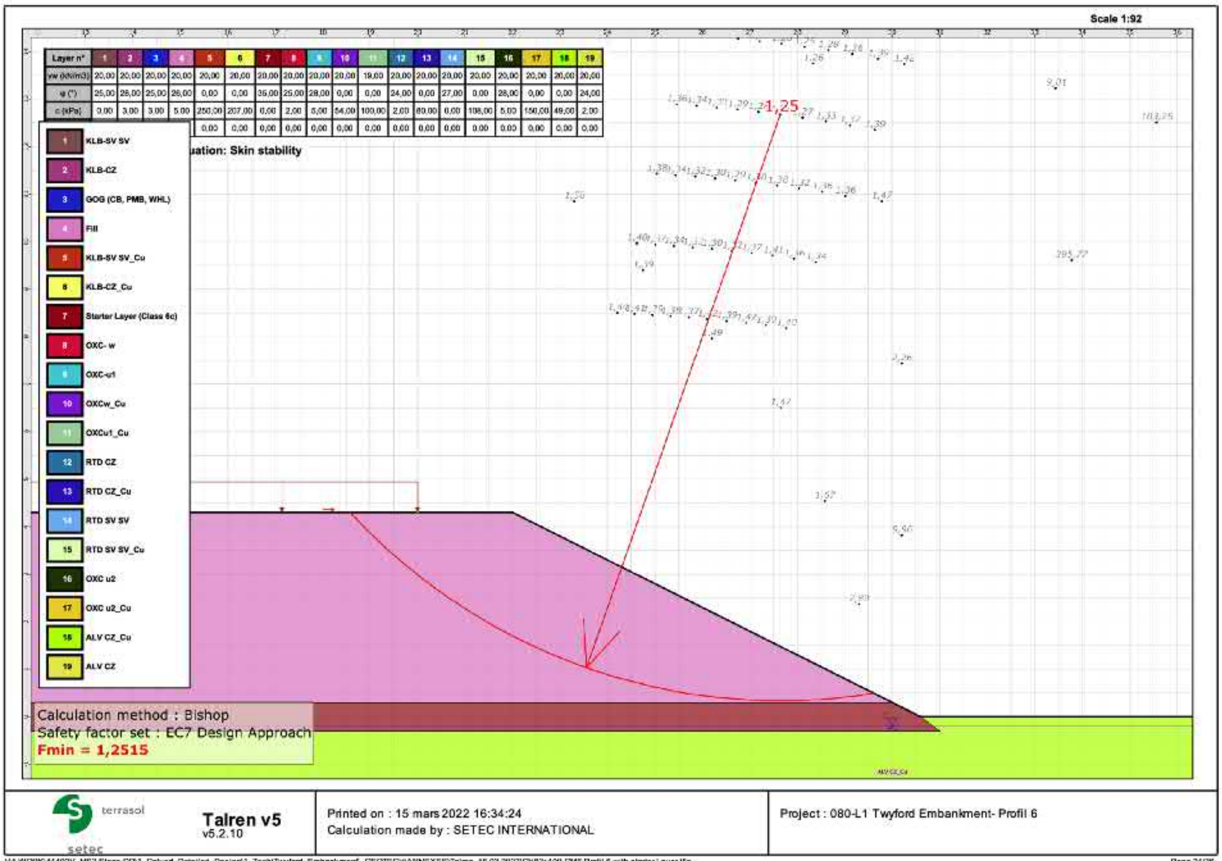
Results

Minimum safety factor : 1,2515

Coordinates of the critical centre and radius of the critical circle : N°= 489; X0= 27,64; Y0= 12,67; R= 12,33

terrasol setec | **Talren v5** v5.2.10 | Printed on : 15 mars 2022 16:34:23
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+100 GM6 Profil 6 with starter Layer.t5p Page 23/26


Scale 1:92
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 19,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 25,00 26,00 25,00 26,00 0,00 0,00 35,00 25,00 28,00 0,00 0,00 24,00 0,00 27,00 0,00 28,00 0,00 0,00 24,00
c (kPa) 0,00 3,00 3,00 5,00 250,00 207,00 0,00 2,00 5,00 54,00 100,00 2,00 80,00 0,00 108,00 5,00 150,00 49,00 2,00
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
uation: Skin stability
1,25
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,2515
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:34:24
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

Data of the situation 2

Stage name : Seismic - 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 10,000

Search type : Imposed passage point

Imposed passage point : X= 30,000; Y= -0,042

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

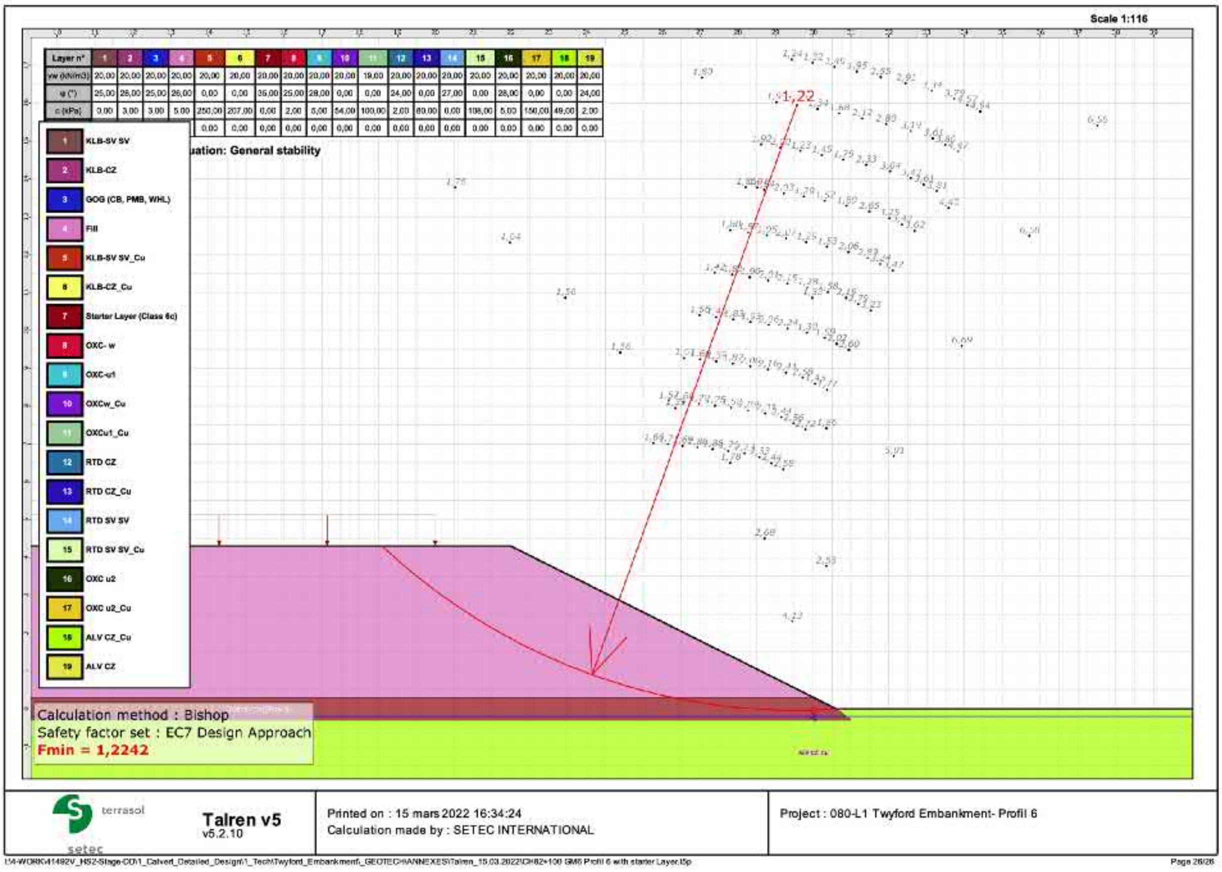
av/g coefficient (vertical acceleration) : -0,012

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,2242

Coordinates of the critical centre and radius of the critical circle : N°= 751; X0= 29,56; Y0= 15,95; R= 15,99


Scale 1:116
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 19,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 25,00 26,00 25,00 26,00 0,00 0,00 35,00 25,00 28,00 0,00 0,00 24,00 0,00 27,00 0,00 28,00 0,00 0,00 24,00
c (kPa) 0,00 3,00 3,00 5,00 250,00 207,00 0,00 2,00 5,00 54,00 100,00 2,00 80,00 0,00 108,00 5,00 150,00 49,00 2,00
0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
uation: General stability
1,22
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,2242
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:34:24
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 6

Project data

Project reference : HS2

Calculation title : 080-L1 Twyford Embankment- Profil 7

Location : H = 5.5m - Ch. 82+289 - Ground model 6

Comments : N/A

Units : kN, kPa, kN/m3

γw : 10.0

Soil layers

	Name	Colour	γ	φ	c	Δc	qs nails	pl	KsB	Anisotropy	Favorable	Specific safety factors
1	KLB-SV SV		20,0	25,00	0,0	0,0	-	-	-	No	No	No
2	KLB-CZ		20,0	28,00	3,0	0,0	-	-	-	No	No	No
3	GOG (CB, PMB, WHL)		20,0	25,00	3,0	0,0	-	-	-	No	No	No
4	Fill		20,0	26,00	5,0	0,0	-	-	-	No	No	No
5	KLB-SV SV_Cu		20,0	0,00	250,0	0,0	-	-	-	No	No	No
6	KLB-CZ_Cu		20,0	0,00	207,0	0,0	-	-	-	No	No	No
7	Starter Layer (Class 6c)		20,0	35,00	0,0	0,0	-	-	-	No	No	No
8	OXC- w		20,0	25,00	2,0	0,0	-	-	-	No	No	No
9	OXC-u1		20,0	28,00	5,0	0,0	-	-	-	No	No	No
10	OXCw_Cu		20,0	0,00	54,0	0,0	-	-	-	No	No	No
11	OXCu1_Cu		19,0	0,00	100,0	0,0	-	-	-	No	No	No
12	RTD CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No
13	RTD CZ_Cu		20,0	0,00	80,0	0,0	-	-	-	No	No	No
14	RTD SV SV		20,0	27,00	0,0	0,0	-	-	-	No	No	No
15	RTD SV SV_Cu		20,0	0,00	110,0	0,0	-	-	-	No	No	No
16	OXC u2		20,0	28,00	5,0	0,0	-	-	-	No	No	No
17	OXC u2_Cu		20,0	0,00	150,0	0,0	-	-	-	No	No	No
18	ALV CZ_Cu		20,0	0,00	49,0	0,0	-	-	-	No	No	No
19	ALV CZ		20,0	23,00	2,0	0,0	-	-	-	No	No	No

Soil layers (cont.)

	Name	Colour	Γγ	Γc	Γtan(φ)	Cohesion type	Curve
1	KLB-SV SV		-	-	-	Effective	Linear
2	KLB-CZ		-	-	-	Effective	Linear
3	GOG (CB, PMB, WHL)		-	-	-	Effective	Linear
4	Fill		-	-	-	Effective	Linear
5	KLB-SV SV_Cu		-	-	-	Undrained	Linear
6	KLB-CZ_Cu		-	-	-	Undrained	Linear
7	Starter Layer (Class 6c)		-	-	-	Effective	Linear
8	OXC- w		-	-	-	Effective	Linear
9	OXC-u1		-	-	-	Effective	Linear
10	OXCw_Cu		-	-	-	Undrained	Linear
11	OXCu1_Cu		-	-	-	Undrained	Linear
12	RTD CZ		-	-	-	Effective	Linear
13	RTD CZ_Cu		-	-	-	Undrained	Linear
14	RTD SV SV		-	-	-	Effective	Linear
15	RTD SV SV_Cu		-	-	-	Effective	Linear
16	OXC u2		-	-	-	Effective	Linear
17	OXC u2_Cu		-	-	-	Undrained	Linear
18	ALV CZ_Cu		-	-	-	Undrained	Linear
19	ALV CZ		-	-	-	Effective	Linear

Points

	X	Y		X	Y		X	Y		X	Y		X	Y		X	Y
2	60,000	0,000	3	0,000	-3,000	4	60,000	-3,000	11	0,000	5,500	13	33,000	0,000	32	60,000	-2,000
43	22,000	5,500	50	0,000	-2,000	73	0,000	-7,000	76	60,000	-7,000	78	0,000	-9,000	79	60,000	-9,000
80	0,000	-10,500	81	60,000	-10,500	82	0,000	-2,500	83	60,000	-2,500	84	0,000	-5,000	85	60,000	-5,000
86	0,000	-14,000	87	60,000	-14,000	88	0,000	0,300	89	0,000	-0,300	91	60,000	-0,300	92	60,000	0,300
93	32,185	0,407	94	33,500	-0,300												

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:52:05
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7

Project data

Segments

	Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2
51	4	3	107	32	50	142	2	13	147	43	11	148	73	76	156	81	79	157	79	78
159	81	80	160	32	83	161	4	83	162	83	82	163	4	85	164	76	85	165	85	84
166	87	86	177	88	93	178	93	43	179	93	13	180	89	94	181	91	94	182	94	13

Distributed loads

	Name	X left	Y left	q left	X right	Y right	q right	Ang/horizontal
1	10 kPa	19,340	5,500	10,0	21,500	5,500	10,0	90,00
2	57 kPa	0,000	5,500	57,0	20,000	5,500	57,0	90,00
3	20 kPa	0,000	5,500	20,0	20,000	5,500	20,0	90,00
4	30 kPa Seismic	0,000	5,500	30,0	20,000	5,500	30,0	90,00

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:52:05
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+289 GM6 Profil 7 with Starter Layer.t5p

Data of the situation 1

Stage name : Short term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 13,000

Search type : Imposed passage point

Imposed passage point : X= 31,650; Y= 0,062

Number of slices : 100

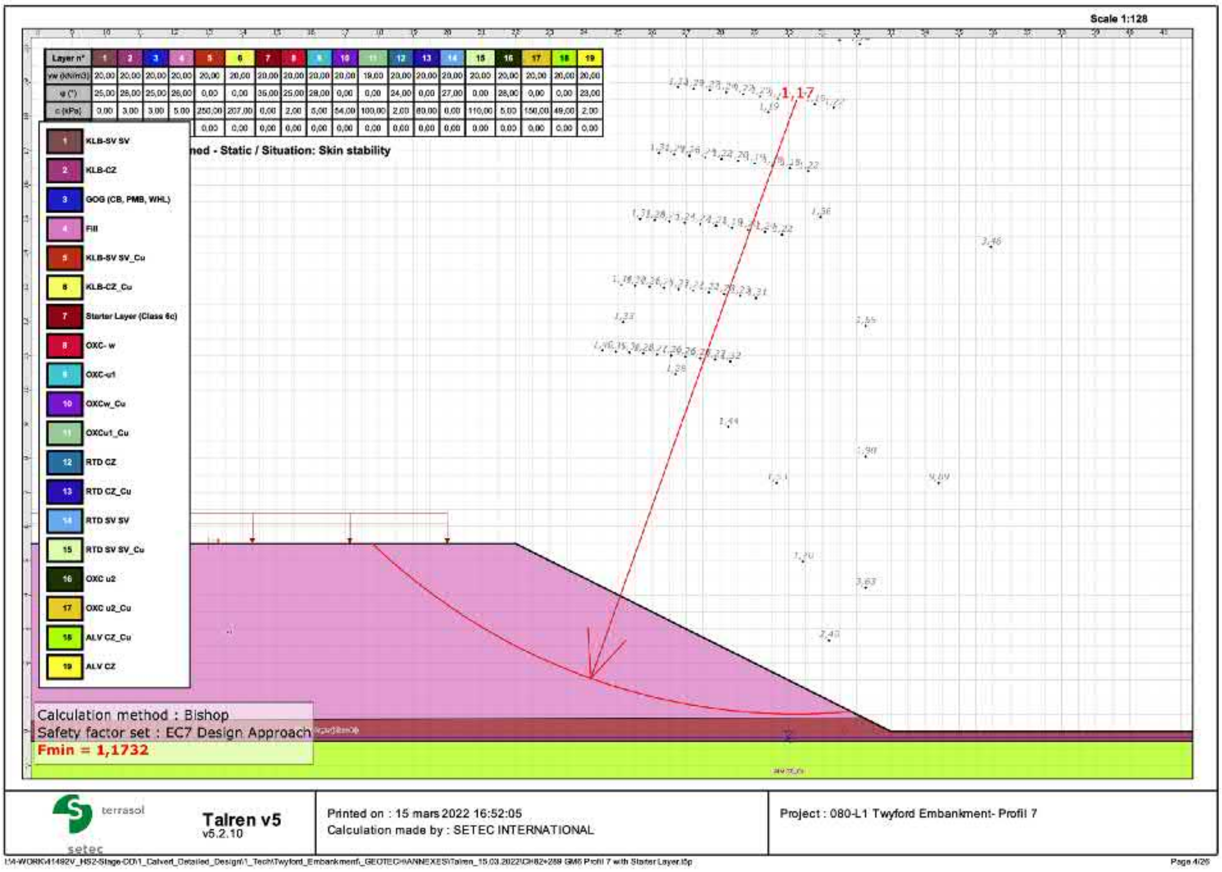
Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1732

Coordinates of the critical centre and radius of the critical circle : N°= 406; X0= 30,22; Y0= 18,45; R= 17,94



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	19,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	26,00	25,00	26,00	0,00	0,00	35,00	25,00	28,00	0,00	0,00	24,00	0,00	27,00	0,00	28,00	0,00	0,00	23,00
c (kPa)	0,00	3,00	3,00	5,00	250,00	207,00	0,00	2,00	5,00	54,00	100,00	2,00	80,00	0,00	110,00	5,00	150,00	49,00	2,00
					0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Short term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 10,000

Search type : Imposed passage point

Imposed passage point : X= 32,000; Y= -0,200

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1528

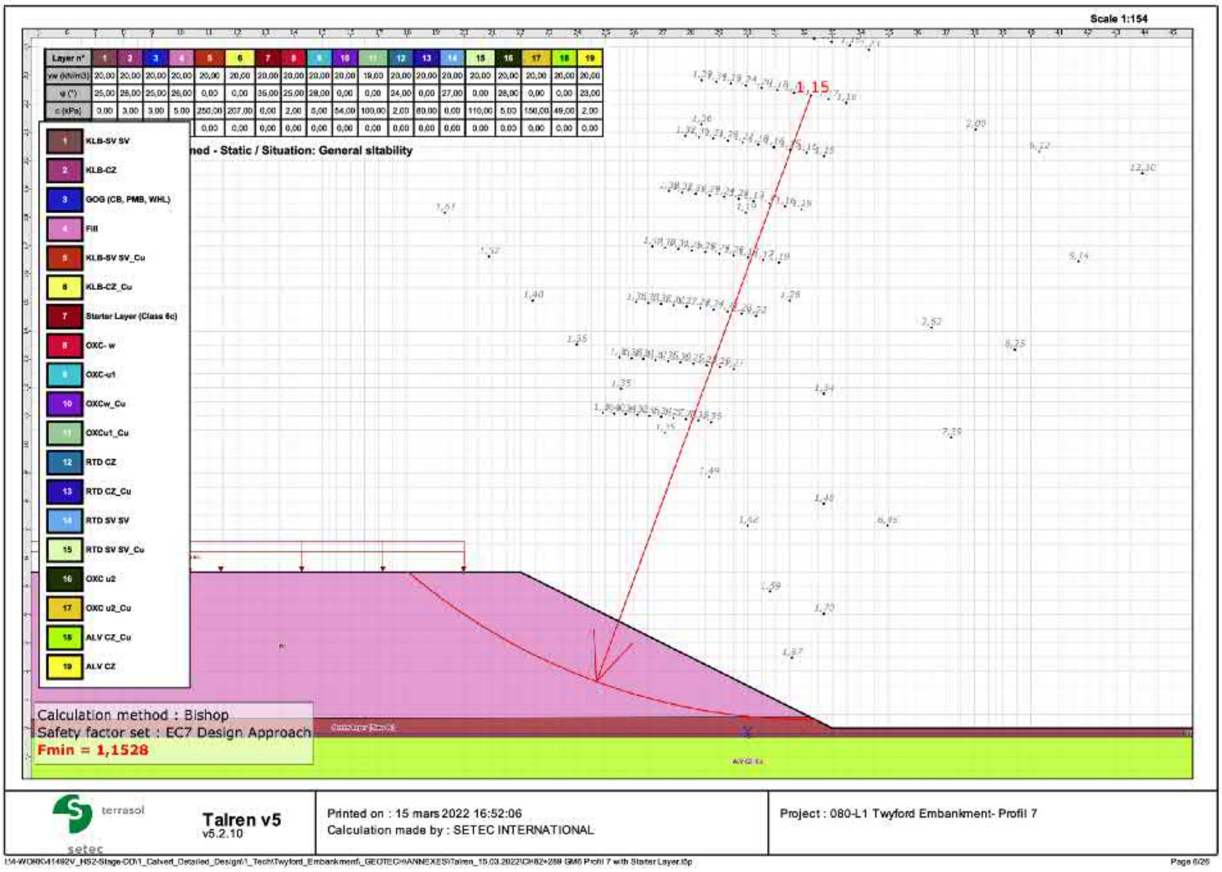
Coordinates of the critical centre and radius of the critical circle : N°= 517; X0= 32,24; Y0= 22,29; R= 21,98

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:52:06
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+289 GM6 Profil 7 with Starter Layer.t5p Page 5/26


Scale 1:154
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 19,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 25,00 28,00 25,00 26,00 0,00 0,00 35,00 25,00 28,00 0,00 0,00 24,00 0,00 27,00 0,00 28,00 0,00 0,00 23,00
c (kPa) 0,00 3,00 3,00 5,00 250,00 207,00 0,00 2,00 5,00 54,00 100,00 2,00 80,00 0,00 110,00 5,00 150,00 49,00 2,00
0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
ned - Static / Situation: General stability
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
1,15
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1528
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:52:06
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7

Data of the situation 1

Stage name : Short term - Drained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 15,500

Search type : Imposed passage point

Imposed passage point : X= 31,725; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

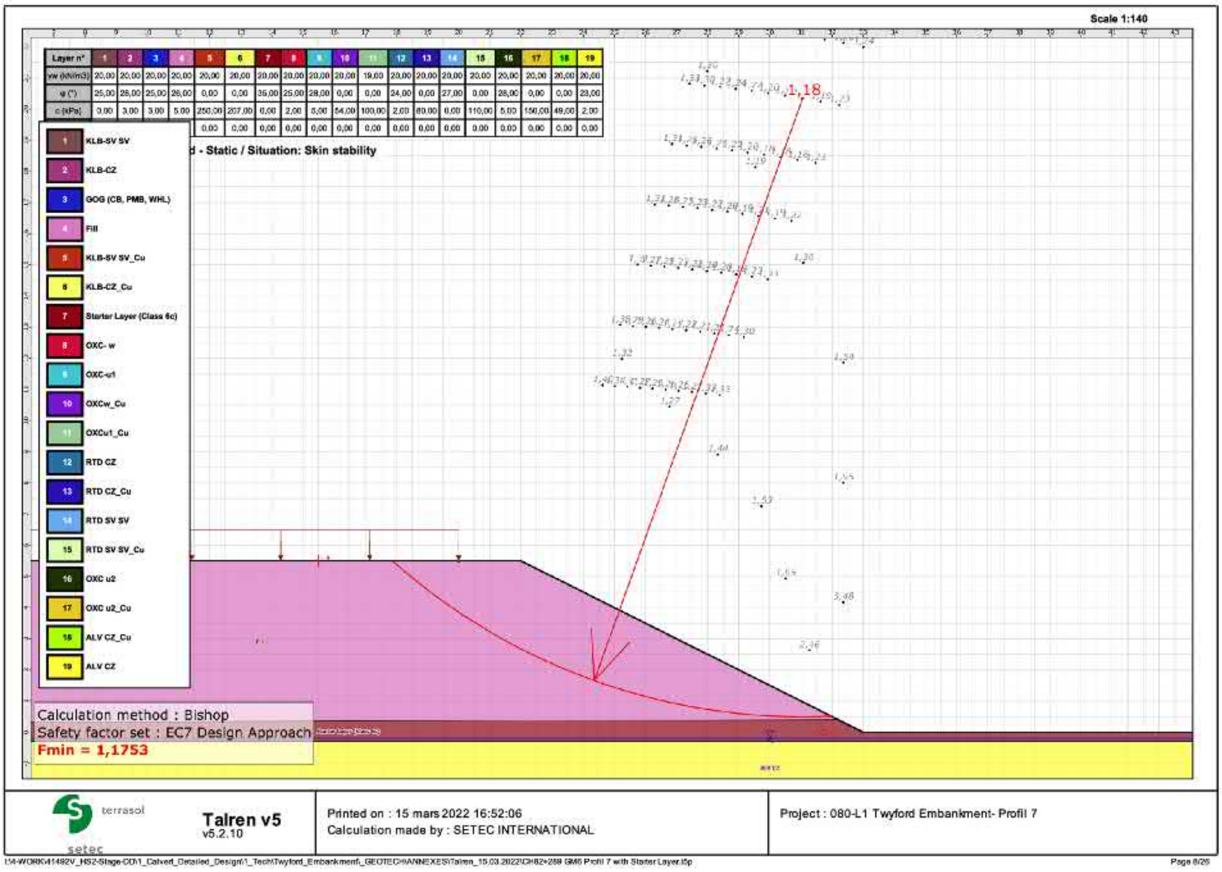
Minimum safety factor : 1,1753

Coordinates of the critical centre and radius of the critical circle : N°= 391; X0= 31,05; Y0= 20,34; R= 19,85

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 16:52:06
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+289 GM6 Profil 7 with Starter Layer.t5p Page 7/26


Scale 1:140
Static / Situation: Skin stability
KLB-SV SV
KLB-CZ
GOG (CB, PMB, WHL)
Fill
KLB-SV SV_Cu
KLB-CZ_Cu
Starter Layer (Class 6c)
OXC- w
OXC-u1
OXCw_Cu
OXCu1_Cu
RTD CZ
RTD CZ_Cu
RTD SV SV
RTD SV SV_Cu
OXC u2
OXC u2_Cu
ALV CZ_Cu
ALV CZ
1,18
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1753
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:52:06
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7

Data of the situation 2

Stage name : Short term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 32,000

Search type : Imposed passage point

Imposed passage point : X= 22,000; Y= 0,358

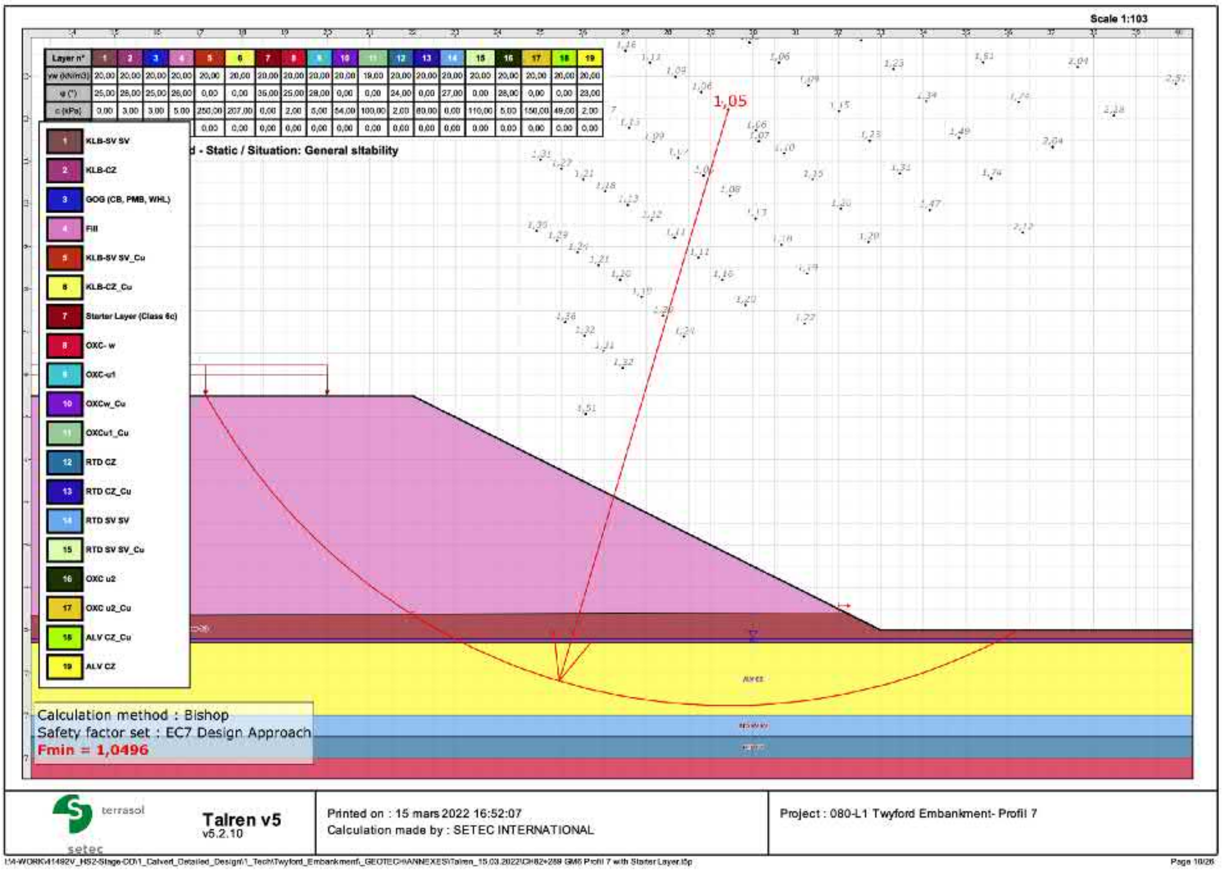
Number of slices : 100

Seismic properties : No

Results

Minimum safety factor : 1,0496

Coordinates of the critical centre and radius of the critical circle : N°= 684; X0= 29,42; Y0= 12,21; R= 13,98


Scale 1:103
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 19,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 25,00 26,00 25,00 26,00 0,00 0,00 35,00 25,00 28,00 0,00 0,00 24,00 0,00 27,00 0,00 28,00 0,00 0,00 23,00
c (kPa) 0,00 3,00 3,00 5,00 250,00 207,00 0,00 2,00 5,00 54,00 100,00 2,00 80,00 0,00 110,00 5,00 150,00 49,00 2,00
0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
d - Static / Situation: General sitability
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
1,05
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,0496
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:52:07
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7
Page 10/26

Data of the situation 1

Stage name : Long term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 13,000

Search type : Imposed passage point

Imposed passage point : X= 31,650; Y= 0,062

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

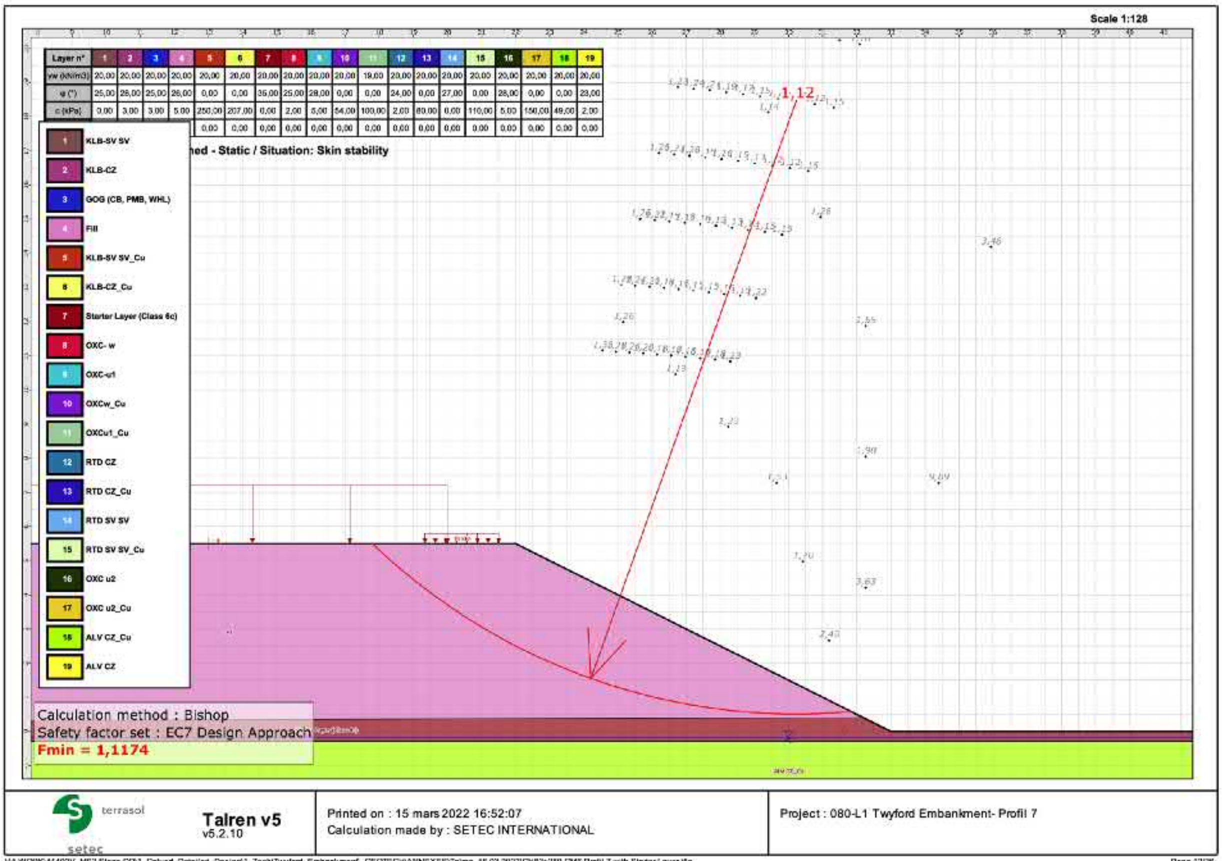
Results

Minimum safety factor : 1,1174

Coordinates of the critical centre and radius of the critical circle : N°= 406; X0= 30,22; Y0= 18,45; R= 17,94

terrasol setec | **Talren v5** v5.2.10 | Printed on : 15 mars 2022 16:52:07 Calculation made by : SETEC INTERNATIONAL Project : 080-L1 Twyford Embankment- Profil 7

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+289 GM6 Profil 7 with Starter Layer.t5p Page 1/26


Scale 1:128
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 19,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 26,00 | 25,00 | 26,00 | 0,00 | 0,00 | 35,00 | 25,00 | 28,00 | 0,00 | 0,00 | 24,00 | 0,00 | 27,00 | 0,00 | 28,00 | 0,00 | 0,00 | 23,00
c (kPa) | 0,00 | 3,00 | 3,00 | 5,00 | 250,00 | 207,00 | 0,00 | 2,00 | 5,00 | 54,00 | 100,00 | 2,00 | 80,00 | 0,00 | 110,00 | 5,00 | 150,00 | 49,00 | 2,00
0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
hed - Static / Situation: Skin stability
1,12
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1174
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:52:07
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7

Data of the situation 2

Stage name : Long term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 10,000

Search type : Imposed passage point

Imposed passage point : X= 32,000; Y= -0,200

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,1811

Coordinates of the critical centre and radius of the critical circle : N°= 394; X0= 34,44; Y0= 27,99; R= 28,29

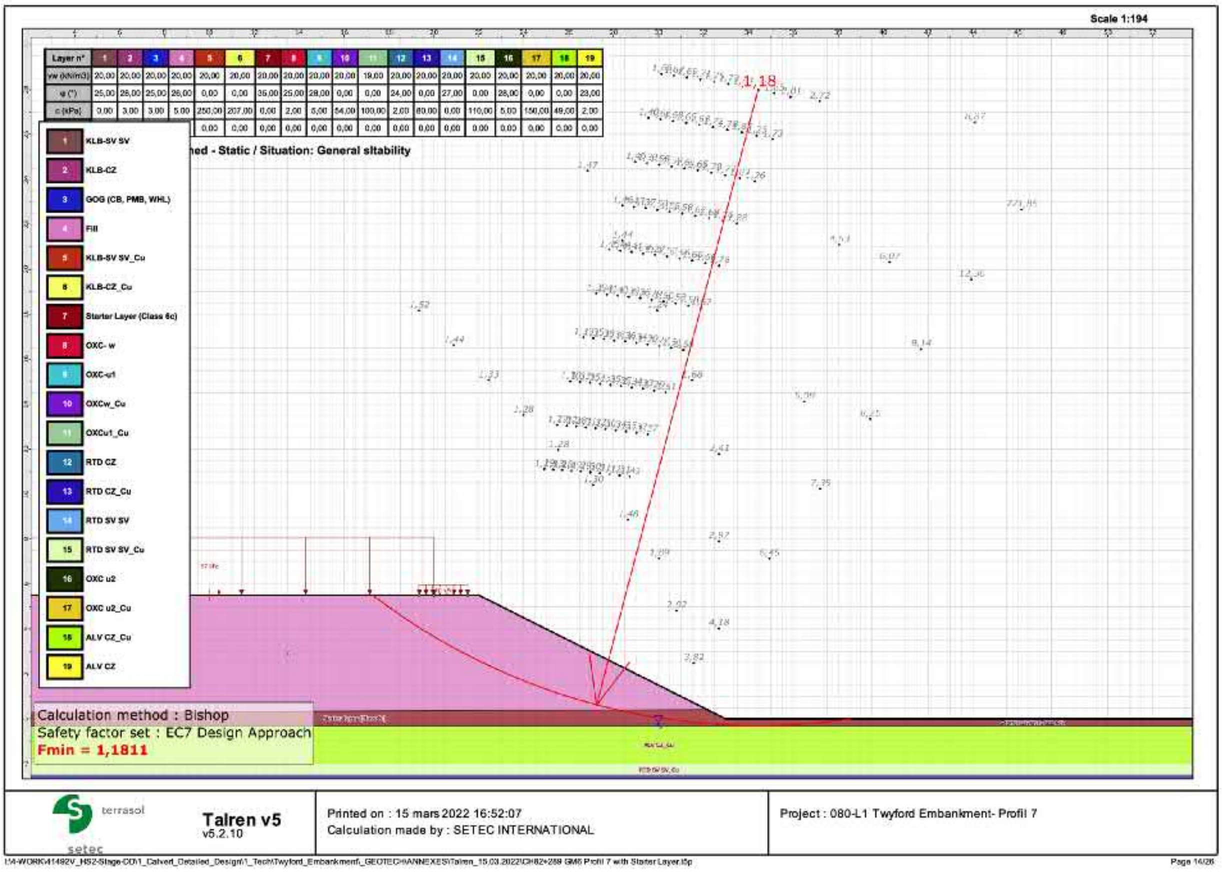
terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:52:07
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+289 GM6 Profil 7 with Starter Layer.t5p

Page 13/26


Scale 1:194
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 19,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 25,00 28,00 25,00 26,00 0,00 0,00 35,00 25,00 28,00 0,00 0,00 24,00 0,00 27,00 0,00 28,00 0,00 0,00 23,00
c (kPa) 0,00 3,00 3,00 5,00 250,00 207,00 0,00 2,00 5,00 54,00 100,00 2,00 80,00 0,00 110,00 5,00 150,00 49,00 2,00
0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
hed - Static / Situation: General sitability
1,18
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1811
terrasol setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:52:07
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7
Page 14/26

Data of the situation 1

Stage name : Long term - Drained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 15,500

Search type : Imposed passage point

Imposed passage point : X= 31,725; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1179

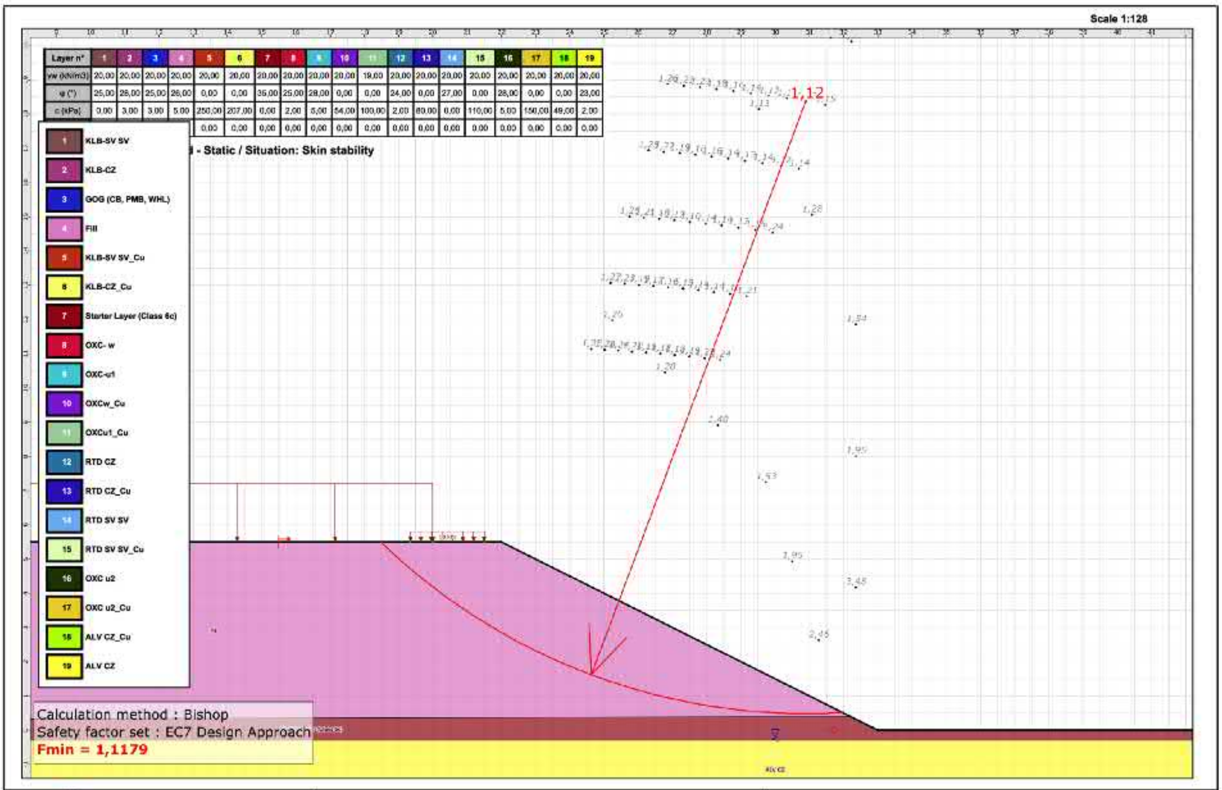
Coordinates of the critical centre and radius of the critical circle : N°= 343; X0= 30,89; Y0= 18,37; R= 17,88

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:52:08
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+289 GM6 Profil 7 with Starter Layer.t5p Page 15/26



terrasol setec Talren v5 v5.2.10

Printed on : 15 mars 2022 16:52:08
Calculation made by : SETEC INTERNATIONAL

Project : 080-L1 Twyford Embankment- Profil 7

Page 16/26

Data of the situation 2

Stage name : Long term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 32,000

Search type : Imposed passage point

Imposed passage point : X= 22,000; Y= 0,358

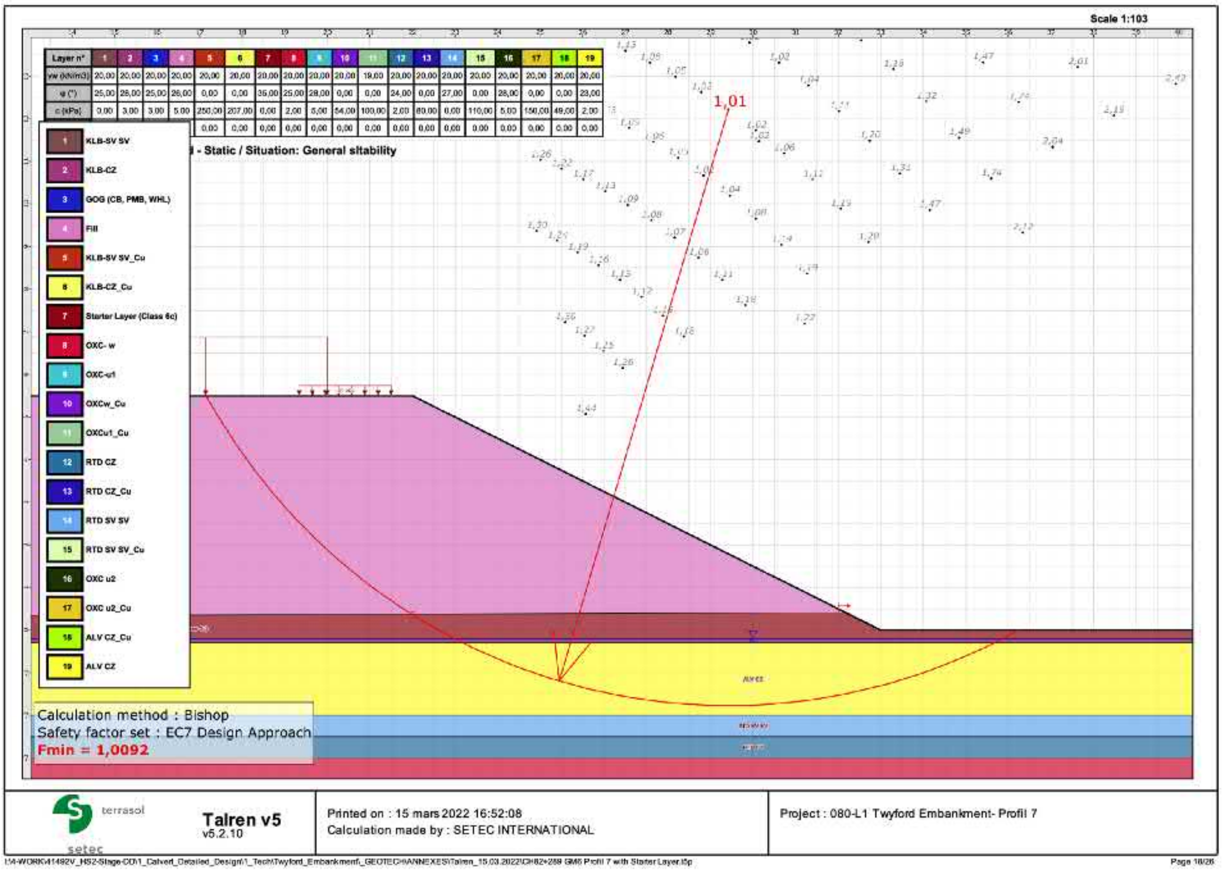
Number of slices : 100

Seismic properties : No

Results

Minimum safety factor : 1,0092

Coordinates of the critical centre and radius of the critical circle : N°= 684; X0= 29,42; Y0= 12,21; R= 13,98


Scale 1:103
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 19,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 25,00 26,00 25,00 26,00 0,00 0,00 35,00 25,00 28,00 0,00 0,00 24,00 0,00 27,00 0,00 28,00 0,00 0,00 23,00
c (kPa) 0,00 3,00 3,00 5,00 250,00 207,00 0,00 2,00 5,00 54,00 100,00 2,00 60,00 0,00 110,00 5,00 150,00 49,00 2,00
0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
- Static / Situation: General sitability
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
1,01
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,0092
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:52:08
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7

Data of the situation 1

Stage name : Seismic + 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 14,500

Search type : Imposed passage point

Imposed passage point : X= 31,570; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1686

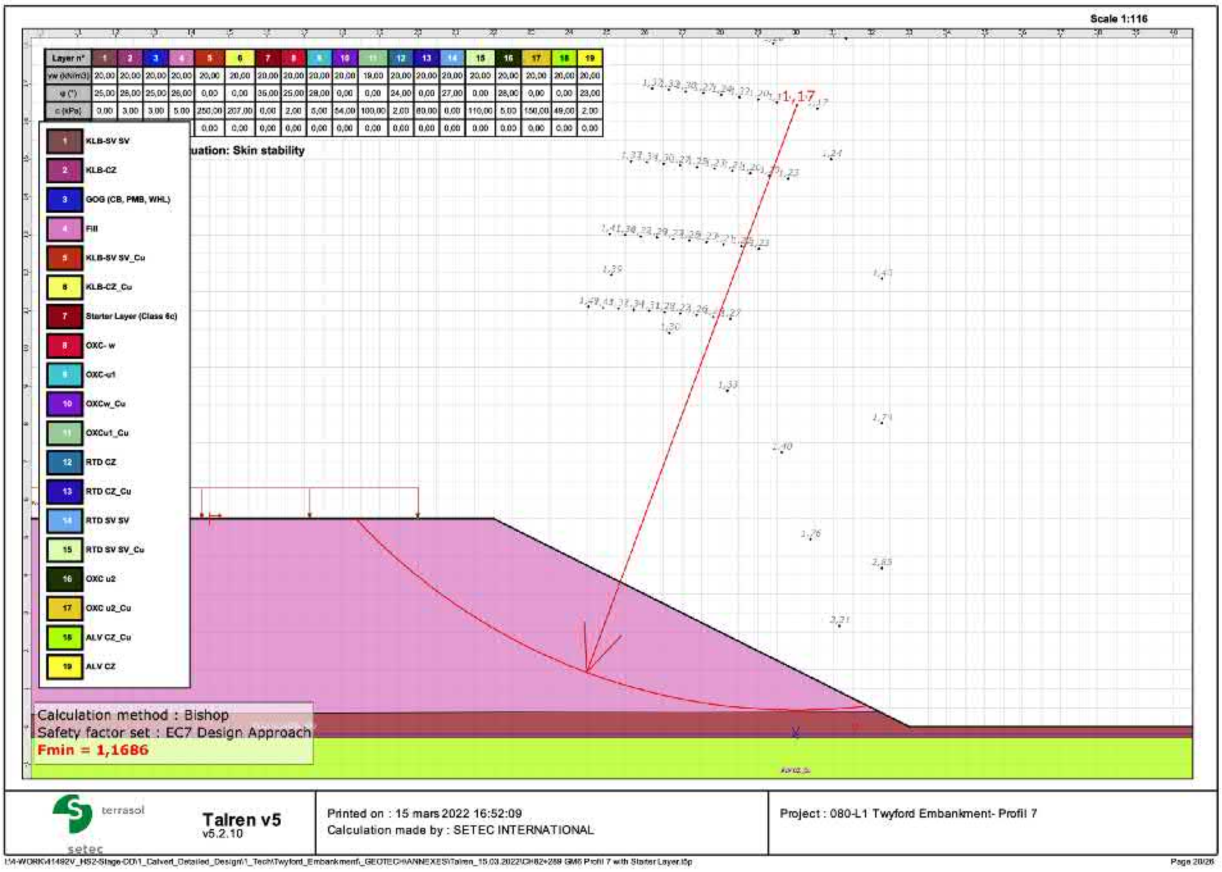
Coordinates of the critical centre and radius of the critical circle : N°= 335; X0= 30,03; Y0= 16,43; R= 15,99

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:52:08
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+289 GM6 Profil 7 with Starter Layer.t5p Page 19/26



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	19,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	26,00	25,00	26,00	0,00	0,00	35,00	25,00	28,00	0,00	0,00	24,00	0,00	27,00	0,00	28,00	0,00	0,00	23,00
c (kPa)	0,00	3,00	3,00	5,00	250,00	207,00	0,00	2,00	5,00	54,00	100,00	2,00	80,00	0,00	110,00	5,00	150,00	49,00	2,00
					0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Seismic + 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 32,000

Search type : Imposed passage point

Imposed passage point : X= 30,500; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

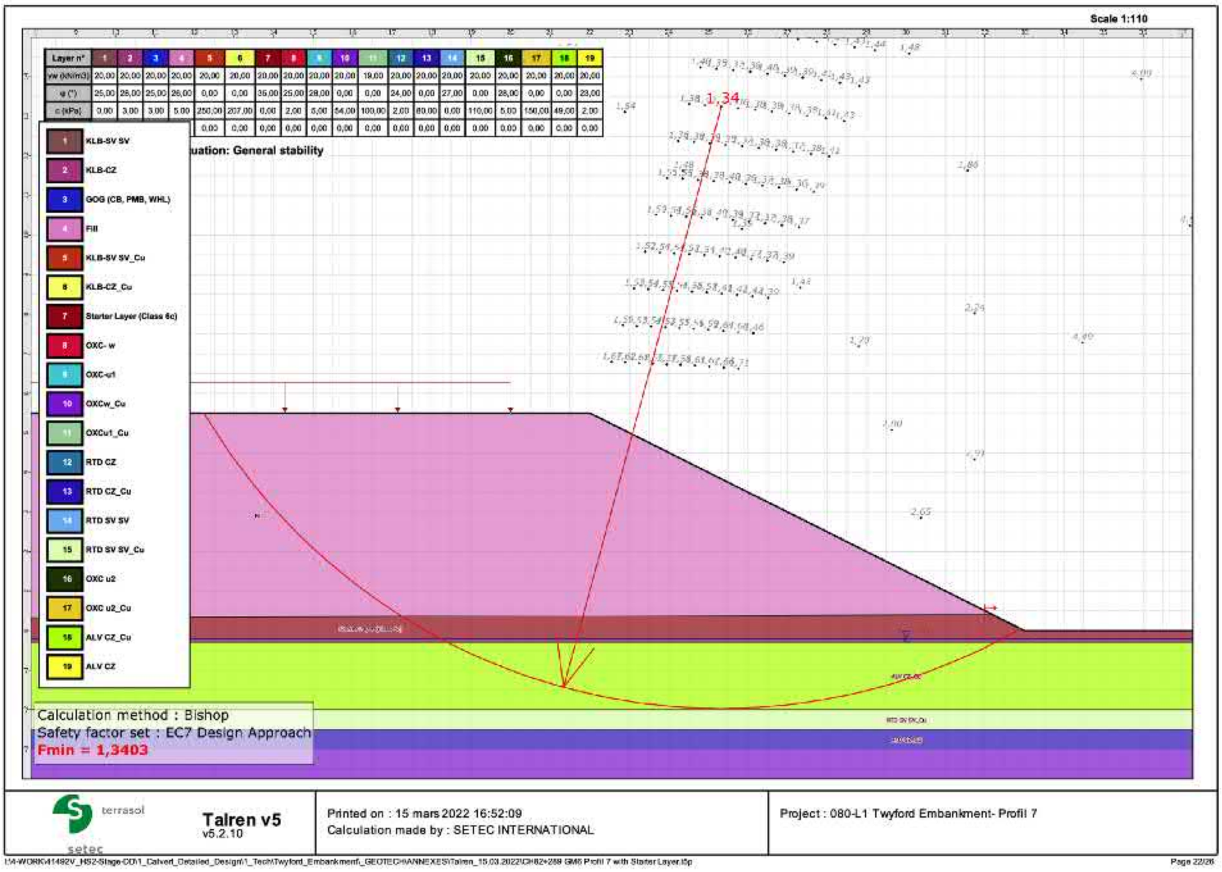
av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,3403

Coordinates of the critical centre and radius of the critical circle : N°= 521; X0= 25,33; Y0= 13,24; R= 15,21

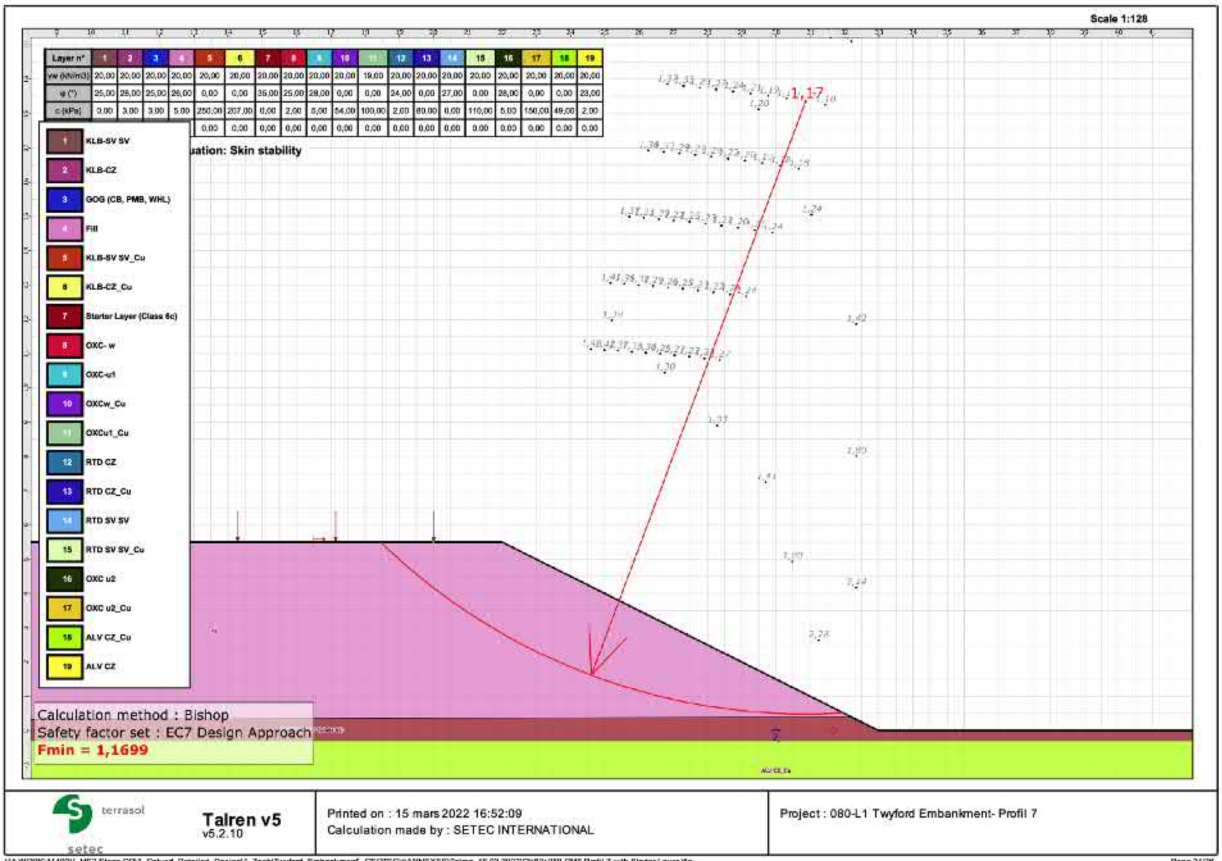

Scale 1:110
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 19,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 26,00 | 25,00 | 26,00 | 0,00 | 0,00 | 35,00 | 25,00 | 28,00 | 0,00 | 0,00 | 24,00 | 0,00 | 27,00 | 0,00 | 28,00 | 0,00 | 0,00 | 23,00
c (kPa) | 0,00 | 3,00 | 3,00 | 5,00 | 250,00 | 207,00 | 0,00 | 2,00 | 5,00 | 54,00 | 100,00 | 2,00 | 80,00 | 0,00 | 110,00 | 5,00 | 150,00 | 49,00 | 2,00
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
uation: General stability
1,34
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3403
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:52:09
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7
Page 22/26

Data of the situation 1

Stage name : Seismic - 2500
Situation name : Skin stability
Calculation method : Bishop
Safety factor set for this situation : EC7 Design Approach
Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular
Number of intervals : 10
Increment for circle radius : 0,500
Min abscissa of the circle emergence point : 16,500
Search type : Imposed passage point
Imposed passage point : X= 31,683; Y= 0,000
Number of slices : 100
Seismic properties : Yes
ah/g coefficient (horizontal acceleration) : 0,037
av/g coefficient (vertical acceleration) : -0,012
Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)
Results
Minimum safety factor : 1,1699
Coordinates of the critical centre and radius of the critical circle : N°= 341; X0= 30,86; Y0= 18,35; R= 17,86



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	19,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	26,00	25,00	26,00	0,00	0,00	35,00	25,00	28,00	0,00	0,00	24,00	0,00	27,00	0,00	28,00	0,00	0,00	23,00
c (kPa)	0,00	3,00	3,00	5,00	250,00	207,00	0,00	2,00	5,00	54,00	100,00	2,00	80,00	0,00	110,00	5,00	150,00	49,00	2,00
					0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

\\54-WORK\41492V_HS2-Stage-C0\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH82+289 GM6 Profil 7 with Starter Layer.t5p Page 24/26

HS2 Ltd - Code 1 - Accepted

Data of the situation 2

Stage name : Seismic - 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 16,500

Search type : Imposed passage point

Imposed passage point : X= 31,500; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : -0,012

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

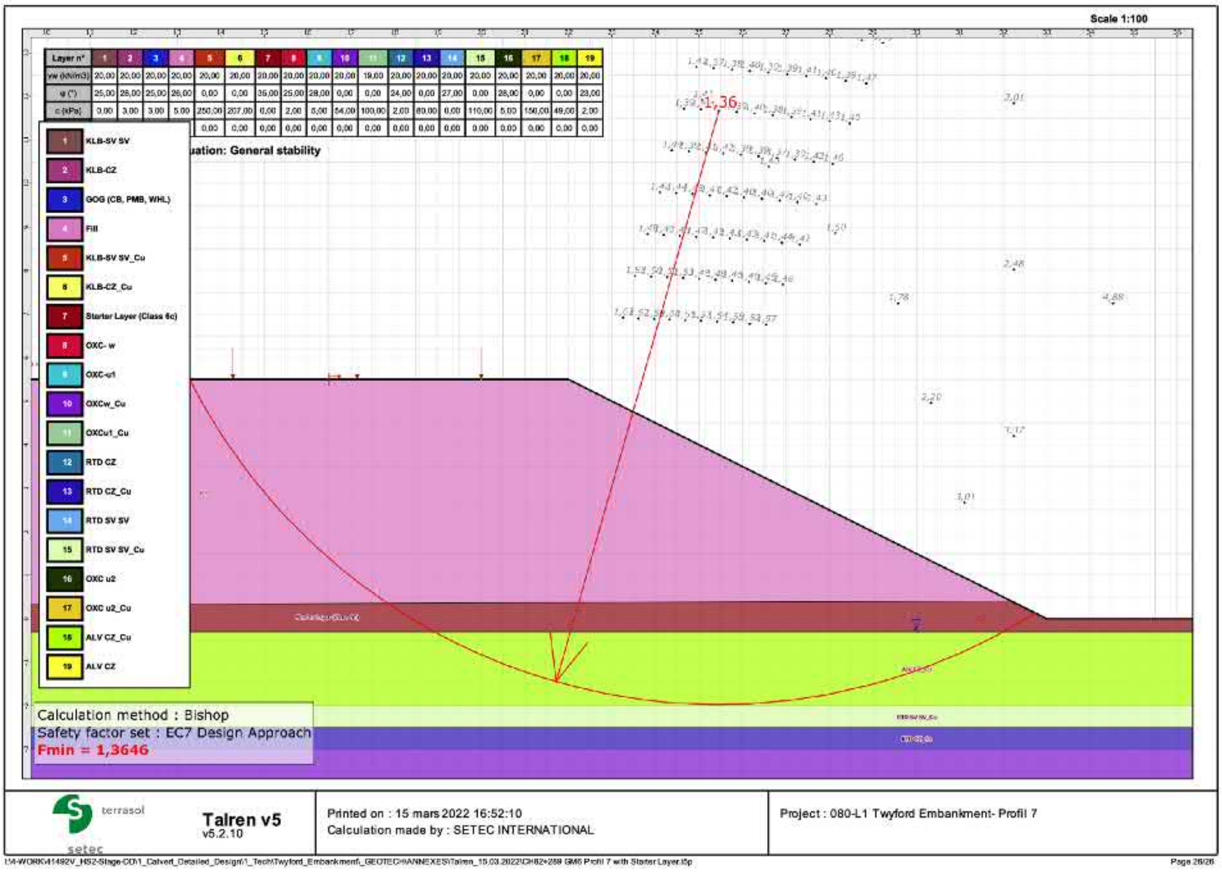
Minimum safety factor : 1,3646

Coordinates of the critical centre and radius of the critical circle : N°= 722; X0= 25,46; Y0= 11,67; R= 13,64

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 16:52:10
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7


Scale 1:100
Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
yw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	19,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	26,00	25,00	26,00	0,00	0,00	35,00	25,00	28,00	0,00	0,00	24,00	0,00	27,00	0,00	28,00	0,00	0,00	23,00
c (kPa)	0,00	3,00	3,00	5,00	250,00	207,00	0,00	2,00	5,00	54,00	100,00	2,00	80,00	0,00	110,00	5,00	150,00	49,00	2,00
					0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-SV SV_Cu
6 KLB-CZ_Cu
7 Starter Layer (Class 6c)
8 OXC- w
9 OXC-u1
10 OXCw_Cu
11 OXCu1_Cu
12 RTD CZ
13 RTD CZ_Cu
14 RTD SV SV
15 RTD SV SV_Cu
16 OXC u2
17 OXC u2_Cu
18 ALV CZ_Cu
19 ALV CZ
uation: General stability
1,36
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3646
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 16:52:10
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 7

A High-Speed Design Partnership

Project data

Project reference : HS2
Calculation title : 080-L1 Twyford Embankment- Profil 8
Location : H = 2m - Ch. 81+ 420 - Ground model 2
Comments : N/A
Units : kN, kPa, kN/m3
γw : 10.0

Soil layers

	Name	Colour	γ	φ	c	Δc	qs nails	pl	KsB	Anisotropy	Favorable	Specific safety factors
1	ALV CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No
2	KLB-SV SV		20,0	25,00	0,0	0,0	-	-	-	No	No	No
3	KLB-CZ		20,0	28,00	3,0	0,0	-	-	-	No	No	No
4	GOG (CB, PMB, WHL)		20,0	25,00	3,0	0,0	-	-	-	No	No	No
5	Fill		20,0	26,00	5,0	0,0	-	-	-	No	No	No
6	ALV CZ_Cu		20,0	0,00	49,0	0,0	-	-	-	No	No	No
7	KLB-CZ_Cu		20,0	0,00	207,0	0,0	-	-	-	No	No	No
8	KLB-SV SV_Cu		20,0	0,00	250,0	0,0	-	-	-	No	No	No
9	RTD SV SV		20,0	27,00	0,0	0,0	-	-	-	No	No	No
10	RTD SV SV_Cu		20,0	0,00	108,0	0,0	-	-	-	No	No	No
11	RTD CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No
12	RTD CZ_Cu		20,0	0,00	83,0	0,0	-	-	-	No	No	No
13	Starter Layer (Class 6c)		20,0	35,00	0,0	0,0	-	-	-	No	No	No

Soil layers (cont.)

	Name	Colour	Γγ	Γc	Γtan(φ)	Cohesion type	Curve
1	ALV CZ		-	-	-	Effective	Linear
2	KLB-SV SV		-	-	-	Effective	Linear
3	KLB-CZ		-	-	-	Effective	Linear
4	GOG (CB, PMB, WHL)		-	-	-	Effective	Linear
5	Fill		-	-	-	Effective	Linear
6	ALV CZ_Cu		-	-	-	Undrained	Linear
7	KLB-CZ_Cu		-	-	-	Undrained	Linear
8	KLB-SV SV_Cu		-	-	-	Undrained	Linear
9	RTD SV SV		-	-	-	Effective	Linear
10	RTD SV SV_Cu		-	-	-	Undrained	Linear
11	RTD CZ		-	-	-	Effective	Linear
12	RTD CZ_Cu		-	-	-	Undrained	Linear
13	Starter Layer (Class 6c)		-	-	-	Effective	Linear

Points

	X	Y		X	Y		X	Y		X	Y		X	Y		X	Y
2	60,000	0,000	3	0,000	-4,000	4	60,000	-4,000	11	0,000	2,000	13	26,000	0,000	32	60,000	-2,800
43	22,000	2,000	50	0,000	-2,800	64	0,000	-6,000	65	60,000	-6,000	68	0,000	-8,500	69	60,000	-8,500
70	0,000	-10,500	71	60,000	-10,500	80	25,400	0,300	82	0,000	-0,300	83	30,000	-0,000	84	0,000	0,300
86	26,531	-0,280															

Segments

	Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2
51	4	3	107	32	50	132	65	64	144	68	69	145	71	70	147	43	11	172	80	43
173	80	13	177	83	2	178	83	13	181	80	84	186	86	13	187	86	82			

Distributed loads

	Name	X left	Y left	q left	X right	Y right	q right	Ang/horizontal
1	10 kPa	19,343	2,000	10,0	21,500	2,000	10,0	90,00
2	57 kPa	0,000	2,000	57,0	19,344	2,000	57,0	90,00
3	20 kPa	0,000	2,000	20,0	21,500	2,000	20,0	90,00
4	30 kPa Seismic	0,000	2,000	30,0	19,344	2,000	30,0	90,00

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 17:05:04
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 8

Data of the situation 1

Stage name : Short term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 20,000

Search type : Imposed passage point

Imposed passage point : X= 26,315; Y= -0,292

Number of slices : 100

Seismic properties : No

Results

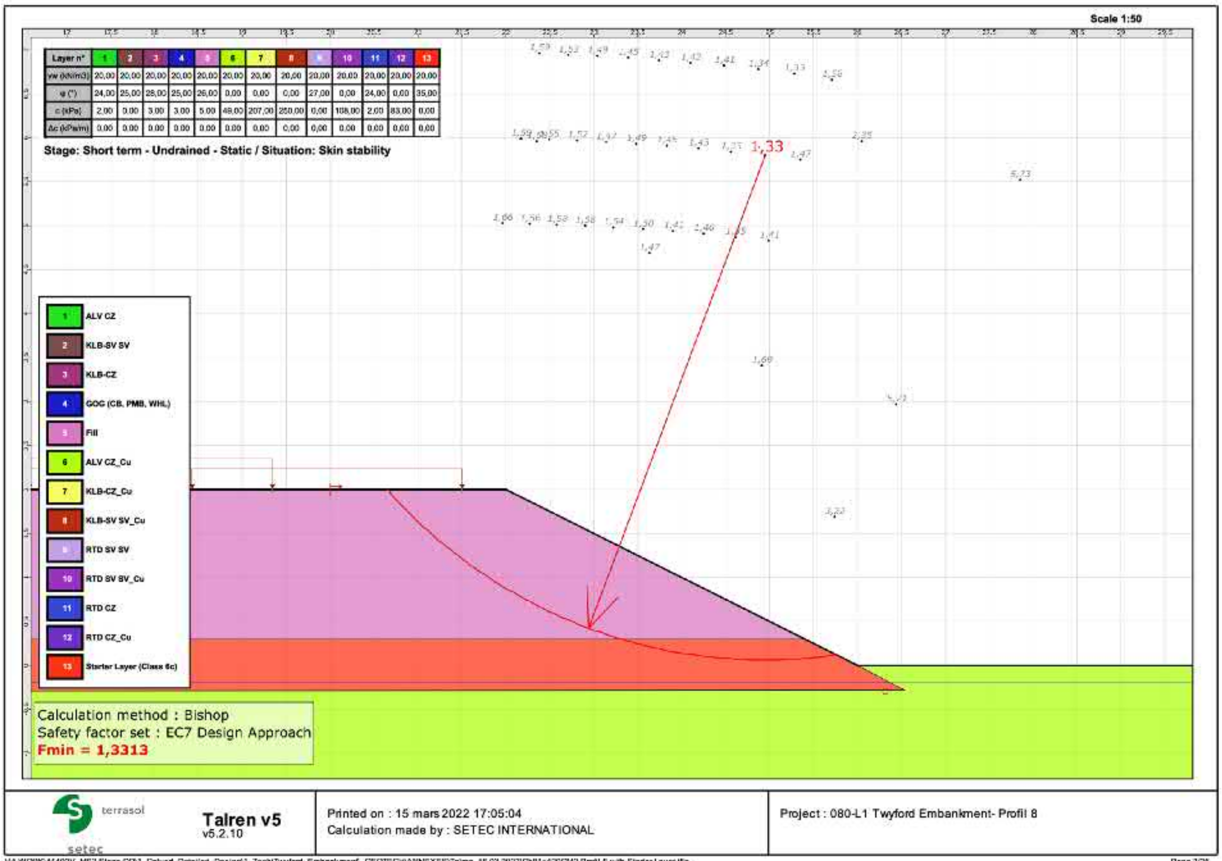
Minimum safety factor : 1,3313

Coordinates of the critical centre and radius of the critical circle : N°= 814; X0= 24,95; Y0= 5,80; R= 5,74

terrasol setec | **Talren v5** v5.2.10 | Printed on : 15 mars 2022 17:05:04
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 8

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\Ch81+420GM2 Profil 8 with Starter Layer.t5p

Page 2/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	49,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Short term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 20,000

Search type : Imposed passage point

Imposed passage point : X= 26,000; Y= -0,076

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

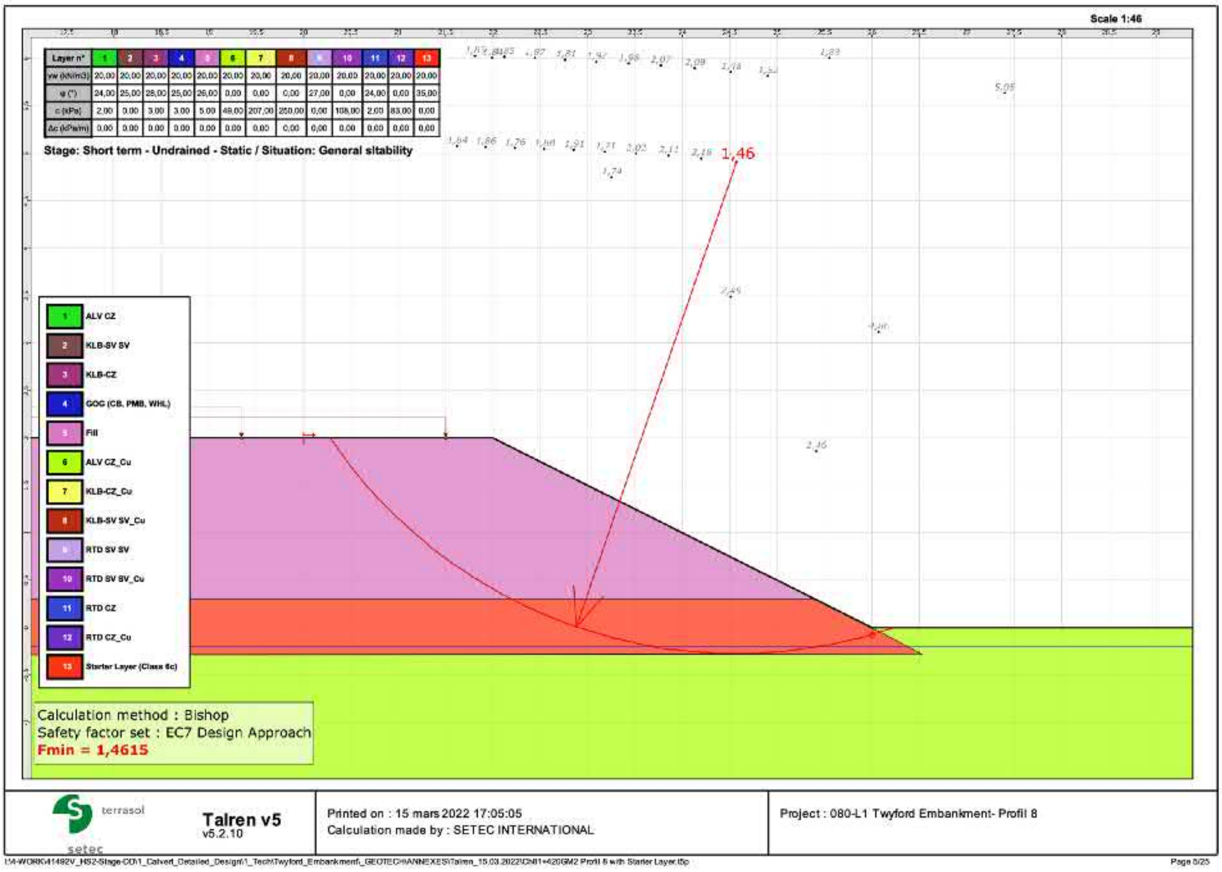
Minimum safety factor : 1,4615

Coordinates of the critical centre and radius of the critical circle : N°= 481; X0= 24,57; Y0= 4,91; R= 5,18

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 17:05:05
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 8

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\Ch81+420GM2 Profil 8 with Starter Layer.t5p Page 4/25


Scale 1:46
Layer n° 1 2 3 4 5 6 7 8 9 10 11 12 13
γw (kN/m3) 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00 20,00
φ (°) 24,00 25,00 28,00 25,00 26,00 0,00 0,00 0,00 27,00 0,00 24,00 0,00 35,00
c (kPa) 2,00 0,00 3,00 3,00 5,00 48,00 207,00 250,00 0,00 108,00 2,00 83,00 0,00
Δc (kPa/m) 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00
Stage: Short term - Undrained - Static / Situation: General sitability
1,46
1 ALV CZ
2 KLB-SV SV
3 KLB-CZ
4 GOG (CB, PMB, WHL)
5 Fill
6 ALV CZ_Cu
7 KLB-CZ_Cu
8 KLB-SV SV_Cu
9 RTD SV SV
10 RTD SV SV_Cu
11 RTD CZ
12 RTD CZ_Cu
13 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,4615
terrasol setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:05:05
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 8
Page 5/25

Data of the situation 1

Stage name : Short term - Drained - Static
Situation name : Skin stability
Calculation method : Bishop
Safety factor set for this situation : EC7 Design Approach
Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

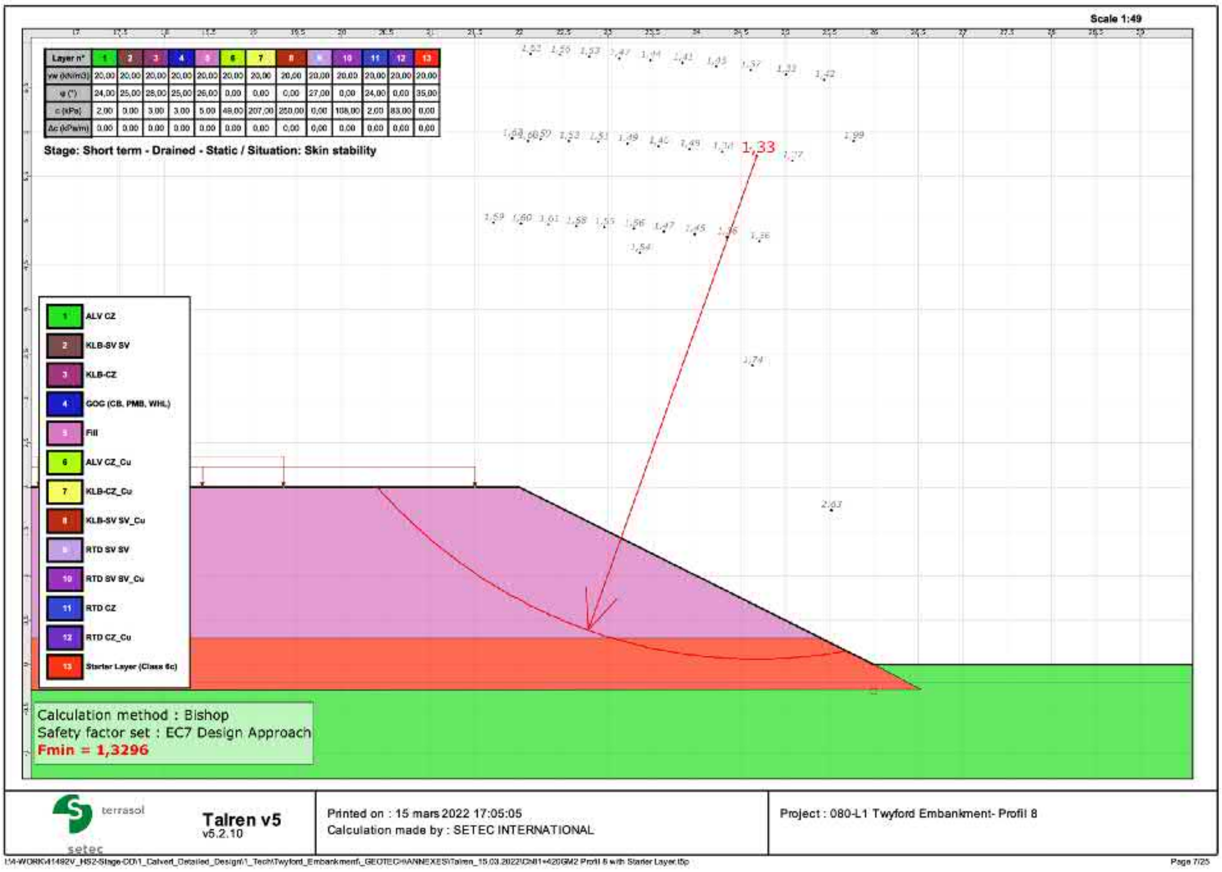
Type of failure surface : Automatic circular
Number of intervals : 10
Increment for circle radius : 0,500
Min abscissa of the circle emergence point : 17,000
Search type : Imposed passage point
Imposed passage point : X= 26,000; Y= -0,300
Number of slices : 100
Seismic properties : No
Passage conditions through soil layers : Must pass out in ALV CZ
Results
Minimum safety factor : 1,3296
Coordinates of the critical centre and radius of the critical circle : N°= 291; X0= 24,68; Y0= 5,73; R= 5,67

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 17:05:05
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 8

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\Ch81+420GM2 Profil 8 with Starter Layer.t5p



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Short term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 4,000

Search type : Imposed passage point

Imposed passage point : X= 23,837; Y= -0,500

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ

Results

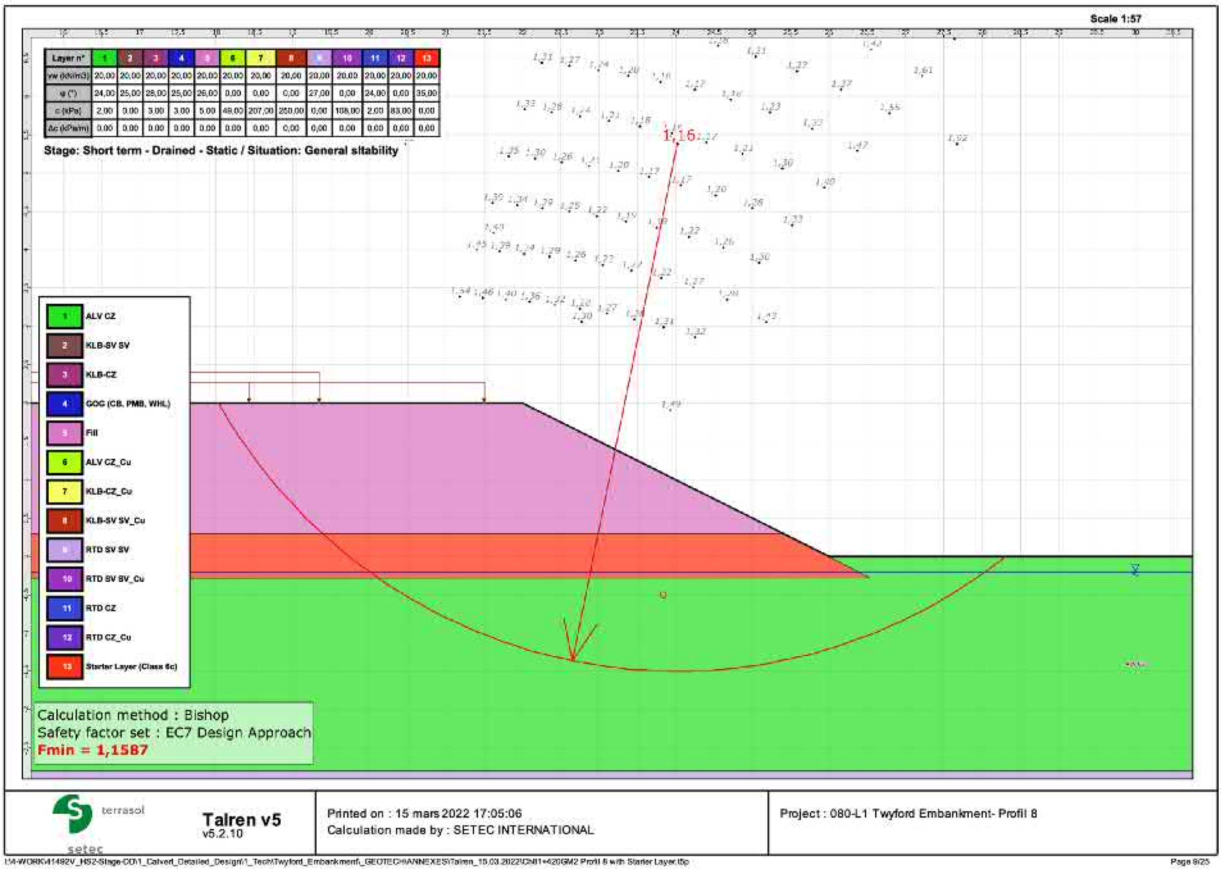
Minimum safety factor : 1,1587

Coordinates of the critical centre and radius of the critical circle : N°= 80; X0= 24,02; Y0= 5,38; R= 6,87

terrasol setec **Talren v5** v5.2.10

Printed on : 15 mars 2022 17:05:05
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 8

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\Ch81+420GM2 Profil 8 with Starter Layer.t5p Page 8/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

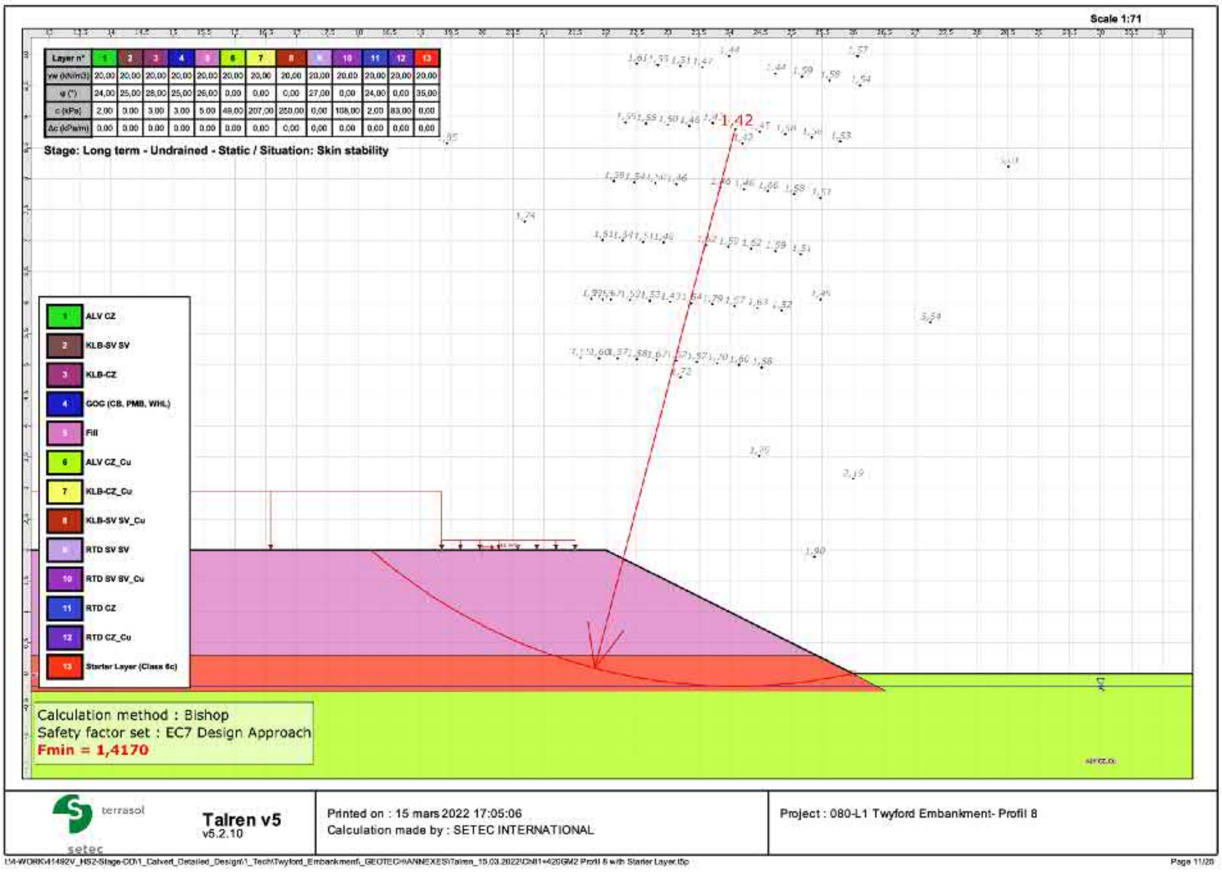
Stage name : Long term - Undrained - Static
Situation name : Skin stability
Calculation method : Bishop
Safety factor set for this situation : EC7 Design Approach
Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular
Number of intervals : 10
Increment for circle radius : 0,500
Min abscissa of the circle emergence point : 20,000
Search type : Imposed passage point
Imposed passage point : X= 26,000; Y= 0,000
Number of slices : 100
Seismic properties : No
Passage conditions through soil layers : Must pass in in Starter Layer (Class 6c)
Results
Minimum safety factor : 1,4170
Coordinates of the critical centre and radius of the critical circle : N°= 709; X0= 24,09; Y0= 8,80; R= 9,00

terrasol setec | **Talren v5** v5.2.10 | Printed on : 15 mars 2022 17:05:06
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 8

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\Ch81+420GM2 Profil 8 with Starter Layer.t5p Page 10/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	49,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Long term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 7,684

Search type : Imposed passage point

Imposed passage point : X= 26,127; Y= -0,280

Number of slices : 100

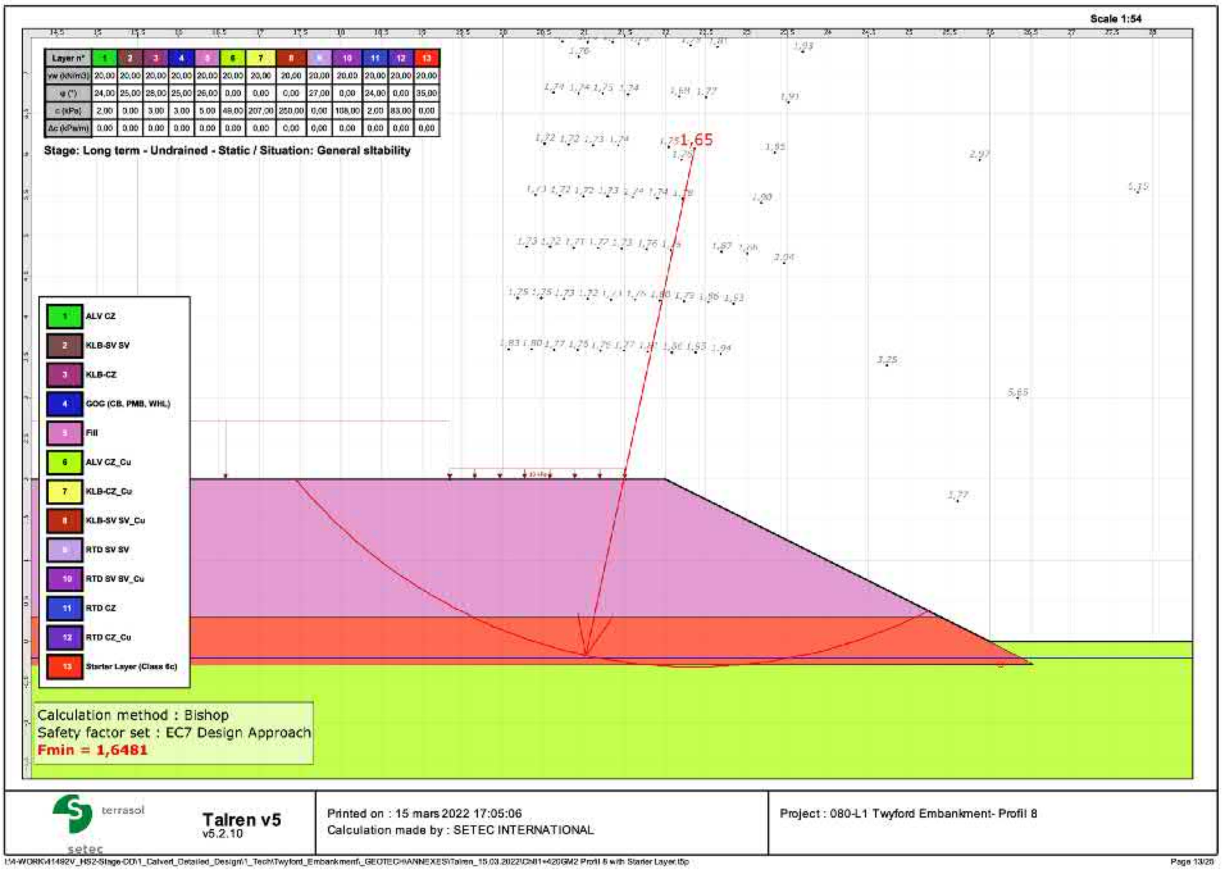
Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,6481

Coordinates of the critical centre and radius of the critical circle : N°= 691; X0= 22,36; Y0= 6,07; R= 6,38



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	49,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Long term - Drained -Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 17,000

Search type : Imposed passage point

Imposed passage point : X= 25,946; Y= 0,027

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in ALV CZ

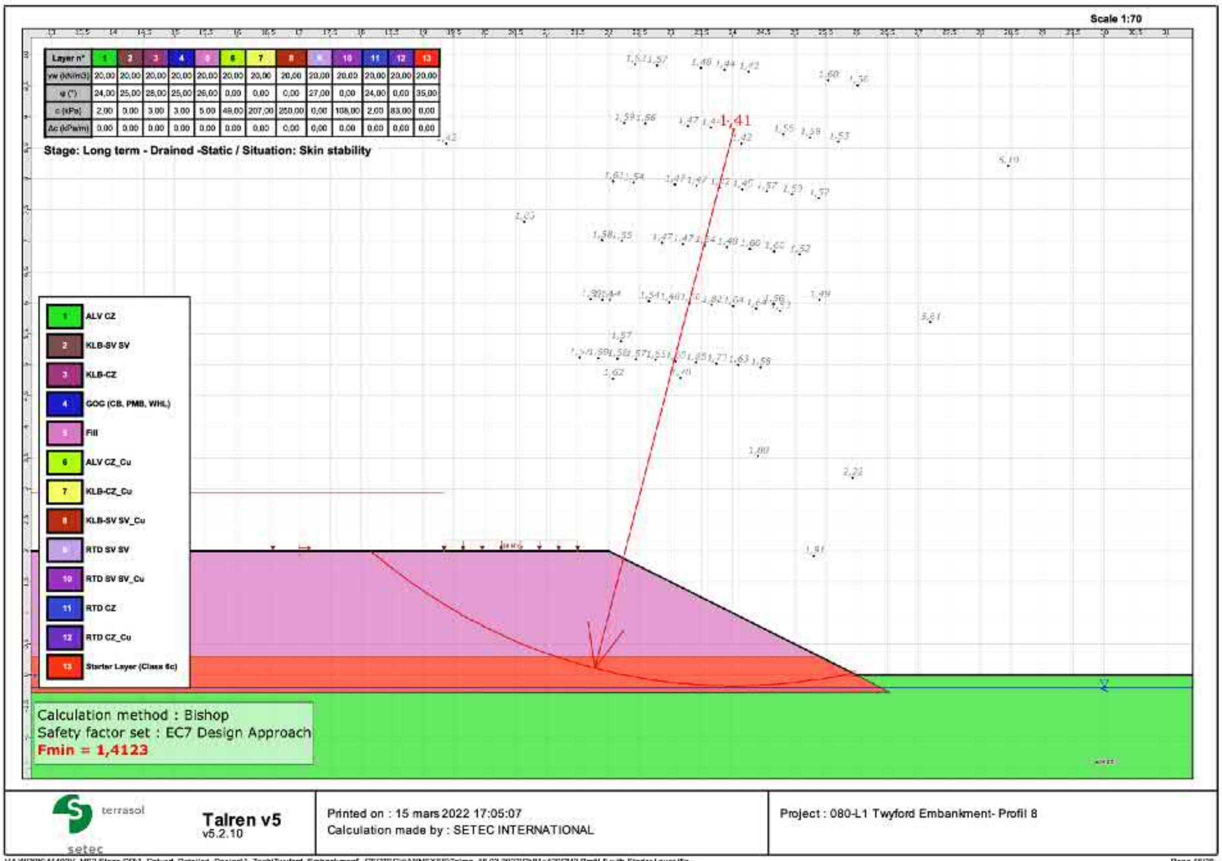
Results

Minimum safety factor : 1,4123

Coordinates of the critical centre and radius of the critical circle : N°= 448; X0= 24,02; Y0= 8,80; R= 8,97

terrasol setec | **Talren v5** v5.2.10 | Printed on : 15 mars 2022 17:05:07
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 8

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\Ch81+420GM2 Profil 8 with Starter Layer.t5p Page 14/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Long term - Drained -Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 0,500

Search type : Imposed passage point

Imposed passage point : X= 32,500; Y= 0,000

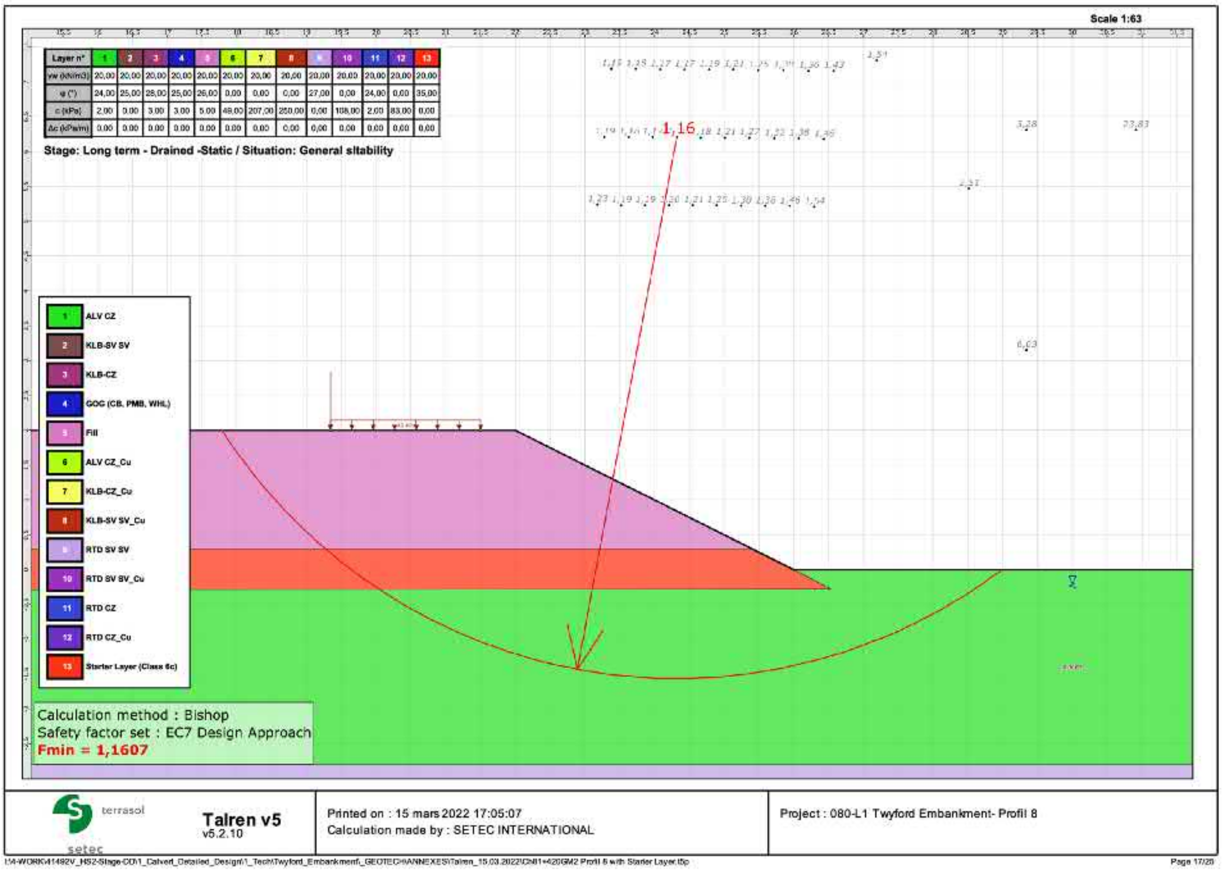
Number of slices : 100

Seismic properties : No

Results

Minimum safety factor : 1,1607

Coordinates of the critical centre and radius of the critical circle : N°= 1218; X0= 24,32; Y0= 6,21; R= 7,77



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Seismic + 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 14,500

Search type : Imposed passage point

Imposed passage point : X= 26,000; Y= 0,000

Number of slices : 100

Seismic properties : Yes

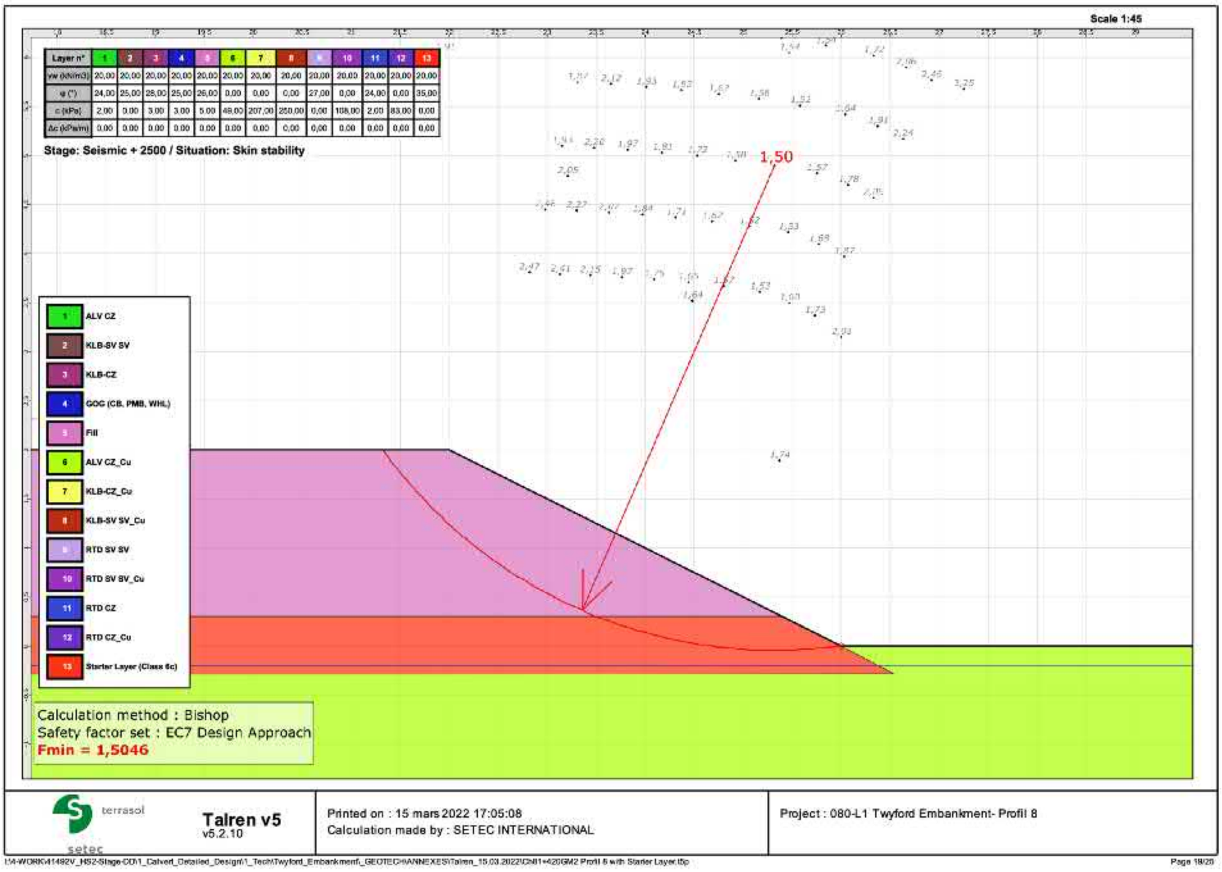
ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : 0,012

Results

Minimum safety factor : 1,5046

Coordinates of the critical centre and radius of the critical circle : N°= 884; X0= 25,32; Y0= 4,90; R= 4,94



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Seismic + 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 2,500

Search type : Imposed passage point

Imposed passage point : X= 26,213; Y= -0,280

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

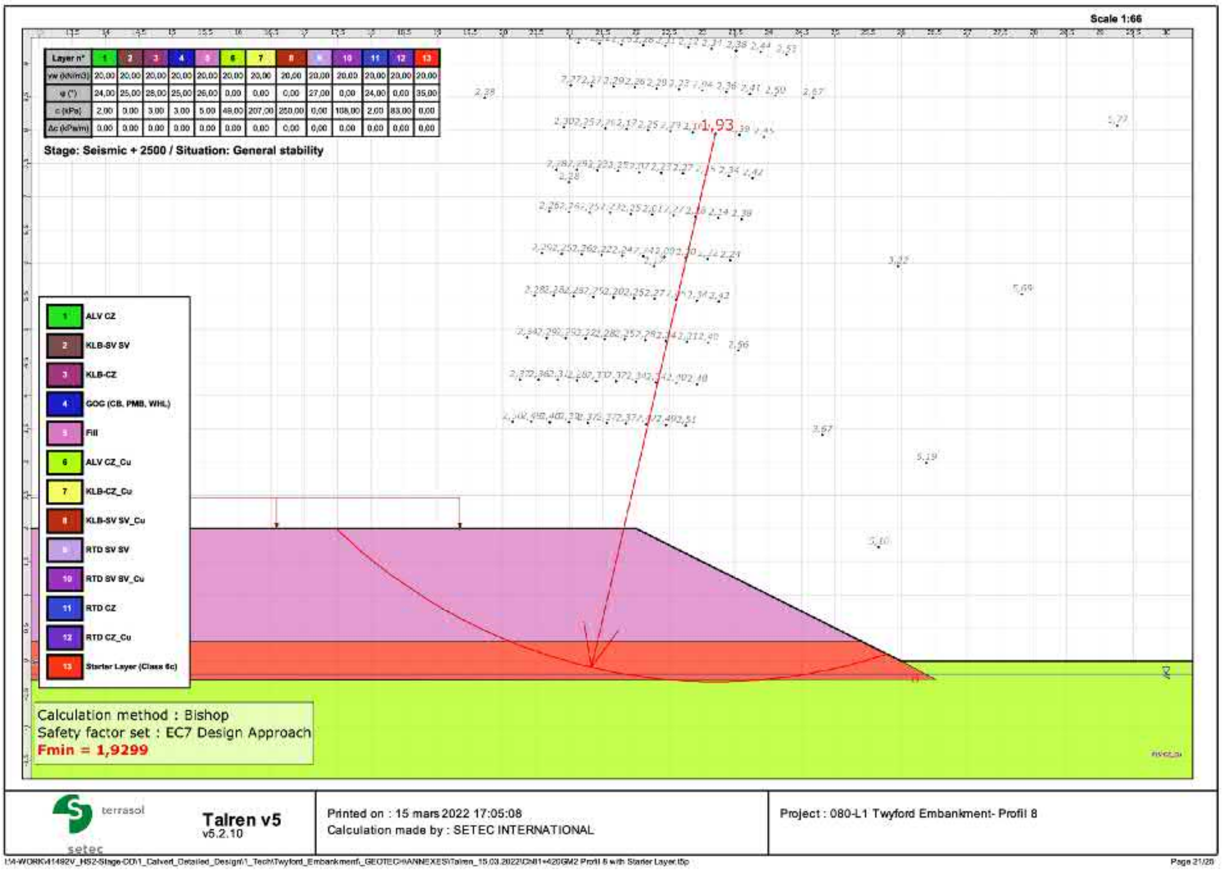
av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,9299

Coordinates of the critical centre and radius of the critical circle : N°= 652; X0= 23,20; Y0= 7,95; R= 8,26



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Seismic - 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 16,000

Search type : Imposed passage point

Imposed passage point : X= 26,145; Y= -0,165

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : -0,012

Results

Minimum safety factor : 1,5864

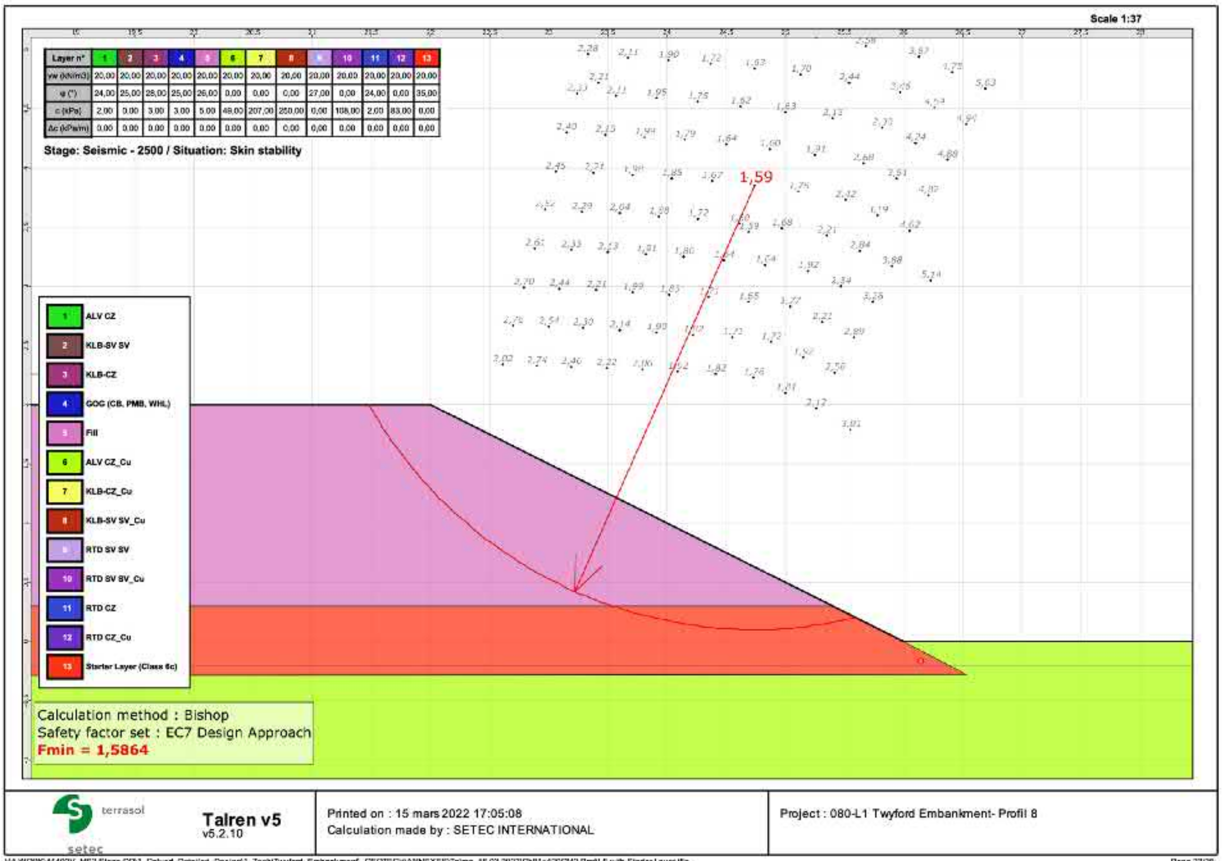
Coordinates of the critical centre and radius of the critical circle : N°= 1024; X0= 24,74; Y0= 3,85; R= 3,75

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 17:05:08
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 8

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\Ch81+420GM2 Profil 8 with Starter Layer.t5p



Layer n°	1	2	3	4	5	6	7	8	[illegible]	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Page 23/29

Data of the situation 2

Stage name : Seismic - 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 4,500

Search type : Imposed passage point

Imposed passage point : X= 26,115; Y= -0,181

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : -0,012

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

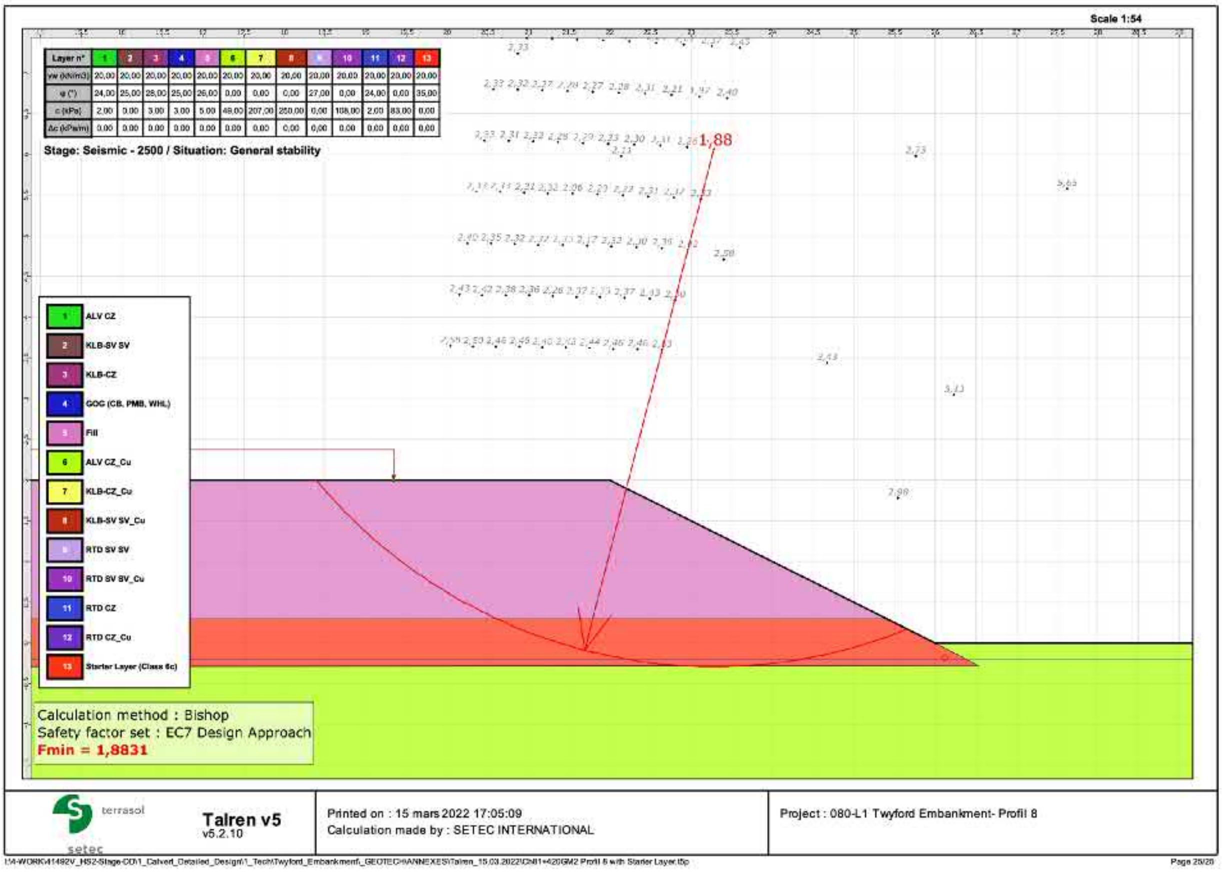
Minimum safety factor : 1,8831

Coordinates of the critical centre and radius of the critical circle : N°= 516; X0= 23,28; Y0= 6,07; R= 6,36

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 17:05:09
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 8



Layer n°	1	2	3	4	5	6	7	8	9	10	11	12	13
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	24,00	25,00	28,00	25,00	26,00	0,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	2,00	0,00	3,00	3,00	5,00	48,00	207,00	250,00	0,00	108,00	2,00	83,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Project data

Project reference : HS2
Calculation title : 080-L1 Twyford Embankment- Profil 9
Location : H = 5.6m - Ch. 81+ 560 - Ground model 3
Comments : N/A
Units : kN, kPa, kN/m3
γw : 10.0

Soil layers

	Name	Colour	γ	φ	c	Δc	qs nails	pl	KsB	Anisotropy	Favorable	Specific safety factors
1	KLB-SV SV		20,0	25,00	0,0	0,0	-	-	-	No	No	No
2	KLB-CZ		20,0	28,00	3,0	0,0	-	-	-	No	No	No
3	GOG (CB, PMB, WHL)		20,0	25,00	3,0	0,0	-	-	-	No	No	No
4	Fill		20,0	26,00	5,0	0,0	-	-	-	No	No	No
5	KLB-CZ_Cu		20,0	0,00	207,0	0,0	-	-	-	No	No	No
6	KLB-SV SV_Cu		20,0	0,00	250,0	0,0	-	-	-	No	No	No
7	RTD SV SV		20,0	27,00	0,0	0,0	-	-	-	No	No	No
8	RTD SV SV_Cu		20,0	0,00	108,0	0,0	-	-	-	No	No	No
9	RTD CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No
10	RTD CZ_Cu		20,0	0,00	80,0	0,0	-	-	-	No	No	No
11	Starter Layer (Class 6c)		20,0	35,00	0,0	0,0	-	-	-	No	No	No

Soil layers (cont.)

	Name	Colour	Γγ	Γc	Γtan(φ)	Cohesion type	Curve
1	KLB-SV SV		-	-	-	Effective	Linear
2	KLB-CZ		-	-	-	Effective	Linear
3	GOG (CB, PMB, WHL)		-	-	-	Effective	Linear
4	Fill		-	-	-	Effective	Linear
5	KLB-CZ_Cu		-	-	-	Undrained	Linear
6	KLB-SV SV_Cu		-	-	-	Undrained	Linear
7	RTD SV SV		-	-	-	Effective	Linear
8	RTD SV SV_Cu		-	-	-	Undrained	Linear
9	RTD CZ		-	-	-	Effective	Linear
10	RTD CZ_Cu		-	-	-	Undrained	Linear
11	Starter Layer (Class 6c)		-	-	-	Effective	Linear

Points

	X	Y		X	Y		X	Y		X	Y		X	Y		X	Y
2	60,000	0,000	3	0,000	-2,800	4	60,000	-2,800	11	0,000	5,600	13	33,200	0,000	43	22,000	5,600
64	0,000	-3,700	65	60,000	-3,700	68	0,000	-5,000	69	60,000	-5,000	70	0,000	-6,200	71	60,000	-6,200
75	0,000	0,300	76	0,000	-0,300	78	60,000	-0,300	80	32,666	0,267	81	33,712	-0,300			

Segments

	Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2
51	4	3	132	65	64	142	2	13	144	68	69	145	71	70	147	43	11	163	75	80
164	80	13	165	80	43	166	76	81	167	78	81	168	13	81						

Distributed loads

	Name	X left	Y left	q left	X right	Y right	q right	Ang/horizontal
1	10 kPa	19,343	5,600	10,0	21,500	5,600	10,0	90,00
2	57 kPa	0,000	5,600	57,0	19,344	5,600	57,0	90,00
3	20 kPa	0,000	5,600	20,0	21,500	5,600	20,0	90,00
4	30 kPa Seismic	0,000	5,600	30,0	19,344	5,600	30,0	90,00

Data of the situation 1

Stage name : Short term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 20,000

Search type : Imposed passage point

Imposed passage point : X= 32,500; Y= 0,000

Number of slices : 100

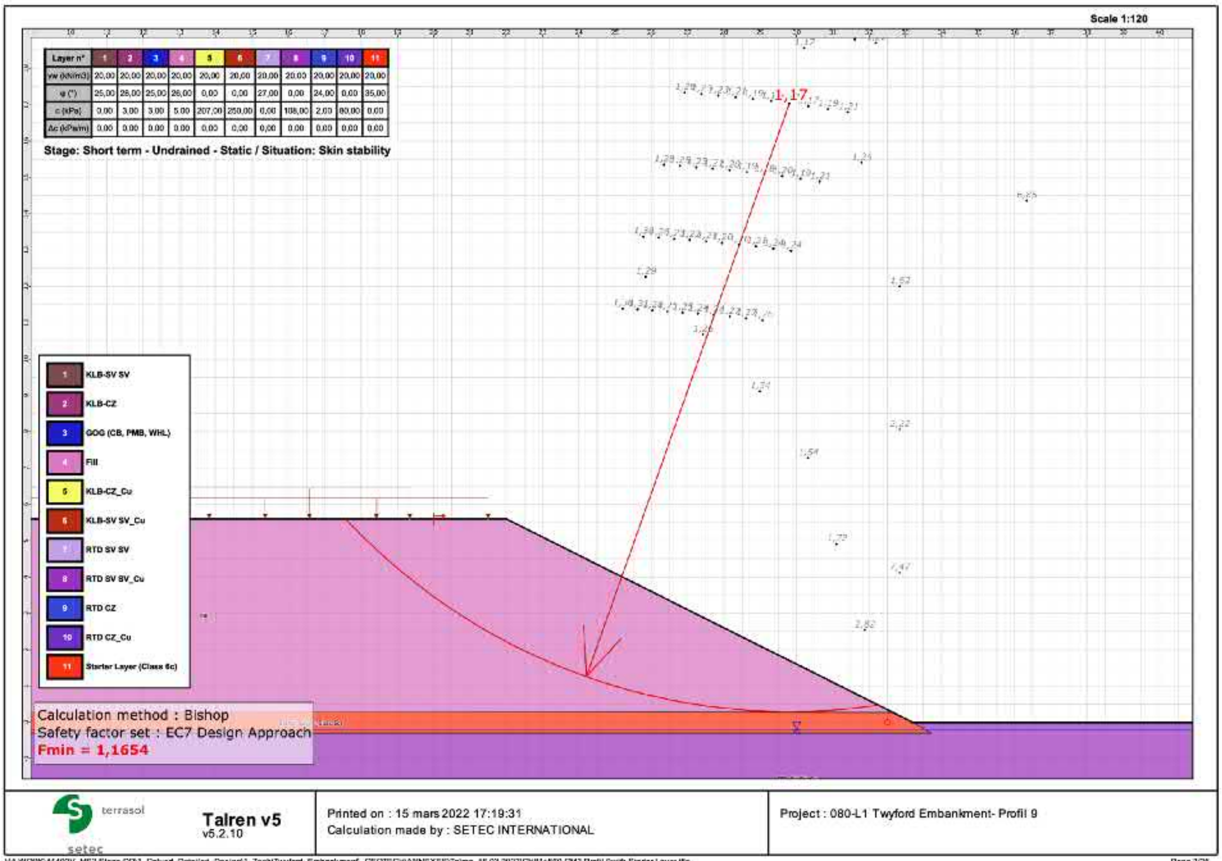
Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1654

Coordinates of the critical centre and radius of the critical circle : N°= 476; X0= 29,80; Y0= 17,03; R= 16,74


Scale 1:120
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 26,00 | 25,00 | 26,00 | 0,00 | 0,00 | 27,00 | 0,00 | 24,00 | 0,00 | 35,00
c (kPa) | 0,00 | 3,00 | 3,00 | 5,00 | 207,00 | 250,00 | 0,00 | 108,00 | 2,00 | 80,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Short term - Undrained - Static / Situation: Skin stability
1,17
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-CZ_Cu
6 KLB-SV SV_Cu
7 RTD SV SV
8 RTD SV SV_Cu
9 RTD CZ
10 RTD CZ_Cu
11 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1654
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:19:31
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 9
Page 3/25

Data of the situation 2

Stage name : Short term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 3,000

Search type : Imposed passage point

Imposed passage point : X= 33,000; Y= -0,797

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass in in RTD SV SV_Cu

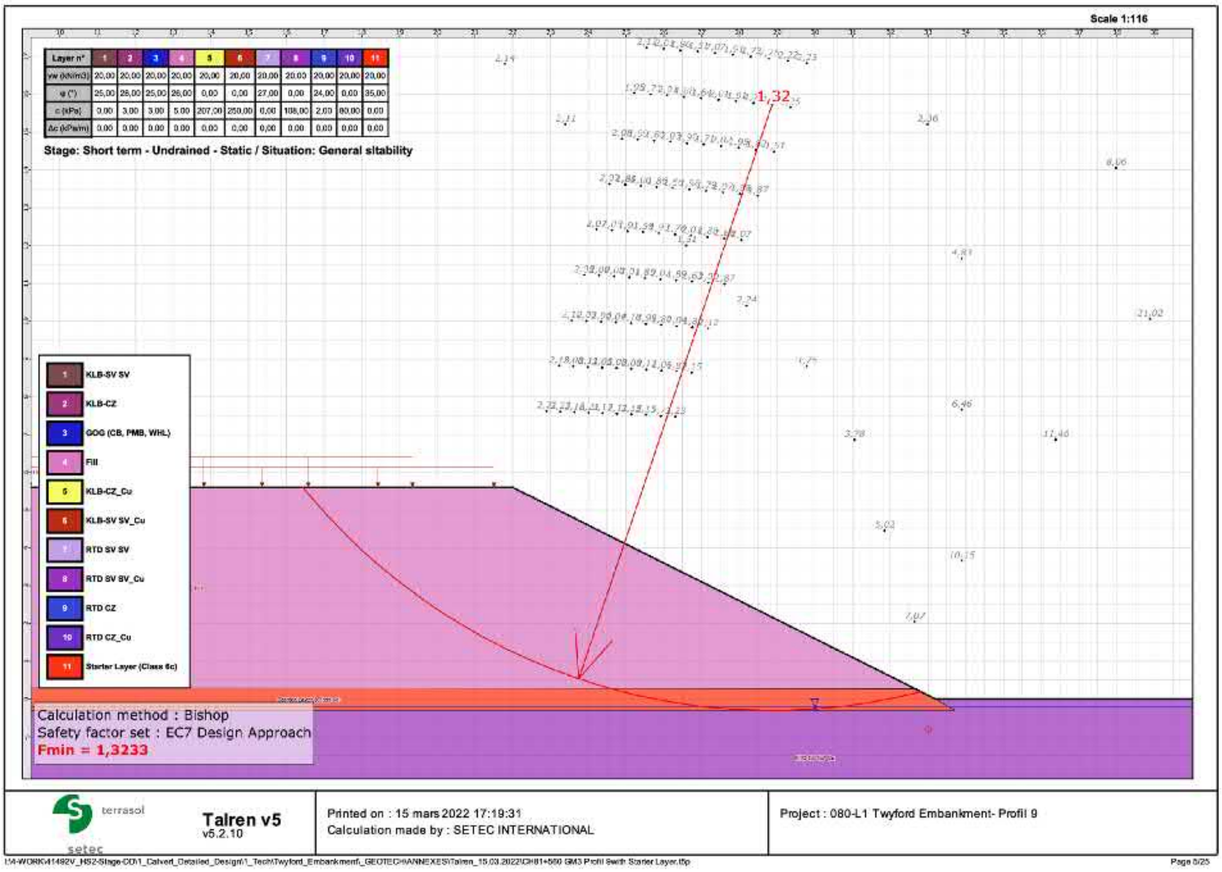
Results

Minimum safety factor : 1,3233

Coordinates of the critical centre and radius of the critical circle : N°= 423; X0= 28,87; Y0= 15,72; R= 16,02

terrasol setec | **Talren v5** v5.2.10 | Printed on : 15 mars 2022 17:19:31
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 9

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+560 GM3 Profil 9with Starter Layer.t5p


Scale 1:116
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 26,00 | 25,00 | 26,00 | 0,00 | 0,00 | 27,00 | 0,00 | 24,00 | 0,00 | 35,00
c (kPa) | 0.00 | 3.00 | 3.00 | 5.00 | 207,00 | 250,00 | 0,00 | 108,00 | 2,00 | 80,00 | 0.00
Δc (kPa/m) | 0.00 | 0.00 | 0.00 | 0.00 | 0,00 | 0,00 | 0,00 | 0.00 | 0,00 | 0,00 | 0.00
Stage: Short term - Undrained - Static / Situation: General sitability
1,32
KLB-SV SV
KLB-CZ
GOG (CB, PMB, WHL)
Fill
KLB-CZ_Cu
KLB-SV SV_Cu
RTD SV SV
RTD SV SV_Cu
RTD CZ
RTD CZ_Cu
Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3233
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:19:31
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 9
Page 5/25

Data of the situation 1

Stage name : Short term - Drained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 17,000

Search type : Imposed passage point

Imposed passage point : X= 32,235; Y= 0,124

Number of slices : 100

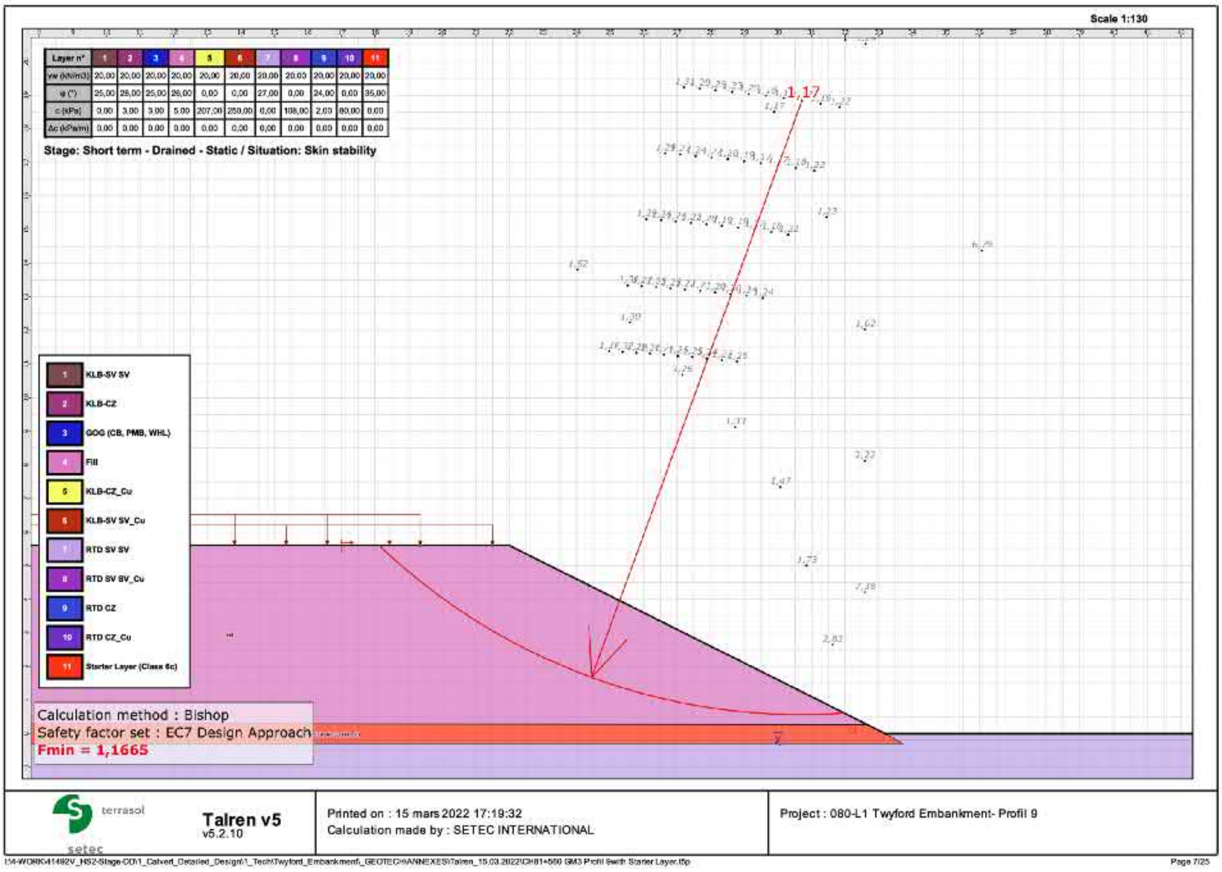
Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1665

Coordinates of the critical centre and radius of the critical circle : N°= 449; X0= 30,71; Y0= 18,83; R= 18,26


Scale 1:130
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 26,00 | 25,00 | 26,00 | 0,00 | 0,00 | 27,00 | 0,00 | 24,00 | 0,00 | 35,00
c (kPa) | 0,00 | 3,00 | 3,00 | 5,00 | 207,00 | 250,00 | 0,00 | 108,00 | 2,00 | 80,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Short term - Drained - Static / Situation: Skin stability
1,17
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-CZ_Cu
6 KLB-SV SV_Cu
7 RTD SV SV
8 RTD SV SV_Cu
9 RTD CZ
10 RTD CZ_Cu
11 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1665
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:19:32
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 9
Page 7/25

Data of the situation 2

Stage name : Short term - Drained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 0,500

Search type : Imposed passage point

Imposed passage point : X= 32,500; Y= 0,000

Number of slices : 100

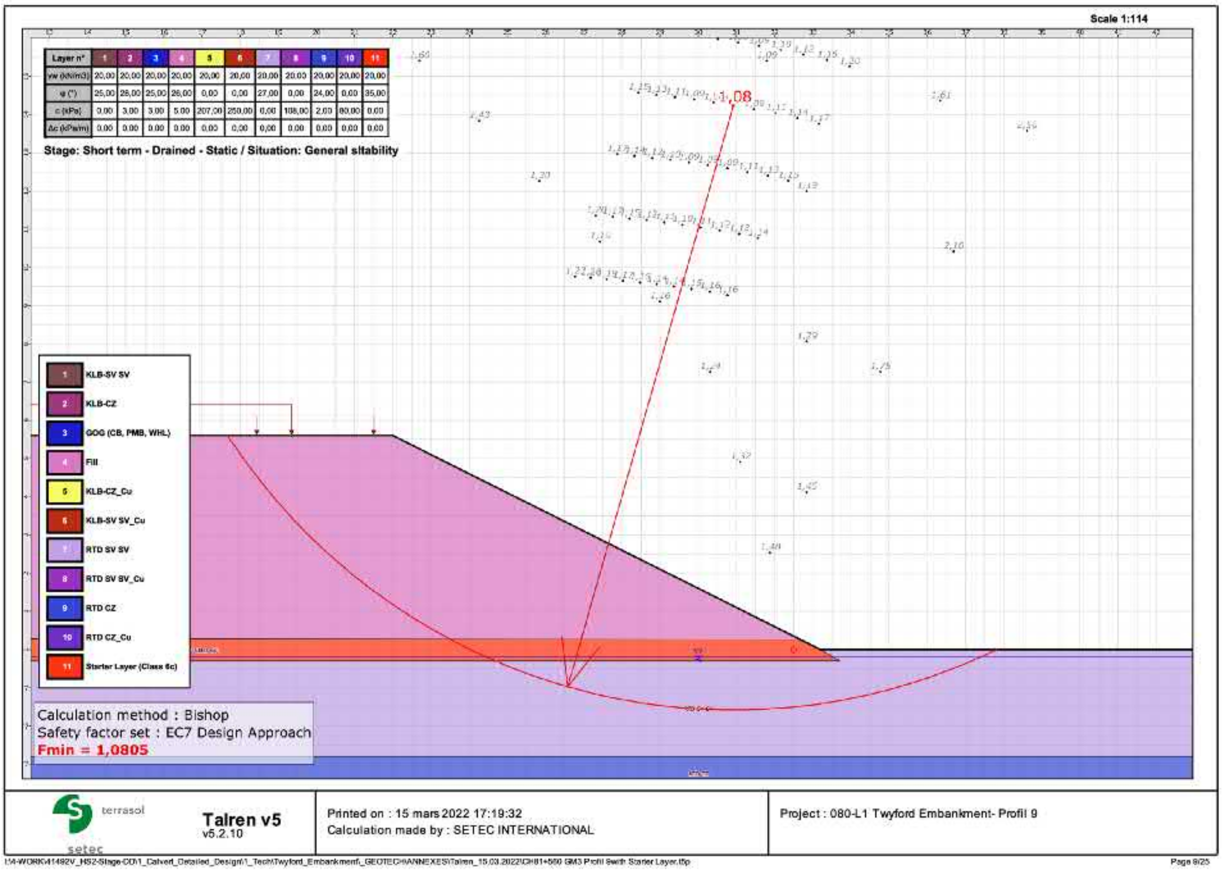
Seismic properties : No

Passage conditions through soil layers : Must pass in in RTD SV SV

Results

Minimum safety factor : 1,0805

Coordinates of the critical centre and radius of the critical circle : N°= 473; X0= 30,92; Y0= 14,24; R= 15,82



Layer n°	1	2	3	4	5	6	7	8	9	10	11
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	26,00	25,00	26,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	0,00	3,00	3,00	5,00	207,00	250,00	0,00	108,00	2,00	80,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Long term - Undrained - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 20,000

Search type : Imposed passage point

Imposed passage point : X= 32,500; Y= 0,000

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1701

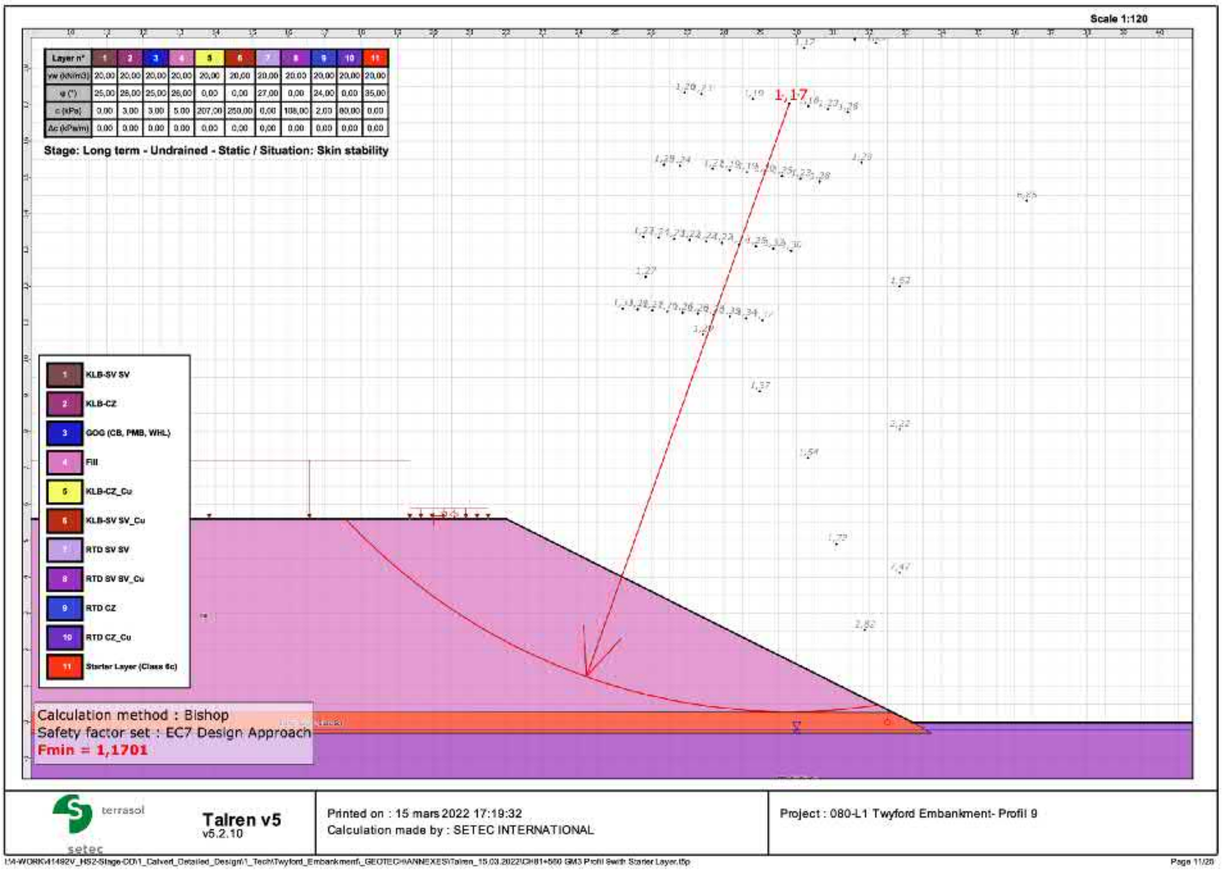
Coordinates of the critical centre and radius of the critical circle : N°= 470; X0= 29,80; Y0= 17,03; R= 16,74

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 17:19:32
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 9

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+560 GM3 Profil 9with Starter Layer.t5p


Scale 1:120
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 26,00 | 25,00 | 26,00 | 0,00 | 0,00 | 27,00 | 0,00 | 24,00 | 0,00 | 35,00
c (kPa) | 0,00 | 3,00 | 3,00 | 5,00 | 207,00 | 250,00 | 0,00 | 108,00 | 2,00 | 80,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Long term - Undrained - Static / Situation: Skin stability
1,17
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-CZ_Cu
6 KLB-SV SV_Cu
7 RTD SV SV
8 RTD SV SV_Cu
9 RTD CZ
10 RTD CZ_Cu
11 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1701
terrasol setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:19:32
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 9

Data of the situation 2

Stage name : Long term - Undrained - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 31,000

Search type : Imposed passage point

Imposed passage point : X= 26,000; Y= 1,500

Number of slices : 100

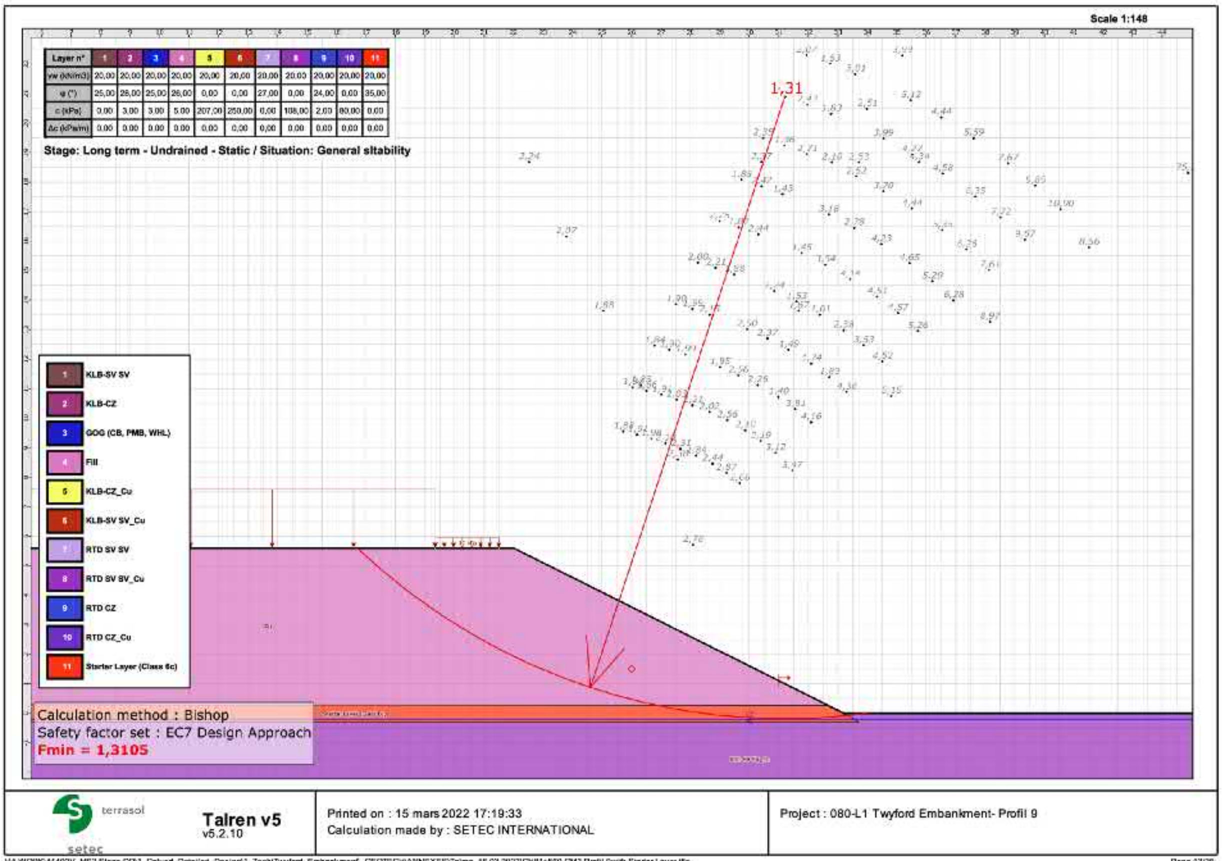
Seismic properties : No

Passage conditions through soil layers : Must pass in in RTD SV SV_Cu

Results

Minimum safety factor : 1,3105

Coordinates of the critical centre and radius of the critical circle : N°= 550; X0= 31,20; Y0= 20,89; R= 21,08



Layer n°	1	2	3	4	5	6	7	8	9	10	11
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	26,00	25,00	26,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	0,00	3,00	3,00	5,00	207,00	250,00	0,00	108,00	2,00	80,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Long term - Drained -Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 17,000

Search type : Imposed passage point

Imposed passage point : X= 32,235; Y= 0,124

Number of slices : 100

Seismic properties : No

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,1714

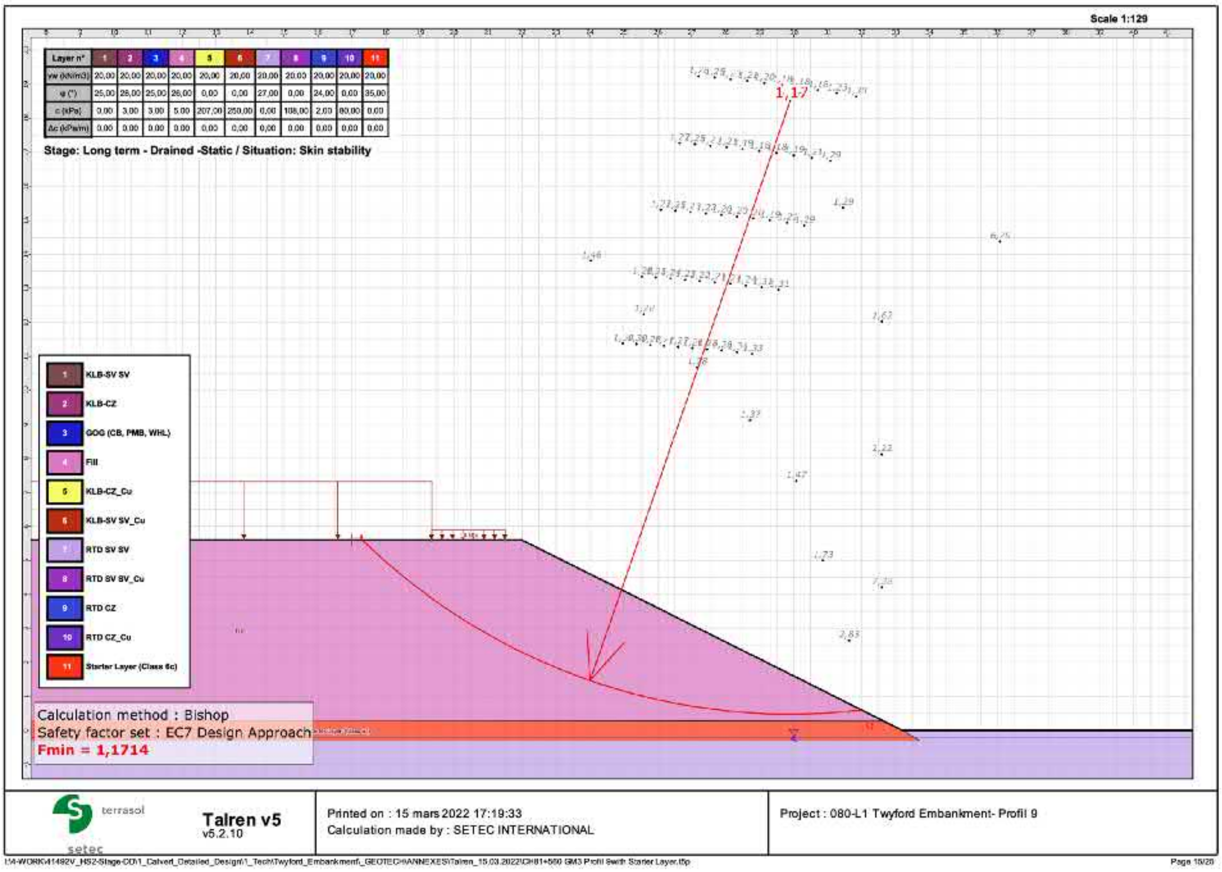
Coordinates of the critical centre and radius of the critical circle : N°= 88; X0= 29,89; Y0= 18,50; R= 18,02

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 17:19:33
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 9

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+560 GM3 Profil 9with Starter Layer.t5p Page 14/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	26,00	25,00	26,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	0,00	3,00	3,00	5,00	207,00	250,00	0,00	108,00	2,00	80,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Long term - Drained -Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 0,500

Search type : Imposed passage point

Imposed passage point : X= 32,500; Y= 0,000

Number of slices : 100

Seismic properties : No

Results

Minimum safety factor : 1,0871

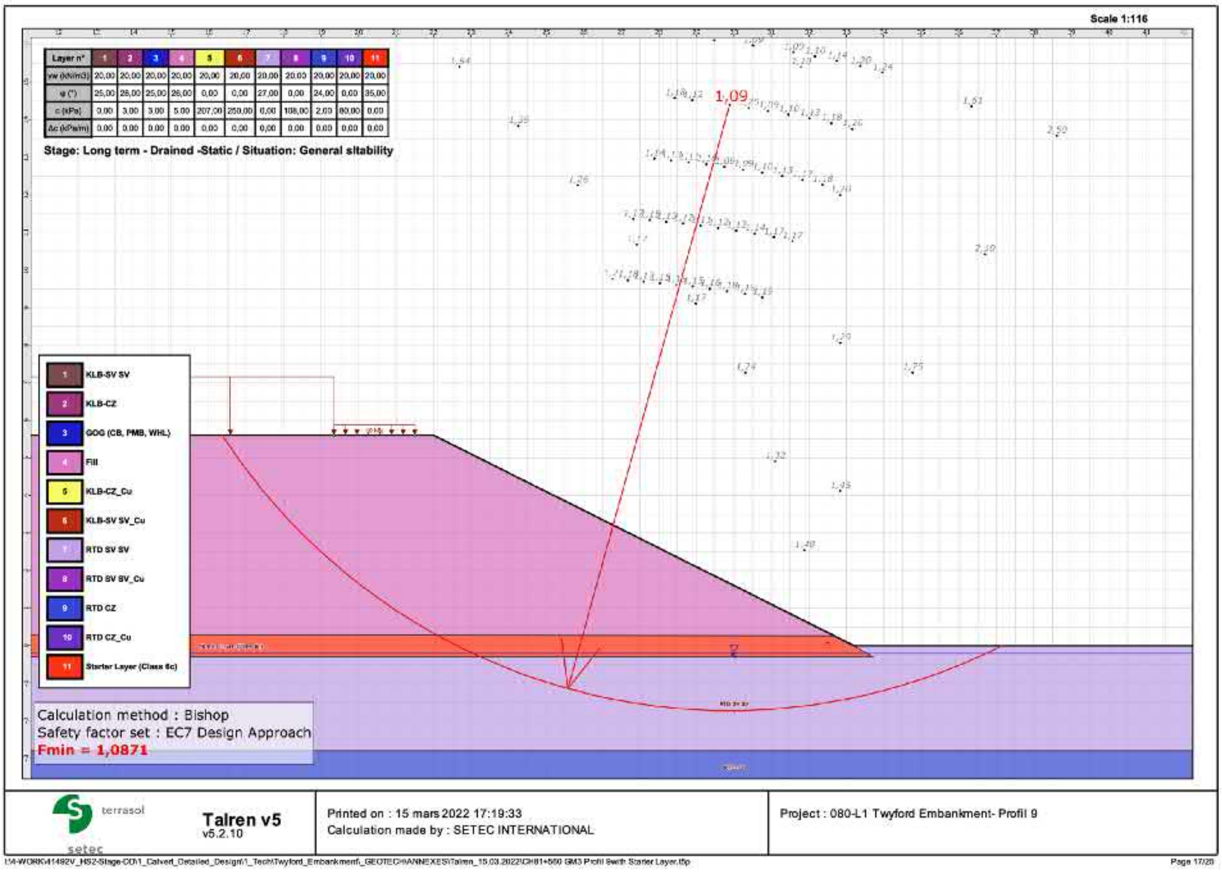
Coordinates of the critical centre and radius of the critical circle : N°= 1112; X0= 29,89; Y0= 14,40; R= 16,13

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 17:19:33
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 9

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+560 GM3 Profil 9with Starter Layer.t5p Page 16/25


Scale 1:116
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 26,00 | 25,00 | 26,00 | 0,00 | 0,00 | 27,00 | 0,00 | 24,00 | 0,00 | 35,00
c (kPa) | 0.00 | 3.00 | 3.00 | 5.00 | 207,00 | 250,00 | 0,00 | 108,00 | 2.00 | 80,00 | 0.00
Δc (kPa/m) | 0.00 | 0.00 | 0.00 | 0.00 | 0,00 | 0,00 | 0,00 | 0.00 | 0.00 | 0,00 | 0.00
Stage: Long term - Drained -Static / Situation: General sitability
1,09
KLB-SV SV
KLB-CZ
GOG (CB, PMB, WHL)
Fill
KLB-CZ_Cu
KLB-SV SV_Cu
RTD SV SV
RTD SV SV_Cu
RTD CZ
RTD CZ_Cu
Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,0871
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:19:33
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 9
Page 17/20

Data of the situation 1

Stage name : Seismic + 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 14,500

Search type : Imposed passage point

Imposed passage point : X= 32,500; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

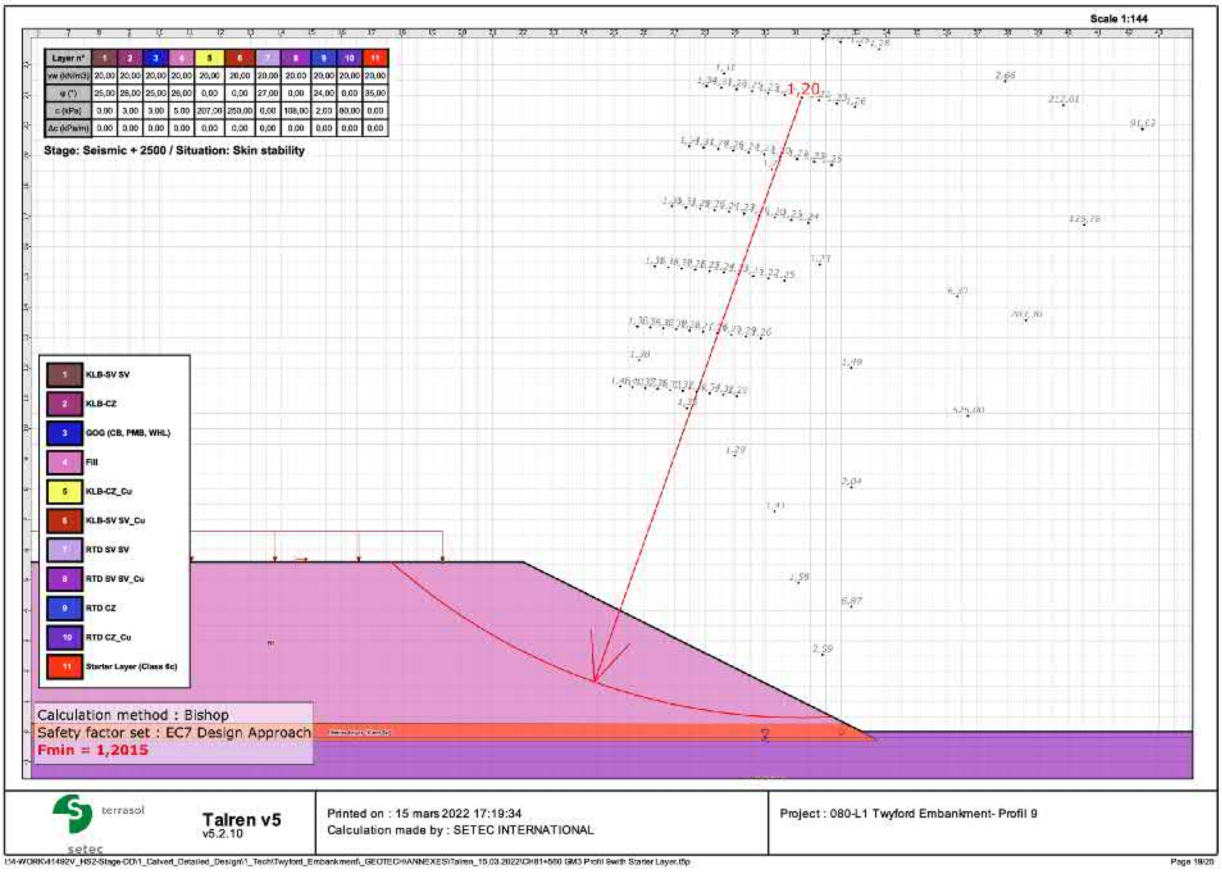
av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,2015

Coordinates of the critical centre and radius of the critical circle : N°= 486; X0= 31,20; Y0= 20,92; R= 20,45



Layer n°	1	2	3	4	5	6	7	8	9	10	11
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	26,00	25,00	26,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	0,00	3,00	3,00	5,00	207,00	250,00	0,00	108,00	2,00	80,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 2

Stage name : Seismic + 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 33,000

Search type : Imposed passage point

Imposed passage point : X= 26,000; Y= 1,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass in in RTD SV SV_Cu

Results

Minimum safety factor : 1,3121

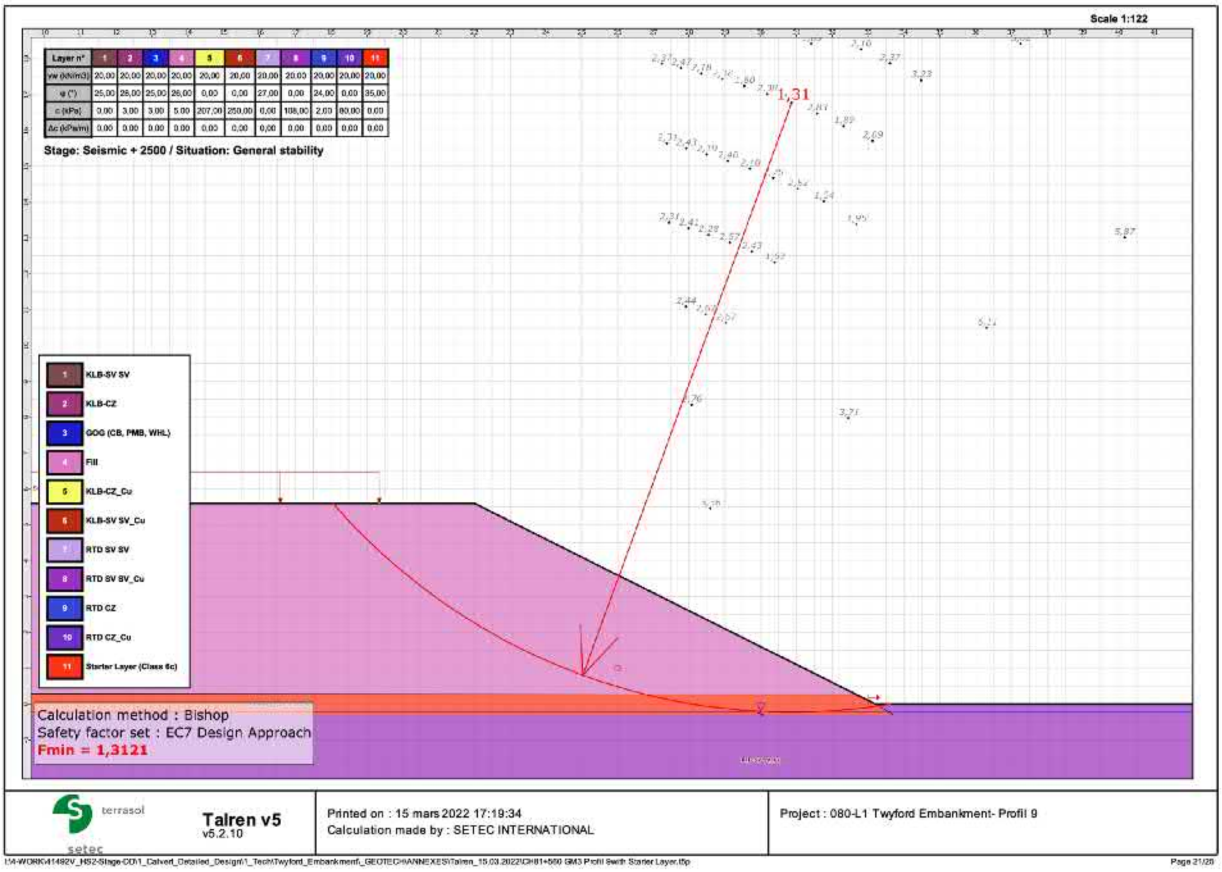
Coordinates of the critical centre and radius of the critical circle : N°= 355; X0= 30,86; Y0= 16,77; R= 17,00

terrasol setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 17:19:34
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 9

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+560 GM3 Profil 9with Starter Layer.t5p Page 20/25



Layer n°	1	2	3	4	5	6	7	8	9	10	11
γw (kN/m3)	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
φ (°)	25,00	26,00	25,00	26,00	0,00	0,00	27,00	0,00	24,00	0,00	35,00
c (kPa)	0,00	3,00	3,00	5,00	207,00	250,00	0,00	108,00	2,00	80,00	0,00
Δc (kPa/m)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Data of the situation 1

Stage name : Seismic - 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 16,000

Search type : Imposed passage point

Imposed passage point : X= 32,365; Y= 0,000

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

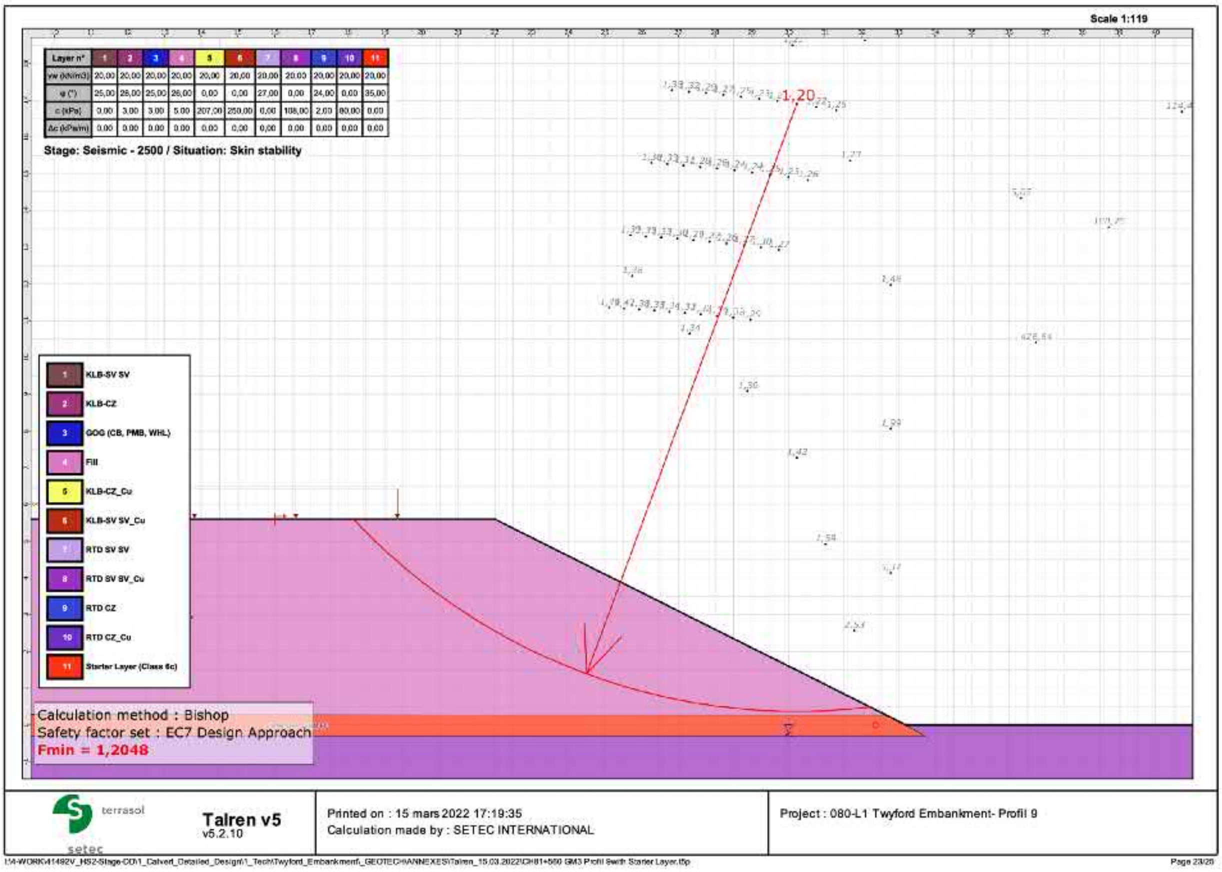
av/g coefficient (vertical acceleration) : -0,012

Passage conditions through soil layers : Must pass out in Starter Layer (Class 6c)

Results

Minimum safety factor : 1,2048

Coordinates of the critical centre and radius of the critical circle : N°= 433; X0= 30,22; Y0= 16,90; R= 16,53


Scale 1:119
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 28,00 | 25,00 | 26,00 | 0,00 | 0,00 | 27,00 | 0,00 | 24,00 | 0,00 | 35,00
c (kPa) | 0,00 | 3,00 | 3,00 | 5,00 | 207,00 | 250,00 | 0,00 | 108,00 | 2,00 | 80,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Seismic - 2500 / Situation: Skin stability
1,20
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-CZ_Cu
6 KLB-SV SV_Cu
7 RTD SV SV
8 RTD SV SV_Cu
9 RTD CZ
10 RTD CZ_Cu
11 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,2048
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:19:35
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 9
Page 23/28

Data of the situation 2

Stage name : Seismic - 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 33,000

Search type : Imposed passage point

Imposed passage point : X= 27,000; Y= 0,208

Number of slices : 100

Seismic properties : Yes

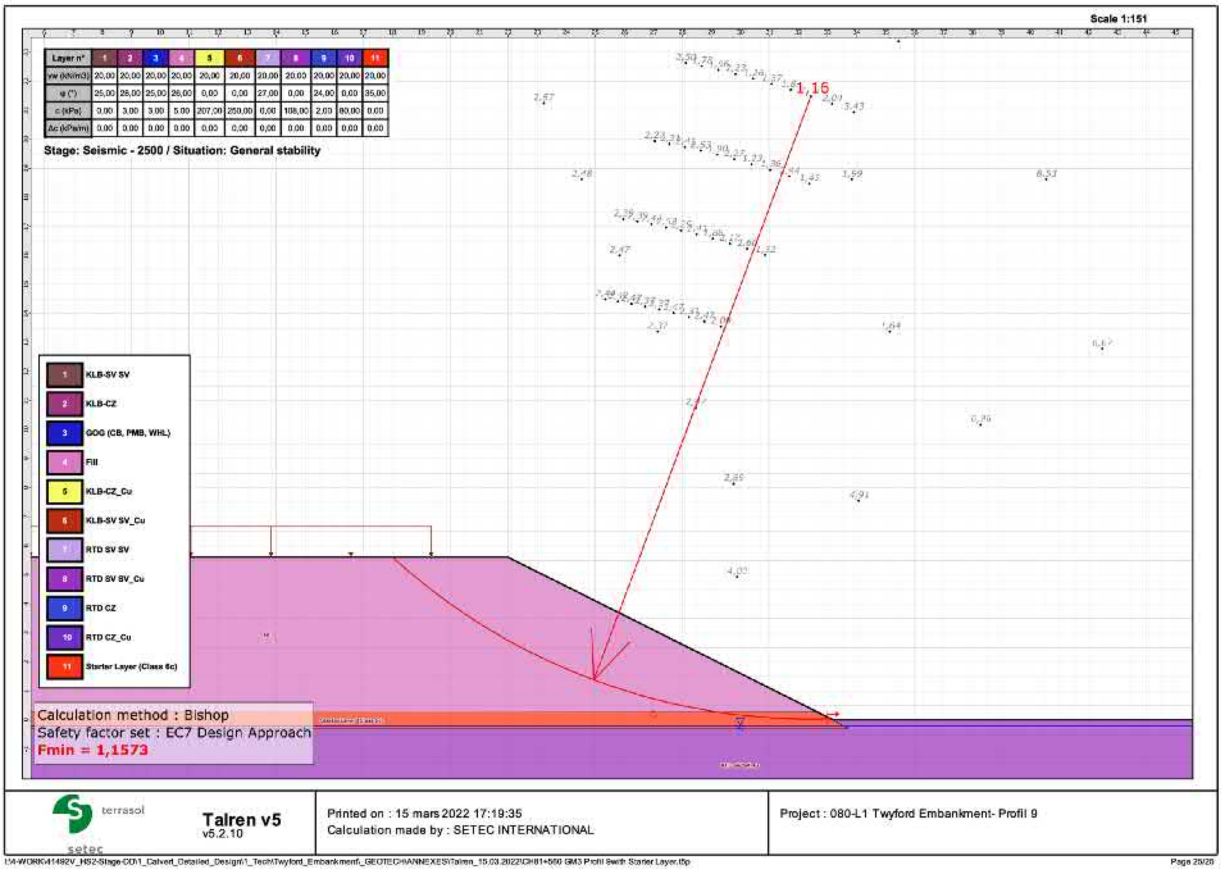
ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : -0,012

Results

Minimum safety factor : 1,1573

Coordinates of the critical centre and radius of the critical circle : N°= 348; X0= 32,43; Y0= 21,48; R= 21,45


Scale 1:151
Layer n° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11
γw (kN/m3) | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00 | 20,00
φ (°) | 25,00 | 26,00 | 25,00 | 26,00 | 0,00 | 0,00 | 27,00 | 0,00 | 24,00 | 0,00 | 35,00
c (kPa) | 0,00 | 3,00 | 3,00 | 5,00 | 207,00 | 250,00 | 0,00 | 108,00 | 2,00 | 80,00 | 0,00
Δc (kPa/m) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00
Stage: Seismic - 2500 / Situation: General stability
1,16
1 KLB-SV SV
2 KLB-CZ
3 GOG (CB, PMB, WHL)
4 Fill
5 KLB-CZ_Cu
6 KLB-SV SV_Cu
7 RTD SV SV
8 RTD SV SV_Cu
9 RTD CZ
10 RTD CZ_Cu
11 Starter Layer (Class 6c)
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,1573
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:19:35
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Profil 9
Page 25/28

Project data

Project reference : HS2

Calculation title : 080-L1 Twyford Embankment- Lundscape - Profil 10

Location : H = 5.5m - Ch. 81+660 - Ground model 4

Comments : N/A

Units : kN, kPa, kN/m3

γw : 10.0

Soil layers

	Name	Colour	γ	φ	c	Δc	qs nails	pl	KsB	Anisotropy	Favorable	Specific safety factors
1	ALV CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No
2	KLB-SV SV		20,0	25,00	0,0	0,0	-	-	-	No	No	No
3	KLB-CZ		20,0	28,00	3,0	0,0	-	-	-	No	No	No
4	GOG (CB, PMB, WHL)		20,0	25,00	3,0	0,0	-	-	-	No	No	No
5	Landcape Bunds		19,0	23,00	1,0	0,0	-	-	-	No	No	No
6	ALV CZ_Cu		20,0	0,00	49,0	0,0	-	-	-	No	No	No
7	KLB-SV SV_Cu		20,0	0,00	250,0	0,0	-	-	-	No	No	No
8	KLB-CZ_Cu		20,0	0,00	207,0	0,0	-	-	-	No	No	No
9	OXC- w		20,0	25,00	2,0	0,0	-	-	-	No	No	No
10	OXC-u1		20,0	28,00	5,0	0,0	-	-	-	No	No	No
11	OXCw_Cu		20,0	0,00	54,0	0,0	-	-	-	No	No	No
12	OXCu1_Cu		19,0	0,00	100,0	0,0	-	-	-	No	No	No
13	RTD CZ		20,0	24,00	2,0	0,0	-	-	-	No	No	No
14	RTD CZ_Cu		20,0	0,00	80,0	0,0	-	-	-	No	No	No
15	RTD SV SV		20,0	27,00	0,0	0,0	-	-	-	No	No	No
16	RTD SV SV_Cu		20,0	27,00	110,0	0,0	-	-	-	No	No	No
17	OXC u2		20,0	25,00	5,0	0,0	-	-	-	No	No	No
18	OXC u2_Cu		20,0	0,00	150,0	0,0	-	-	-	No	No	No
19	ALV SV SV		20,0	25,00	0,0	0,0	-	-	-	No	No	No
20	ALV SV SV -Cu		20,0	0,00	40,0	0,0	-	-	-	No	No	No

Soil layers (cont.)

	Name	Colour	Γγ	Γc	Γtan(φ)	Cohesion type	Curve
1	ALV CZ		-	-	-	Effective	Linear
2	KLB-SV SV		-	-	-	Effective	Linear
3	KLB-CZ		-	-	-	Effective	Linear
4	GOG (CB, PMB, WHL)		-	-	-	Effective	Linear
5	Landcape Bunds		-	-	-	Effective	Linear
6	ALV CZ_Cu		-	-	-	Undrained	Linear
7	KLB-SV SV_Cu		-	-	-	Effective	Linear
8	KLB-CZ_Cu		-	-	-	Undrained	Linear
9	OXC- w		-	-	-	Effective	Linear
10	OXC-u1		-	-	-	Effective	Linear
11	OXCw_Cu		-	-	-	Undrained	Linear
12	OXCu1_Cu		-	-	-	Undrained	Linear
13	RTD CZ		-	-	-	Effective	Linear
14	RTD CZ_Cu		-	-	-	Undrained	Linear
15	RTD SV SV		-	-	-	Effective	Linear
16	RTD SV SV_Cu		-	-	-	Effective	Linear
17	OXC u2		-	-	-	Effective	Linear
18	OXC u2_Cu		-	-	-	Undrained	Linear
19	ALV SV SV		-	-	-	Effective	Linear
20	ALV SV SV -Cu		-	-	-	Undrained	Linear

Points

	X	Y		X	Y		X	Y		X	Y		X	Y		X	Y
2	60,000	0,000	3	0,000	-4,500	4	60,000	-4,500	11	0,000	5,500	13	44,000	0,000	32	60,000	-2,700
43	22,000	5,500	50	0,000	-2,700	63	0,000	0,000	73	0,000	-8,000	76	60,000	-8,000	83	60,000	-2,500
84	0,000	-6,000	85	60,000	-6,000												

Project data

Segments

	Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2		Point 1	Point 2
51	4	3	107	32	50	126	43	13	128	13	63	142	2	13	147	43	11	148	73	76
160	32	83	163	4	85	164	76	85	165	85	84	167	4	32	168	83	32			

Distributed loads

	Name	X left	Y left	q left	X right	Y right	q right	Ang/horizontal
1	10 KPa	19,500	5,500	10,0	21,500	5,500	10,0	90,00

Data of the situation 1

Stage name : Long term - Static

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 19,000

Search type : Imposed passage point

Imposed passage point : X= 44,000; Y= 0,000

Number of slices : 100

Seismic properties : No

Results

Minimum safety factor : 1,5078

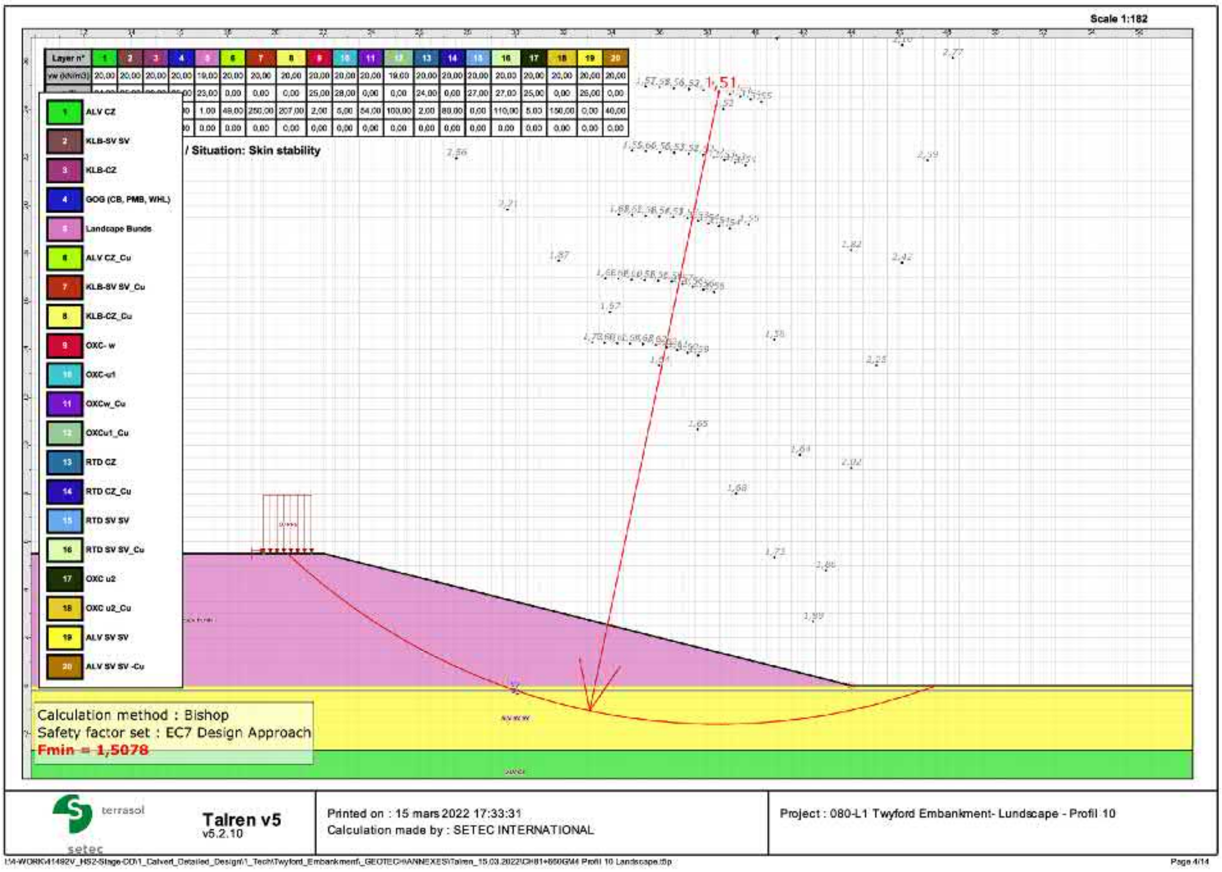
Coordinates of the critical centre and radius of the critical circle : N°= 907; X0= 38,49; Y0= 24,75; R= 26,35

terrasol
setec

Talren v5
v5.2.10

Printed on : 15 mars 2022 17:33:31
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Lundscape - Profil 10

I:\4-WORK\41492V_HS2-Stage-DD\1_Calvert_Detailed_Design\1_Tech\Twyford_Embankment_GEOTECH\ANNEXES\Talren_15.03.2022\CH81+660GM4 Profil 10 Landscape.t5p


Scale 1:182
/ Situation: Skin stability
ALV CZ
KLB-SV SV
KLB-CZ
GOG (CB, PMB, WHL)
Landscape Bunds
ALV CZ_Cu
KLB-SV SV_Cu
KLB-CZ_Cu
OXC- w
OXC-u1
OXCw_Cu
OXCu1_Cu
RTD CZ
RTD CZ_Cu
RTD SV SV
RTD SV SV_Cu
OXC u2
OXC u2_Cu
ALV SV SV
ALV SV SV -Cu
1,51
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,5078
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:33:31
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Lundscape - Profil 10
Page 4/14

Data of the situation 2

Stage name : Long term - Static

Situation name : General sltability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 8,000

Search type : Imposed passage point

Imposed passage point : X= 44,000; Y= -0,643

Number of slices : 100

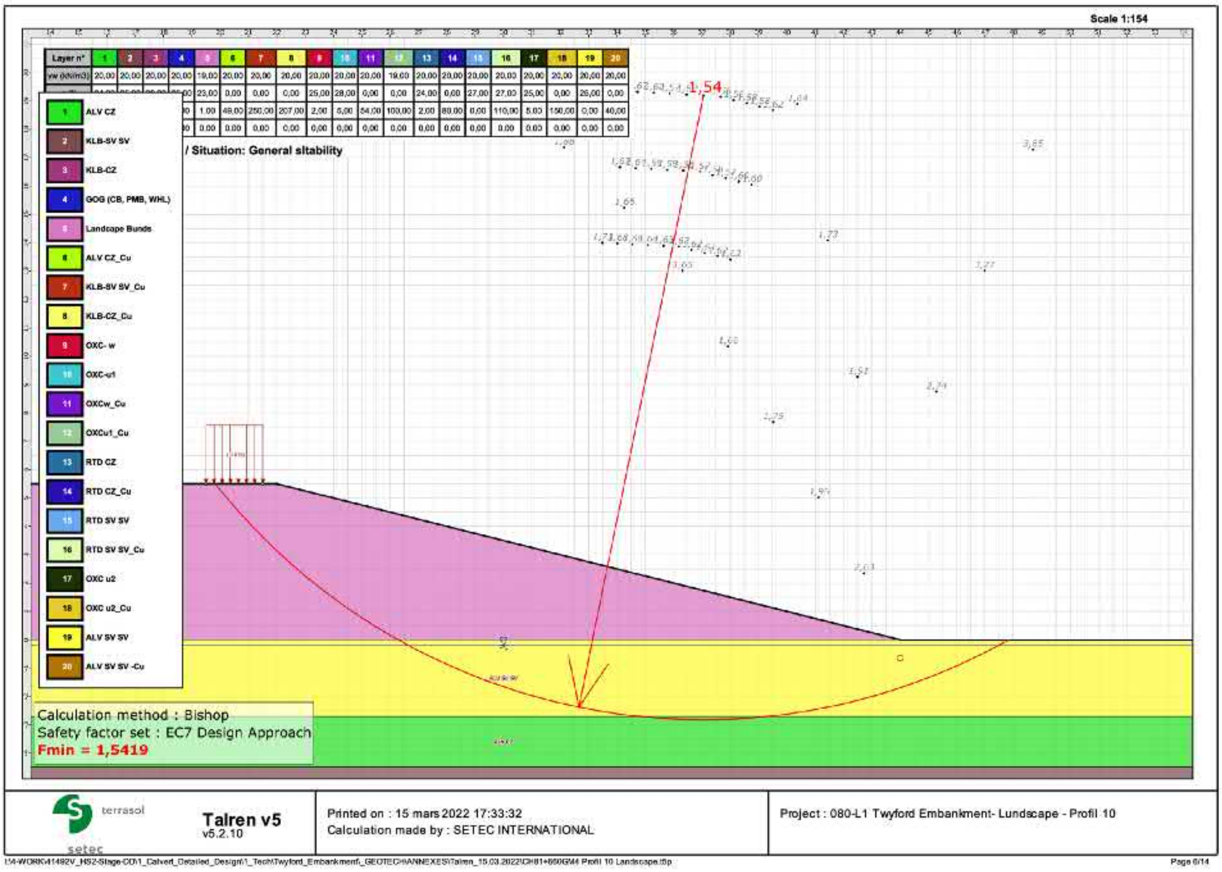
Seismic properties : No

Passage conditions through soil layers : Must pass in in ALV CZ

Results

Minimum safety factor : 1,5419

Coordinates of the critical centre and radius of the critical circle : N°= 152; X0= 37,06; Y0= 19,19; R= 22,01


Scale 1:154
Layer n°
/ Situation: General sltability
ALV CZ
KLB-SV SV
KLB-CZ
GOG (CB, PMB, WHL)
Landcape Bunds
ALV CZ_Cu
KLB-SV SV_Cu
KLB-CZ_Cu
OXC- w
OXC-u1
OXCw_Cu
OXCu1_Cu
RTD CZ
RTD CZ_Cu
RTD SV SV
RTD SV SV_Cu
OXC u2
OXC u2_Cu
ALV SV SV
ALV SV SV -Cu
1,54
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,5419
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:33:32
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Lundscape - Profil 10

Data of the situation 1

Stage name : Seismic + 2500

Situation name : Skin stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 18,000

Search type : Imposed passage point

Imposed passage point : X= 43,719; Y= -0,286

Number of slices : 100

Seismic properties : Yes

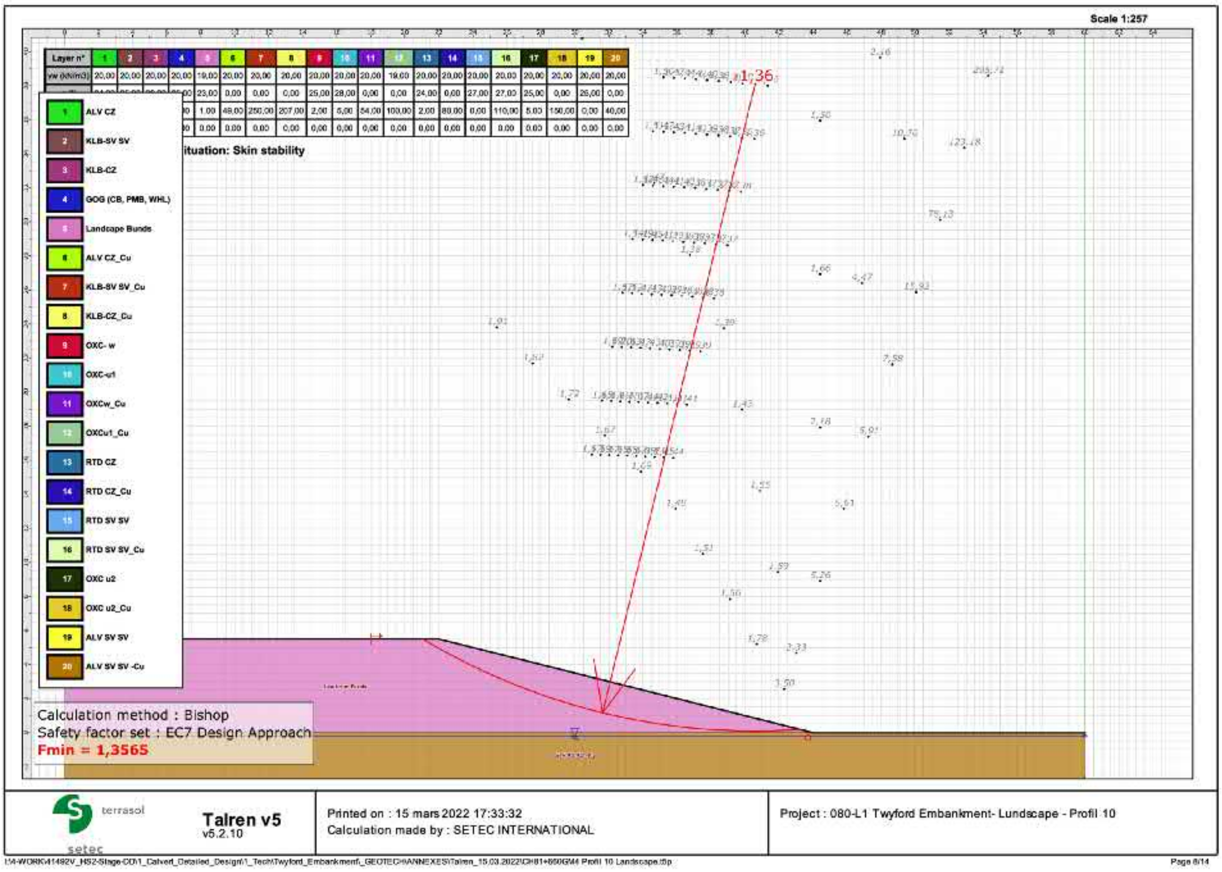
ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : 0,012

Results

Minimum safety factor : 1,3565

Coordinates of the critical centre and radius of the critical circle : N°= 640; X0= 40,60; Y0= 38,08; R= 37,99


Scale 1:257
Layer n°
ALV CZ
KLB-SV SV
KLB-CZ
GOG (CB, PMB, WHL)
Landscape Bunds
ALV CZ_Cu
KLB-SV SV_Cu
KLB-CZ_Cu
OXC- w
OXC-u1
OXCw_Cu
OXCu1_Cu
RTD CZ
RTD CZ_Cu
RTD SV SV
RTD SV SV_Cu
OXC u2
OXC u2_Cu
ALV SV SV
ALV SV SV -Cu
ituation: Skin stability
1,36
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3565
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:33:32
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Lundscape - Profil 10

Data of the situation 2

Stage name : Seismic + 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 8,000

Search type : Imposed passage point

Imposed passage point : X= 44,000; Y= -0,159

Number of slices : 100

Seismic properties : Yes

ah/g coefficient (horizontal acceleration) : 0,037

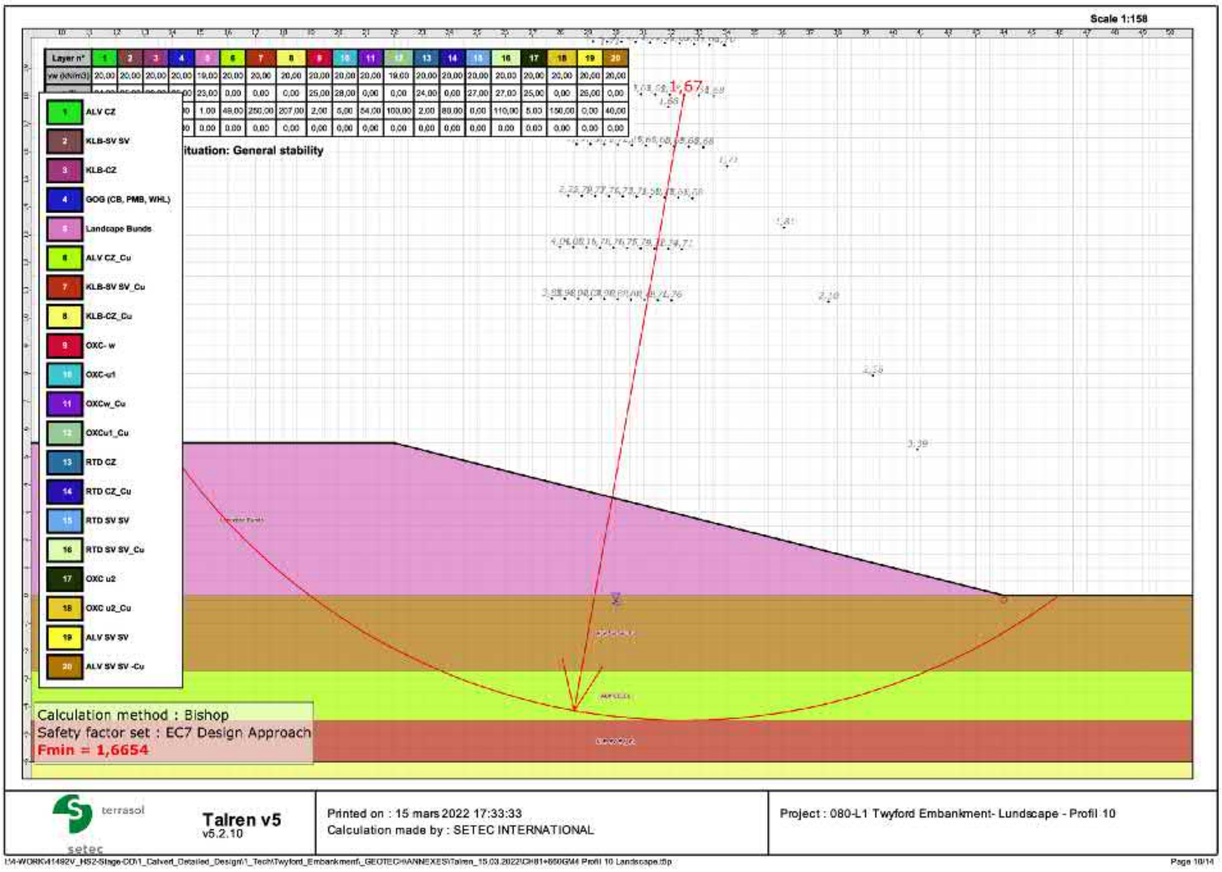
av/g coefficient (vertical acceleration) : 0,012

Passage conditions through soil layers : Must pass in in ALV CZ_Cu

Results

Minimum safety factor : 1,6654

Coordinates of the critical centre and radius of the critical circle : N°= 208; X0= 32,47; Y0= 18,04; R= 22,54

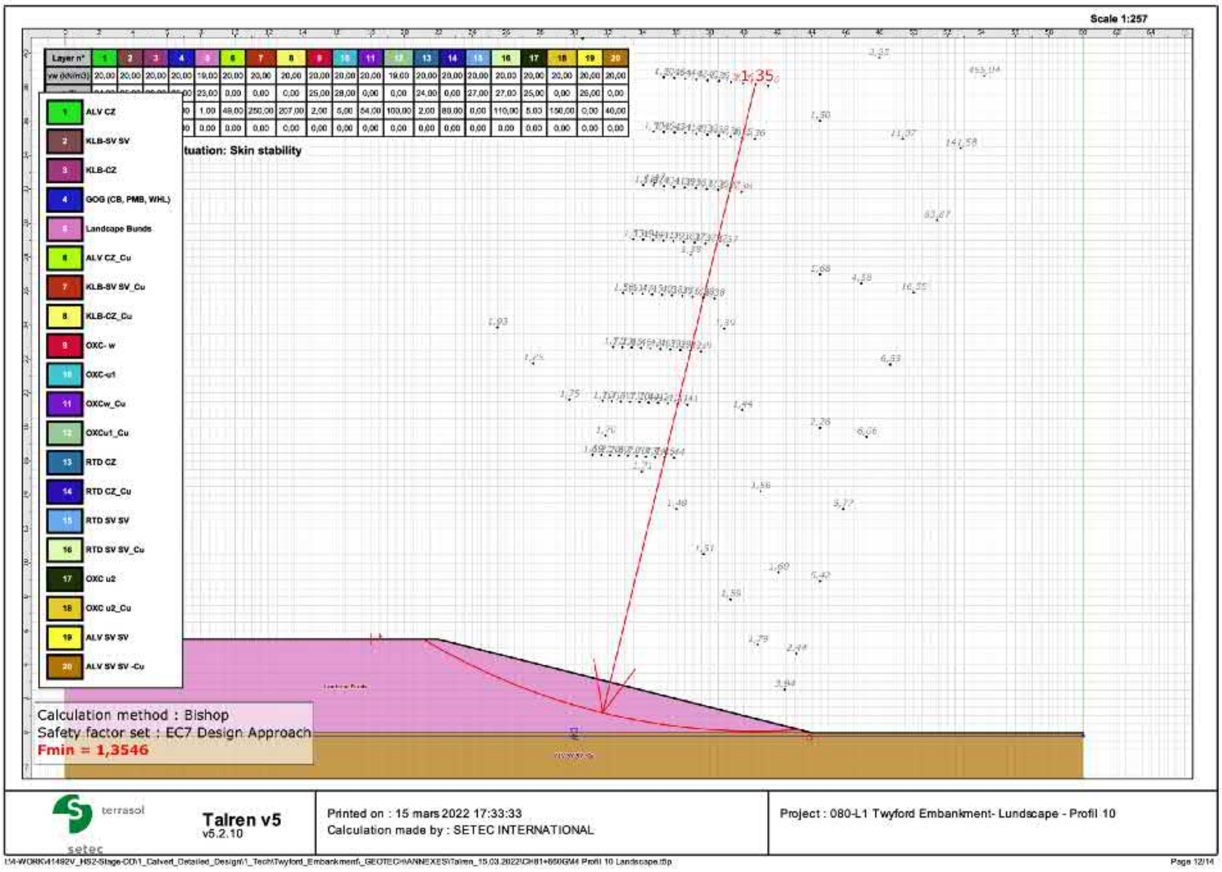

Scale 1:158
Layer n°
ALV CZ
KLB-SV SV
KLB-CZ
GOG (CB, PMB, WHL)
Landscape Bunds
ALV CZ_Cu
KLB-SV SV_Cu
KLB-CZ_Cu
OXC- w
OXC-u1
OXCw_Cu
OXCu1_Cu
RTD CZ
RTD CZ_Cu
RTD SV SV
RTD SV SV_Cu
OXC u2
OXC u2_Cu
ALV SV SV
ALV SV SV -Cu
ituation: General stability
1,67
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,6654
terrasol
setec
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:33:33
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Lundscape - Profil 10
Page 10/14

Data of the situation 1

Stage name : Seismic - 2500
Situation name : Skin stability
Calculation method : Bishop
Safety factor set for this situation : EC7 Design Approach
Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular
Number of intervals : 10
Increment for circle radius : 0,500
Min abscissa of the circle emergence point : 18,000
Search type : Imposed passage point
Imposed passage point : X= 43,846; Y= -0,286
Number of slices : 100
Seismic properties : Yes
ah/g coefficient (horizontal acceleration) : 0,037
av/g coefficient (vertical acceleration) : -0,012
Results
Minimum safety factor : 1,3546
Coordinates of the critical centre and radius of the critical circle : N°= 637; X0= 40,69; Y0= 38,19; R= 38,10


Scale 1:257
tuation: Skin stability
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3546
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:33:33
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Landscape - Profil 10

Data of the situation 2

Stage name : Seismic - 2500

Situation name : General stability

Calculation method : Bishop

Safety factor set for this situation : EC7 Design Approach

Details of the safety factor set

Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient	Name	Coefficient
Γmin	1,000	Γs1	1,000	Γ's1	1,000	Γφ	1,250	Γc'	1,250	Γcu	1,400
ΓQ	1,300	Γqsl,nail,ab	1,000	Γqsl,nail,es	1,000	Γqsl,anchor,ab	1,000	Γqsl,anchor,es	1,000	Γqsl,strip	1,000
Γpl	1,000	Γa,nail	1,000	Γa,anchor	1,000	Γa,strip	1,000	Γstrut	1,000	Γs3	1,000

Type of failure surface : Automatic circular

Number of intervals : 10

Increment for circle radius : 0,500

Min abscissa of the circle emergence point : 10,000

Search type : Imposed passage point

Imposed passage point : X= 44,000; Y= -1,000

Number of slices : 100

Seismic properties : Yes

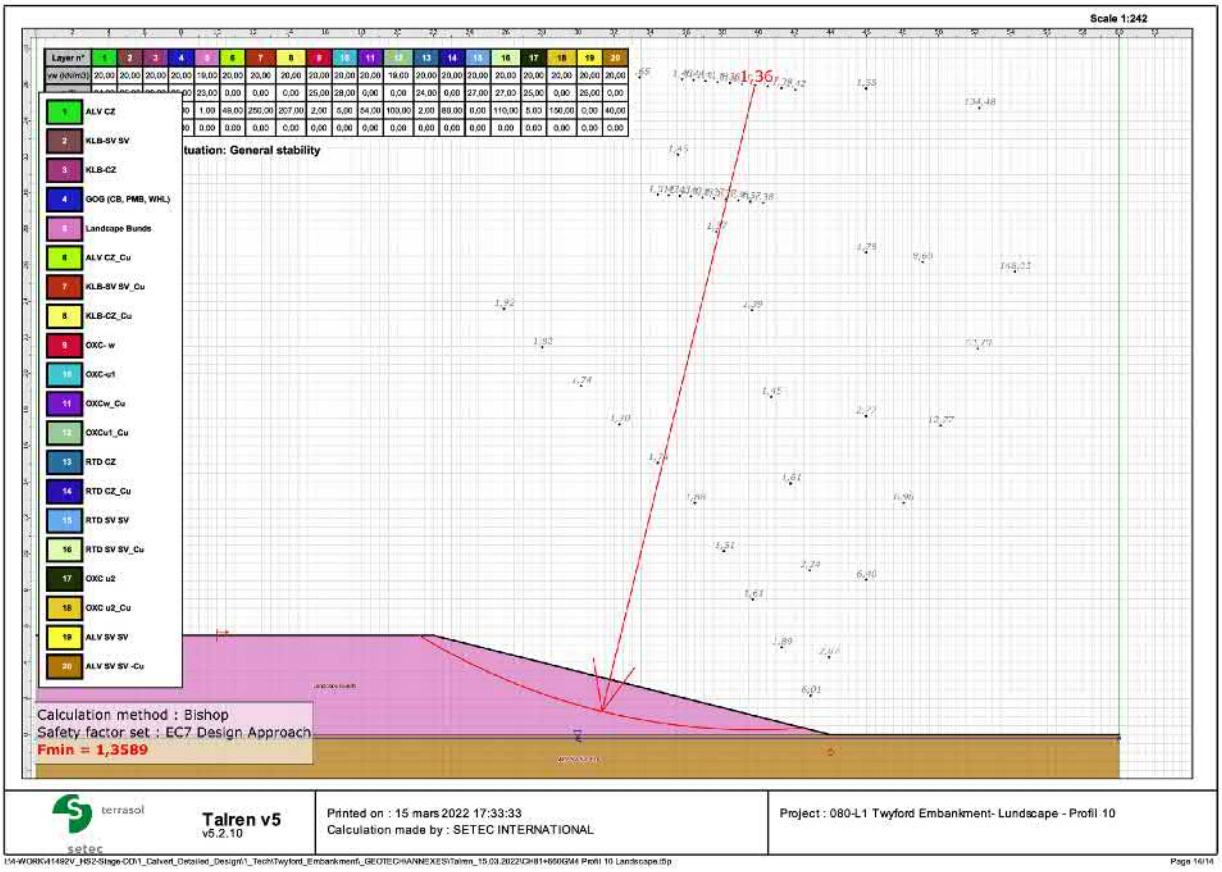
ah/g coefficient (horizontal acceleration) : 0,037

av/g coefficient (vertical acceleration) : -0,012

Results

Minimum safety factor : 1,3589

Coordinates of the critical centre and radius of the critical circle : N°= 601; X0= 39,82; Y0= 35,97; R= 35,70


Scale 1:242
Situation: General stability
Calculation method : Bishop
Safety factor set : EC7 Design Approach
Fmin = 1,3589
Talren v5
v5.2.10
Printed on : 15 mars 2022 17:33:33
Calculation made by : SETEC INTERNATIONAL
Project : 080-L1 Twyford Embankment- Lundscape - Profil 10
Page 14/14

HS2 – C2 – Calvert Area – Detailed Design

Profile 1 - GM1a - Ch. 80940 - Embankment Impact

gr (kN/m³)	20,00
Hf (m)	2,70
Hr (m)	2,7
Side slope (H/V)	2,00
Width PF (m)	44,00
Surcharge of the embankmant (kPa)	54,0
Static surcharge (kPa)	30,00
Sr (kPa)	84,0

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	0
c1	5,4
c2	5,4
d1	24,7
d2	24,7

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	0,0	1,000	84,0	20	0	0,2	10000,0	0,9	0,0	0,0	0,0
ALV	0,0	2,7	1,000	84,0	20	16	0,2	6,0	0,9	37,7	33,9	3,8
OXC W	2,7	4,1	0,999	83,9	20	36	0,2	7,8	0,5	15,1	7,5	7,5
OXC U	4,1	9,0	0,993	83,4	20	68	0,2	17,5	0,4	23,4	9,4	14,0
KLB V SV	9,0	11,0	0,976	82,0	20	102	0,2	85,0	0,1	1,9	0,2	1,7
KLB CZ	11,0	14,0	0,958	80,4	20	127	0,2	34,4	0,4	7,0	2,8	4,2
GOC	14,0	14,0	0,944	79,3	20	142	0,2	133,3	0,4	0,0	0,0	0,0
			Total settlement at 0 m from the axis (mm)							85	54	31

nb iteration 0
Convergence m

Stress inc. / s'v0 56%

w Rail Load	85	54	31
wo Rail Load	54	34	19
difference	-31	**-20**	-12

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	6
number of days	30,4
secondes	15778800

With surcharge anticipation (anticipation rail load 30 kPa)

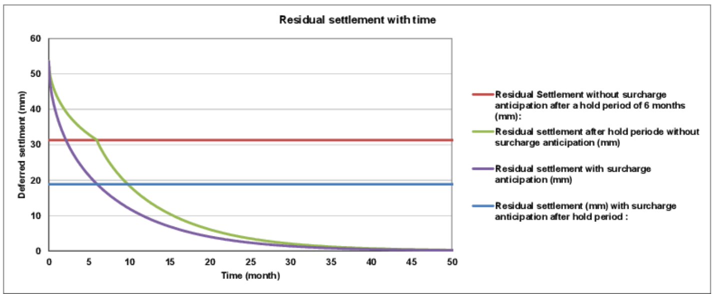
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-08	0,0	1,58E+03	100,0	0,0
ALV	1,20E-07	2,7	2,62E-01	57,5	19,5
OXC W	3,80E-07	2,1	1,36E+00	97,2	7,3
OXC U	4,20E-07	4,9	2,76E-01	59,0	5,5
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,2
KLB CZ	4,20E-07	3,0	7,36E-01	86,8	2,4
GOC	1,00E-08	3,0	1,75E-02	14,9	0,0

Total settlement at 0 m from the axis in 6 months (mm): 34,9 65%

With surcharge anticipation		Landsc.	TOTAL
Residual settlement (mm) with surcharge anticipation after hold period :	18,8	1,1	20,0
Settlement with surcharge anticipation over 12 months after a hold period 6 months (mm):	13,9	0,9	14,8

Duration after hold period (months) 12

Without anticipation		Landsc.	TOTAL
Residual Settlement without surcharge anticipation after a hold period of 6 months (mm):	31,3	1,1	32,5
Settlement without surcharge anticipation over 12 after a hold period of 6 months (mm):	23,8	0,9	24,7



https://arcadiso365.sharepoint.com/teams/HS2ASC/03 Project Execution/05 - C2 Calvert/09 - Twyford Embankment (IMD)/06 - GT - Geotechnical/Settlements transition viaduct/. FINAL ANALYSIS/01 GM1a - 80940_PAD.xlsm - EMB (0)

HS2 – C2 – Calvert Area – Detailed Design

Profile 1 - GM1a - Ch. 80940 - Superior Landscape Impact

gr (kN/m³)	19,50
Hf (m)	3,20
Hr (m)	3,2
Side slope (H/V)	4,00
Width PF (m)	3,00
Surcharge of the embankmant (kPa)	62,4
Static surcharge (kPa)	0,00
Sr (kPa)	62,4

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	27,26
c1	12,8
c2	12,8
d1	-19,4
d2	35,2

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	0,0	0,000	0,0	20	0	0,2	10000,0	0,9	0,0	0,0	0,0
ALV	0,0	2,7	0,000	0,0	20	16	0,2	6,0	0,9	0,0	0,0	0,0
OXC W	2,7	4,1	0,001	0,1	20	36	0,2	7,8	0,5	0,0	0,0	0,0
OXC U	4,1	9,0	0,007	0,5	20	68	0,2	17,5	0,4	0,1	0,1	0,1
KLB V SV	9,0	11,0	0,021	1,3	20	102	0,2	85,0	0,1	0,0	0,0	0,0
KLB CZ	11,0	14,0	0,033	2,1	20	127	0,2	34,4	0,4	0,2	0,1	0,1
GOC	14,0	14,0	0,042	2,6	20	142	0,2	133,3	0,4	0,0	0,0	0,0
			Total settlement at 27,26 m from the axis (							0	0	0

nb iteration 0

Convergence m

Stress inc. / s'v0 2%

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	0
number of days	30,4
secondes	0

With surcharge anticipation (anticipation rail load 30 kPa)

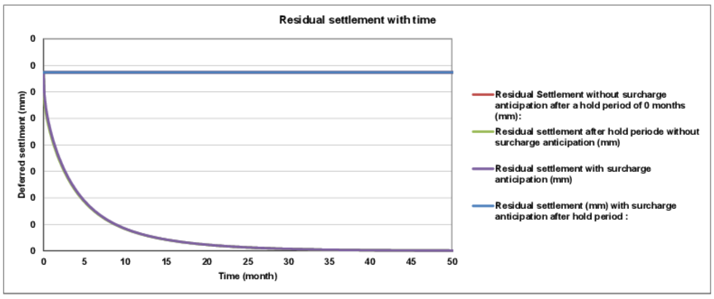
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-08	0,0	0,00E+00	0,4	0,0
ALV	1,20E-07	2,7	0,00E+00	0,4	0,0
OXC W	3,80E-07	2,1	0,00E+00	0,4	0,0
OXC U	4,20E-07	4,9	0,00E+00	0,4	0,0
KLB V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
KLB CZ	4,20E-07	3,0	0,00E+00	0,4	0,0
GOC	1,00E-08	3,0	0,00E+00	0,4	0,0

Total settlement at 27,26 m from the axis in 0 months (mm):	0,0	0%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	0,1
Settlement with surcharge anticipation over 12 months after a hold period 0 months (mm):	0,1

Duration after hold period (months)	12

Without anticipation	
Residual Settlement without surcharge anticipation after a hold period of 0 months (mm):	0,1
Settlement without surcharge anticipation over 12 after a hold period of 0 months (mm):	0,1



HS2 – C2 – Calvert Area – Detailed Design

Profile 1 - GM1a - Ch. 80940 - Inferior Landscape Impact

gr (kN/m³)	19,50
Hf (m)	2,70
Hr (m)	2,7
Side slope (H/V)	4,00
Width PF (m)	33,40
Surcharge of the embankmant (kPa)	52,7
Static surcharge (kPa)	0,00
Sr (kPa)	52,7

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	27,26
c1	10,8
c2	10,8
d1	-5,2
d2	49,4

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	0,0	0,022	1,2	20	0	0,2	10000,0	0,9	0,0	0,0	0,0
ALV	0,0	2,7	0,052	2,7	20	16	0,2	6,0	0,9	1,2	1,1	0,1
OXC W	2,7	4,1	0,108	5,7	20	36	0,2	7,8	0,5	1,0	0,5	0,5
OXC U	4,1	9,0	0,184	9,7	20	68	0,2	17,5	0,4	2,7	1,1	1,6
KLB V SV	9,0	11,0	0,246	12,9	20	102	0,2	85,0	0,1	0,3	0,0	0,3
KLB CZ	11,0	14,0	0,279	14,7	20	127	0,2	34,4	0,4	1,3	0,5	0,8
GOC	14,0	14,0	0,294	15,5	20	142	0,2	133,3	0,4	0,0	0,0	0,0
			Total settlement at 27,26 m from the axis (							7	3	3

nb iteration 0
Convergence m

Stress inc. / s'v0 11%

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	6
number of days	30,4
secondes	15778800

With surcharge anticipation (anticipation rail load 30 kPa)

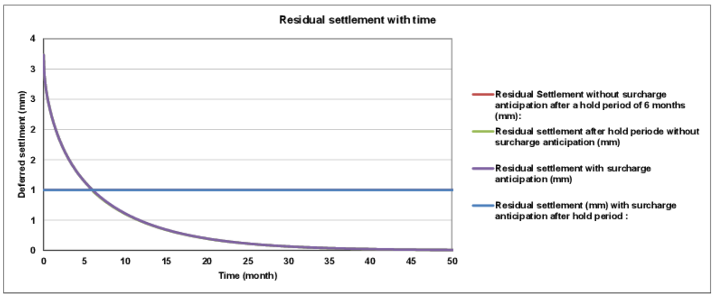
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-08	0,0	1,58E+03	100,0	0,0
ALV	1,20E-07	2,7	2,62E-01	57,5	0,6
OXC W	3,80E-07	2,1	1,36E+00	97,2	0,5
OXC U	4,20E-07	4,9	2,76E-01	59,0	0,6
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,0
KLB CZ	4,20E-07	3,0	7,36E-01	86,8	0,4
GOC	1,00E-08	3,0	1,75E-02	14,9	0,0

Total settlement at 27,26 m from the axis in 6 months (mm):	2,2	69%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	1,0
Settlement with surcharge anticipation over 12 months after a hold period 6 months (mm):	0,8

Duration after hold period (months)	12

Without anticipation	
Residual Settlement without surcharge anticipation after a hold period of 6 months (mm):	1,0
Settlement without surcharge anticipation over 12 after a hold period of 6 months (mm):	0,8



HS2 – C2 – Calvert Area – Detailed Design

Profile 1 - GM1a - Ch. 80940 - Embankment Impact

gr (kN/m³)	20,00
Hf (m)	2,70
Hr (m)	2,7
Side slope (H/V)	2,00
Width PF (m)	44,00
Surcharge of the embankmant (kPa)	54,0
Static surcharge (kPa)	30,00
Sr (kPa)	84,0

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	0
c1	5,4
c2	5,4
d1	24,7
d2	24,7

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ration	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	2,0	1,000	84,0	20	12	0,2	10000,0	0,9	0,0	0,0	0,0
ALV	2,0	2,7	1,000	84,0	20	26	0,2	6,0	0,9	9,8	8,8	1,0
OXC W	2,7	4,1	0,999	83,9	20	36	0,2	7,8	0,5	15,1	7,5	7,5
OXC U	4,1	9,0	0,993	83,4	20	68	0,2	17,5	0,4	23,4	9,4	14,0
KLB V SV	9,0	11,0	0,976	82,0	20	102	0,2	85,0	0,1	1,9	0,2	1,7
KLB CZ	11,0	14,0	0,958	80,4	20	127	0,2	34,4	0,4	7,0	2,8	4,2
GOC	14,0	14,0	0,944	79,3	20	142	0,2	133,3	0,4	0,0	0,0	0,0
			Total settlement at 0 m from the axis (mm)							57	29	29

nb iteration 0
Convergence m

Stress inc. / s'v0 56%

w Rail Load	57	29	29
wo Rail Load	36	18	18
difference	-21	-11	

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	6
number of days	30,4
secondes	15778800

With surcharge anticipation (anticipation rail load 30 kPa)

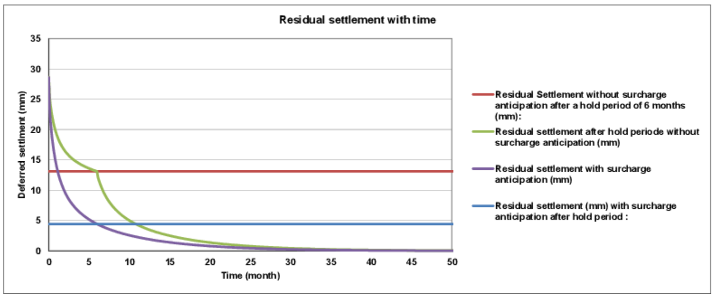
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-08	0,0	1,58E+03	100,0	0,0
ALV	1,20E-07	0,7	3,86E+00	100,0	8,8
OXC W	3,80E-07	2,1	1,36E+00	97,2	7,3
OXC U	4,20E-07	4,9	2,76E-01	59,0	5,5
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,2
KLB CZ	4,20E-07	3,0	7,36E-01	86,8	2,4
GOC	1,00E-08	3,0	1,75E-02	14,9	0,0

Total settlement at 0 m from the axis in 6 months (mm): 24,3 85%

With surcharge anticipation		Landsc.	TOTAL
Residual settlement (mm) with surcharge anticipation after hold period :	4,4	0,5	4,9
Settlement with surcharge anticipation over 12 months after a hold period 6 months (mm):	3,4	0,2	3,6

Duration after hold period (months) 12

Without anticipation		Landsc.	TOTAL
Residual Settlement without surcharge anticipation after a hold period of 6 months (mm):	13,1	0,5	13,6
Settlement without surcharge anticipation over 12 after a hold period of 6 months (mm):	11,4	0,2	11,5



https://arcadiso365.sharepoint.com/teams/HS2ASC/03 Project Execution/05 - C2 Calvert/09 - Twyford Embankment (MD)/06 - GT - Geotechnical/Settlements transition viaduct/. FINAL ANALYSIS/01 GM1a - 80940_PAD.xlsm - EMB (2)

HS2 – C2 – Calvert Area – Detailed Design

Profile 1 - GM1a - Ch. 80940 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	3,20
Hr (m)	3,2
Side slope (H/V)	4,00
Width PF (m)	3,00
Surcharge of the embankmant (kPa)	62,4
Static surcharge (kPa)	0,00
Sr (kPa)	62,4

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	27,26
c1	12,8
c2	12,8
d1	-19,4
d2	35,2

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	2,0	0,000	0,0	20	12	0,2	1,00E+04	0,9	0,0	0,0	0,0
ALV	2,0	2,7	0,000	0,0	20	26	0,2	6,0	0,9	0,0	0,0	0,0
OXC W	2,7	4,1	0,001	0,1	20	36	0,2	7,8	0,5	0,0	0,0	0,0
OXC U	4,1	9,0	0,007	0,5	20	68	0,2	34,4	0,3	0,1	0,0	0,0
KLB V SV	9,0	11,0	0,021	1,3	20	102	0,2	85,0	0,3	0,0	0,0	0,0
KLB CZ	11,0	14,0	0,033	2,1	20	127	0,2	34,4	0,3	0,2	0,1	0,1
GOC	14,0	14,0	0,042	2,6	20	142	0,2	34,4	0,3	0,0	0,0	0,0
			Total settlement at 27,26 m from the axis							0	0	0

nb iteration 0
Convergence m
Stress inc. / s'v0 2%

w Rail Load	0	0	0
wo Rail Load	64	42	22
difference	64	42	

2 - CONSOLIDATION BY TIME (without vertical drains)

Time	
month	0
number of days	30,4
secondes	0

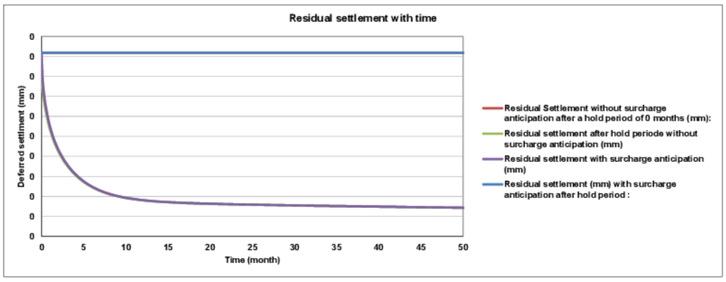
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-08	2,0	0,00E+00	0,4	0,0
ALV	1,20E-07	0,7	0,00E+00	0,4	0,0
OXC W	3,80E-07	1,4	0,00E+00	0,4	0,0
OXC U	1,00E-08	4,9	0,00E+00	0,4	0,0
KLB V SV	1,00E-06	2,0	0,00E+00	0,4	0,0
KLB CZ	4,20E-07	3,0	0,00E+00	0,4	0,0
GOC	1,00E-08	0,0	0,00E+00	0,4	0,0

Total settlement at 27,26 m from the axis in 0 months (mm): 0,0 0%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	0,1
Settlement with surcharge anticipation over 12 months after a hold period 0 months (mm):	0,1

Duration after hold period (months) 12

Without anticipation	
Residual Settlement without surcharge anticipation after a hold period of 0 months (mm):	0,1
Settlement without surcharge anticipation over 12 after a hold period of 0 months (mm):	0,1



HS2 – C2 – Calvert Area – Detailed Design

Profile 1 - GM1a - Ch. 80940 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	2,70
Hr (m)	2,7
Side slope (H/V)	4,00
Width PF (m)	33,40
Surcharge of the embankmant (kPa)	52,7
Static surcharge (kPa)	0,00
Sr (kPa)	52,7

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	27,26
c1	10,8
c2	10,8
d1	-5,2
d2	49,4

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	2,0	0,042	2,2	20	12	0,2	1,00E+04	0,9	0,0	0,0	0,0
ALV	2,0	2,7	0,080	4,2	20	26	0,2	6,0	0,9	0,5	0,4	0,0
OXC W	2,7	4,1	0,108	5,7	20	36	0,2	7,8	0,5	1,0	0,5	0,5
OXC U	4,1	9,0	0,184	9,7	20	68	0,2	34,4	0,3	1,4	0,4	1,0
KLB V SV	9,0	11,0	0,246	12,9	20	102	0,2	85,0	0,3	0,3	0,1	0,2
KLB CZ	11,0	14,0	0,279	14,7	20	127	0,2	34,4	0,3	1,3	0,4	0,9
GOC	14,0	14,0	0,294	15,5	20	142	0,2	34,4	0,3	0,0	0,0	0,0
			Total settlement at 27,26 m from the axis							4	2	3

nb iteration 0
Convergence m

Stress inc. / s'V0 11%

w Rail Load	4	2	3
wo Rail Load	64	42	22
difference	60	40	

2 - CONSOLIDATION BY TIME (without vertical drains)

Time	
month	6
number of days	30,4
secondes	15778800

With surcharge anticipation (anticipation rail load 30 kPa)

Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-08	2,0	3,94E-02	22,4	0,0
ALV	1,20E-07	0,7	3,86E+00	100,0	0,4
OXC W	3,80E-07	1,4	3,06E+00	100,0	0,5
OXC U	1,00E-08	4,9	6,57E-03	9,2	0,0
KLB V SV	1,00E-06	2,0	3,94E+00	100,0	0,1
KLB CZ	4,20E-07	3,0	7,36E-01	86,8	0,3
GOC	1,00E-08	0,0	1,58E+05	100,0	0,0

Total settlement at 27,26 m from the axis in 6 months (mm): 1,4 77%

With surcharge anticipation

Residual settlement (mm) with surcharge anticipation after hold period : 0,4

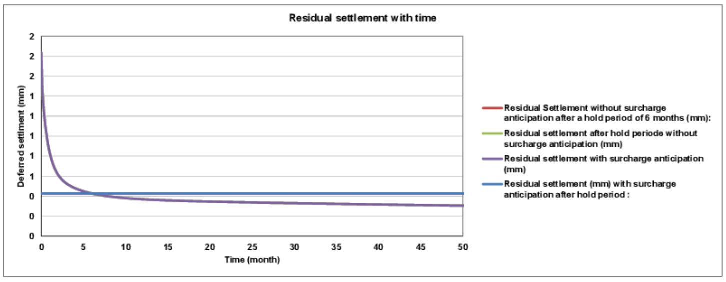
Settlement with surcharge anticipation over 12 months after a hold period 6 months (mm): 0,1

Duration after hold period (months) 12

Without anticipation

Residual Settlement without surcharge anticipation after a hold period of 6 months (mm): 0,4

Settlement without surcharge anticipation over 12 after a hold period of 6 months (mm): 0,1



HS2 – C2 – Calvert Area – Detailed Design

Profile 02 - GM1c - Ch. HS2. 81+220 - Embankment Impact

gr (kN/m³)	20,00
Hf (m)	2,70
Hr (m)	2,7
Side slope (H/V)	2,00
Width PF (m)	44,00
Surcharge of the embankmant (kPa)	54,0
Static surcharge (kPa)	30,00
Sr (kPa)	84,0

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	0
c1	5,4
c2	5,4
d1	24,7
d2	24,7

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
ALV	0,0	2,4	1,000	84,0	20	14	0,2	6,0	0,9	33,6	30,2	3,4
OXC W	2,4	5,0	0,999	83,9	20	39	0,2	7,8	0,5	28,0	14,0	14,0
OXC U1	5,0	6,0	0,995	83,6	20	57	0,2	13,9	0,5	6,0	3,0	3,0
KLB V SV	6,0	8,0	0,991	83,2	20	72	0,2	85,0	0,1	2,0	0,2	1,8
KLB CZ	8,0	10,0	0,982	82,5	20	92	0,2	34,4	0,4	4,8	1,9	2,9
GOC	10,0	14,0	0,962	80,8	20	122	0,2	133,3	0,4	2,4	1,0	1,5
GOC	14,0	28,0	0,864	72,6	20	212	0,2	133,3	0,4	7,6	3,0	4,6
			Total settlement at 0 m from the axis (mm) :							84	53	31

nb iteration 0
Convergence m

Stress inc. / s'V0 34%

w Rail Load	84	53	31
wo Rail Load	50	24	26
Rail L. Impact	**34**	**29**	**5**

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	6
number of days / r	30,4
secondes	15778800

With surcharge anticipation (anticipation rail load 30 kPa)

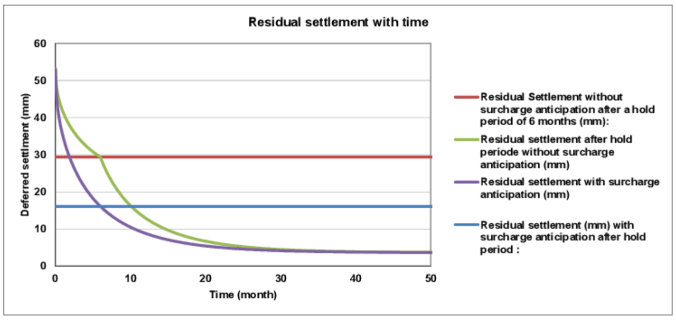
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV	1,20E-07	2,4	3,29E-01	64,0	19,3
OXC W	3,80E-07	2,6	8,87E-01	90,9	12,7
OXC U1	5,00E-07	1,0	7,89E+00	100,0	3,0
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,2
KLB CZ	4,20E-07	2,0	1,66E+00	98,6	1,9
GOC	1,00E-08	6,0	4,38E-03	7,5	0,1
GOC	1,00E-08	20,0	3,94E-04	2,3	0,1

Total settlement at 0 m from the axis in 6 months (mm): 37,3 70%

With surcharge anticipation		Landsc.	TOTAL
Residual settlement (mm) with surcharge anticipation after hold period :	16,1	1,0	17,1
ment with surcharge anticipation over 12 months after a hold period 6 months (mm):	10,1	0,1	10,2

Duration after hold period (months) 12

Without anticipation		Landsc.	TOTAL
idual Settlement without surcharge anticipation after a hold period of 6 months (mm):	29,4	1,0	30,4
ttlement without surcharge anticipation over 12 after a hold period of 6 months (mm):	21,8	0,1	21,9



https://arcadiso365.sharepoint.com/teams/HS2ASC/03 Project Execution/05 - C2 Calvert/09 - Twyford Embankment (IMD)/06 - GT - Geotechnical/Settlements transition viaduct/. FINAL ANALYSIS/02 GM1c - 81220.xlsm EMB (0)

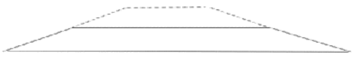
HS2 – C2 – Calvert Area – Detailed Design

Profile 02 - GM1c - Ch. HS2. 81+220 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	2,70
Hr (m)	2,7
Side slope (H/V)	4,00
Width PF (m)	42,20
Surcharge of the embankmant (kPa)	52,7
Static surcharge (kPa)	0,00
Sr (kPa)	52,7

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-35,35
c1	10,8
c2	10,8
d1	61,9
d2	-8,9



Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
ALV	0,0	2,4	0,001	0,1	20	14	0,2	6,0	0,9	0,0	0,0	0,0
OXC W	2,4	5,0	0,023	1,2	20	39	0,2	7,8	0,5	0,4	0,2	0,2
OXC U1	5,0	6,0	0,052	2,7	20	57	0,2	13,9	0,5	0,2	0,1	0,1
KLB V SV	6,0	8,0	0,078	4,1	20	72	0,2	85,0	0,1	0,1	0,0	0,1
KLB CZ	8,0	10,0	0,113	6,0	20	92	0,2	34,4	0,4	0,3	0,1	0,2
GOC	10,0	14,0	0,161	8,5	20	122	0,2	133,3	0,4	0,3	0,1	0,2
GOC	14,0	28,0	0,259	13,6	20	212	0,2	133,3	0,4	1,4	0,6	0,9
			Total settlement at -35,35 m from the axis (mm)							3	1	2

nb iteration 0 Stress inc. / s'v0 6%
Convergence m

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	6
number of days / r	30,4
secondes	15778800

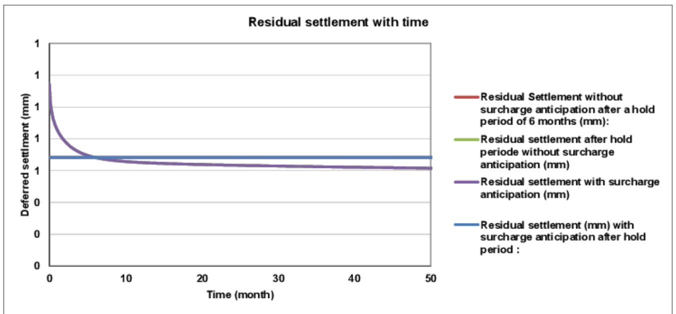
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV	1,20E-07	2,4	3,29E-01	64,0	0,0
OXC W	3,80E-07	2,6	8,87E-01	90,9	0,2
OXC U1	5,00E-07	1,0	7,89E+00	100,0	0,1
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,0
KLB CZ	4,20E-07	2,0	1,66E+00	98,6	0,1
GOC	1,00E-08	6,0	4,38E-03	7,5	0,0
GOC	1,00E-08	20,0	3,94E-04	2,3	0,0

Total settlement at -35,35 m from the axis in 6 months (mm):	0,5	41%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	0,7
ment with surcharge anticipation over 12 months after a hold period 6 months (mm):	0,0

Duration after hold period (months)	12

Without anticipation	
idual Settlement without surcharge anticipation after a hold period of 6 months (mm):	0,7
ttlement without surcharge anticipation over 12 after a hold period of 6 months (mm):	0,0



HS2 – C2 – Calvert Area – Detailed Design

Profile 02 - GM1c - Ch. HS2. 81+220 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	4,90
Hr (m)	4,9
Side slope (H/V)	4,00
Width PF (m)	3,00
Surcharge of the embankmant (kPa)	95,6
Static surcharge (kPa)	0,00
Sr (kPa)	95,6

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-35,35
c1	19,6
c2	19,6
d1	46,7
d2	-24,1

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
ALV	0,0	2,4	0,000	0,0	20	14	0,2	6,0	0,9	0,0	0,0	0,0
OXC W	2,4	5,0	0,001	0,1	20	39	0,2	7,8	0,5	0,0	0,0	0,0
OXC U1	5,0	6,0	0,003	0,3	20	57	0,2	13,9	0,5	0,0	0,0	0,0
KLB V SV	6,0	8,0	0,006	0,5	20	72	0,2	85,0	0,1	0,0	0,0	0,0
KLB CZ	8,0	10,0	0,011	1,0	20	92	0,2	34,4	0,4	0,1	0,0	0,0
GOC	10,0	14,0	0,022	2,1	20	122	0,2	133,3	0,4	0,1	0,0	0,0
GOC	14,0	28,0	0,063	6,0	20	212	0,2	133,3	0,4	0,6	0,3	0,4
			Total settlement at -35,35 m from the axis (mm)							1	0	0

nb iteration 0 Stress inc. / s'V0 3%
Convergence m

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	0
number of days / r	30,4
secondes	0

With surcharge anticipation (anticipation rail load 30 kPa)

Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV	1,20E-07	2,4	0,00E+00	0,4	0,0
OXC W	3,80E-07	2,6	0,00E+00	0,4	0,0
OXC U1	5,00E-07	1,0	0,00E+00	0,4	0,0
KLB V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
KLB CZ	4,20E-07	2,0	0,00E+00	0,4	0,0
GOC	1,00E-08	6,0	0,00E+00	0,4	0,0
GOC	1,00E-08	20,0	0,00E+00	0,4	0,0

Total settlement at -35,35 m from the axis in 0 months (mm): 0,0 0%

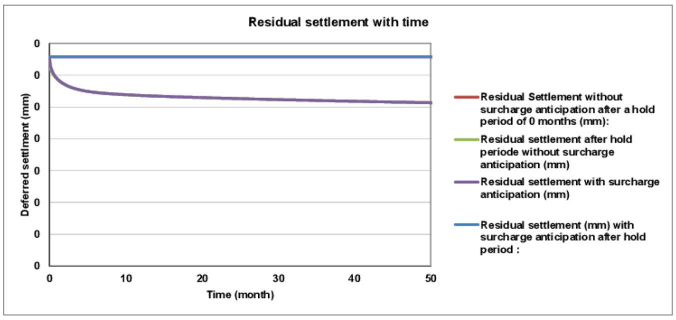
With surcharge anticipation

Residual settlement (mm) with surcharge anticipation after hold period :	0,3
ment with surcharge anticipation over 12 months after a hold period 0 months (mm):	0,1

Duration after hold period (months) 12

Without anticipation

idual Settlement without surcharge anticipation after a hold period of 0 months (mm):	0,3
ttlement without surcharge anticipation over 12 after a hold period of 0 months (mm):	0,1



HS2 – C2 – Calvert Area – Detailed Design

Profile 02 - GM1c - Ch. HS2. 81+220 - Embankment Impact

gr (kN/m³)	20,00
Hf (m)	2,70
Hr (m)	2,7
Side slope (H/V)	2,00
Width PF (m)	44,00
Surcharge of the embankmant (kPa)	54,0
Static surcharge (kPa)	30,00
Sr (kPa)	84,0

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	0
c1	5,4
c2	5,4
d1	24,7
d2	24,7

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	2,0	1,000	84,0	20	12	0,2	10000,0	0,9	0,0	0,0	0,0
ALV CZ	2,0	2,4	1,000	84,0	20	24	0,2	6,0	0,9	5,6	5,0	0,6
OXC W	2,4	5,0	0,999	83,9	20	39	0,2	7,8	0,5	28,0	14,0	14,0
OXC U1	5,0	6,0	0,995	83,6	20	57	0,2	13,9	0,5	6,0	3,0	3,0
KLB V SV	6,0	8,0	0,991	83,2	20	72	0,2	85,0	0,1	2,0	0,2	1,8
KLB CZ	8,0	10,0	0,982	82,5	20	92	0,2	34,4	0,4	4,8	1,9	2,9
GOC	10,0	28,0	0,889	74,7	20	192	0,2	133,3	0,4	10,1	4,0	6,0
			Total settlement at 0 m from the axis (mm) :							56	28	28

nb iteration	0	Stress inc. / s'v0	39%		
Convergence	m				
		w Rail Load	56	28	28
		wo Rail Load	36	17	19
		Rail L. Impact	**20**	**11**	**9**

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	6
number of days / r	30,4
secondes	15778800

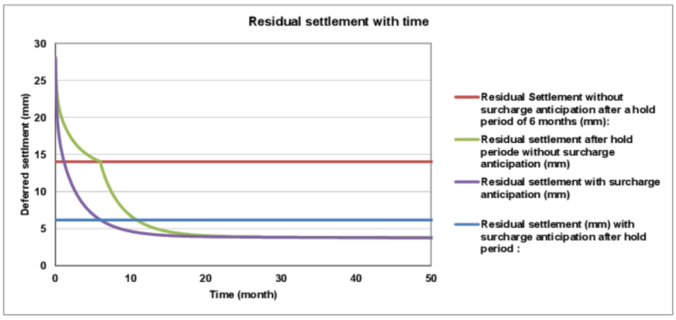
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-08	0,0	1,58E+03	100,0	0,0
ALV CZ	1,20E-07	0,4	1,18E+01	100,0	5,0
OXC W	3,80E-07	3,0	6,66E-01	84,3	11,8
OXC U1	5,00E-07	2,0	1,97E+00	99,4	3,0
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,2
KLB CZ	4,20E-07	2,0	1,66E+00	98,6	1,9
GOC	1,00E-08	20,0	3,94E-04	2,3	0,1

Total settlement at 0 m from the axis in 6 months (mm):	22,0	78%

With surcharge anticipation		Landsc.	TOTAL
Residual settlement (mm) with surcharge anticipation after hold period :	6,2	1,0	7,2
ment with surcharge anticipation over 12 months after a hold period 6 months (mm):	2,2	0,1	2,3

Duration after hold period (months)	12

Without anticipation		Landsc.	TOTAL
idual Settlement without surcharge anticipation after a hold period of 6 months (mm):	14,0	1,0	15,1
ttlement without surcharge anticipation over 12 after a hold period of 6 months (mm):	9,8	0,1	9,9



HS2 – C2 – Calvert Area – Detailed Design

Profile 02 - GM1c - Ch. HS2. 81+220 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	2,70
Hr (m)	2,7
Side slope (H/V)	4,00
Width PF (m)	42,20
Surcharge of the embankmant (kPa)	52,7
Static surcharge (kPa)	0,00
Sr (kPa)	52,7

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-35,35
c1	10,8
c2	10,8
d1	61,9
d2	-8,9

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	2,0	0,001	0,0	20	12	0,2	10000,0	0,9	0,0	0,0	0,0
ALV CZ	2,0	2,4	0,007	0,3	20	24	0,2	6,0	0,4	0,0	0,0	0,0
OXC W	2,4	5,0	0,023	1,2	20	39	0,2	7,8	0,5	0,4	0,2	0,2
OXC U1	5,0	6,0	0,052	2,7	20	57	0,2	13,9	0,5	0,2	0,1	0,1
KLB V SV	6,0	8,0	0,078	4,1	20	72	0,2	85,0	0,1	0,1	0,0	0,1
KLB CZ	8,0	10,0	0,113	6,0	20	92	0,2	34,4	0,4	0,3	0,1	0,2
GOC	10,0	28,0	0,242	12,8	20	192	0,2	133,3	0,4	1,7	0,7	1,0
			Total settlement at -35,35 m from the axis (mm)							3	1	2

nb iteration 0   Stress inc. / s'V0 7%

Convergence m

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	6
number of days / r	30,4
secondes	15778800

With surcharge anticipation (anticipation rail load 30 kPa)

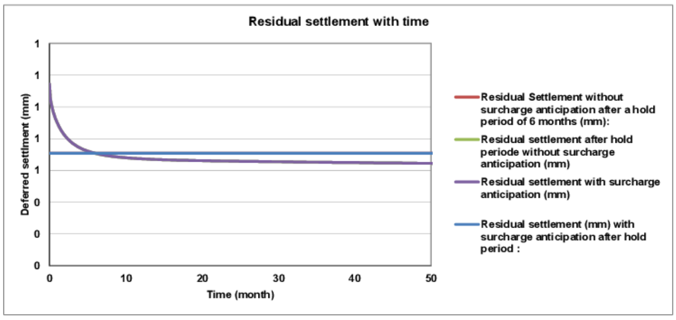
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-08	0,0	1,58E+03	100,0	0,0
ALV CZ	1,20E-07	0,4	1,18E+01	100,0	0,0
OXC W	3,80E-07	3,0	6,66E-01	84,3	0,2
OXC U1	5,00E-07	2,0	1,97E+00	99,4	0,1
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,0
KLB CZ	4,20E-07	2,0	1,66E+00	98,6	0,1
GOC	1,00E-08	20,0	3,94E-04	2,3	0,0

Total settlement at -35,35 m from the axis in 6 months (mm):	0,4	38%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	0,7
ment with surcharge anticipation over 12 months after a hold period 6 months (mm):	0,0

Duration after hold period (months)	12

Without anticipation	
idual Settlement without surcharge anticipation after a hold period of 6 months (mm):	0,7
ttlement without surcharge anticipation over 12 after a hold period of 6 months (mm):	0,0



HS2 – C2 – Calvert Area – Detailed Design

Profile 02 - GM1c - Ch. HS2. 81+220 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	4,90
Hr (m)	4,9
Side slope (H/V)	4,00
Width PF (m)	3,00
Surcharge of the embankmant (kPa)	95,6
Static surcharge (kPa)	0,00
Sr (kPa)	95,6

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-35,35
c1	19,6
c2	19,6
d1	46,7
d2	-24,1

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	2,0	0,000	0,0	20	12	0,2	10000,0	0,9	0,0	0,0	0,0
ALV CZ	2,0	2,4	0,000	0,0	20	24	0,2	6,0	0,4	0,0	0,0	0,0
OXC W	2,4	5,0	0,001	0,1	20	39	0,2	7,8	0,5	0,0	0,0	0,0
OXC U1	5,0	6,0	0,003	0,3	20	57	0,2	13,9	0,5	0,0	0,0	0,0
KLB V SV	6,0	8,0	0,006	0,5	20	72	0,2	85,0	0,1	0,0	0,0	0,0
KLB CZ	8,0	10,0	0,011	1,0	20	92	0,2	34,4	0,4	0,1	0,0	0,0
GOC	10,0	28,0	0,054	5,1	20	192	0,2	133,3	0,4	0,7	0,3	0,4
			Total settlement at -35,35 m from the axis (mm)							1	0	0

nb iteration 0 Stress inc. / s'V0 3%
Convergence m

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	0
number of days / r	30,4
secondes	0

With surcharge anticipation (anticipation rail load 30 kPa)

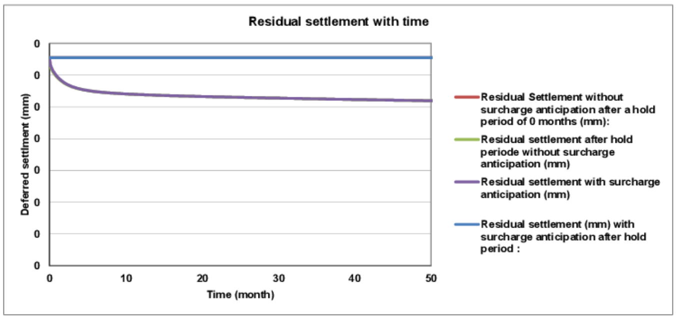
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-08	0,0	0,00E+00	0,4	0,0
ALV CZ	1,20E-07	0,4	0,00E+00	0,4	0,0
OXC W	3,80E-07	3,0	0,00E+00	0,4	0,0
OXC U1	5,00E-07	2,0	0,00E+00	0,4	0,0
KLB V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
KLB CZ	4,20E-07	2,0	0,00E+00	0,4	0,0
GOC	1,00E-08	20,0	0,00E+00	0,4	0,0

Total settlement at -35,35 m from the axis in 0 months (mm):	0,0	0%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	0,3
ment with surcharge anticipation over 12 months after a hold period 0 months (mm):	0,1

Duration after hold period (months)	12

Without anticipation	
idual Settlement without surcharge anticipation after a hold period of 0 months (mm):	0,3
ttlement without surcharge anticipation over 12 after a hold period of 0 months (mm):	0,1



HS2 – C2 – Calvert Area – Detailed Design

Profile 3 . GM2 - Ch. HS2. 81+600 - Embankment Impact

gr (kN/m³)	20,00
Hf (m)	5,00
Hr (m)	5,0
Side slope (H/V)	2,00
Width PF (m)	33,00
Surcharge of the embankmant (kPa)	100,0
Static surcharge (kPa)	30,00
Sr (kPa)	130,0

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	0
c1	10,0
c2	10,0
d1	21,5
d2	21,5

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	0,0	1,000	130,0	20	0	0,2	1,00E+04	0,9	0,0	0,0	0,0
ALV CZ	0,0	2,8	1,000	130,0	20	16	0,2	6,0	0,9	60,4	54,4	6,0
RTD S V SV	2,8	4,0	0,998	129,8	20	36	0,2	26,0	0,4	6,0	2,4	3,6
RTD CZ	4,0	6,0	0,994	129,3	20	52	0,2	6,3	0,4	41,0	16,4	24,6
KLB S V SV	6,0	8,5	0,984	128,0	20	75	0,2	85,0	0,4	3,8	1,5	2,3
KLB CZ	8,5	10,5	0,968	125,8	20	97	0,2	34,4	0,4	7,3	2,9	4,4
CB LMST	10,5	30,0	0,831	108,0	20	205	0,2	208,5	0,4	10,1	4,0	6,1
			Total settlement at 0 m from the axis (mm)							129	82	47

nb iteration 0
Convergence m

Stress inc. / s'V0 53%

w Rail Load	129	82	47
wo Rail Load	116	74	42
Rail Load Impact	13	8	5

2 - CONSOLIDATION BY TIME (without vertical drains)

Time	
month	6
number of days	30,4
secondes	15778800

With surcharge anticipation (anticipation rail load 30 kPa)

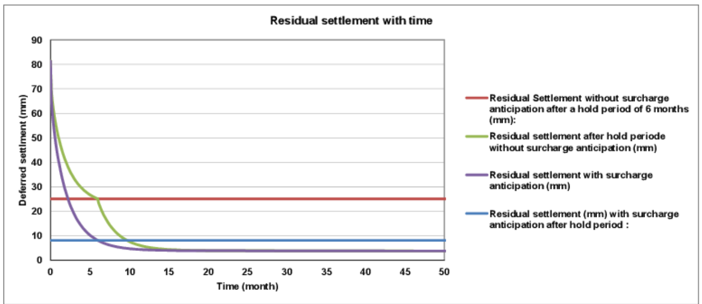
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-06	0,0	1,58E+05	100,0	0,0
ALV CZ	1,20E-07	1,4	9,73E-01	92,7	50,4
RTD S V SV	1,00E-06	0,0	1,58E+05	100,0	2,4
RTD CZ	1,20E-07	1,0	1,89E+00	99,2	16,3
KLB S V SV	1,00E-06	0,0	1,58E+05	100,0	1,5
KLB CZ	4,20E-07	2,0	1,66E+00	98,6	2,9
CB LMST	1,00E-08	21,5	3,41E-04	2,1	0,1

Total settlement at 0 m from the axis in 6 months (mm): 73,6 90%

With surcharge anticipation		Landsc.	TOTAL
Residual settlement (mm) with surcharge anticipation after hold period :	8,1	3,4	11,5
Settlement with surcharge anticipation over 12 months after a hold period 6 months (mm):	4,2	1,4	5,6

Duration after hold period (months) 12

Without anticipation		Landsc.	TOTAL
Residual Settlement without surcharge anticipation after a hold period of 6 months (mm):	25,1	2,8	27,9
Settlement without surcharge anticipation over 12 after a hold period of 6 months (mm):	21,0	1,3	22,3



https://arcadiso365.sharepoint.com/teams/HS2ASC/03 Project Execution/05 - C2 Calvert/09 - Twyford Embankment (IMD)/06 - GT - Geotechnical/Settlements transition viaduct/. FINAL ANALYSIS/03 GM2 - 81600.xlsm - EMB (0)

HS2 – C2 – Calvert Area – Detailed Design

Profile 3 . GM2 - Ch. HS2. 81+600 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	5,00
Hr (m)	5,0
Side slope (H/V)	4,00
Width PF (m)	40,00
Surcharge of the embankmant (kPa)	97,5
Static surcharge (kPa)	0,00
Sr (kPa)	97,5

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-32
c1	20,0
c2	20,0
d1	62,0
d2	-2,0

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	0,0	0,400	39,0	20	0	0,2	1,00E+04	0,9	0,0	0,0	0,0
ALV CZ	0,0	2,8	0,400	39,0	20	16	0,2	6,0	0,9	18,1	16,3	1,8
RTD S V SV	2,8	4,0	0,402	39,1	20	36	0,2	26,0	0,4	1,8	0,7	1,1
RTD CZ	4,0	6,0	0,404	39,4	20	52	0,2	6,3	0,4	12,5	5,0	7,5
KLB S V SV	6,0	8,5	0,410	39,9	20	75	0,2	85,0	0,4	1,2	0,5	0,7
KLB CZ	8,5	10,5	0,416	40,6	20	97	0,2	34,4	0,4	2,4	0,9	1,4
CB LMST	10,5	30,0	0,439	42,8	20	205	0,2	208,5	0,4	4,0	1,6	2,4
			Total settlement at -32 m from the axis (mm							40	25	15

nb iteration 0
Convergence m

Stress inc. / s'v0 21%

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	6
number of days	30,4
secondes	15778800

With surcharge anticipation (anticipation rail load 30 kPa)

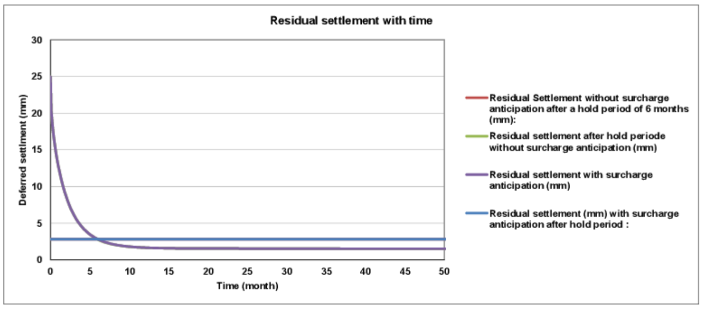
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-06	0,0	1,58E+05	100,0	0,0
ALV CZ	1,20E-07	1,4	9,73E-01	92,7	15,1
RTD S V SV	1,00E-06	0,0	1,58E+05	100,0	0,7
RTD CZ	1,20E-07	1,0	1,89E+00	99,2	5,0
KLB S V SV	1,00E-06	0,0	1,58E+05	100,0	0,5
KLB CZ	4,20E-07	2,0	1,66E+00	98,6	0,9
CB LMST	1,00E-08	21,5	3,41E-04	2,1	0,0

Total settlement at -32 m from the axis in 6 months (mm):	22,2	89%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	2,8
Settlement with surcharge anticipation over 12 months after a hold period 6 months (mm):	1,3

Duration after hold period (months)	12

Without anticipation	
Residual Settlement without surcharge anticipation after a hold period of 6 months (mm):	2,8
Settlement without surcharge anticipation over 12 after a hold period of 6 months (mm):	1,3



03 GM2 - 81600.xlsm

HS2 – C2 – Calvert Area – Detailed Design

Profile 3 . GM2 - Ch. HS2. 81+600 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	5,40
Hr (m)	5,4
Side slope (H/V)	4,00
Width PF (m)	3,00
Surcharge of the embankmant (kPa)	105,3
Static surcharge (kPa)	0,00
Sr (kPa)	105,3

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-32
c1	21,6
c2	21,6
d1	44,3
d2	-19,7

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	0,0	0,000	0,0	20	0	0,2	1,00E+04	0,9	0,0	0,0	0,0
ALV CZ	0,0	2,8	0,000	0,0	20	16	0,2	6,0	0,9	0,0	0,0	0,0
RTD S V SV	2,8	4,0	0,002	0,2	20	36	0,2	26,0	0,4	0,0	0,0	0,0
RTD CZ	4,0	6,0	0,006	0,6	20	52	0,2	6,3	0,4	0,2	0,1	0,1
KLB S V SV	6,0	8,5	0,014	1,5	20	75	0,2	85,0	0,4	0,0	0,0	0,0
KLB CZ	8,5	10,5	0,026	2,8	20	97	0,2	34,4	0,4	0,2	0,1	0,1
CB LMST	10,5	30,0	0,094	9,9	20	205	0,2	208,5	0,4	0,9	0,4	0,6
			Total settlement at -32 m from the axis (mr							1	1	1

nb iteration 0
Convergence m

Stress inc. / s'v0 5%

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	0
number of days	30,4
secondes	0

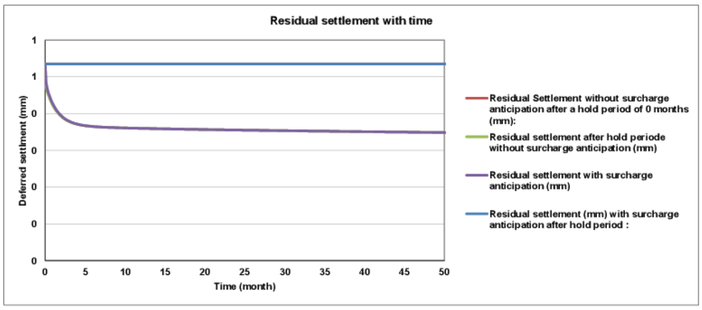
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-06	0,0	0,00E+00	0,4	0,0
ALV CZ	1,20E-07	1,4	0,00E+00	0,4	0,0
RTD S V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
RTD CZ	1,20E-07	1,0	0,00E+00	0,4	0,0
KLB S V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
KLB CZ	4,20E-07	2,0	0,00E+00	0,4	0,0
CB LMST	1,00E-08	21,5	0,00E+00	0,4	0,0

Total settlement at -32 m from the axis in 0 months (mm):	0,0	0%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	0,5
Settlement with surcharge anticipation over 12 months after a hold period 0 months (mm):	0,2

Duration after hold period (months)	12

Without anticipation	
Residual Settlement without surcharge anticipation after a hold period of 0 months (mm):	0,5
Settlement without surcharge anticipation over 12 after a hold period of 0 months (mm):	0,2



03 GM2 - 81600.xlsm

HS2 – C2 – Calvert Area – Detailed Design

Profile 4 GM4 Ch. HS2. 81+715 - Embankment Impact

gr (kN/m³)	20,00
Hf (m)	5,80
Hr (m)	5,8
Side slope (H/V)	2,00
Width PF (m)	28,60
Surcharge of the embankmant (kPa)	116,0
Static surcharge (kPa)	30,00
Sr (kPa)	146,0

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	0
c1	11,6
c2	11,6
d1	20,1
d2	20,1

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
ALV S V SV	0,0	2,7	1,000	146,0	20	16	0,2	6,70E+00	0,10	58,8	5,9	52,9
ALV-CZ	2,7	4,5	0,997	145,6	20	38	0,2	6,00	0,90	43,7	39,3	4,4
KLB V SV	4,5	6,0	0,992	144,8	20	55	0,2	94,40	0,10	2,3	0,2	2,1
KLB CZ	6,0	8,0	0,982	143,4	20	72	0,2	31,00	0,40	9,3	3,7	5,6
GOC	8,0	20,0	0,904	131,9	20	142	0,2	104,00	0,30	15,2	4,6	10,7
GOC	20,0	35,0	0,697	101,8	20	277	0,2	179,60	0,30	8,5	2,6	6,0
GOC	35,0	35,0	0,601	87,8	20	352	0,2	221,60	0,30	0,0	0,0	0,0
GOC	35,0	35,0	0,601	87,8	20	352	0,2	221,60	0,30	0,0	0,0	0,0
GOC	35,0	35,0	0,601	87,8	20	352	0,2	221,60	0,30	0,0	0,0	0,0
GOC	35,0	35,0	0,601	87,8	20	352	0,2	221,60	0,30	0,0	0,0	0,0
			Total settlement at 0 m from the axis (mm) :							138	56	82

nb iteration 0 Stress inc. / s'v0 25%
Convergence m

w Rail Load	138	56	82
wo Rail Load	109	44	64
difference	-29	-12	

2 - CONSOLIDATION BY TIME (without vertical drains)

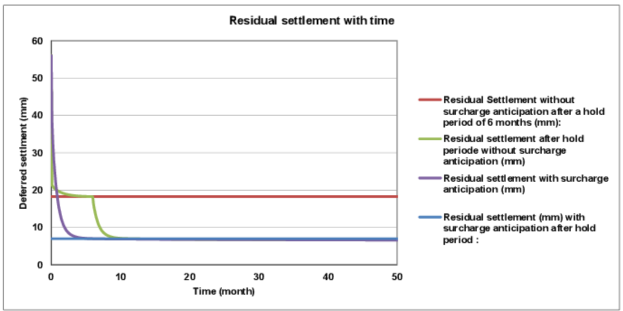
	Time	
month	6	6
number of days	30,4	
secondes	15778800	

With surcharge anticipation (anticipation rail load 30 kPa)						
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)	
ALV S V SV	1,00E-06	0,0	1,58E+05	100,0	5,9	100%
ALV-CZ	1,20E-07	0,8	3,37E+00	100,0	39,3	100%
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,2	100%
KLB CZ	4,20E-07	2,0	1,66E+00	98,6	3,6	99%
GOC	1,00E-08	14,0	8,05E-04	3,2	0,1	3%
GOC	1,00E-08	29,0	1,88E-04	1,6	0,0	2%
GOC	1,00E-08	29,0	1,88E-04	1,6	0,0	
GOC	1,00E-08	29,0	1,88E-04	1,6	0,0	
GOC	1,00E-08	29,0	1,88E-04	1,6	0,0	
Total settlement at 0 m from the axis in 6 months (mm):					49,3	88%

With surcharge anticipation		Landsc.	TOTAL
Residual settlement (mm) with surcharge anticipation after hold period :	7,0	4,0	11,0
th surcharge anticipation over 12 months after a hold period 6 months (mm):	0,2	0,2	0,4

Duration after hold period (months)	12

Without anticipation		Landsc.	TOTAL
ttlement without surcharge anticipation after a hold period of 6 months (mm):	18,2	4,0	22,2
without surcharge anticipation over 12 after a hold period of 6 months (mm):	11,4	0,2	11,6



https://arcadiso365.sharepoint.com/teams/HS2ASC/03 Project Execution/05 - C2 Calvert/09 - Twyford Embankment (IMD)/06 - GT - Geotechnical/Settlements transition viaduct/. FINAL ANALYSIS/04 GM4 - 81720.xlsm - EMB (0)

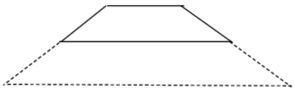
HS2 – C2 – Calvert Area – Detailed Design

Profile 4 GM4 Ch. HS2. 81+715 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	4,40
Hr (m)	4,4
Side slope (H/V)	4,00
Width PF (m)	3,00
Surcharge of the embankmant (kPa)	85,8
Static surcharge (kPa)	0,00
Sr (kPa)	85,8

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-30
c1	17,6
c2	17,6
d1	40,3
d2	-19,7



Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation setllment)
ALV S V SV	0,0	2,7	0,000	0,0	20	16	0,2	6,70E+00	0,10	0,0	0,0	0,0
ALV-CZ	2,7	4,5	0,002	0,1	20	38	0,2	6,00	0,90	0,0	0,0	0,0
KLB V SV	4,5	6,0	0,005	0,4	20	55	0,2	94,40	0,10	0,0	0,0	0,0
KLB CZ	6,0	8,0	0,010	0,9	20	72	0,2	31,00	0,40	0,1	0,0	0,0
GOC	8,0	20,0	0,048	4,1	20	142	0,2	104,00	0,30	0,5	0,1	0,3
GOC	20,0	35,0	0,116	9,9	20	277	0,2	179,60	0,30	0,8	0,2	0,6
GOC	35,0	35,0	0,135	11,6	20	352	0,2	221,60	0,30	0,0	0,0	0,0
GOC	35,0	35,0	0,135	11,6	20	352	0,2	221,60	0,30	0,0	0,0	0,0
GOC	35,0	35,0	0,135	11,6	20	352	0,2	221,60	0,30	0,0	0,0	0,0
GOC	35,0	35,0	0,135	11,6	20	352	0,2	221,60	0,30	0,0	0,0	0,0
			Total settlement at -30 m from the axis (mm) :							1	0	1

nb iteration 0 Stress inc. / s'V0 3%
Convergence m

2 - CONSOLIDATION BY TIME (without vertical drains)

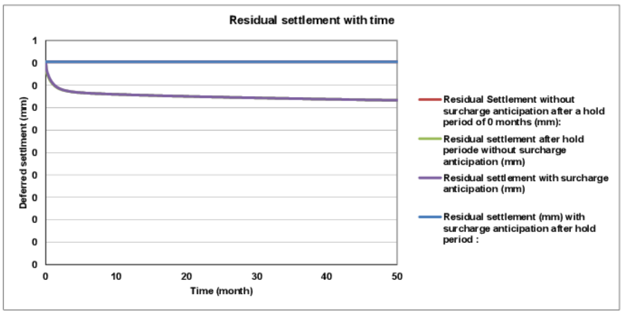
	Time
month	0
number of days	30,4
secondes	0

With surcharge anticipation (anticipation rail load 30 kPa)						
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)	
ALV S V SV	1,00E-06	0,0	0,00E+00	0,4	0,0	0%
ALV-CZ	1,20E-07	0,8	0,00E+00	0,4	0,0	26%
KLB V SV	1,00E-06	0,0	0,00E+00	0,4	0,0	0%
KLB CZ	4,20E-07	2,0	0,00E+00	0,4	0,0	0%
GOC	1,00E-08	14,0	0,00E+00	0,4	0,0	0%
GOC	1,00E-08	29,0	0,00E+00	0,4	0,0	
GOC	1,00E-08	29,0	0,00E+00	0,4	0,0	
GOC	1,00E-08	29,0	0,00E+00	0,4	0,0	
GOC	1,00E-08	29,0	0,00E+00	0,4	0,0	
Total settlement at -30 m from the axis in 0 months (mm):					0,0	0%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	0,5
th surcharge anticipation over 12 months after a hold period 0 months (mm):	0,1

Duration after hold period (months)	12

Without anticipation	
ttlement without surcharge anticipation after a hold period of 0 months (mm):	0,5
without surcharge anticipation over 12 after a hold period of 0 months (mm):	0,1



https://arcadiso365.sharepoint.com/teams/HS2ASC/03 Project Execution/05 - C2 Calvert/09 - Twyford Embankment (IMD)/06 - GT - Geotechnical/Settlements transition viaduct/. FINAL ANALYSIS/GM4 - 81720.xlsm - LAN (0.1)

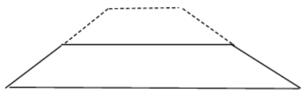
HS2 – C2 – Calvert Area – Detailed Design

Profile 4 GM4 Ch. HS2. 81+715 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	5,80
Hr (m)	5,8
Side slope (H/V)	4,00
Width PF (m)	40,00
Surcharge of the embankmant (kPa)	113,1
Static surcharge (kPa)	0,00
Sr (kPa)	113,1

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-30
c1	23,2
c2	23,2
d1	61,6
d2	1,6



Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation setllment)
ALV S V SV	0,0	2,7	0,569	64,3	20	16	0,2	6,70	0,10	25,9	2,6	23,3
ALV-CZ	2,7	4,5	0,568	64,3	20	38	0,2	6,00	0,90	19,3	17,3	1,9
KLB V SV	4,5	6,0	0,567	64,1	20	55	0,2	94,40	0,10	1,0	0,1	0,9
KLB CZ	6,0	8,0	0,564	63,8	20	72	0,2	31,00	0,40	4,1	1,6	2,5
GOC	8,0	20,0	0,549	62,1	20	142	0,2	104,00	0,30	7,2	2,2	5,0
GOC	20,0	35,0	0,517	58,5	20	277	0,2	179,60	0,30	4,9	1,5	3,4
GOC	35,0	35,0	0,498	56,3	20	352	0,2	221,60	0,30	0,0	0,0	0,0
GOC	35,0	35,0	0,498	56,3	20	352	0,2	221,60	0,30	0,0	0,0	0,0
GOC	35,0	35,0	0,498	56,3	20	352	0,2	221,60	0,30	0,0	0,0	0,0
GOC	35,0	35,0	0,498	56,3	20	352	0,2	221,60	0,30	0,0	0,0	0,0
			Total settlement at -30 m from the axis (mm) :							62,4	25,3	37,1

nb iteration 0 Stress inc. / s'v0 16%
Convergence m

2 - CONSOLIDATION BY TIME (without vertical drains)

Time	
month	6
number of days	30,4
secondes	15778800

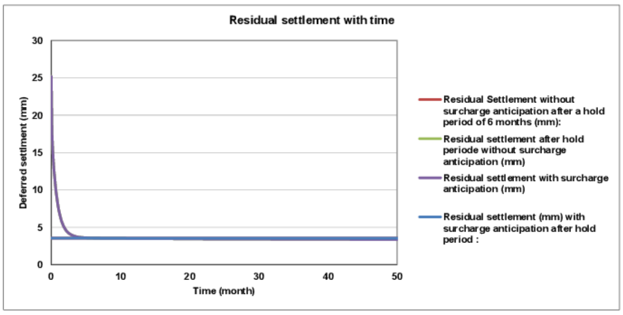
With surcharge anticipation (anticipation rail load 30 kPa)

Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)	
ALV S V SV	1,00E-06	0,0	1,58E+05	100,0	2,6	100%
ALV-CZ	1,20E-07	0,8	3,37E+00	100,0	17,3	17034%
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,1	6%
KLB CZ	4,20E-07	2,0	1,66E+00	98,6	1,6	76%
GOC	1,00E-08	14,0	8,05E-04	3,2	0,1	5%
GOC	1,00E-08	29,0	1,88E-04	1,6	0,0	
GOC	1,00E-08	29,0	1,88E-04	1,6	0,0	
GOC	1,00E-08	29,0	1,88E-04	1,6	0,0	
GOC	1,00E-08	29,0	1,88E-04	1,6	0,0	
Total settlement at -30 m from the axis in 6 months (mm):					21,8	86%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	3,5
th surcharge anticipation over 12 months after a hold period 6 months (mm):	0,1

Duration after hold period (months)	12

Without anticipation	
ttlement without surcharge anticipation after a hold period of 6 months (mm):	3,5
without surcharge anticipation over 12 after a hold period of 6 months (mm):	0,1



HS2 – C2 – Calvert Area – Detailed Design

Profile 5 GM5 Ch. HS2. 81+920 - Embankment Impact

gr (kN/m³)	20,00
Hf (m)	5,10
Hr (m)	5,1
Side slope (H/V)	2,00
Width PF (m)	37,14
Surcharge of the embankmant (kPa)	102,0
Static surcharge (kPa)	30,00
Sr (kPa)	132,0

Embankment geometry for calculating the influence factor at the axis
distance to the axis (m):

c1	10,2
c2	10,2
d1	23,7
d2	23,7

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation setllment)
Fill Material	0,0	0,0	1,000	132,0	20	0	0,2	1,00E+04	0,10	0,0	0,0	0,0
ALV-CZ	0,0	2,0	1,000	132,0	20	12	0,2	6,00	0,50	43,8	21,9	21,9
OXC W	2,0	4,0	0,999	131,9	20	32	0,2	7,80	0,50	33,8	16,9	16,9
OXC U1	4,0	5,7	0,996	131,5	20	51	0,2	13,90	0,40	16,1	6,4	9,6
KLB V SV	5,7	9,2	0,987	130,3	20	77	0,2	94,40	0,10	4,8	0,5	4,3
KLB CZ	9,2	10,6	0,973	128,4	20	101	0,2	31,00	0,35	5,8	2,0	3,8
GOC	10,6	33,0	0,838	110,7	20	220	0,2	147,68	0,30	16,8	5,0	11,8
GOC	33,0	33,0	0,693	91,5	20	332	0,2	210,40	0,30	0,0	0,0	0,0
GOC	33,0	33,0	0,693	91,5	20	332	0,2	210,40	0,30	0,0	0,0	0,0
GOC	33,0	33,0	0,693	91,5	20	332	0,2	210,40	0,30	0,0	0,0	0,0
			Total settlement at m from the axis (mm) :							121	53	68

nb iteration 0
Convergence m

Stress inc. / s'v0 28%

w Rail Load	121	53	68
wo Rail Load	92	40	52
difference	-29	-12	

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	6
number of days	30,4
secondes	15778800

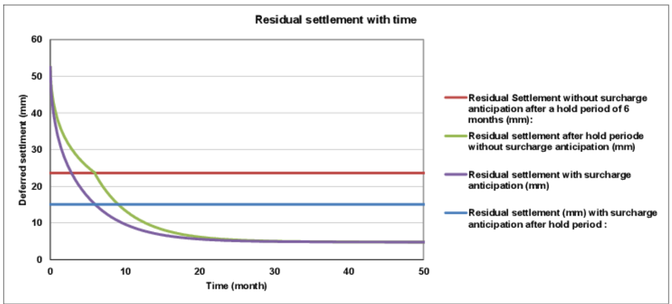
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV-CZ	1,20E-07	2,0	4,78E-01	75,1	16,4
OXC W	3,80E-07	3,7	4,38E-01	72,5	12,3
OXC U1	5,00E-07	1,7	2,73E+00	99,9	6,4
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,5
KLB CZ	4,20E-07	1,4	3,38E+00	100,0	2,0
GOC	1,00E-08	23,8	2,79E-04	1,9	0,1
GOC	1,00E-08	23,8	2,79E-04	1,9	0,0
GOC	1,00E-08	23,8	2,79E-04	1,9	0,0
GOC	1,00E-08	23,8	2,79E-04	1,9	0,0
Total settlement at m from the axis in 6 months (mm):					37,7

71%

With surcharge anticipation		Landsc.	TOTAL
Residual settlement (mm) with surcharge anticipation after hold period :	15,1	4,3	19,3
surcharge anticipation over 12 months after a hold period 6 months (mm):	9,1	2,1	11,2

Duration after hold period (months)	12

Without anticipation		Landsc.	TOTAL
lement without surcharge anticipation after a hold period of 6 months (mm):	23,6	4,3	27,9
without surcharge anticipation over 12 after a hold period of 6 months (mm):	16,9	2,1	18,9



https://arcadiso365.sharepoint.com/teams/HS2ASC/03 Project Execution/05 - C2 Calvert/09 - Twyford Embankment (GDR)/06 - GT - Geotechnical/Settlements transition viaduct/. FINAL ANALYSIS/05 GM5 - 81920.xlsm - EMB (0) Page 1/1

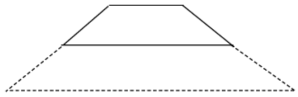
HS2 – C2 – Calvert Area – Detailed Design

Profile 5 GM5 Ch. HS2. 81+920 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	4,90
Hr (m)	4,9
Side slope (H/V)	4,00
Width PF (m)	3,00
Surcharge of the embankmant (kPa)	95,6
Static surcharge (kPa)	0,00
Sr (kPa)	95,6

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-35,55
c1	19,6
c2	19,6
d1	46,9
d2	-24,3



Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	0,0	0,000	0,0	20	0	0,2	1,00E+04	0,10	0,0	0,0	0,0
ALV-CZ	0,0	2,0	0,000	0,0	20	12	0,2	6,00	0,50	0,0	0,0	0,0
OXC W	2,0	4,0	0,000	0,0	20	32	0,2	7,80	0,50	0,0	0,0	0,0
OXC U1	4,0	5,7	0,002	0,2	20	51	0,2	13,90	0,40	0,0	0,0	0,0
KLB V SV	5,7	9,2	0,007	0,6	20	77	0,2	94,40	0,10	0,0	0,0	0,0
KLB CZ	9,2	10,6	0,013	1,3	20	101	0,2	31,00	0,35	0,1	0,0	0,0
GOC	10,6	33,0	0,066	6,3	20	220	0,2	147,68	0,30	1,0	0,3	0,7
GOC	33,0	33,0	0,106	10,2	20	332	0,2	210,40	0,30	0,0	0,0	0,0
GOC	33,0	33,0	0,106	10,2	20	332	0,2	210,40	0,30	0,0	0,0	0,0
GOC	33,0	33,0	0,106	10,2	20	332	0,2	210,40	0,30	0,0	0,0	0,0
			Total settlement at -35,55 m from the axis (mm) :							1	0	1

nb iteration 0 Stress inc. / s'V0 3%
Convergence m

w Rail Load	1	0	1
wo Rail Load	93	41	52
difference	92	40	

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	0
number of days	30,4
secondes	0

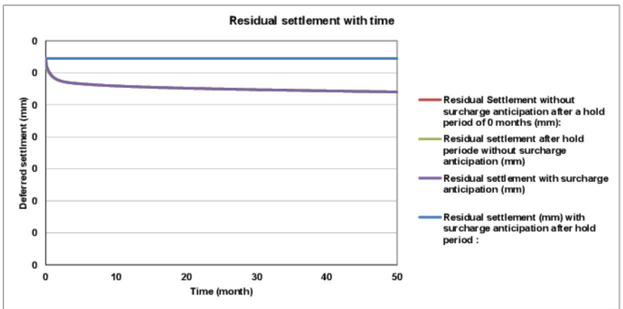
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV-CZ	1,20E-07	2,0	0,00E+00	0,4	0,0
OXC W	3,80E-07	3,7	0,00E+00	0,4	0,0
OXC U1	5,00E-07	1,7	0,00E+00	0,4	0,0
KLB V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
KLB CZ	4,20E-07	1,4	0,00E+00	0,4	0,0
GOC	1,00E-08	23,8	0,00E+00	0,4	0,0
GOC	1,00E-08	23,8	0,00E+00	0,4	0,0
GOC	1,00E-08	23,8	0,00E+00	0,4	0,0
GOC	1,00E-08	23,8	0,00E+00	0,4	0,0
Total settlement at -35,55 m from the axis in 0 months (mm):					0,0

0%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	0,3
th surcharge anticipation over 12 months after a hold period 0 months (mm):	0,0

Duration after hold period (months)	12

Without anticipation	
ttlement without surcharge anticipation after a hold period of 0 months (mm):	0,3
without surcharge anticipation over 12 after a hold period of 0 months (mm):	0,0



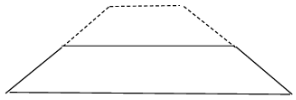
HS2 – C2 – Calvert Area – Detailed Design

Profile 5 GM5 Ch. HS2. 81+920 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	5,10
Hr (m)	5,1
Side slope (H/V)	4,00
Width PF (m)	42,20
Surcharge of the embankmant (kPa)	99,5
Static surcharge (kPa)	0,00
Sr (kPa)	99,5

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-35,55
c1	20,4
c2	20,4
d1	66,9
d2	-4,3



Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	0,0	0,292	29,0	20	0	0,2	1,00E+04	0,10	0,0	0,0	0,0
ALV-CZ	0,0	2,0	0,292	29,0	20	12	0,2	6,00	0,50	9,6	4,8	4,8
OXC W	2,0	4,0	0,294	29,3	20	32	0,2	7,80	0,50	7,5	3,8	3,8
OXC U1	4,0	5,7	0,301	29,9	20	51	0,2	13,90	0,40	3,7	1,5	2,2
KLB V SV	5,7	9,2	0,315	31,4	20	77	0,2	94,40	0,10	1,2	0,1	1,0
KLB CZ	9,2	10,6	0,331	32,9	20	101	0,2	31,00	0,35	1,5	0,5	1,0
GOC	10,6	33,0	0,386	38,4	20	220	0,2	147,68	0,30	5,8	1,7	4,1
GOC	33,0	33,0	0,403	40,1	20	332	0,2	210,40	0,30	0,0	0,0	0,0
GOC	33,0	33,0	0,403	40,1	20	332	0,2	210,40	0,30	0,0	0,0	0,0
GOC	33,0	33,0	0,403	40,1	20	332	0,2	210,40	0,30	0,0	0,0	0,0
			Total settlement at -35,55 m from the axis (mm) :							29	12	17

nb iteration 0 Stress inc. / s'v0 12%
Convergence m

w Rail Load	29	12	17
wo Rail Load	93	41	52
difference	64	28	

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time	
month	6	6
number of days	30,4	
secondes	15778800	

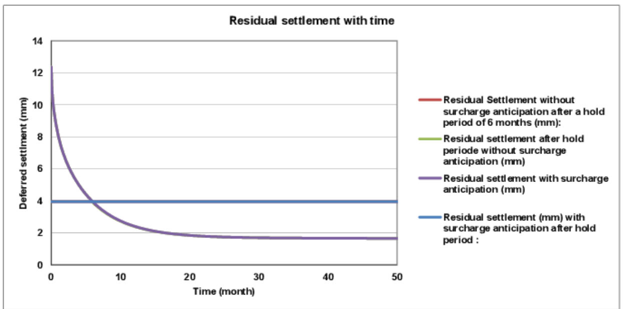
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV-CZ	1,20E-07	2,0	4,78E-01	75,1	3,6
OXC W	3,80E-07	3,7	4,38E-01	72,5	2,7
OXC U1	5,00E-07	1,7	2,73E+00	99,9	1,5
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,1
KLB CZ	4,20E-07	1,4	3,38E+00	100,0	0,5
GOC	1,00E-08	23,8	2,79E-04	1,9	0,0
GOC	1,00E-08	23,8	2,79E-04	1,9	0,0
GOC	1,00E-08	23,8	2,79E-04	1,9	0,0
GOC	1,00E-08	23,8	2,79E-04	1,9	0,0
Total settlement at -35,55 m from the axis in 6 months (mm):					8,5

68%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	3,9
th surcharge anticipation over 12 months after a hold period 6 months (mm):	2,0

Duration after hold period (months)	12

Without anticipation	
ttlement without surcharge anticipation after a hold period of 6 months (mm):	3,9
without surcharge anticipation over 12 after a hold period of 6 months (mm):	2,0



Página 3

HS2 – C2 – Calvert Area – Detailed Design

Profile 5 GM5 Ch. HS2. 81+920 - Embankment Impact

gr (kN/m³)	20,00	Embankment geometry for calculating the influence factor at the axis		
Hf (m)	5,10	distance to the axis (m):		
Hr (m)	5,1	c1		10,2
Side slope (H/V)	2,00	c2		10,2
Width PF (m)	37,14	d1		23,7
Surcharge of the embankmant (kPa)	102,0	d2		23,7
Static surcharge (kPa)	30,00			
Sr (kPa)	132,0			
		Groundwater level	0,2	m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation setlment)
Fill Material	0,0	1,0	1,000	132,0	20	7	0,2	1,00E+04	0,10	0,0	0,0	0,0
ALV-CZ	1,0	2,0	1,000	132,0	20	17	0,2	6,00	0,50	22,0	11,0	11,0
OXC W	2,0	4,0	0,999	131,9	20	32	0,2	7,80	0,50	33,8	16,9	16,9
OXC U1	4,0	5,7	0,996	131,5	20	51	0,2	13,90	0,40	16,1	6,4	9,6
KLB V SV	5,7	9,2	0,987	130,3	20	77	0,2	94,40	0,10	4,8	0,5	4,3
KLB CZ	9,2	10,6	0,973	128,4	20	101	0,2	31,00	0,35	5,8	2,0	3,8
GOC	10,6	33,0	0,838	110,7	20	220	0,2	147,68	0,30	16,8	5,0	11,8
GOC	33,0	33,0	0,693	91,5	20	332	0,2	210,40	0,30	0,0	0,0	0,0
GOC	33,0	33,0	0,693	91,5	20	332	0,2	210,40	0,30	0,0	0,0	0,0
GOC	33,0	33,0	0,693	91,5	20	332	0,2	210,40	0,30	0,0	0,0	0,0
			Total settlement at m from the axis (mm) :							99	42	57

nb iteration	0	Stress inc. / s'V0	28%
Convergence	m		

w Rail Load	99	42	57
wo Rail Load	75	32	43
difference	-24	-10	

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	3
number of days	30,4
secondes	7889400

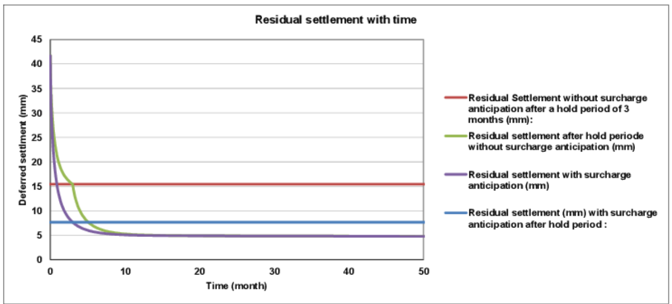
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV-CZ	1,20E-07	1,0	9,47E-01	92,2	10,1
OXC W	3,80E-07	1,0	3,00E+00	100,0	16,9
OXC U1	5,00E-07	3,0	4,38E-01	72,5	4,7
KLB V SV	1,00E-06	0,0	7,89E+04	100,0	0,5
KLB CZ	4,20E-07	1,4	1,69E+00	98,8	2,0
GOC	1,00E-08	23,8	1,39E-04	1,4	0,1
GOC	1,00E-08	23,8	1,39E-04	1,4	0,0
GOC	1,00E-08	23,8	1,39E-04	1,4	0,0
GOC	1,00E-08	23,8	1,39E-04	1,4	0,0
Total settlement at m from the axis in 3 months (mm):					34,3

82%

With surcharge anticipation		Landsc.	TOTAL
Residual settlement (mm) with surcharge anticipation after hold period :	7,6	2,6	10,3
surcharge anticipation over 12 months after a hold period 3 months (mm):	2,7	0,7	3,4

Duration after hold period (months)	12

Without anticipation		Landsc.	TOTAL
lement without surcharge anticipation after a hold period of 3 months (mm):	15,4	2,6	18,1
ithout surcharge anticipation over 12 after a hold period of 3 months (mm):	10,5	0,7	11,1



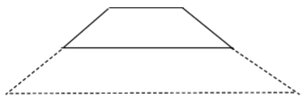
HS2 – C2 – Calvert Area – Detailed Design

Profile 5 GM5 Ch. HS2. 81+920 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	4,90
Hr (m)	4,9
Side slope (H/V)	4,00
Width PF (m)	3,00
Surcharge of the embankmant (kPa)	95,6
Static surcharge (kPa)	0,00
Sr (kPa)	95,6

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-35,55
c1	19,6
c2	19,6
d1	46,9
d2	-24,3



Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	Total settlement DH (mm)	Consolidation settlement DH (mm) (= total settlement x geological correction factor)	Immediate Settlement (mm) (= total - consolidation settlment)
Fill Material	0,0	1,0	0,000	0,0	20	7	0,2	1,00E+04	0,10	0,0	0,0	0,0
ALV-CZ	1,0	2,0	0,000	0,0	20	17	0,2	6,00	0,50	0,0	0,0	0,0
OXC W	2,0	4,0	0,000	0,0	20	32	0,2	7,80	0,50	0,0	0,0	0,0
OXC U1	4,0	5,7	0,002	0,2	20	51	0,2	13,90	0,40	0,0	0,0	0,0
KLB V SV	5,7	9,2	0,007	0,6	20	77	0,2	94,40	0,10	0,0	0,0	0,0
KLB CZ	9,2	10,6	0,013	1,3	20	101	0,2	31,00	0,35	0,1	0,0	0,0
GOC	10,6	33,0	0,066	6,3	20	220	0,2	147,68	0,30	1,0	0,3	0,7
GOC	33,0	33,0	0,106	10,2	20	332	0,2	210,40	0,30	0,0	0,0	0,0
GOC	33,0	33,0	0,106	10,2	20	332	0,2	210,40	0,30	0,0	0,0	0,0
GOC	33,0	33,0	0,106	10,2	20	332	0,2	210,40	0,30	0,0	0,0	0,0
			Total settlement at -35,55 m from the axis (mm) :							1	0	1

nb iteration 0 Stress inc. / s'v0 3%
Convergence m

w Rail Load	1	0	1
wo Rail Load	93	41	52
difference	92	40	

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time	
month	0	0
number of days	30,4	
secondes	0	

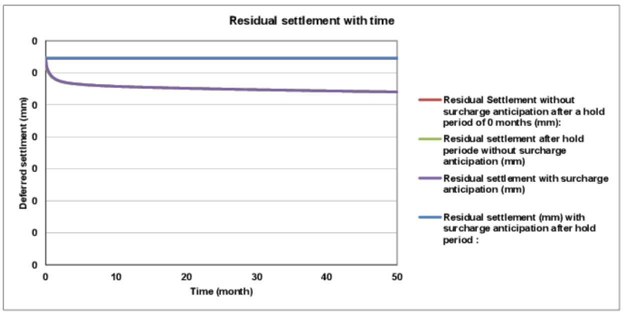
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV-CZ	1,20E-07	1,0	0,00E+00	0,4	0,0
OXC W	3,80E-07	1,0	0,00E+00	0,4	0,0
OXC U1	5,00E-07	3,0	0,00E+00	0,4	0,0
KLB V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
KLB CZ	4,20E-07	1,4	0,00E+00	0,4	0,0
GOC	1,00E-08	23,8	0,00E+00	0,4	0,0
GOC	1,00E-08	23,8	0,00E+00	0,4	0,0
GOC	1,00E-08	23,8	0,00E+00	0,4	0,0
GOC	1,00E-08	23,8	0,00E+00	0,4	0,0
Total settlement at -35,55 m from the axis in 0 months (mm):					0,0

0%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	0,3
th surcharge anticipation over 12 months after a hold period 0 months (mm):	0,0

Duration after hold period (months)	12

Without anticipation	
ttlement without surcharge anticipation after a hold period of 0 months (mm):	0,3
without surcharge anticipation over 12 after a hold period of 0 months (mm):	0,0



Página 5

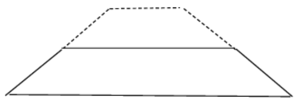
HS2 – C2 – Calvert Area – Detailed Design

Profile 5 GM5 Ch. HS2. 81+920 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	5,10
Hr (m)	5,1
Side slope (H/V)	4,00
Width PF (m)	42,20
Surcharge of the embankmant (kPa)	99,5
Static surcharge (kPa)	0,00
Sr (kPa)	99,5

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-35,55
c1	20,4
c2	20,4
d1	66,9
d2	-4,3



Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	1,0	0,292	29,0	20	7	0,2	1,00E+04	0,10	0,0	0,0	0,0
ALV-CZ	1,0	2,0	0,292	29,0	20	17	0,2	6,00	0,50	4,8	2,4	2,4
OXC W	2,0	4,0	0,294	29,3	20	32	0,2	7,80	0,50	7,5	3,8	3,8
OXC U1	4,0	5,7	0,301	29,9	20	51	0,2	13,90	0,40	3,7	1,5	2,2
KLB V SV	5,7	9,2	0,315	31,4	20	77	0,2	94,40	0,10	1,2	0,1	1,0
KLB CZ	9,2	10,6	0,331	32,9	20	101	0,2	31,00	0,35	1,5	0,5	1,0
GOC	10,6	33,0	0,386	38,4	20	220	0,2	147,68	0,30	5,8	1,7	4,1
GOC	33,0	33,0	0,403	40,1	20	332	0,2	210,40	0,30	0,0	0,0	0,0
GOC	33,0	33,0	0,403	40,1	20	332	0,2	210,40	0,30	0,0	0,0	0,0
GOC	33,0	33,0	0,403	40,1	20	332	0,2	210,40	0,30	0,0	0,0	0,0
			Total settlement at -35,55 m from the axis (mm) :							24	10	14

nb iteration 0 Stress inc. / s'v0 12%
Convergence m

w Rail Load	24	10	14
wo Rail Load	93	41	52
difference	69	31	

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	3
number of days	30,4
secondes	7889400

With surcharge anticipation (anticipation rail load 30 kPa)

Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV-CZ	1,20E-07	1,0	9,47E-01	92,2	2,2
OXC W	3,80E-07	1,0	3,00E+00	100,0	3,8
OXC U1	5,00E-07	3,0	4,38E-01	72,5	1,1
KLB V SV	1,00E-06	0,0	7,89E+04	100,0	0,1
KLB CZ	4,20E-07	1,4	1,69E+00	98,8	0,5
GOC	1,00E-08	23,8	1,39E-04	1,4	0,0
GOC	1,00E-08	23,8	1,39E-04	1,4	0,0
GOC	1,00E-08	23,8	1,39E-04	1,4	0,0
GOC	1,00E-08	23,8	1,39E-04	1,4	0,0
Total settlement at -35,55 m from the axis in 3 months (mm):					7,7

77%

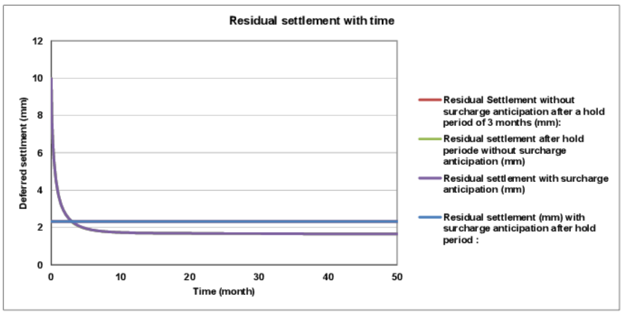
With surcharge anticipation

Residual settlement (mm) with surcharge anticipation after hold period :	2,3
th surcharge anticipation over 12 months after a hold period 3 months (mm):	0,6

Duration after hold period (months)	12

Without anticipation

ttlement without surcharge anticipation after a hold period of 3 months (mm):	2,3
without surcharge anticipation over 12 after a hold period of 3 months (mm):	0,6



https://arcadiso365.sharepoint.com/teams/HS2ASC/03 Project Execution/05 - C2 Calvert/09 - Twyford EmbankmRagiht(MD)/06 - GT - Geotechnical/Settlements transition viaduct/. FINAL ANALYSIS/05 GM5 - 81920.xlsm - LAN (1.2)

HS2 – C2 – Calvert Area – Detailed Design

Profile 6 - GM6 - Ch. HS2. 82+100 - Embankment Impact

gr (kN/m³)	20,00
Hf (m)	4,30
Hr (m)	4,3
Side slope (H/V)	2,00
Width PF (m)	24,00
Surcharge of the embankmant (kPa)	86,0
Static surcharge (kPa)	30,00
Sr (kPa)	116,0

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	0
c1	8,6
c2	8,6
d1	16,3
d2	16,3

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	0,0	1,000	116,0	20	0	0,2	1,00E+04	0,10	0,0	0,0	0,0
ALV-CZ	0,0	2,0	1,000	116,0	20	12	0,2	6,00E+00	0,50	38,5	19,2	19,2
RTD S V SV	2,0	2,5	0,999	115,9	20	25	0,2	24,0	0,10	2,4	0,2	2,2
RTD-C Z	2,5	3,0	0,998	115,7	20	30	0,2	5,7	0,50	10,2	5,1	5,1
OXC W	3,0	5,0	0,993	115,2	20	42	0,2	7,8	0,50	29,5	14,8	14,8
OXC U1	5,0	7,0	0,980	113,6	20	62	0,2	13,9	0,50	16,4	8,2	8,2
OXC U2	7,0	9,0	0,957	111,1	20	82	0,2	21,0	0,40	10,6	4,2	6,3
KLB V SV	9,0	10,5	0,932	108,1	20	100	0,2	85,0	0,10	1,9	0,2	1,7
KLB CZ	10,5	14,0	0,889	103,1	20	125	0,2	34,4	0,40	10,5	4,2	6,3
GOC	14,0	20,0	0,797	92,5	20	172	0,2	221,6	0,40	2,5	1,0	1,5
GOC	20,0	50,0	0,518	60,1	20	352	0,2	221,6	0,30	8,1	2,4	5,7
			Total settlement at 0 m from the axis (mm) :							131	60	71

nb iteration 0 Stress inc. / s'v0 17%
Convergence m

w Rail Load	131	60	71
wo Rail Load	112	51	61
difference	-18	-8	

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time	
month	6	6
number of days	30,4	
secondes	15778800	

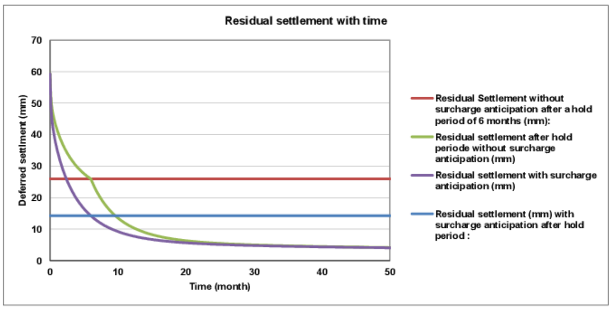
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV-CZ	1,20E-07	2,0	4,78E-01	75,1	14,4
RTD S V SV	1,00E-06	0,0	1,58E+05	100,0	0,2
RTD-C Z	3,80E-07	0,5	2,40E+01	100,0	5,1
OXC W	3,80E-07	2,5	9,59E-01	92,4	13,7
OXC U1	5,00E-07	4,0	4,93E-01	76,0	6,2
OXC U2	4,20E-07	2,0	1,66E+00	98,6	4,2
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,2
KLB CZ	4,20E-07	9,5	7,34E-02	30,6	1,3
GOC	1,00E-08	39,5	0,000	1,2	0,0
Total settlement at 0 m from the axis in 6 months (mm):					45,3

76%

With surcharge anticipation		Landsc.	TOTAL
Residual settlement (mm) with surcharge anticipation after hold period :	14,3	6,9	21,2
surcharge anticipation over 12 months after a hold period 6 months (mm):	8,3	3,6	11,9

Duration after hold period (months)	12

Without anticipation		Landsc.	TOTAL
lement without surcharge anticipation after a hold period of 6 months (mm):	26,0	6,9	32,9
ithout surcharge anticipation over 12 after a hold period of 6 months (mm):	19,1	0,4	19,5

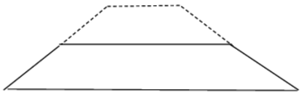


https://arcadis365.sharepoint.com/teams/HS2ASC/03 Project Execution/05 - C2 Calvert/09 - Twyford Embankment (MD)/06 - GT - Geotechnical/Settlements transition viaduct/. FINAL ANALYSIS/06 GM6 - 82100.xlsm - EMB (0)

HS2 – C2 – Calvert Area – Detailed Design

Profile 6 - GM6 - Ch. HS2. 82+100 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	4,30
Hr (m)	4,3
Side slope (H/V)	4,00
Width PF (m)	48,60
Surcharge of the embankmant (kPa)	83,9
Static surcharge (kPa)	0,00
Sr (kPa)	83,9



-32,4

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	0,0	0,529	44,4	20	0	0,2	1,00E+04	0,10	0,0	0,0	0,0
ALV-CZ	0,0	2,0	0,529	44,4	20	12	0,2	6,00E+00	0,50	14,7	7,4	7,4
RTD S V SV	2,0	2,5	0,529	44,3	20	25	0,2	24,0	0,10	0,9	0,1	0,8
RTD-C Z	2,5	3,0	0,529	44,3	20	30	0,2	5,7	0,50	3,9	1,9	1,9
OXC W	3,0	5,0	0,528	44,3	20	42	0,2	7,8	0,50	11,4	5,7	5,7
OXC U1	5,0	7,0	0,526	44,1	20	62	0,2	13,9	0,50	6,3	3,2	3,2
OXC U2	7,0	9,0	0,524	43,9	20	82	0,2	21,0	0,40	4,2	1,7	2,5
KLB V SV	9,0	10,5	0,522	43,8	20	100	0,2	85,0	0,10	0,8	0,1	0,7
KLB CZ	10,5	14,0	0,519	43,5	20	125	0,2	34,4	0,40	4,4	1,8	2,7
GOC	14,0	20,0	0,513	43,0	20	172	0,2	120,8	0,30	2,1	0,6	1,5
GOC	20,0	50,0	0,484	40,6	20	352	0,2	221,6	0,30	5,5	1,6	3,8
			Total settlement at -32,4 m from the axis (mm) :							54	24,1	30

nb iteration 0 Stress inc. / s'v0 12%
Convergence m

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time	
month	6	6
number of days	30,4	
secondes	15778800	

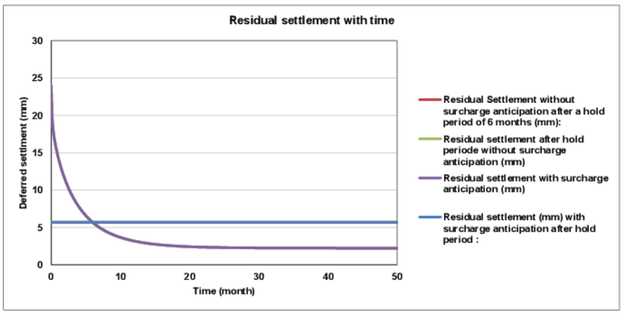
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV-CZ	1,20E-07	2,0	4,78E-01	75,1	5,5
RTD S V SV	1,00E-06	0,0	1,58E+05	100,0	0,1
RTD-C Z	3,80E-07	0,5	2,40E+01	100,0	1,9
OXC W	3,80E-07	2,5	9,59E-01	92,4	5,2
OXC U1	5,00E-07	4,0	4,93E-01	76,0	2,4
OXC U2	4,20E-07	2,0	1,66E+00	98,6	1,7
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,1
KLB CZ	4,20E-07	3,5	5,41E-01	78,7	1,4
GOC	1,00E-08	39,5	0,000	1,2	0,0
Total settlement at -32,4 m from the axis in 6 months (mm):					18,4

76%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	5,7
th surcharge anticipation over 12 months after a hold period 6 months (mm):	3,2

Duration after hold period (months)	12

Without anticipation	
ttlement without surcharge anticipation after a hold period of 6 months (mm):	5,7
without surcharge anticipation over 12 after a hold period of 6 months (mm):	3,2



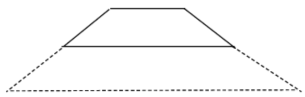
HS2 – C2 – Calvert Area – Detailed Design

Profile 6 - GM6 - Ch. HS2. 82+100 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	5,70
Hr (m)	5,7
Side slope (H/V)	4,00
Width PF (m)	3,00
Surcharge of the embankmant (kPa)	111,2
Static surcharge (kPa)	0,00
Sr (kPa)	111,2

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-32,4
c1	22,8
c2	22,8
d1	45,3
d2	-19,5



Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	Total settlement DH (mm)	Consolidation settlement DH (mm) (= total settlement x geological correction factor)	Immediate Settlement (mm) (= total - consolidation settlment)
Fill Material	0,0	0,0	0,000	0,0	20	0	0,2	1,00E+04	0,10	0,0	0,0	0,0
ALV-CZ	0,0	2,0	0,000	0,0	20	12	0,2	6,00E+00	0,50	0,0	0,0	0,0
RTD S V SV	2,0	2,5	0,001	0,1	20	25	0,2	24,0	0,10	0,0	0,0	0,0
RTD-C Z	2,5	3,0	0,001	0,1	20	30	0,2	5,7	0,50	0,0	0,0	0,0
OXC W	3,0	5,0	0,003	0,4	20	42	0,2	7,8	0,50	0,1	0,0	0,0
OXC U1	5,0	7,0	0,010	1,1	20	62	0,2	13,9	0,50	0,2	0,1	0,1
OXC U2	7,0	9,0	0,020	2,2	20	82	0,2	21,0	0,40	0,2	0,1	0,1
KLB V SV	9,0	10,5	0,030	3,4	20	100	0,2	85,0	0,10	0,1	0,0	0,1
KLB CZ	10,5	14,0	0,047	5,2	20	125	0,2	34,4	0,40	0,5	0,2	0,3
GOC	14,0	20,0	0,079	8,8	20	172	0,2	221,6	0,30	0,2	0,1	0,2
GOC	20,0	50,0	0,155	17,3	20	352	0,2	221,6	0,30	2,3	0,7	1,6
			Total settlement at -32,4 m from the axis (mm) :							3,7	1,2	2,4

nb iteration 0   Stress inc. / s'v0 5%
Convergence m

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	0
number of days	30,4
secondes	0

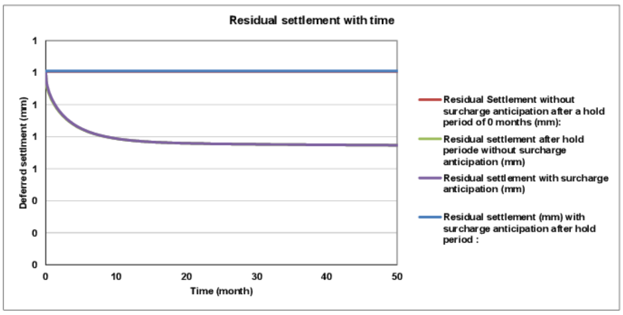
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV-CZ	1,20E-07	2,0	0,00E+00	0,4	0,0
RTD S V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
RTD-C Z	3,80E-07	0,5	0,00E+00	0,4	0,0
OXC W	3,80E-07	2,5	0,00E+00	0,4	0,0
OXC U1	5,00E-07	4,0	0,00E+00	0,4	0,0
OXC U2	4,20E-07	2,0	0,00E+00	0,4	0,0
KLB V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
KLB CZ	4,20E-07	3,5	0,00E+00	0,4	0,0
GOC	1,00E-08	39,5	0,000	0,4	0,0
Total settlement at -32,4 m from the axis in 0 months (mm):					0,0

0%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	1,2
th surcharge anticipation over 12 months after a hold period 0 months (mm):	0,4

Duration after hold period (months)	12

Without anticipation	
ttlement without surcharge anticipation after a hold period of 0 months (mm):	1,2
without surcharge anticipation over 12 after a hold period of 0 months (mm):	0,4



HS2 – C2 – Calvert Area – Detailed Design

Profile 6 - GM6 - Ch. HS2. 82+100 - Embankment Impact

gr (kN/m³)	20,00
Hf (m)	4,30
Hr (m)	4,3
Side slope (H/V)	2,00
Width PF (m)	24,00
Surcharge of the embankmant (kPa)	86,0
Static surcharge (kPa)	30,00
Sr (kPa)	116,0

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	0
c1	8,6
c2	8,6
d1	16,3
d2	16,3

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	1,0	1,000	116,0	20	7	0,2	1,00E+04	0,10	0,0	0,0	0,0
ALV-CZ	1,0	2,0	1,000	116,0	20	17	0,2	6,00E+00	0,50	19,3	9,7	9,7
RTD S V SV	2,0	2,5	0,999	115,9	20	25	0,2	24,0	0,10	2,4	0,2	2,2
RTD-C Z	2,5	3,0	0,998	115,7	20	30	0,2	5,7	0,50	10,2	5,1	5,1
OXC W	3,0	5,0	0,993	115,2	20	42	0,2	7,8	0,50	29,5	14,8	14,8
OXC U1	5,0	7,0	0,980	113,6	20	62	0,2	13,9	0,50	16,4	8,2	8,2
OXC U2	7,0	9,0	0,957	111,1	20	82	0,2	21,0	0,40	10,6	4,2	6,3
KLB V SV	9,0	10,5	0,932	108,1	20	100	0,2	85,0	0,10	1,9	0,2	1,7
KLB CZ	10,5	15,0	0,879	102,0	20	130	0,2	3,44E+01	0,40	13,3	5,3	8,0
GOC	15,0	20,0	0,788	91,4	20	177	0,2	123,6	0,40	3,7	1,5	2,2
GOC	20,0	50,0	0,518	60,1	20	352	0,2	221,6	0,30	8,1	2,4	5,7
			Total settlement at 0 m from the axis (mm) :							115	52	64

nb iteration 0   Stress inc. / s'v0 17%
Convergence m

w Rail Load	115	52	64
wo Rail Load	98	44	54
difference	-18	-8	

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time	
month	6	6
number of days	30,4	
secondes	15778800	

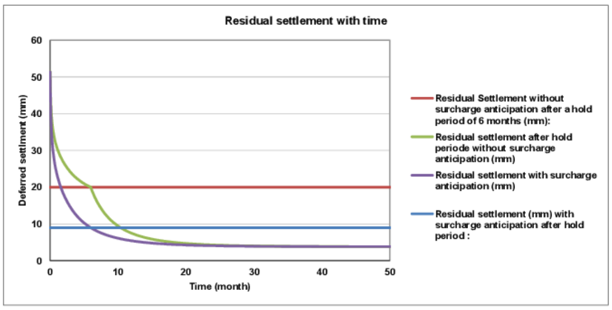
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV-CZ	1,20E-07	0,5	7,57E+00	100,0	9,7
RTD S V SV	1,00E-06	0,0	1,58E+05	100,0	0,2
RTD-C Z	3,80E-07	0,5	2,40E+01	100,0	5,1
OXC W	3,80E-07	2,5	9,59E-01	92,4	13,7
OXC U1	5,00E-07	4,0	4,93E-01	76,0	6,2
OXC U2	4,20E-07	2,0	1,66E+00	98,6	4,2
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,2
KLB CZ	4,20E-07	4,5	3,27E-01	63,8	3,4
GOC	1,00E-08	39,5	0,000	1,2	0,0
Total settlement at 0 m from the axis in 6 months (mm):					42,7

83%

With surcharge anticipation		Landsc.	TOTAL
Residual settlement (mm) with surcharge anticipation after hold period :	8,9	5,1	14,1
surcharge anticipation over 12 months after a hold period 6 months (mm):	4,5	1,9	6,5

Duration after hold period (months)	12

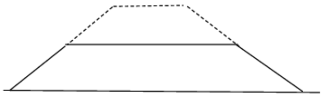
Without anticipation		Landsc.	TOTAL
lement without surcharge anticipation after a hold period of 6 months (mm):	20,0	5,1	25,1
ithout surcharge anticipation over 12 after a hold period of 6 months (mm):	15,0	1,9	16,9



HS2 – C2 – Calvert Area – Detailed Design

Profile 6 - GM6 - Ch. HS2. 82+100 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	4,30
Hr (m)	4,3
Side slope (H/V)	4,00
Width PF (m)	48,60
Surcharge of the embankmant (kPa)	83,9
Static surcharge (kPa)	0,00
Sr (kPa)	83,9



-32,4

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	Total settlement DH (mm)	Consolidation settlement DH (mm) (= total settlement x geological correction factor)	Immediate Settlement (mm) (= total - consolidation setllment)
Fill Material	0,0	1,0	0,529	44,4	20	7	0,2	1,00E+04	0,10	0,0	0,0	0,0
ALV-CZ	1,0	2,0	0,529	44,4	20	17	0,2	6,00E+00	0,50	7,4	3,7	3,7
RTD S V SV	2,0	2,5	0,529	44,3	20	25	0,2	24,0	0,10	0,9	0,1	0,8
RTD-C Z	2,5	3,0	0,529	44,3	20	30	0,2	5,7	0,50	3,9	1,9	1,9
OXC W	3,0	5,0	0,528	44,3	20	42	0,2	7,8	0,50	11,4	5,7	5,7
OXC U1	5,0	7,0	0,526	44,1	20	62	0,2	13,9	0,50	6,3	3,2	3,2
OXC U2	7,0	9,0	0,524	43,9	20	82	0,2	21,0	0,40	4,2	1,7	2,5
KLB V SV	9,0	10,5	0,522	43,8	20	100	0,2	85,0	0,10	0,8	0,1	0,7
KLB CZ	10,5	14,0	0,519	43,5	20	125	0,2	34,4	0,40	4,4	1,8	2,7
GOC	14,0	20,0	0,513	43,0	20	172	0,2	120,8	0,30	2,1	0,6	1,5
GOC	20,0	50,0	0,484	40,6	20	352	0,2	221,6	0,30	5,5	1,6	3,8
			Total settlement at -32,4 m from the axis (mm) :							47	20,4	27

nb iteration 0 Stress inc. / s'v0 12%
Convergence m

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time	
month	6	6
number of days	30,4	
secondes	15778800	

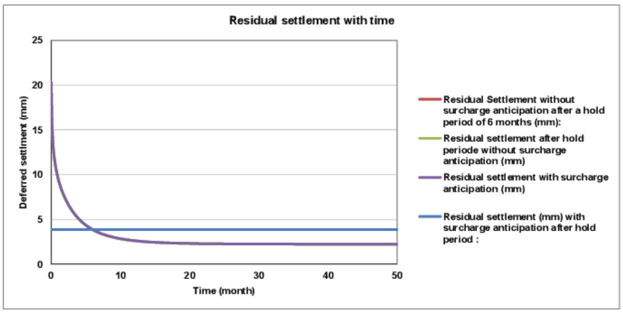
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV-CZ	1,20E-07	0,5	7,57E+00	100,0	3,7
RTD S V SV	1,00E-06	0,0	1,58E+05	100,0	0,1
RTD-C Z	3,80E-07	0,5	2,40E+01	100,0	1,9
OXC W	3,80E-07	2,5	9,59E-01	92,4	5,2
OXC U1	5,00E-07	4,0	4,93E-01	76,0	2,4
OXC U2	4,20E-07	2,0	1,66E+00	98,6	1,7
KLB V SV	1,00E-06	0,0	1,58E+05	100,0	0,1
KLB CZ	4,20E-07	3,5	5,41E-01	78,7	1,4
GOC	1,00E-08	39,5	0,000	1,2	0,0
Total settlement at -32,4 m from the axis in 6 months (mm):					16,5

81%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	3,9
th surcharge anticipation over 12 months after a hold period 6 months (mm):	1,5

Duration after hold period (months)	12

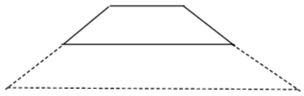
Without anticipation	
ttlement without surcharge anticipation after a hold period of 6 months (mm):	3,9
without surcharge anticipation over 12 after a hold period of 6 months (mm):	1,5



HS2 – C2 – Calvert Area – Detailed Design

Profile 6 - GM6 - Ch. HS2. 82+100 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	5,70
Hr (m)	5,7
Side slope (H/V)	4,00
Width PF (m)	3,00
Surcharge of the embankmant (kPa)	111,2
Static surcharge (kPa)	0,00
Sr (kPa)	111,2



-32,4

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	1,0	0,000	0,0	20	7	0,2	1,00E+04	0,10	0,0	0,0	0,0
ALV-CZ	1,0	2,0	0,000	0,0	20	17	0,2	6,00E+00	0,50	0,0	0,0	0,0
RTD S V SV	2,0	2,5	0,001	0,1	20	25	0,2	24,0	0,10	0,0	0,0	0,0
RTD-C Z	2,5	3,0	0,001	0,1	20	30	0,2	5,7	0,50	0,0	0,0	0,0
OXC W	3,0	5,0	0,003	0,4	20	42	0,2	7,8	0,50	0,1	0,0	0,0
OXC U1	5,0	7,0	0,010	1,1	20	62	0,2	13,9	0,50	0,2	0,1	0,1
OXC U2	7,0	9,0	0,020	2,2	20	82	0,2	21,0	0,40	0,2	0,1	0,1
KLB V SV	9,0	10,5	0,030	3,4	20	100	0,2	85,0	0,10	0,1	0,0	0,1
KLB CZ	10,5	14,0	0,047	5,2	20	125	0,2	34,4	0,40	0,5	0,2	0,3
GOC	14,0	20,0	0,079	8,8	20	172	0,2	120,8	0,30	0,4	0,1	0,3
GOC	20,0	50,0	0,155	17,3	20	352	0,2	221,6	0,30	2,3	0,7	1,6
			Total settlement at -32,4 m from the axis (mm) :							3,9	1,3	2,6

nb iteration 0 Stress inc. / s'v0 5%
Convergence m

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time	
month	0	0
number of days	30,4	
secondes	0	

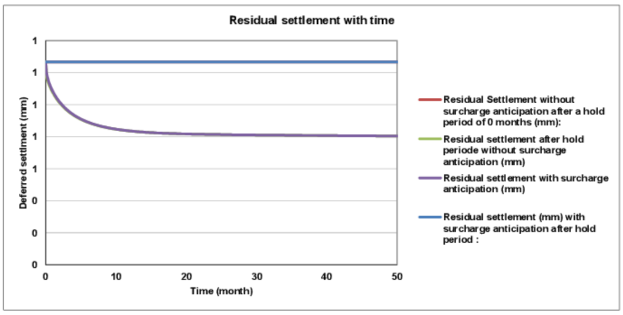
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
ALV-CZ	1,20E-07	0,5	0,00E+00	0,4	0,0
RTD S V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
RTD-C Z	3,80E-07	0,5	0,00E+00	0,4	0,0
OXC W	3,80E-07	2,5	0,00E+00	0,4	0,0
OXC U1	5,00E-07	4,0	0,00E+00	0,4	0,0
OXC U2	4,20E-07	2,0	0,00E+00	0,4	0,0
KLB V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
KLB CZ	4,20E-07	3,5	0,00E+00	0,4	0,0
GOC	1,00E-08	39,5	0,000	0,4	0,0
Total settlement at -32,4 m from the axis in 0 months (mm):					0,0

0%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	1,3
th surcharge anticipation over 12 months after a hold period 0 months (mm):	0,4

Duration after hold period (months)	12

Without anticipation	
ttlement without surcharge anticipation after a hold period of 0 months (mm):	1,3
without surcharge anticipation over 12 after a hold period of 0 months (mm):	0,4



https://arcadiso365.sharepoint.com/teams/HS2ASC/03 Project Execution/05 - C2 Calvert/09 - Twyford Embankment (IMD)/06 - GT - Geotechnical/Settlements transition viaduct/. FINAL ANALYSIS/GM6 - 82100.xlsm - LAN (1.1)

HS2 – C2 – Calvert Area – Detailed Design

Profile 8. GM2 - Ch. HS2. 81420 - Embankment impact

gr (kN/m³)	20,00
Hf (m)	2,00
Hr (m)	2,0
Side slope (H/V)	2,00
Width PF (m)	43,90
Surcharge of the embankmant (kPa)	40,0
Static surcharge (kPa)	30,00
Sr (kPa)	70,0

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	0
c1	4,0
c2	4,0
d1	24,0
d2	24,0

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	0,0	1,000	70,0	20	0	0,2	1,00E+04	0,9	0,0	0,0	0,0
ALV CZ	0,0	2,8	1,000	70,0	20	16	0,2	6,0	0,9	32,5	29,3	3,3
RTD S V SV	2,8	4,0	0,999	69,9	20	36	0,2	26,0	0,4	3,2	1,3	1,9
RTD CZ	4,0	6,0	0,996	69,7	20	52	0,2	6,3	0,4	22,1	8,9	13,3
KLB S V SV	6,0	8,5	0,989	69,2	20	75	0,2	85,0	0,4	2,0	0,8	1,2
KLB CZ	8,5	10,5	0,978	68,4	20	97	0,2	34,4	0,4	4,0	1,6	2,4
CB LMST	10,5	30,0	0,866	60,6	20	205	0,2	208,5	0,4	5,7	2,3	3,4
			Total settlement at 0 m from the axis (mm)							70	44	25

nb iteration 0
Convergence m

Stress inc. / s'v0 30%

w Rail Load	70	44	25
wo Rail Load	39	25	14
Rail Load Impact	31	19	11

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	6
number of days	30,4
secondes	15778800

With surcharge anticipation (anticipation rail load 30 kPa)

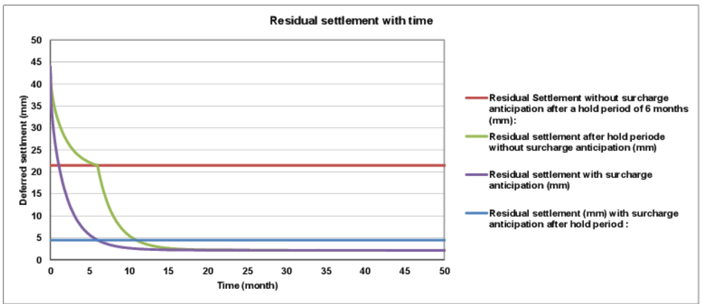
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-06	0,0	1,58E+05	100,0	0,0
ALV CZ	1,20E-07	1,4	9,73E-01	92,7	27,1
RTD S V SV	1,00E-06	0,0	1,58E+05	100,0	1,3
RTD CZ	1,20E-07	1,0	1,89E+00	99,2	8,8
KLB S V SV	1,00E-06	0,0	1,58E+05	100,0	0,8
KLB CZ	4,20E-07	2,0	1,66E+00	98,6	1,6
CB LMST	1,00E-08	21,5	3,41E-04	2,1	0,0

Total settlement at 0 m from the axis in 6 months (mm): 39,7 — 90%

With surcharge anticipation		Landsc.	TOTAL
Residual settlement (mm) with surcharge anticipation after hold period :	4,5	0,7	5,2
Settlement with surcharge anticipation over 12 months after a hold period 6 months (mm):	2,3	0,1	2,4

Duration after hold period (months) 12

Without anticipation		Landsc.	TOTAL
Residual Settlement without surcharge anticipation after a hold period of 6 months (mm):	21,5	0,7	22,2
Settlement without surcharge anticipation over 12 after a hold period of 6 months (mm):	19,1	0,1	19,2



https://arcadiso365.sharepoint.com/teams/HS2ASC/03 Project Execution/05 - C2 Calvert/09 - Twyford Embankment (IMD)/06 - GT - Geotechnical/Settlements transition viaduct/. FINAL ANALYSIS/08 GM2 - 81420.xlsm - EMB (0)

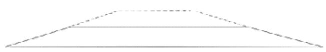
HS2 – C2 – Calvert Area – Detailed Design

Profile 8. GM2 - Ch. HS2. 81420 - Landscape impact

gr (kN/m³)	19,50
Hf (m)	2,00
Hr (m)	2,0
Side slope (H/V)	4,00
Width PF (m)	37,00
Surcharge of the embankmant (kPa)	39,0
Static surcharge (kPa)	0,00
Sr (kPa)	39,0

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	29,6
c1	8,0
c2	8,0
d1	-7,1
d2	52,1



Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	0,0	0,000	0,0	20	0	0,2	1,00E+04	0,9	0,0	0,0	0,0
ALV CZ	0,0	2,8	0,003	0,1	20	16	0,2	6,0	0,9	0,1	0,1	0,0
RTD S V SV	2,8	4,0	0,029	1,1	20	36	0,2	26,0	0,4	0,1	0,0	0,0
RTD CZ	4,0	6,0	0,061	2,4	20	52	0,2	6,3	0,4	0,8	0,3	0,5
KLB S V SV	6,0	8,5	0,111	4,3	20	75	0,2	85,0	0,4	0,1	0,1	0,1
KLB CZ	8,5	10,5	0,157	6,1	20	97	0,2	34,4	0,4	0,4	0,1	0,2
CB LMST	10,5	30,0	0,287	11,2	20	205	0,2	208,5	0,4	1,0	0,4	0,6
			Total settlement at 29,6 m from the axis (m							2	1	1

nb iteration 0
Convergence m

Stress inc. / s'v0 5%

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	6
number of days	30,4
secondes	15778800

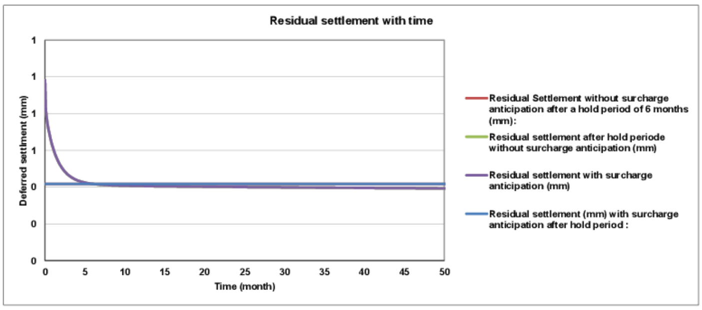
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-06	0,0	1,58E+05	100,0	0,0
ALV CZ	1,20E-07	1,4	9,73E-01	92,7	0,0
RTD S V SV	1,00E-06	0,0	1,58E+05	100,0	0,0
RTD CZ	1,20E-07	1,0	1,89E+00	99,2	0,3
KLB S V SV	1,00E-06	0,0	1,58E+05	100,0	0,1
KLB CZ	4,20E-07	2,0	1,66E+00	98,6	0,1
CB LMST	1,00E-08	21,5	3,41E-04	2,1	0,0

Total settlement at 29,6 m from the axis in 6 months (mm): 0,6 58%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	0,4
Settlement with surcharge anticipation over 12 months after a hold period 6 months (mm):	0,0

Duration after hold period (months) 12

Without anticipation	
Residual Settlement without surcharge anticipation after a hold period of 6 months (mm):	0,4
Settlement without surcharge anticipation over 12 after a hold period of 6 months (mm):	0,0



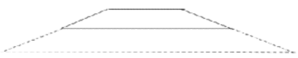
HS2 – C2 – Calvert Area – Detailed Design

Profile 8. GM2 - Ch. HS2. 81420 - Landscape impact

gr (kN/m³)	19,50
Hf (m)	3,90
Hr (m)	3,9
Side slope (H/V)	4,00
Width PF (m)	3,00
Surcharge of the embankmant (kPa)	76,1
Static surcharge (kPa)	0,00
Sr (kPa)	76,1

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	29,6
c1	15,6
c2	15,6
d1	-20,3
d2	38,9



Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	0,0	0,000	0,0	20	0	0,2	1,00E+04	0,9	0,0	0,0	0,0
ALV CZ	0,0	2,8	0,000	0,0	20	16	0,2	6,0	0,9	0,0	0,0	0,0
RTD S V SV	2,8	4,0	0,001	0,1	20	36	0,2	26,0	0,4	0,0	0,0	0,0
RTD CZ	4,0	6,0	0,003	0,3	20	52	0,2	6,3	0,4	0,1	0,0	0,0
KLB S V SV	6,0	8,5	0,009	0,7	20	75	0,2	85,0	0,4	0,0	0,0	0,0
KLB CZ	8,5	10,5	0,018	1,4	20	97	0,2	34,4	0,4	0,1	0,0	0,0
CB LMST	10,5	30,0	0,075	5,7	20	205	0,2	208,5	0,4	0,5	0,2	0,3
			Total settlement at 29,6 m from the axis (m							1	0	0

nb iteration 0
Convergence m

Stress inc. / s'v0 3%

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	0
number of days	30,4
secondes	0

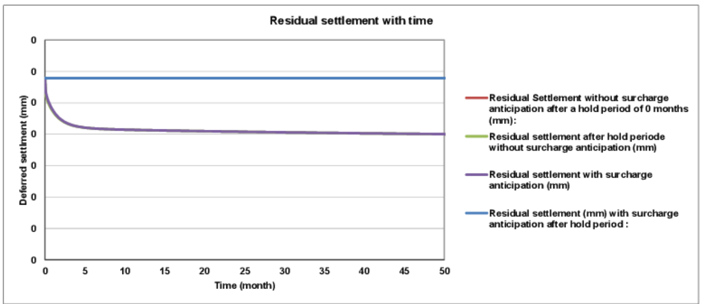
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-06	0,0	0,00E+00	0,4	0,0
ALV CZ	1,20E-07	1,4	0,00E+00	0,4	0,0
RTD S V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
RTD CZ	1,20E-07	1,0	0,00E+00	0,4	0,0
KLB S V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
KLB CZ	4,20E-07	2,0	0,00E+00	0,4	0,0
CB LMST	1,00E-08	21,5	0,00E+00	0,4	0,0

Total settlement at 29,6 m from the axis in 0 months (mm):	0,0	0%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	0,3
Settlement with surcharge anticipation over 12 months after a hold period 0 months (mm):	0,1

Duration after hold period (months)	12

Without anticipation	
Residual Settlement without surcharge anticipation after a hold period of 0 months (mm):	0,3
Settlement without surcharge anticipation over 12 after a hold period of 0 months (mm):	0,1



HS2 – C2 – Calvert Area – Detailed Design

Profile 8. GM2 - Ch. HS2. 81420 - Embankment impact

gr (kN/m³)	20,00
Hf (m)	2,00
Hr (m)	2,0
Side slope (H/V)	2,00
Width PF (m)	43,90
Surcharge of the embankmant (kPa)	40,0
Static surcharge (kPa)	30,00
Sr (kPa)	70,0

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	0
c1	4,0
c2	4,0
d1	24,0
d2	24,0

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	2,0	1,000	70,0	20	12	0,2	1,00E+04	0,9	0,0	0,0	0,0
ALV CZ	2,0	2,8	1,000	70,0	20	26	0,2	6,0	0,9	9,3	8,4	0,9
RTD S V SV	2,8	4,0	0,999	69,9	20	36	0,2	26,0	0,4	3,2	1,3	1,9
RTD CZ	4,0	6,0	0,996	69,7	20	52	0,2	6,3	0,4	22,1	8,9	13,3
KLB S V SV	6,0	8,5	0,989	69,2	20	75	0,2	85,0	0,4	2,0	0,8	1,2
KLB CZ	8,5	10,5	0,978	68,4	20	97	0,2	34,4	0,4	4,0	1,6	2,4
CB LMST	10,5	30,0	0,866	60,6	20	205	0,2	208,5	0,4	5,7	2,3	3,4
			Total settlement at 0 m from the axis (mm)							46	23	23

nb iteration	0	Stress inc. / s'v0	30%		
Convergence	m				
			w Rail Load	46	23	23
			wo Rail Load	39	25	14
			Rail Load Impact	7	-2	9

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	2
number of days	30,4
secondes	5259600

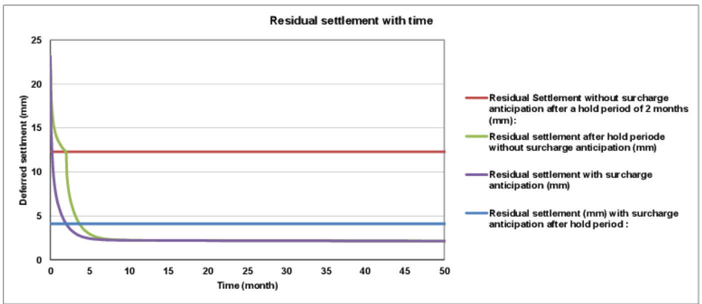
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-06	0,0	5,26E+04	100,0	0,0
ALV CZ	1,20E-07	0,4	3,94E+00	100,0	8,4
RTD S V SV	1,00E-06	0,0	5,26E+04	100,0	1,3
RTD CZ	1,20E-07	1,0	6,31E-01	82,9	7,3
KLB S V SV	1,00E-06	0,0	5,26E+04	100,0	0,8
KLB CZ	4,20E-07	2,0	5,52E-01	79,3	1,3
CB LMST	1,00E-08	21,5	1,14E-04	1,3	0,0

Total settlement at 0 m from the axis in 2 months (mm):	19,1	82%

With surcharge anticipation		Landsc.	TOTAL
Residual settlement (mm) with surcharge anticipation after hold period :	4,1	0,7	4,8
Settlement with surcharge anticipation over 12 months after a hold period 2 months (mm):	1,9	0,1	2,0

Duration after hold period (months)	12

Without anticipation		Landsc.	TOTAL
Residual Settlement without surcharge anticipation after a hold period of 2 months (mm):	12,3	0,7	13,0
Settlement without surcharge anticipation over 12 after a hold period of 2 months (mm):	10,1	0,1	10,2



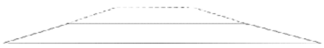
HS2 – C2 – Calvert Area – Detailed Design

Profile 8. GM2 - Ch. HS2. 81420 - Landscape impact

gr (kN/m³)	19,50
Hf (m)	2,00
Hr (m)	2,0
Side slope (H/V)	4,00
Width PF (m)	37,00
Surcharge of the embankmant (kPa)	39,0
Static surcharge (kPa)	0,00
Sr (kPa)	39,0

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	29,6
c1	8,0
c2	8,0
d1	-7,1
d2	52,1



Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
Fill Material	0,0	2,0	0,001	0,0	20	12	0,2	1,00E+04	0,9	0,0	0,0	0,0
ALV CZ	2,0	2,8	0,013	0,5	20	26	0,2	6,0	0,9	0,1	0,1	0,0
RTD S V SV	2,8	4,0	0,029	1,1	20	36	0,2	26,0	0,4	0,1	0,0	0,0
RTD CZ	4,0	6,0	0,061	2,4	20	52	0,2	6,3	0,4	0,8	0,3	0,5
KLB S V SV	6,0	8,5	0,111	4,3	20	75	0,2	85,0	0,4	0,1	0,1	0,1
KLB CZ	8,5	10,5	0,157	6,1	20	97	0,2	34,4	0,4	0,4	0,1	0,2
CB LMST	10,5	30,0	0,287	11,2	20	205	0,2	208,5	0,4	1,0	0,4	0,6
			Total settlement at 29,6 m from the axis (m							2	1	1

nb iteration	0	Stress inc. / s'v0	5%	w Rail Load	2	1	1
Convergence	m						

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	2
number of days	30,4
secondes	5259600

With surcharge anticipation (anticipation rail load 30 kPa)

Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-06	0,0	5,26E+04	100,0	0,0
ALV CZ	1,20E-07	0,4	3,94E+00	100,0	0,1
RTD S V SV	1,00E-06	0,0	5,26E+04	100,0	0,0
RTD CZ	1,20E-07	1,0	6,31E-01	82,9	0,3
KLB S V SV	1,00E-06	0,0	5,26E+04	100,0	0,1
KLB CZ	4,20E-07	2,0	5,52E-01	79,3	0,1
CB LMST	1,00E-08	21,5	1,14E-04	1,3	0,0

Total settlement at 29,6 m from the axis in 2 months (mm): 0,5 — 50%

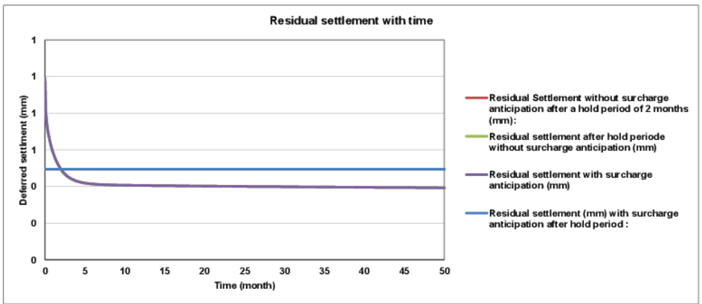
With surcharge anticipation

Residual settlement (mm) with surcharge anticipation after hold period :	0,5
Settlement with surcharge anticipation over 12 months after a hold period 2 months (mm):	0,1

Duration after hold period (months)	12

Without anticipation

Residual Settlement without surcharge anticipation after a hold period of 2 months (mm):	0,5
Settlement without surcharge anticipation over 12 after a hold period of 2 months (mm):	0,1



HS2 – C2 – Calvert Area – Detailed Design

Profile 8. GM2 - Ch. HS2. 81420 - Landscape impact

gr (kN/m³)	19,50
Hf (m)	3,90
Hr (m)	3,9
Side slope (H/V)	4,00
Width PF (m)	3,00
Surcharge of the embankmant (kPa)	76,1
Static surcharge (kPa)	0,00
Sr (kPa)	76,1

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	29,6
c1	15,6
c2	15,6
d1	-20,3
d2	38,9

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	Total settlement DH (mm)	Consolidation settlement DH (mm) (= total settlement x geological correction factor)	Immediate Settlement (mm) (= total - consolidation settlment)
Fill Material	0,0	2,0	0,000	0,0	20	12	0,2	1,00E+04	0,9	0,0	0,0	0,0
ALV CZ	2,0	2,8	0,000	0,0	20	26	0,2	6,0	0,9	0,0	0,0	0,0
RTD S V SV	2,8	4,0	0,001	0,1	20	36	0,2	26,0	0,4	0,0	0,0	0,0
RTD CZ	4,0	6,0	0,003	0,3	20	52	0,2	6,3	0,4	0,1	0,0	0,0
KLB S V SV	6,0	8,5	0,009	0,7	20	75	0,2	85,0	0,4	0,0	0,0	0,0
KLB CZ	8,5	10,5	0,018	1,4	20	97	0,2	34,4	0,4	0,1	0,0	0,0
CB LMST	10,5	30,0	0,075	5,7	20	205	0,2	208,5	0,4	0,5	0,2	0,3
			Total settlement at 29,6 m from the axis (m							1	0	0

nb iteration 0
Convergence m

Stress inc. / s'v0 3%

w Rail Load 1 0 0

2 - CONSOLIDATION BY TIME (without vertical drains)

	Time
month	2
number of days	30,4
secondes	5259600

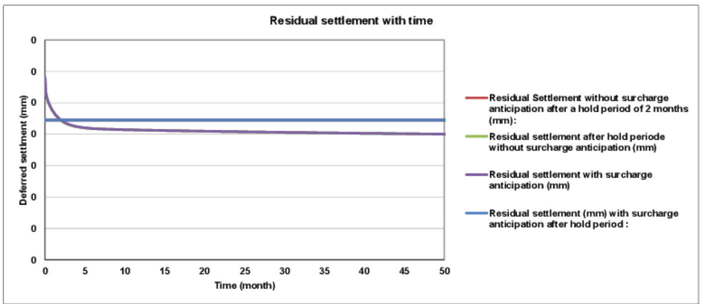
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
Fill Material	1,00E-06	0,0	5,26E+04	100,0	0,0
ALV CZ	1,20E-07	0,4	3,94E+00	100,0	0,0
RTD S V SV	1,00E-06	0,0	5,26E+04	100,0	0,0
RTD CZ	1,20E-07	1,0	6,31E-01	82,9	0,0
KLB S V SV	1,00E-06	0,0	5,26E+04	100,0	0,0
KLB CZ	4,20E-07	2,0	5,52E-01	79,3	0,0
CB LMST	1,00E-08	21,5	1,14E-04	1,3	0,0

Total settlement at 29,6 m from the axis in 2 months (mm):	0,1	24%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	0,2
Settlement with surcharge anticipation over 12 months after a hold period 2 months (mm):	0,0

Duration after hold period (months)	12

Without anticipation	
Residual Settlement without surcharge anticipation after a hold period of 2 months (mm):	0,2
Settlement without surcharge anticipation over 12 after a hold period of 2 months (mm):	0,0



HS2 – C2 – Calvert Area – Detailed Design

Profile 9 . GM3 - Ch. HS2. 81560 - Embankment Impact

gr (kN/m³)	20,00
Hf (m)	5,60
Hr (m)	5,6
Side slope (H/V)	2,00
Width PF (m)	36,00
harge of the embankmant (kPa)	112,0
Static surcharge (kPa)	30,00
Sr (kPa)	142,0

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	0
c1	11,2
c2	11,2
d1	23,6
d2	23,6

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'v0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	Total settlement DH (mm)	Consolidation settlement DH (mm) (= total settlement x geological correction factor)	Immediate Settlement (mm) (= total - consolidation settlment)
RTD SV	0,0	2,8	1,000	142,0	20	16	0,2	24,0	0,1	16,6	1,7	14,9
RTD CZ	2,8	3,7	0,999	141,8	20	35	0,2	5,7	0,5	22,4	11,2	11,2
KLB V SV	3,7	5,0	0,997	141,6	20	46	0,2	85,0	0,1	2,2	0,2	1,9
KLB CZ	5,0	6,2	0,994	141,2	20	58	0,2	34,4	0,4	4,9	2,0	3,0
GOC	6,2	25,0	0,916	130,1	20	158	0,2	169,4	0,4	14,4	5,8	8,7
GOC	25,0	40,0	0,697	99,0	20	327	0,2	311,4	0,4	4,8	1,9	2,9
GOC	40,0	40,0	0,614	87,2	20	402	0,2	374,4	0,4	0,0	0,0	0,0
			Total settlement at 0 m from the axis (mm)							65	23	43

nb iteration 0
Convergence m

Stress inc. / s'v0 22%

w Rail Load	65	23	43
wo Rail Load	59	21	38
difference	-6	-2	

2 - CONSOLIDATION BY TIME (without vertical drains)

Time	
month	2
number of days	30,4
secondes	5259600

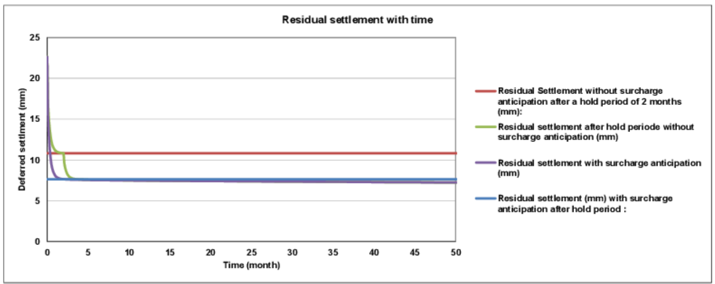
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
RTD SV	1,00E-06	0,0	5,26E+04	100,0	1,7
RTD CZ	1,20E-07	0,5	3,12E+00	100,0	11,2
KLB V SV	1,00E-06	0,0	5,26E+04	100,0	0,2
KLB CZ	4,20E-07	1,2	1,53E+00	98,2	1,9
GOC	1,00E-08	20,0	1,31E-04	1,4	0,1
GOC	1,00E-08	35,0	4,29E-05	0,9	0,0
GOC	1,00E-08	35,0	4,29E-05	0,9	0,0

Total settlement at 0 m from the axis in 2 months (mm): 15,1 66%

With surcharge anticipation		Landsc.	TOTAL
Residual settlement (mm) with surcharge anticipation after hold period :	7,6	5,4	13,1
Settlement with surcharge anticipation over 12 months after a hold period 2 months (mm):	0,2	1,8	1,9

Duration after hold period (months) 12

Without anticipation		Landsc.	TOTAL
Residual Settlement without surcharge anticipation after a hold period of 2 months (mm):	10,8	5,4	16,3
Settlement without surcharge anticipation over 12 after a hold period of 2 months (mm):	3,4	1,8	5,1



https://arcadiso365.sharepoint.com/teams/HS2ASC/03 Project Execution/05 - C2 Calvert/09 - Twyford Embankment (IMD)/06 - GT - Geotechnical/Settlements transition viaduct/. FINAL ANALYSIS/09 GM3 - 81560.xlsm - EMB (0)

HS2 – C2 – Calvert Area – Detailed Design

Profile 9 . GM3 - Ch. HS2. 81560 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	5,60
Hr (m)	5,6
Side slope (H/V)	4,00
Width PF (m)	30,00
harge of the embankmant (kPa)	109,2
Static surcharge (kPa)	0,00
Sr (kPa)	109,2

Landscape | HS2

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-25
c1	22,4
c2	22,4
d1	51,2
d2	1,2

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	**Total settlement DH (mm)**	**Consolidation settlement DH (mm)** (= total settlement x geological correction factor)	**Immediate Settlement (mm)** (= total - consolidation settlment)
RTD SV	0,0	2,8	0,554	60,4	20	16	0,2	24,0	0,1	7,1	0,7	6,3
RTD CZ	2,8	3,7	0,553	60,4	20	35	0,2	5,7	0,5	9,5	4,8	4,8
KLB V SV	3,7	5,0	0,552	60,3	20	46	0,2	85,0	0,1	0,9	0,1	0,8
KLB CZ	5,0	10,0	0,548	59,9	20	77	0,2	34,4	0,4	8,7	3,5	5,2
GOC	10,0	25,0	0,527	57,5	20	177	0,2	185,4	0,4	4,7	1,9	2,8
GOC	25,0	40,0	0,484	52,8	20	327	0,2	311,4	0,4	2,5	1,0	1,5
GOC	40,0	40,0	0,459	50,1	20	402	0,2	374,4	0,4	0,0	0,0	0,0
			Total settlement at -25 m from the axis (mm							33	12	21

nb iteration 0
Convergence m

Stress inc. / s'v0 12%

w Rail Load	33	12	21
wo Rail Load	64	23	41
difference	31	11	

2 - CONSOLIDATION BY TIME (without vertical drains)

Time	
month	2
number of days	30,4
secondes	5259600

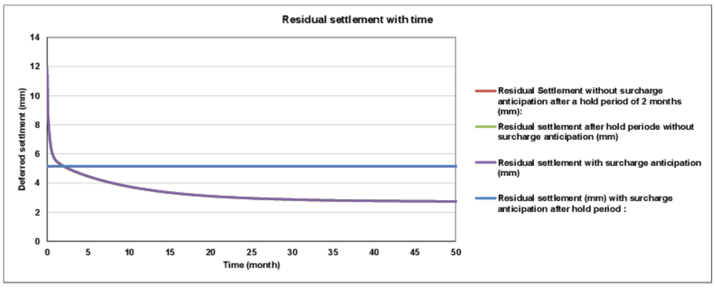
With surcharge anticipation (anticipation rail load 30 kPa)					
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
RTD SV	1,00E-06	0,0	5,26E+04	100,0	0,7
RTD CZ	1,20E-07	0,5	3,12E+00	100,0	4,8
KLB V SV	1,00E-06	0,0	5,26E+04	100,0	0,1
KLB CZ	4,20E-07	5,0	8,84E-02	33,5	1,2
GOC	1,00E-08	20,0	1,31E-04	1,4	0,0
GOC	1,00E-08	35,0	4,29E-05	0,9	0,0
GOC	1,00E-08	35,0	4,29E-05	0,9	0,0

Total settlement at -25 m from the axis in 2 months (mm): 6,8 57%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	5,2
Settlement with surcharge anticipation over 12 months after a hold period 2 months (mm):	1,8

Duration after hold period (months) 12

Without anticipation	
Residual Settlement without surcharge anticipation after a hold period of 2 months (mm):	5,2
Settlement without surcharge anticipation over 12 after a hold period of 2 months (mm):	1,8



C:\Users\tec4\Desktop\20-10018 HS2\@_TWYFORD\settlement calculation sheets\final\09 GM3 - 81560.xlsm - LAN (0,1)

HS2 – C2 – Calvert Area – Detailed Design

Profile 9 . GM3 - Ch. HS2. 81560 - Landscape Impact

gr (kN/m³)	19,50
Hf (m)	2,80
Hr (m)	2,8
Side slope (H/V)	4,00
Width PF (m)	3,00
harge of the embankmant (kPa)	54,6
Static surcharge (kPa)	0,00
Sr (kPa)	54,6

Landscape	HS2

Embankment geometry for calculating the influence factor at the axis

distance to the axis (m):	-25
c1	11,2
c2	11,2
d1	32,1
d2	-17,9

Groundwater level 0,2 m

1 - ESTIMATED SETTLEMENT

Layers	Top (m)	Base (m)	influence factor at the center of the layer Kz	Stress increase at the center of the layer (kPa)	g (kN/m3)	s'V0 (kPa)	Poisson ratio n	Characteristic Oedometer Modulus (MPa)	ICEMGE Factor (ratio of consolidation to total settlement)	Total settlement DH (mm)	Consolidation settlement DH (mm) (= total settlement x geological correction factor)	Immediate Settlement (mm) (= total - consolidation settlment)
RTD SV	0,0	2,8	0,000	0,0	20	16	0,2	24,0	0,1	0,0	0,0	0,0
RTD CZ	2,8	3,7	0,001	0,1	20	35	0,2	5,7	0,5	0,0	0,0	0,0
KLB V SV	3,7	5,0	0,003	0,2	20	46	0,2	85,0	0,1	0,0	0,0	0,0
KLB CZ	5,0	10,0	0,012	0,7	20	77	0,2	34,4	0,4	0,1	0,0	0,1
GOC	10,0	25,0	0,066	3,6	20	177	0,2	185,4	0,4	0,3	0,1	0,2
GOC	25,0	40,0	0,114	6,2	20	327	0,2	311,4	0,4	0,3	0,1	0,2
GOC	40,0	40,0	0,119	6,5	20	402	0,2	374,4	0,4	0,0	0,0	0,0
			Total settlement at -25 m from the axis (mm							1	0	0

nb iteration 0
Convergence m

Stress inc. / s'v0 2%

w Rail Load	1	0	0
wo Rail Load	64	23	41
difference	63	23	

2 - CONSOLIDATION BY TIME (without vertical drains)

Time	
month	0
number of days	30,4
secondes	0

With surcharge anticipation (anticipation rail load 30 kPa)

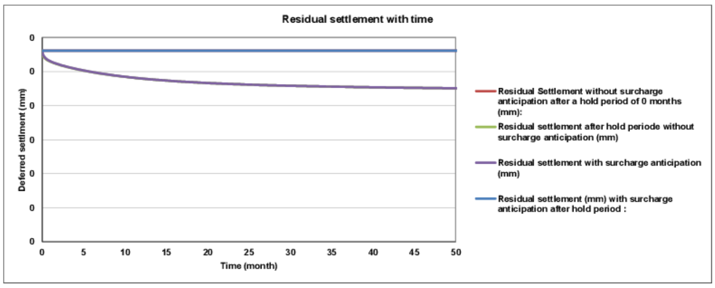
Layers	Cv (m²/s)	drainage height H (m)	Tv	Uv (%)	w (mm)
RTD SV	1,00E-06	0,0	0,00E+00	0,4	0,0
RTD CZ	1,20E-07	0,5	0,00E+00	0,4	0,0
KLB V SV	1,00E-06	0,0	0,00E+00	0,4	0,0
KLB CZ	4,20E-07	5,0	0,00E+00	0,4	0,0
GOC	1,00E-08	20,0	0,00E+00	0,4	0,0
GOC	1,00E-08	35,0	0,00E+00	0,4	0,0
GOC	1,00E-08	35,0	0,00E+00	0,4	0,0

Total settlement at -25 m from the axis in 0 months (mm): 0,0 0%

With surcharge anticipation	
Residual settlement (mm) with surcharge anticipation after hold period :	0,3
Settlement with surcharge anticipation over 12 months after a hold period 0 months (mm):	0,0

Duration after hold period (months) 12

Without anticipation	
Residual Settlement without surcharge anticipation after a hold period of 0 months (mm):	0,3
Settlement without surcharge anticipation over 12 after a hold period of 0 months (mm):	0,0



C:\Users\tec4\Desktop\20-10018 HS2\@_TWYFORD\settlement calculation sheets\final\09 GM3 - 81560.xlsm - LAN (0,2)

Appendix F GRR extract

Number of Pages: 2

Risk ID, Asset, and Status				Risk Details			Current Risk Assessment	Risk Response			Post-mitigation Risk Assessment
Geotechnical Risk ID	Associated CDM Register Risk ID	Level 2 Asset	Risk Status	Risk Description (There is a threat that...)	Risk Cause (Due to....)	Risk Impact (Resulting in....)	Risk Rating	Primary Risk Mitigation Strategy	Mitigation Description / Notes	Next Action Due	Residual Risk Rating
GEO_2240		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	De-structured clays (OXC Formation) due to repeated freeze-thaw activity during the glacial period causing near surface softening / sub-vertical shears in the soils.	1. Presence of OXC weathered Formation 2. Seasonal wet ground conditions	1. Lower soil strength 2. Slope failure	12	Reduce	1. Perform embankment stability calculations with reduced cohesion to take account of potentially weakened geology [complete]	Construction and Manufacture	2
GEO_2958		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Suspected geological faults and potentially weakened ground between Ch.81+915 and Ch.82+050	Displaced geological units, brecciated ground, possible water ingress and loose ground characteristics in this area	1. Differential settlements due to soft ground 2. Differential settlements due to variations in ground stiffness	9	Reduce	1. Review Stage 2 GI prior at a later stage in DD (complete) 2. Hold period and site inspection of base of excavation (after topsoil/subsoil strip) 3. Verification and control during construction to verify minimum undrained shear strength cu of 50 kPa 4. Ground improvement of 1m bGL 5. I&M to follow settlements during construction	Construction and Manufacture	2
GEO_3185		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	High/shallow groundwater level in drift deposits	1. Alluvial and River Terrace deposits (ALV & RTD) adjacent to watercourses (Padbury Brook) 2. Perched water in superficial deposits	1. Instability of slopes due to updward migration of water into embankment 2. Flooding 3. Softer ground 4. Higher consolidation time leading to construction delays	9	Reduce	1. Apply Starter layer [complete] 2. Adopt conservative groundwater level in design (-0,2 bGL) [complete] 3. Review additional ground water monitoring prior to construction stage [complete] 4. Dewatering may be required in sub-excavations 5. Temporary works design to manage slope stability of sub-excavations	Construction and Manufacture	2
GEO_3823		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Soft ground, characterised as having a low strength and high compressibility, is encountered along Twyford Embankment	1. Presence of clayey Alluvial soils 2. Weathered top of OXC Formation	1. Instability embankment slopes 2. Unacceptable total or differential settlements. 2. Bearing requirements not achieved 3. Delay to works / longer hold periods / rutting /trafficability 4. Higher maintenance	16	Reduce	1. Appropriate slopes (refer to stability calculations) [complete] 2. Use a more cautious estimation of soil parameters in DD calculations [complete] 3. Review Stage 2 GI [complete] 4. Reduced tolerances for settlements (15mm) do to HS2 requirements in transitions (switch and crossing, fault, culvert) [complete] 5. Verification testing during construction at base of excavation (after topsoil/subsoil strip) to ensure minimum undrained shear strength of 50 kPa. Ground improvement of 1m bgl. EKFB to include risk provision for additonal ground improvement. 6. Anticipation of rail loads (temporary surcharge at top of embankment) 7. Hold period of up to 6 months with instrumentation and monitoring to ensure settlment s within tolerable limits prior to placing the slab track	Construction and Manufacture	2
GEO_3824		HS2-000001045 - Twyford Embankment	Risk Eliminated/Avoided	Soil volume may change significantly (shrink-swell) with water content	1. Presence of ALV overlying OXC Formation	1. Unacceptable total or differential settlements 2. Delay to works / longer hold periods 3. Higher maintenance	6	Eliminate	1. According to HS Railways design and construction international standards, the shrink/swell behaviour of high plasticity clays is mastered through compliance with the suitability rules of soils for substructure works. Eliminated by mitigation to achieve subgrade stiffness design requirements.	N/A	2
GEO_3825		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	High levels of sulfate in OXC and KLB Formation	1. Sulfate bearing soils resulting in aggressive ground 2. Sulfate in groundwater	Conrete attack and defects	12	Reduce	1. Review Stage 2 sulfate testing (water soluble sulfates in particular) at a later stage in DD to verify sulfate class [Completed] 2. Use cautious Design Sulfate Class (DS) and additional protective measures (APM) after BS 8005-1 : sacrificial concrete layer [complete] 3. Apply DS-4 across Twyford Embakment due to OXC Formation and water soluble sulfate levels	Construction and Manufacture	3
GEO_3827	CDM_2630	HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	There is a threat that the dynamic performance of the completed earthworks does not achieve the Very Short Term (Instantaneous) performance criteria set out in Table 4.2/1 in the HS2 Standard Doc No. HS2-HS2-GT-STD-000-000001	Inadequate subgrade support due to presence of ALV and OXC formation at cut/fill transitions and/or on sections of low embankment	This could result in excessive vibration and deflection of the combined slab track and earthworks, impacting the safe operation and maintenance of the Railway	12	Reduce	1. Ground improvement (excavate and replace) to 3m bFL 2. Review outstanding MASWand CSW tests in at grade section at a later stage in DD to verify design [complete] 3. Demonstration areas and verification and validation testing at construction stage ot realsie potential opportunity in at grade sections	Construction and Manufacture	3
GEO_3828		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Magnitude and/or time of consolidation greater than anticipated	1. Presence of clayey superficial deposits on overconsolidated clays 2. Interbedded sandy layers (RTD, KLB SV) will reduce drainage path	1. Unacceptable total or differential settlements. 2. Bearing requirements not achieved 3. Delay to works / longer hold periods / rutting /trafficability 4. Higher maintenance	12	Reduce	1. Use a more cautious estimation of soil parameters in DD calculations [complete] 2. Reduced tolerances for settlements (15mm) do to HS2 requirements in transitions (switch and crossing, fault, culvert) [complete] 3. Verification testing during construction at base of excavation (after topsoil/subsoil strip) to ensure minimum undrained shear strength of 50 kPa. Ground improvement of 1m bgl. EKFB to include risk provision for additonal ground improvement. 4. Hold period for settlement control prior to placing slab track 5. Anticipation of rail loads 6. Monitoring and instrumentation plan at transition zones to follow settlements	Construction and Manufacture	2
GEO_4092	CDM_2628	HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Potential risk of encountering Made Ground / contamination, predominantly associated with Sewage Works (LQ 13.06) (adjacent to landscape earthworks of asset), and Dismantled Rugby to Quainton Great Central Railway adjacent to route (LQ 13.07) (approx. 60 m southwest of asset). Limitations to where material can be re-used in view of its chemical characteristics/re-use criteria and material incorrectly segregated may not be able to be reused	Limited Made Ground has been encountered across the area of the embankmen, but with limited GI being conducted in the nearby LQ areas (13.06 and 13.07) there is potential for localised Made ground and contamination to be encountered within the confines of the LQ boundaries. Ground contamination has been identified within the asset, with Metals exceedances noted across Soils, Leachate and Groundwater samples. In addition to this, further contamination of inorganic pollutants were noted within the groundwater samples tested. GI sampling was limited within the LQ areas and as such further contamination may be present.	1. Risk to human health and controlled waters during the works. 2. Risk of delays to the programme - potentially from additional GI to classify unexpected material and from potential remediation 3. Failure to comply with regulatory guidance/MMP 4. Increased costs with having to re-do segregation of stockpiled material	6	Reduce	1. Management of potentially contaminated soils s to be in line with the Aylesbury Link and Dismantled Great Central Railway Remediation Outline Strategy 1MC06-CEK-EV-REP-C002-000200. 2. Correct characterisation of soils 3. Intercepted groundwater should be collected, tested and if neccessary treated prior to discharge. 4. Materials Management Plan (MMP) to be adopted	Construction and Manufacture	4
GEO_4093	CDM_2628	HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Risk of ground gases (methane, carbon dioxide and depleted oxygen) can accumulate also migrate across site posing a risk to construction workers and the construction works.	Potential sources of ground gases exist including the Sewage Works (LQ 13.06) and Dismantled Rugby to Quainton Great Central Railway adjacent to route (LQ 13.07). Gas monitoirng has been carried out across the site and indicated that the site is of characteristic situation 1 (CS1), very low risk. It is considered that confined spaces are not proposed within the embankment in which gas could accumulate, however the construction works could create preferential pathways for ground gas migration.	1. Risk to human health during excavation. 2. Potential risk to construction workers entering confined spaces if elevated gas concentrations/depleted oxygen concentrations are encountered. 3. Risk of creation of preferential pathways for gas migration	4	Reduce	1. Further gas assessment to be undertaken once information is available. 2. Excavations and confined spaces should be monitored for gas and depleted oxygen prior to man entry in line with recommendations of HSE guidance.	Construction and Manufacture	2
GEO_4627	CDM_1521 CDM_10189	HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	There is a risk of flooding associated with the Tributary of Padbury Brook crossing HS2 mainline in Twyford East Culvert	1. Tributary of Padbury Brook crossing HS2 mainline at Twyford East Culvert 2. Flooding occurs behind the existing old railway embankment (upstream of HS2 mainline) on the Down side 3. Elevated risk if the existing railway embankment is removed as part of the works, although the mainline will be protected by the landscape bund	1. Erosion 2. Slope instability 3. Delay to works 4. Higher maintenance	6	Reduce	1. No flood protection required according to available FLAR. 2. HS2 mainline protected by old railway embankment 3. HS2 protected by Landscape bund	Construction and Manufacture	3
GEO_4654	CDM_2627	HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Limitations to where material can be re-used in view of its chemical characteristics/re-use criteria and material incorrectly segregated cannot be reused	Limited Made Ground has been indentified within the confiens of the embankment, however, there is very limited GI conducted within the potential contamination sources of the Sewage Works (LQ 13.06) (adjacent to landscape earthworks of asset) and Dismantled Rugby to Quainton Great Central Railway adjacent to route (LQ 13.07) (approx. 60 m southwest of asset). As such due to this limited amount of data available there may be potential for unforseen Made Ground and contamination to be present across the site.	1. Risk to human health and controlled waters during the works. 2. Risk of delays to the programme - potentially from additional GI to classify unexpected material and from potential remediation 3. Failure to comply with regulatory guidance/MMP 4. Increased costs with having to re-do segregation of stockpiled materials	6	Reduce	1. Management of potentially contaminated soils s to be in line with the Aylesbury Link and Dismantled Great Central Railway Remediation Outline Strategy 1MC06-CEK-EV-REP-C002-000200. 2. Correct characterisation of soils 3. Intercepted groundwater should be collected, tested and if neccessary treated prior to discharge. 4. Materials Management Plan (MMP) to be adopted	Construction and Manufacture	3
GEO_CA_0071	CDM_2644 CDM_2645	HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Damage to Gas pipeline (CSO-03-2203)	Gas pipeline beneath HS2 line at the Ch. 80+900 .	1. Damage to pipeline 2. Explosion 3. Delay to works	12	Reduce	1. Non-contestable UTX ihas been installed at approximately 9m bFL at 75.6 m AoD. This depth is adequate to avoid disturbance during construction 2. A concerete protective slab will be placed above the gas pipe	Detailed Design	2
GEO_CA_0072		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Damage to existing building : - Twyford sewage treatment works building : Ch 81+500 - 81+600	Potential differentiel settlement due to the additional load of the landscape and the Mainline Embankment	Damage to building / infrastructure	6	Reduce	1. Use cautious soil parameters and include additional load impact due to landscape bund in settlement calculation [complete] 2. Impact on 3rd party asset detailed in the DD-GMIA report. The risk level is low, the structure is outside the zone of influence. 3. Building condition survey required prior to works 4. I&M may be required on the buiding affected by the planned alignement (to be determined with owner following building survery)	Construction and Manufacture	3
GEO_CA_0073		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Damage to foul sewer (CSO-03-7102)	1. Excessive settlements due to HS2 loading 2. Collision during ground improvement works	1. Damage to pipes 2. Inadequate flow in sewer pipe 3. Delay to works	6	Reduce	1. Settlements within tolerable limits - Phase 2 GMIA [completec] 2. The utility will be installed within a 375mm concrete sleeve for protection 3. Results of GMIA and possible requirement for monitoring to be discussed with the owner	Construction and Manufacture	2
GEO_CA_0074		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Damage to private water supply	Private water supply pipeline passing beneath HS2 line respectively at the following chainages: 81+150 and 82+050).	1. Damage to pipes 2. Delay to works	6	Eliminate	It is assumed that the private water supplies will be removed.	Detailed Design	2
GEO_CA_0075		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Damage to telecom underground cables (C23-81-0001, CSO-03-3108,....)	Temporary diversion of utilties during construction of West Street Bridge prior to rerouting along the new road	1. Damage to cables 2. Delay to works	6	Reduce	Temporary works designer to manage interfaces.	Construction and Manufacture	6
GEO_CA_0076		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	There are some small existing ponds in the fields on the Down side of the disused railway line approximately 125m from HS2 mainline.	Potential impact on temporary works (will not impact mainline construction)	1. Temporary slope instability 2. Water ingress during construction	6	Reduce	Temporary works designer to manage interfaces, as necessary.	Construction and Manufacture	4
GEO_CA_0077		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Soil softening and slope instability due to close proximity of HS2 pond (P-RAI-0821)	1. Shallow pond planned on Up side of the route at around 10m from the toe of embankment 2. Saturated ground and/or water entering embankment fills 3. Fluctuating water levels (seasonal variations) 4. Rapid drawdown of water in pond	1. Pond slope instability and erosion 2. Unacceptable maintenance (Note, very unlikely to cause instability to HS2 but requiring routine inspection and maitenance of pond slopes as these are not lined)	6	Reduce	1. Perform stability calculations [complete] 2. Landscaping area between toe of HS2 embankment and the pond. The landscape will ensure that the land falls down towards the pond (away from HS2) to provide adequate drainage. 3. Natural slope gradient is towards the river, water will flow away from HS2.	Operations and Maintenance	2
GEO_CA_0078	CDM_10708	HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Vulnerability of earthworks slopes to burrowing animals and potential impact on stability	Some existing burrowing animals : presence of badger sets on the downside of HS2 mainline . Found at 100m from the HS2 line alignment at Ch. 81+675.Close to Twyford East Culvert.	1. Slope instability due to burrows 2. Ground movement 3. Delays to HS2 operations Low risk due to the nature of the materials forming the mainline embankments (stiff lime modified clays)	6	Reduce	1. Habitat relocation or closure by Fusion [complete] 2. Survey site inspection	Operations and Maintenance	3
GEO_CA_0079		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Uncertainty in the nature of ALV soils locally with two facies sandy and clayey ALV	1. Uncertainty in the sand content in the superficial soils between Ch. 81+650 and Ch. 81+800.	1. Longer consolidation time 2. Longer construction hold period 3. Embankment side slope instability if soils softer than expected	6	Reduce	1. Settlement hold period during construction 2. Anticipation of rail load (temporary surcharge placed on top of the embankment fills) 2. I&M to follow settlements during construction 3. Hold period and site inspection to verify the ground conditions and undrained shear strength at the base of Twyford East Culvert during foundation works 4. Verification of minimum undrained shear strength of 50 kPa 5. Potential opportuntiy to redcue the dpeth of E&R if sandy soils confirmed by control testing	Construction and Manufacture	2

Risk ID, Asset, and Status				Risk Details			Current Risk Assessment	Risk Response			Post-mitigation Risk Assessment
Geotechnical Risk ID	Associated CDM Register Risk ID	Level 2 Asset	Risk Status	Risk Description (There is a threat that...)	Risk Cause (Due to....)	Risk Impact (Resulting in....)	Risk Rating	Primary Risk Mitigation Strategy	Mitigation Description / Notes	Next Action Due	Residual Risk Rating
GEO_CA_0081	CDM_2634	HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Damage High voltage cable (CSO-003-1404)	Electric underground cable passing beneath HS2 line at chainage 81+300 (installed late 2017)	1. Damage to utilitiy 2. Electrocution 3. Delay to works	15	Reduce	1. DRA assessment as part of DD-GMIA Phase 2 (completed) 2. Diverted and placed at 4m bGL. Protected by a concrete slab	Construction and Manufacture	3
GEO_CA_0082	CDM_2634	HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Obstructions at the existing Overbridge and embankment (Made Ground) located at approx. Ch. 81+650	Existing bridge over former disused raliway line immediately to the north of the sewage works interfering with the landscape bund and mainline embankment	1. Obstructions 2. Material reuse 3. Potential contaminated ground	9	Reduce	1. Appropriate construction plant 2. Additonal testing to confirm level of contamination and remediation strategy (material placement) 3. Footpath diversion to West Street Overbridge	Construction and Manufacture	3
GEO_CA_0083	CDM_2629	HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Overspill from Hillesden bombing range (located approx. 700m north of the embankment at Ch.81+550) is considered to provide a possible source of UXO hazard to the Site due to the potential presence of practice and live UXO. As such there is a Moderate risk within the eastern LLAU between Ch. 81+500 and Ch. 81+700. The remaining LLAU and LOD of the embankment is seen to be at a low risk to UXO.	Desk study data indicating a high risk (red) area of UXO within the region however this is outside the area of EKFB works.There is a low risk (green) area for the presence of UXO between Ch. 81+200 and Ch. 82+200.	Delays to construction works if UXO encountered. If not properly mitigated and anticipated during the construction works there is the potential for fatalities if an explosion occurred through disturbing the UXO in areas of deep dig (deeper than topsoil strip).	5	Reduce	1. Briefing prior to construction in low risk area. 2. EKFB to identify areas of deeper dig and establish method statement with ASC 3. Maintain watching brief through construction 4. The contractor shall stop work immediately should any UXO be encountered during construction works. The contactor shall then employ a specialist contractor to elimate the risk in a controlled manner.	Construction and Manufacture	2
GEO_CA_0247		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Relict slip surfaces in OXCw materials leading to weakened in-situ geology and slope instability under embankment loading (generally considered to be low risk due to flat topography).	1. Presence of OXC weathered Formation 2. Seasonal wet ground conditions	1. Reactivation of shear slip 2. Embankment instability	3	Reduce	1. Ground improvement to 1m bGL from Ch. 81+620 to Ch. 82+269 2. Reveiw additional Stage 2 GI for evidence of polished surfaces [complete] 3. Inspection of sub-excavations prior to backfilling [Witness Point]	Construction and Manufacture	3
GEO_CA_0248		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Relict slip surfaces in OXCw materials leading to weakened in-situ geology and slope instability under embankment loading (generally considered to be low risk due to flat topography). Medium risk where slope gradient >5° between Perry Hill Road Alignement and West Street realignment	1. Presence of OXC weathered Formation 2. Seasonal wet ground conditions	1. Reactivation of shear slip 2. Embankment instability	9	Reduce	1. Ground improvement to 2m bGL from Ch. 81+662 to Ch. 81+470 2. Review additional Stage 2 GI for evidence of polished surfaces [complete] 3. Inspection of sub-excavations prior to backfilling [witness Point] 4. Provision for excavate and replace of any hidden shear surfaces observed on site	Construction and Manufacture	3
GEO_CA_0249		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	High volume of Class 4 soils (insufficient Class 2 soils) that are too wet to compact in landscapes abutting / facing HS2 leading to slope instability / deformation	1. Intermediate to high plastcity soils in saturated state 2. Perched water in superficial deposits that will be excavated as part of ground improvement	1. Poor compaction of landscape fills in Zone 1 and Zone 2 2. Instability of slopes facing HS2 3. Differential / Internal settlements in landscape fills over long term leading to irregular, hummocky surfaces and preferable surface water flow that could lead to erosion 4. Disruption to mass haul 5. Lack of suitable materil for landscape Zone 1 and Zone 2 (abutting / facing HS2)	12	Reduce	1. Landscape zoning and minimum undrained shear strength to be specified by design [complete] 2. Specify method compaction in abutting soils [complete] 3. EKFB to perform sufficient material testing and relationship testing in line with Earthwork Specification Table 1/5 4. Lime modification, if necessary	Construction and Manufacture	9
GEO_CA_0250		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	There is a risk of flooding associated with the Padbury Brook Main Channel crossing HS2 mainline at Twyford Viaduct	1. Main channel of Padbury Brook can flood	1. Erosion of earthwork slopes 2. Slope instability 3. Delay to works 4. High maintenance	16	Reduce	1. Flood protection on embankment slopes	Construction and Manufacture	2
GEO_CA_0251		HS2-000001045 - Twyford Embankment	Risk Reduction in Progress	Damage Temporary High voltage cable	Electric underground cable passing beneath HS2 line at chainage 81+330	1. Damage to utilitiy 2. Electrocution 3. Delay to works	20	Reduce	1. Place temporary cable at adequate depth or relocate to avoid damage during ground improvement works	Construction and Manufacture	2

Appendix G E-GDR Dashboards

Number of pages: 6

EKFB Working in partnership with HS2

Earthworks - Geotechnical Design Report, Geotechnical Parameter Plots for Earthwork Classification – Cohesive Soil

asc A High-Speed Design Partnership ARCADIS COWI

Level 1 Asset Group
Twyford Embankment
*CTRL+Click to multi select from above filter

Geology Code 3
ALV-C Z

Data Drop
Tout

Material in Zone of Reuse
Tout

Weathering Classification
Tout
*CTRL+Click to multi select from above filter

Chainage Range
80862 82289

Offset Range
-994 1508

Depth Top Range
-80,93 -0,05

Reset Filters

Report Date
vendredi, février 19, 2021

Compaction Data 2.5Kg

Parameter	Average

Compaction Data 4.5Kg

Parameter	Average
Dry Density Max (Mg/m3)	1,86
Moisture Content Optimum (%)	14,02
Particle Density (Mg/m3)	2,63
Proportion retained on 20mm sieve (%)	0,17
Proportion retained on 37.5mm sieve (%)	1,50

Compaction Data 2.5Kg

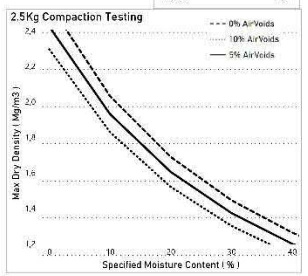
Parameter	Average
Dry Density Max (Mg/m3)	1,76
Moisture Content Optimum (%)	17,44

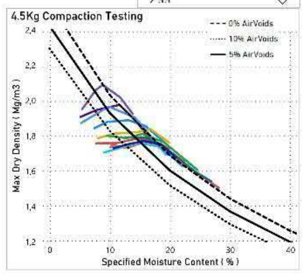
Compaction Data 4.5Kg

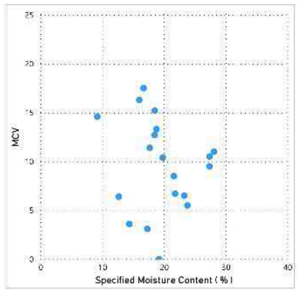
Parameter	Average
Dry Density Max (Mg/m3)	1,76

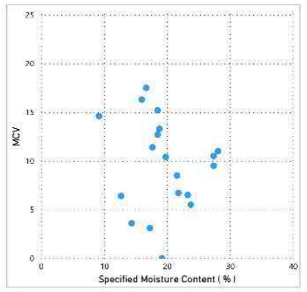
Air Voids Lines 2.5Kg Hammer - Particle Density
2,55

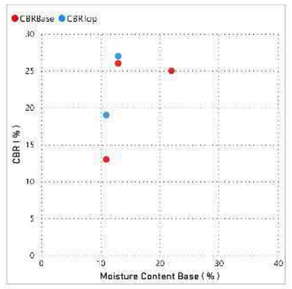
Air Voids Line 4.5kg Hammer - Particle Density
2,55

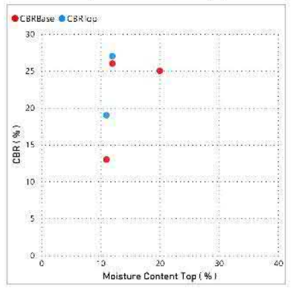


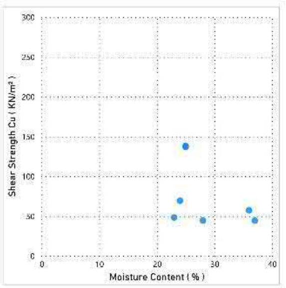


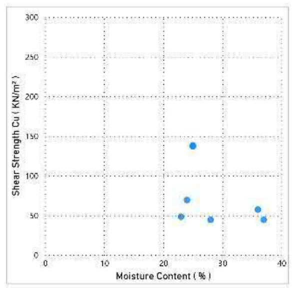


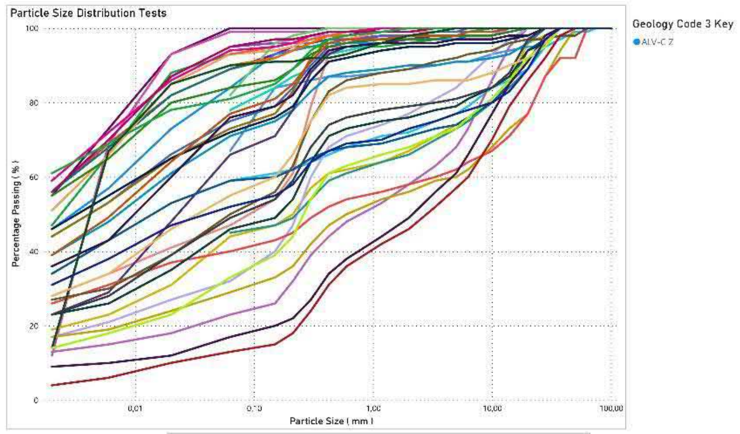


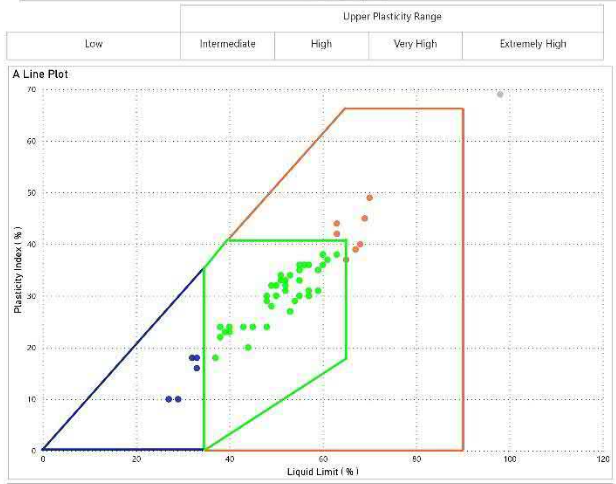












The presented acceptability range of fine grained fill materials on the A-Line plot are taken from Figure 4.3/1 in the Technical Standard – Earthworks (HS2-HS2-GT-STD-000-000001). The specific acceptability ranges for fill materials will be refined through Detailed Design.

Legend	Earthworks Classification	Count	% Count
(green)	May be suitable for HS2 Mainline Earthworks if treated	39	72,22%
(dark blue)	Suitable for use as General Fill in Offline Works and HS2 Mainline Lower Embankment	6	11,11%
(grey)	Outside Named Zones	1	1,85%
(orange)	Suitable for use as Offline Fill but Excluding from HS2 Mainline Earthwork	8	14,81%

Notes:

(1) The Air Void Lines applied to the Compaction Plots need to be assigned using the Particle Density filter. The value to be used is dependent on the mean Particle Density value shown in the associated summary compaction results table based on the defined filters.

(2) Material in Zone of Reuse is considered based on the following criteria:

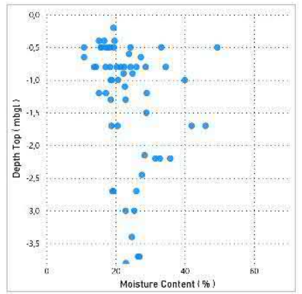
(a) Exploratory holes within 50m of the proposed track centreline.

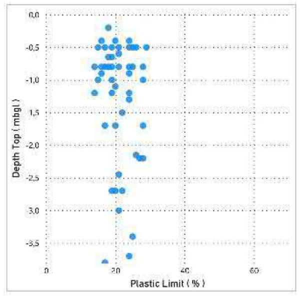
(b) The material tested is taken from samples from depths up to 3m below design level in cuttings or 3 below ground level in Embankments of at least 3m in height.

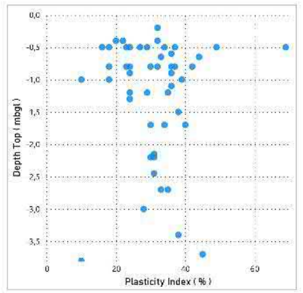
(3) Shear Strength Cu data from triaxial testing are plotted from the results of undisturbed samples as there were no results from triaxial tests undertaken on re-moulded samples.

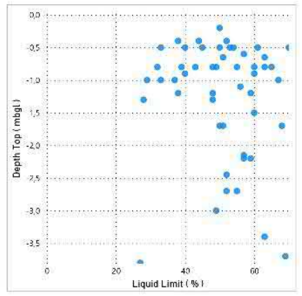
(4) The Geology Code 3 Key does not apply to the either the 2.5 and 4.5 compaction plots, CBR plots, PSD plot or the A-line plot.

(5) All test results shown are from material tested without added stabiliser.







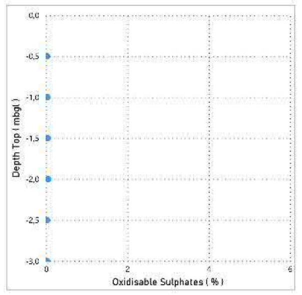


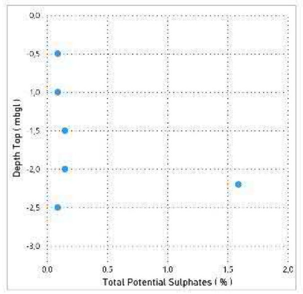
Asset Specific Geotechnical Classification Testing

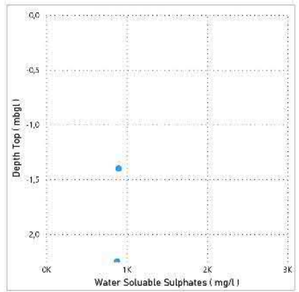
Test	Count	Minimum	Maximum	Average	Standard deviation
Liquid Limit (%)	56	27,00	98,00	51,50	12,62
Moisture Content (%)	74	10,90	49,40	24,76	7,89
Plastic Limit (%)	54	14,00	29,00	20,94	3,96
Plasticity Index (%)	54	10,00	69,00	31,02	9,88

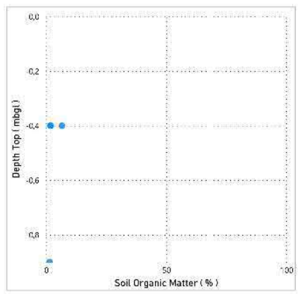
Route Wide Geology Code 3 Geotechnical Classification Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Liquid Limit (%)	56	27,00	98,00	51,50	12,62
Moisture Content (%)	74	10,90	49,40	24,76	7,89
Plastic Limit (%)	54	14,00	29,00	20,94	3,96
Plasticity Index (%)	54	10,00	69,00	31,02	9,88









Asset Specific Geochemistry Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Oxidisable Sulphates (%)	6	0,02	0,05	0,03	0,01
Soil Organic Matter (%)	4	1,40	6,60	2,90	2,14
Total Potential Sulphates (%)	8	0,09	6,24	1,33	2,01
Water Soluble Sulphates (mg/l)	2	880,00	900,00	890,00	10,00

Route Wide Geology Code 3 Geochemistry Testing

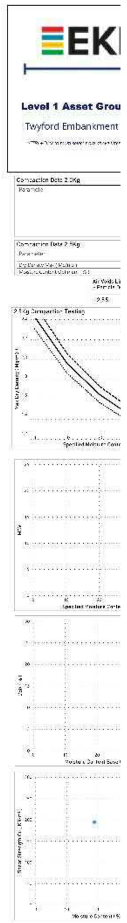
Test	Count	Minimum	Maximum	Average	Standard deviation
Oxidisable Sulphates (%)	6	0,02	0,05	0,03	0,01
Soil Organic Matter (%)	4	1,40	6,60	2,90	2,14
Total Potential Sulphates (%)	8	0,09	6,24	1,33	2,01
Water Soluble Sulphates (mg/l)	2	880,00	900,00	890,00	10,00

Data Source

Data Source	Description
Asset chainages	PMA updated chainages 20190307
C2 Data	C2 v2.0 C2 Combined DataDrop04
C3 Data	C3 v2.0 C3 Combined DataDrop04
Track Elevation & ECL	PMA13 Elevation Comparison

Weathering Class Description

Unified Classification	Weathering class description	Reported Classes in AGS data
0	Unweathered	0, A, I
1	Slightly weathered	1, A/B, B, II
2	Moderately weathered (<50%)	2, B/C, C, III
3	Highly weathered (>50%)	3, C/D, D, IV
4	Completely weathered	4, D/E
5	Residual soil	5, E



EKFB Working in partnership with HS2

Earthworks - Geotechnical Design Report, Geotechnical Parameter Plots for Earthwork Classification – Cohesive Soil

A High-Speed Design Partnership
ARCADIS COWI

Level 1 Asset Group

Twyford Embankment

*CTRL+Click to multi select from above filter

Geology Code 3: OXC-C Z

Data Drop: Tout

Material in Zone of Reuse: Tout

Weathering Classification: Tout

*CTRL+Click to multi select from above filter

Chainage Range: 80862 – 82289

Offset Range: -994 – 1508

Depth Top Range: -80,93 – -0,05

Reset Filters

Report Date

vendredi, février 19, 2021

Compaction Data 2.5Kg

Parameter	Average

Compaction Data 4.5Kg

Parameter	Average
Dry Density Max (Mg/m3)	1,81
Moisture Content Optimum (%)	13,50
Particle Density (Mg/m3)	2,64
Proportion retained on 20mm sieve (%)	0,00
Proportion retained on 37.5mm sieve (%)	0,00

Compaction Data 2.5Kg

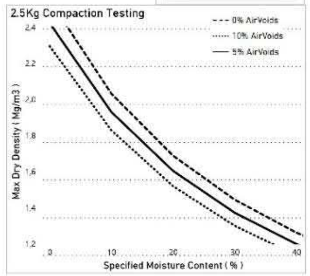
Parameter	Average
Dry Density Max (Mg/m3)	1,76
Moisture Content Optimum (%)	17,44

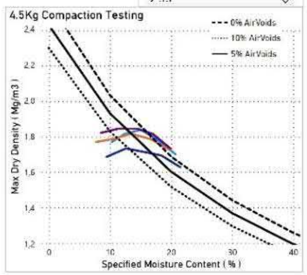
Compaction Data 4.5Kg

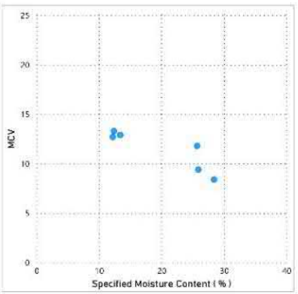
Parameter	Average
Dry Density Max (Mg/m3)	1,76

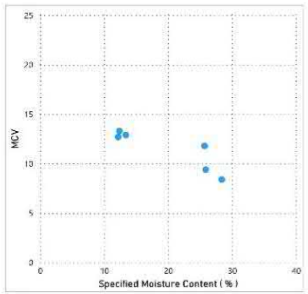
Air Voids Lines 2.5Kg Hammer - Particle Density: 2,55

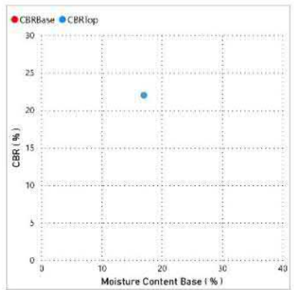
Air Voids Line 4.5kg Hammer - Particle Density: 2,55

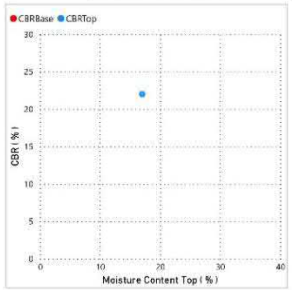


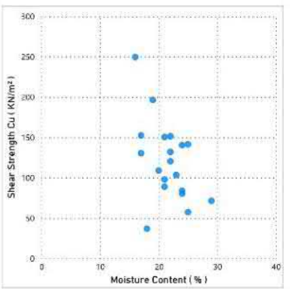


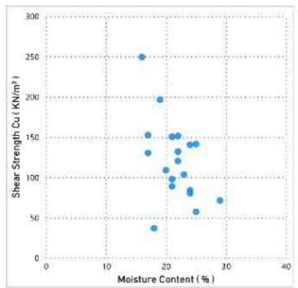


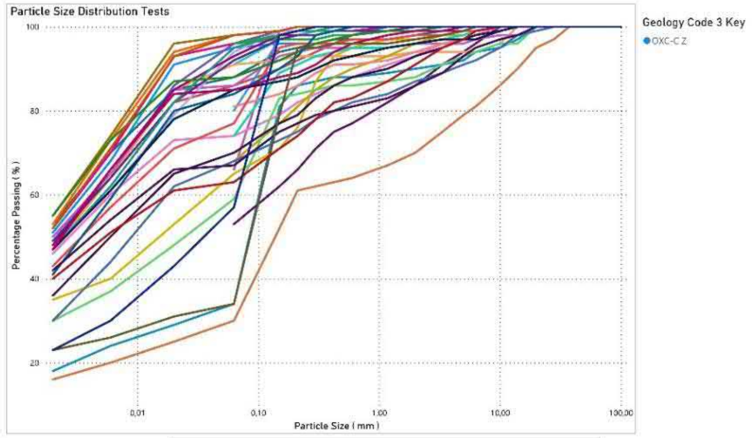






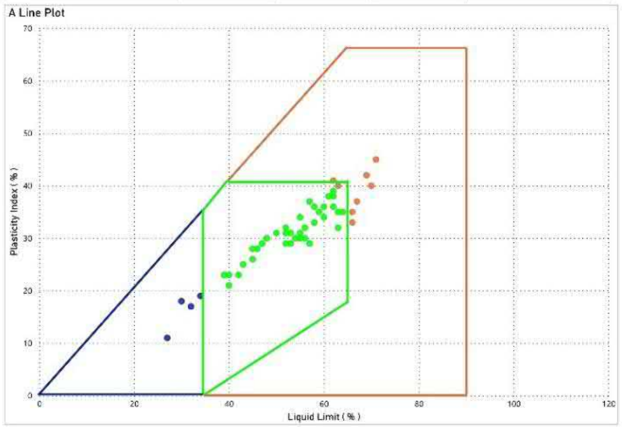






Upper Plasticity Range

Low	Intermediate	High	Very High	Extremely High



The presented acceptability range of fine grained fill materials on the A-Line plot are taken from Figure 4.3/1 in the Technical Standard – Earthworks (HS2-HS2-GT-STD-000-000001). The specific acceptability ranges for fill materials will be refined through Detailed Design.

Legend	Earthworks Classification	Count	% Count
(green)	May be suitable for HS2 Mainline Earthworks if treated	40	76,92%
(blue)	Suitable for use as General Fill in Offline Works and HS2 Mainline Lower Embankment	4	7,69%
(orange)	Suitable for use as Offline Fill but Excluding from HS2 Mainline Earthwork	8	15,38%

Notes:

(1) The Air Void Lines applied to the Compaction Plots need to be assigned using the Particle Density filter. The value to be used is dependent on the mean Particle Density value shown in the associated summary compaction results table based on the defined filters.

(2) Material in Zone of Reuse is considered based on the following criteria:

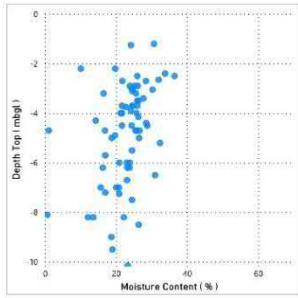
(a) Exploratory holes within 50m of the proposed track centreline.

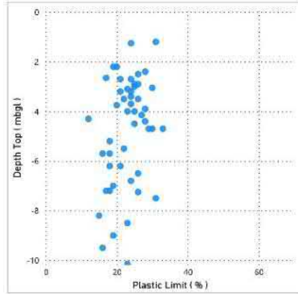
(b) The material tested is taken from samples from depths up to 3m below design level in cuttings or 3 below ground level in Embankments of at least 3m in height.

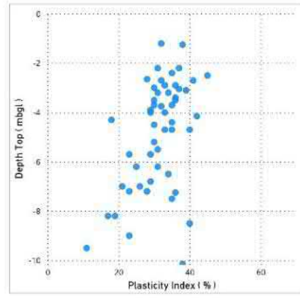
(3) Shear Strength Cu data from triaxial testing are plotted from the results of undisturbed samples as there were no results from triaxial tests undertaken on re-moulded samples.

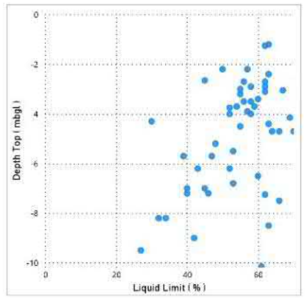
(4) The Geology Code 3 Key does not apply to the either the 2.5 and 4.5 compaction plots, CBR plots, PSD plot or the A-line plot.

(5) All test results shown are from material tested without added stabiliser.







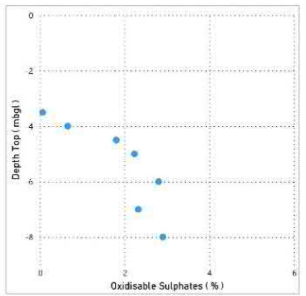


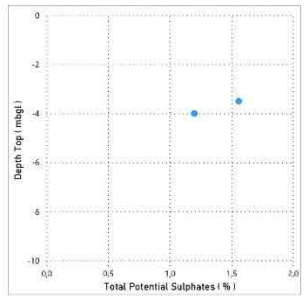
Asset Specific Geotechnical Classification Testing

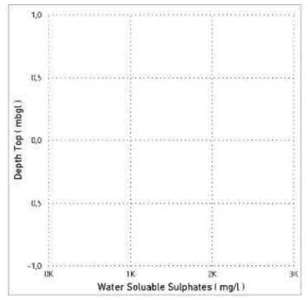
Test	Count	Minimum	Maximum	Average	Standard deviation
Liquid Limit (%)	52	27,00	71,00	54,21	10,38
Moisture Content (%)	103	0,71	36,50	22,76	5,59
Plastic Limit (%)	52	12,00	33,00	22,85	4,67
Plasticity Index (%)	52	11,00	45,00	31,37	6,68

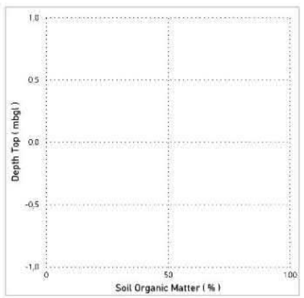
Route Wide Geology Code 3 Geotechnical Classification Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Liquid Limit (%)	52	27,00	71,00	54,21	10,38
Moisture Content (%)	103	0,71	36,50	22,76	5,59
Plastic Limit (%)	52	12,00	33,00	22,85	4,67
Plasticity Index (%)	52	11,00	45,00	31,37	6,68









Asset Specific Geochemistry Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Oxidisable Sulphates (%)	8	0,06	19,00	3,97	5,76
Total Potential Sulphates (%)	15	1,20	20,10	5,84	4,43

Route Wide Geology Code 3 Geochemistry Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Oxidisable Sulphates (%)	8	0,06	19,00	3,97	5,76
Total Potential Sulphates (%)	15	1,20	20,10	5,84	4,43

Data Source

Data Source	Description
Asset chainages	PMA updated chainages 20190307
C2 Data	C2-v2.0 C2 Combined DataDrop04
C3 Data	C3-v2.0 C3 Combined DataDrop04
Track Elevation & EGL	PMA13 Elevation Comparison

Weathering Class Description

Unified Classification	Weathering class description	Reported Classes in AGS data
0	Unweathered	0, A, I
1	Slightly weathered	1, A/B, B, II
2	Moderately weathered (<50%)	2, B/C, C, III
3	Highly weathered (>50%)	3, C/D, D, IV
4	Completely weathered	4, D/E
5	Residual soil	5, E

EKFB Working in partnership with HS2

Earthworks - Geotechnical Design Report, Geotechnical Parameter Plots for Earthwork Classification – Cohesive Soil

asc A High-Speed Design Partnership ARCADIS COWI

Level 1 Asset Group
Twyford Embankment
*CTRL+Click to multi select from above filter

Geology Code 3
RTD-SV

Data Drop
Tout

Material in Zone of Reuse
Tout

Weathering Classification
Tout
*CTRL - Click to multi select from above filter

Chainage Range
80862 82289

Offset Range
-994 1508

Depth Top Range
-80,93 -0,05

Reset Filters

Report Date
vendredi, février 19, 2021

Compaction Data 2.5Kg

Parameter	Average

Compaction Data 4.5Kg

Parameter	Average

Compaction Data 2.5Kg

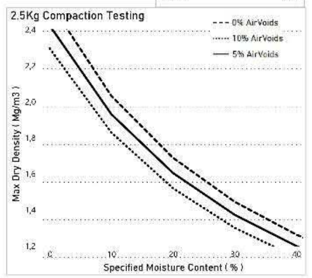
Parameter	Average
Dry Density Max (Mg/m3)	1,76
Moisture Content Optimum (%)	17,44

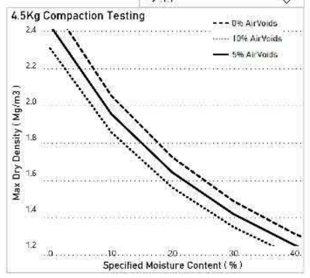
Compaction Data 4.5Kg

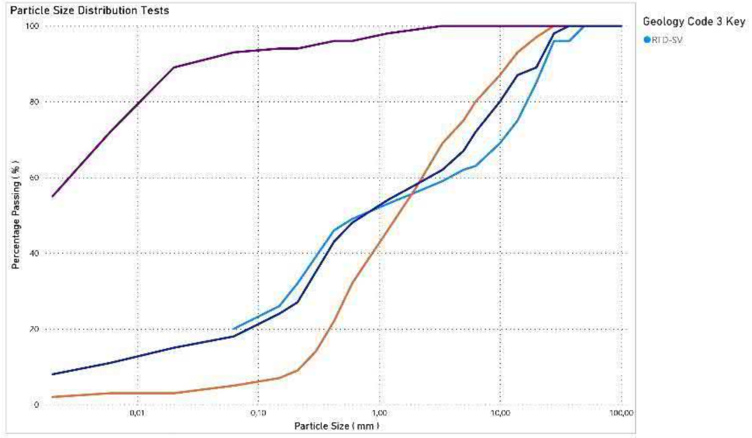
Parameter	Average
Dry Density Max (Mg/m3)	1,76

Air Voids Lines 2.5Kg Hammer - Particle Density
2,55

Air Voids Line 4.5kg Hammer - Particle Density
2,55

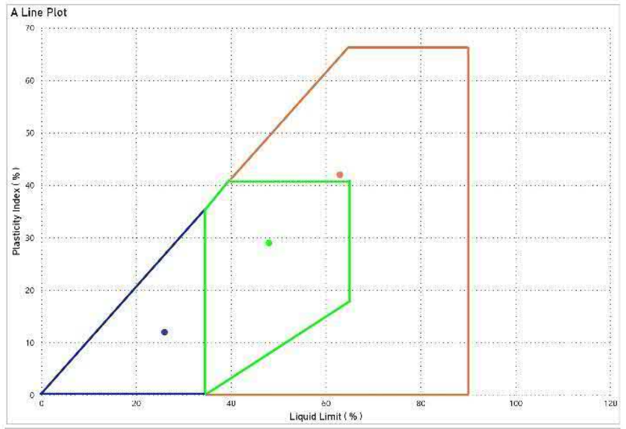






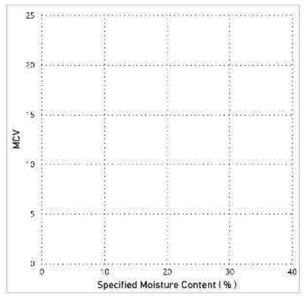
Upper Plasticity Range

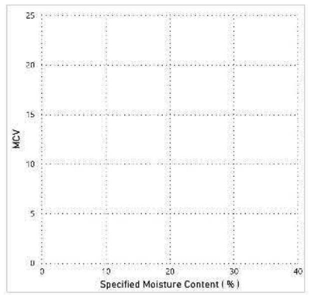
Low	Intermediate	High	Very High	Extremely High

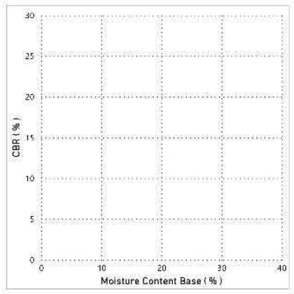


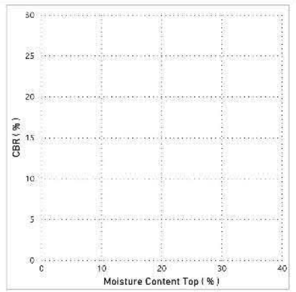
The presented acceptability range of fine grained fill materials on the A-Line plot are taken from Figure 4.3/1 in the Technical Standard – Earthworks (HS2-HS2-GT-STD-000-000001). The specific acceptability ranges for fill materials will be refined through Detailed Design.

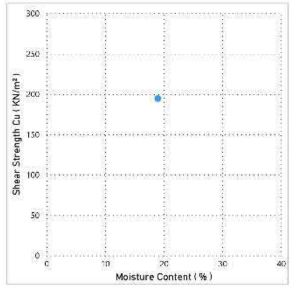
Legend	Earthworks Classification	Count	% Count
(green)	May be suitable for HS2 Mainline Earthworks if treated	1	33,33%
(blue)	Suitable for use as General Fill in Offline Works and HS2 Mainline Lower Embankment	1	33,33%
(orange)	Suitable for use as Offline Fill but Excluding from HS2 Mainline Earthwork	1	33,33%

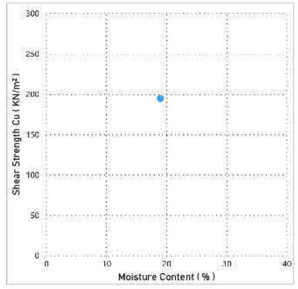












Notes:

(1) The Air Void Lines applied to the Compaction Plots need to be assigned using the Particle Density filter. The value to be used is dependent on the mean Particle Density value shown in the associated summary compaction results table based on the defined filters.

(2) Material in Zone of Reuse is considered based on the following criteria:

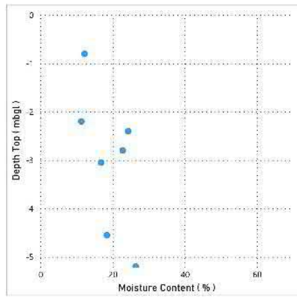
(a) Exploratory holes within 50m of the proposed track centreline.

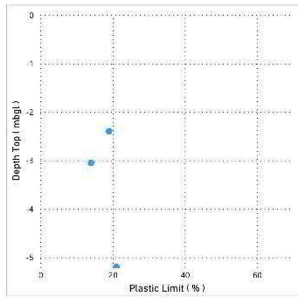
(b) The material tested is taken from samples from depths up to 3m below design level in cuttings or 3 below ground level in Embankments of at least 3m in height.

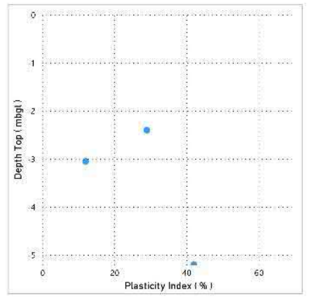
(3) Shear Strength Cu data from triaxial testing are plotted from the results of undisturbed samples as there were no results from triaxial tests undertaken on re moulded samples.

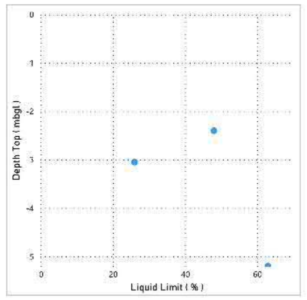
(4) The Geology Code 3 Key does not apply to the either the 2.5 and 4.5 compaction plots, CBR plots, PSD plot or the A-line plot.

(5) All test results shown are from material tested without added stabiliser.







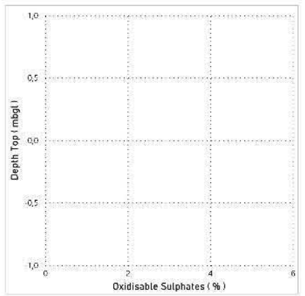


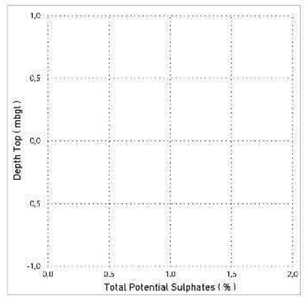
Asset Specific Geotechnical Classification Testing

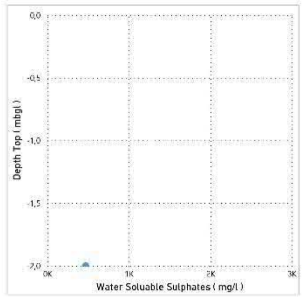
Test	Count	Minimum	Maximum	Average	Standard deviation
Liquid Limit (%)	3	26,00	63,00	45,67	15,20
Moisture Content (%)	8	11,30	26,40	18,90	5,10
Plastic Limit (%)	3	14,00	21,00	18,00	2,94
Plasticity Index (%)	3	12,00	42,00	27,67	12,28

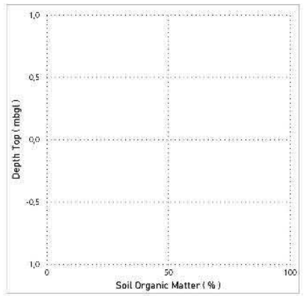
Route Wide Geology Code 3 Geotechnical Classification Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Liquid Limit (%)	3	26,00	63,00	45,67	15,20
Moisture Content (%)	8	11,30	26,40	18,90	5,10
Plastic Limit (%)	3	14,00	21,00	18,00	2,94
Plasticity Index (%)	3	12,00	42,00	27,67	12,28









Asset Specific Geochemistry Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Water Soluble Sulphates (mg/l)	1	470,00	470,00	470,00	0,00

Route Wide Geology Code 3 Geochemistry Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Water Soluble Sulphates (mg/l)	1	470,00	470,00	470,00	0,00

Data Source

Data Source	Description
Asset chainages	PMA updated chainages 20190307
C2 Data	C2-v2.0 C2 Combined DataDrop04
C3 Data	C3-v2.0 C3 Combined DataDrop04
Track Elevation & EGL	PMA13 Elevation Comparison

Weathering Class Description

Unified Classification	Weathering class description	Reported Classes in AGS data
0	Unweathered	0, A, I
1	Slightly weathered	1, A/B, B, II
2	Moderately weathered (<50%)	2, B/C, C, III
3	Highly weathered (>50%)	3, C/D, D, IV
4	Completely weathered	4, D/E
5	Residual soil	5, E

EKFB Working in partnership with HS2

Earthworks - Geotechnical Design Report, Geotechnical Parameter Plots for Earthwork Classification – Cohesive Soil

A High-Speed Design Partnership
ARCADIS COWI

Level 1 Asset Group
Twyford Embankment
*CTRL +Click to multi select from above filter

Geology Code 3
KLB-C Z

Data Drop
Tout

Material in Zone of Reuse
Tout

Weathering Classification
Tout
*CTRL+Click to multi select from above filter

Chainage Range
77759 83973

Offset Range
-994 1508

Depth Top Range
-80,93 -0,05

Reset Filters

Report Date
vendredi, février 19, 2021

Compaction Data 2.5Kg

Parameter	Average

Compaction Data 4.5Kg

Parameter	Average

Compaction Data 2.5Kg

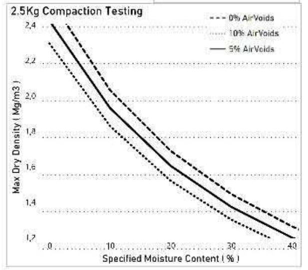
Parameter	Average
Dry Density Max (Mg/m3)	1,76
Moisture Content Optimum (%)	17,44

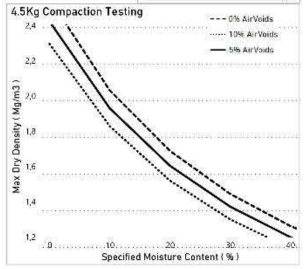
Compaction Data 4.5Kg

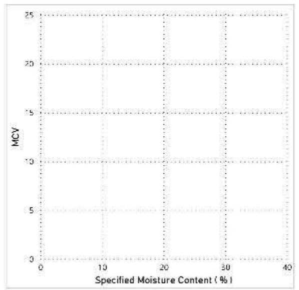
Parameter	Average
Dry Density Max (Mg/m3)	1,76

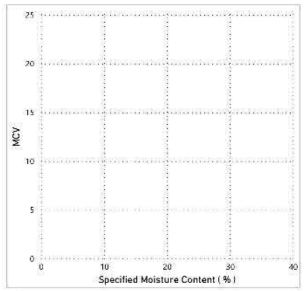
Air Voids Lines 2.5Kg Hammer - Particle Density
2,55

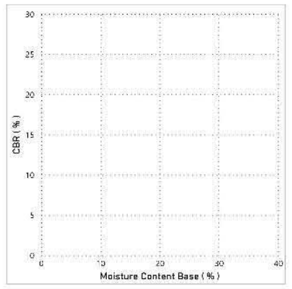
Air Voids Line 4.5kg Hammer - Particle Density
2,55

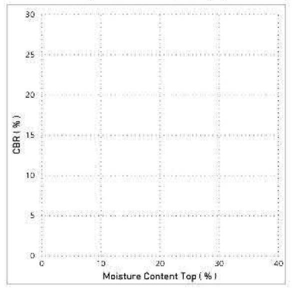


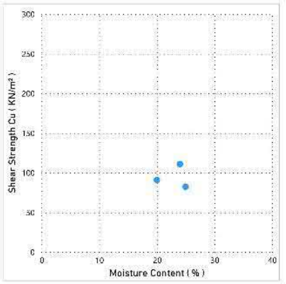


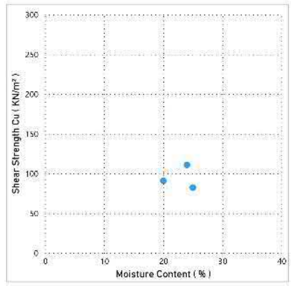


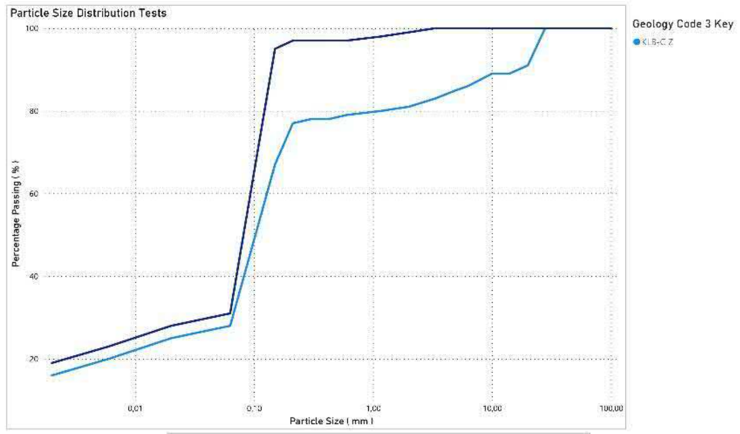


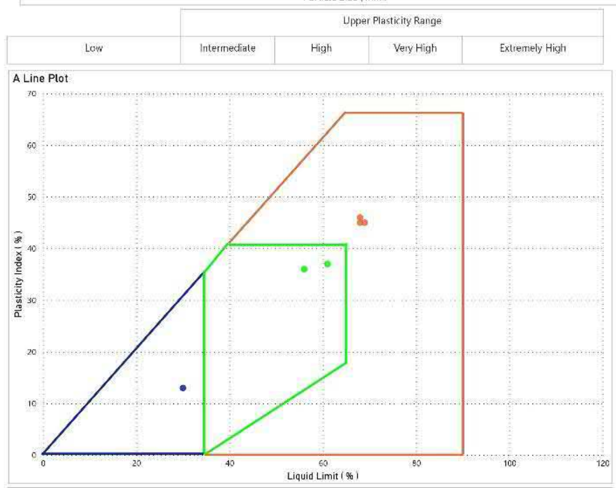












The presented acceptability range of fine grained fill materials on the A-Line plot are taken from Figure 4.3/1 in the Technical Standard – Earthworks (HS2-HS2-GT-STD-000-000001). The specific acceptability ranges for fill materials will be refined through Detailed Design.

Legend	Earthworks Classification	Count	% Count
(green)	May be suitable for HS2 Mainline Earthworks if treated	2	33,33%
(blue)	Suitable for use as General Fill in Offline Works and HS2 Mainline Lower Embankment	1	16,67%
(orange)	Suitable for use as Offline Fill but Excluding from HS2 Mainline Earthwork	3	50,00%

Notes:

(1) The Air Void Lines applied to the Compaction Plots need to be assigned using the Particle Density filter. The value to be used is dependent on the mean Particle Density value shown in the associated summary compaction results table based on the defined filters.

(2) Material in Zone of Reuse is considered based on the following criteria:

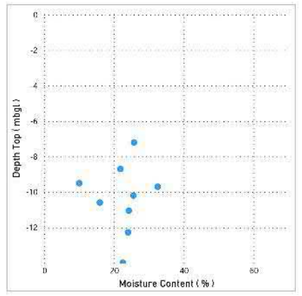
(a) Exploratory holes within 50m of the proposed track centreline.

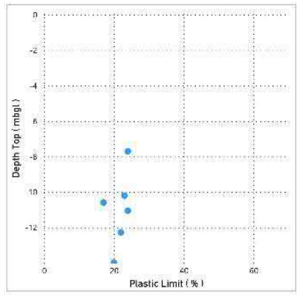
(b) The material tested is taken from samples from depths up to 3m below design level in cuttings or 3 below ground level in Embankments of at least 3m in height.

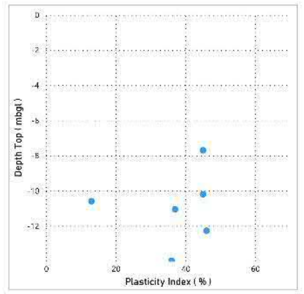
(3) Shear Strength Cu data from triaxial testing are plotted from the results of undisturbed samples as there were no results from triaxial tests undertaken on re-moulded samples.

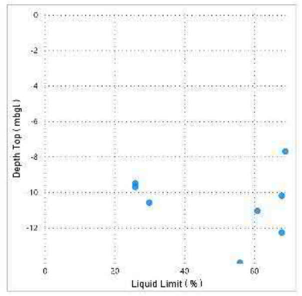
(4) The Geology Code 3 Key does not apply to the either the 2.5 and 4.5 compaction plots, CBR plots, PSD plot or the A-line plot.

(5) All test results shown are from material tested without added stabiliser.







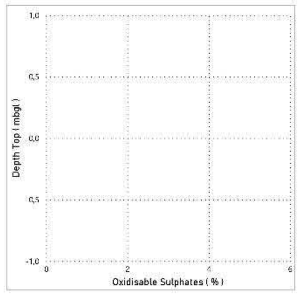


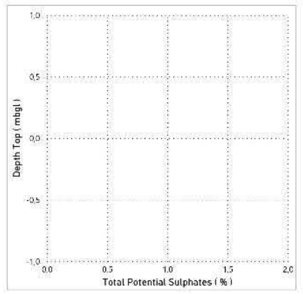
Asset Specific Geotechnical Classification Testing

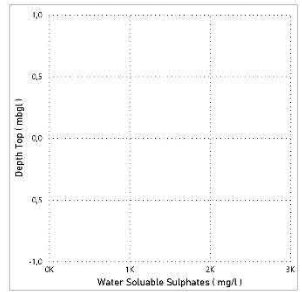
Test	Count	Minimum	Maximum	Average	Standard deviation
Liquid Limit (%)	8	26,00	69,00	50,50	18,43
Moisture Content (%)	15	9,97	32,50	23,34	5,00
Plastic Limit (%)	6	17,00	24,00	21,67	2,49
Plasticity Index (%)	6	13,00	46,00	37,00	11,45

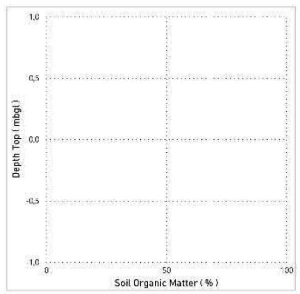
Route Wide Geology Code 3 Geotechnical Classification Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Liquid Limit (%)	12	26,00	69,00	46,00	13,16
Moisture Content (%)	25	9,97	32,50	22,39	4,74
Plastic Limit (%)	7	17,00	29,00	22,71	3,45
Plasticity Index (%)	7	13,00	46,00	37,14	10,60









Asset Specific Geochemistry Testing

Test	Count	Minimum	Maximum	Average	Standard deviation

Route Wide Geology Code 3 Geochemistry Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Oxidisable Sulphates (%)	3	1,68	8,22	4,88	2,67
Total Potential Sulphates (%)	3	1,95	9,72	5,55	3,20
Water Soluble Sulphates (mg/l)	3	20,00	870,00	436,67	347,21

Data Source

Data Source	Description
Asset chainages	PMA updated chainages 20190307
C2 Data	C2 v2.0 C2 Combined DataDrop04
C3 Data	C3 v2.0 C3 Combined DataDrop04
Track Elevation & ECL	PMA13 Elevation Comparison

Weathering Class Description

Unified Classification	Weathering class description	Reported Classes in AGS data
0	Unweathered	0, A, I
1	Slightly weathered	1, A/B, B, II
2	Moderately weathered (<50%)	2, B/C, C, III
3	Highly weathered (>50%)	3, C/D, D, IV
4	Completely weathered	4, D/E
5	Residual soil	5, E

EKFB Working in partnership with HS2

Earthworks - Geotechnical Design Report, Geotechnical Parameter Plots for Earthwork Classification – Cohesive Soil

asc A High-Speed Design Partnership ARCADIS COWI

Level 1 Asset Group
Tout
CTRL +Click to multi select from above filter

Geology Code 3
OXC-C Z

Data Drop
Tout

Material in Zone of Reuse
Tout

Weathering Classification
Tout
CTRL+Click to multi select from above filter

Chainage Range
71800 82289

Offset Range
-994 1508

Depth Top Range
-80,93 -0,05

Reset Filters

Report Date
vendredi, février 19, 2021

Compaction Data 2.5Kg

Parameter	Average
Dry Density Max (Mg/m3)	1,48
Moisture Content Optimum (%)	27,00
Particle Density (Mg/m3)	2,68
Proportion retained on 20mm sieve (%)	0,00
Proportion retained on 37.5mm sieve (%)	0,00

Compaction Data 4.5Kg

Parameter	Average
Dry Density Max (Mg/m3)	1,59
Moisture Content Optimum (%)	23,47
Particle Density (Mg/m3)	2,66
Proportion retained on 20mm sieve (%)	0,07
Proportion retained on 37.5mm sieve (%)	0,08

Compaction Data 2.5Kg

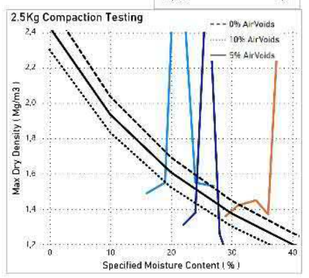
Parameter	Average
Dry Density Max (Mg/m3)	1,76
Moisture Content Optimum (%)	17,44

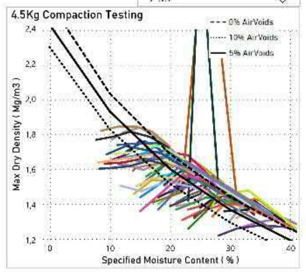
Compaction Data 4.5Kg

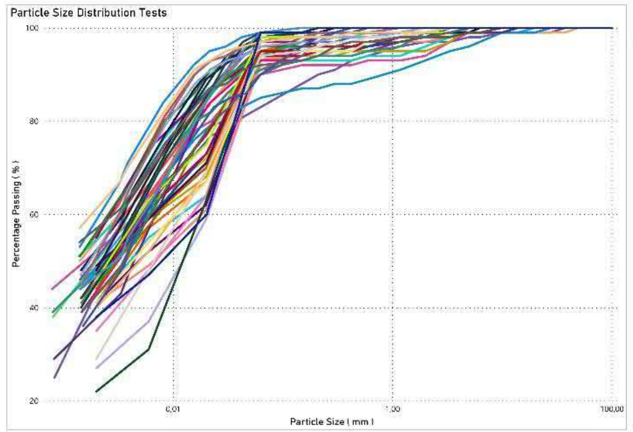
Parameter	Average
Dry Density Max (Mg/m3)	1,76

Air Voids Lines 2.5Kg Hammer - Particle Density
2,55

Air Voids Line 4.5kg Hammer - Particle Density
2,55



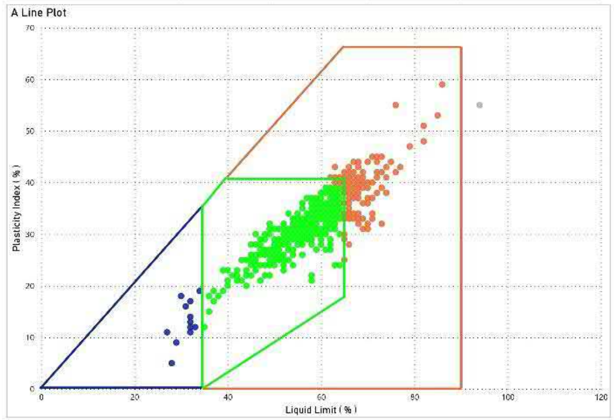




Geology Code 3 Key
OXC-C Z

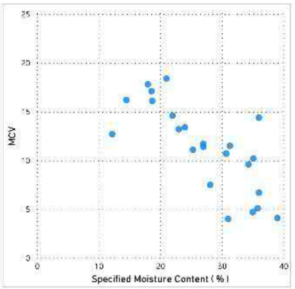
Upper Plasticity Range

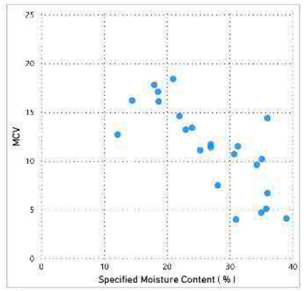
Low	Intermediate	High	Very High	Extremely High

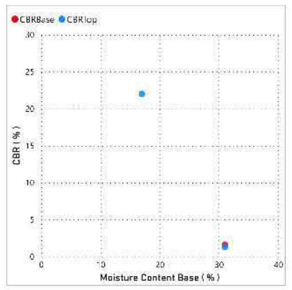


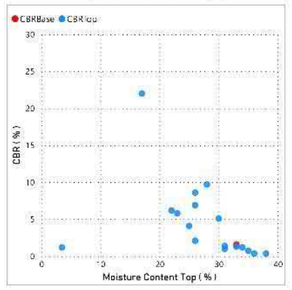
The presented acceptability range of fine grained fill materials on the A-Line plot are taken from Figure 4.3/1 in the Technical Standard – Earthworks (HS2-HS2-GT-STD-000-000001). The specific acceptability ranges for fill materials will be refined through Detailed Design.

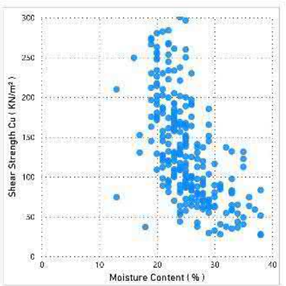
Legend	Earthworks Classification	Count	% Count
(green)	May be suitable for HS2 Mainline Earthworks if treated	403	68,65%
(blue)	Suitable for use as General Fill in Offline Works and HS2 Mainline Lower Embankment	14	2,39%
(grey)	Outside Named Zones	1	0,17%
(orange)	Suitable for use as Offline Fill but Excluding from HS2 Mainline Earthwork	169	28,79%

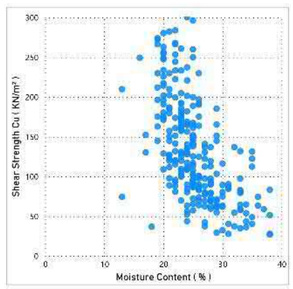












Notes:

(1) The Air Void Lines applied to the Compaction Plots need to be assigned using the Particle Density filter. The value to be used is dependent on the mean Particle Density value shown in the associated summary compaction results table based on the defined filters.

(2) Material in Zone of Reuse is considered based on the following criteria:

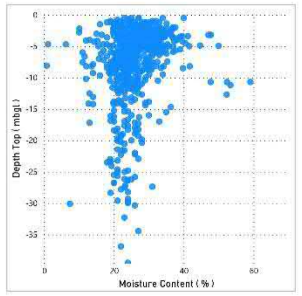
(a) Exploratory holes within 50m of the proposed track centreline.

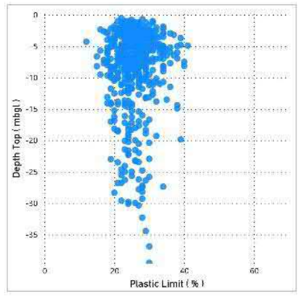
(b) The material tested is taken from samples from depths up to 3m below design level in cuttings or 3 below ground level in Embankments of at least 3m in height.

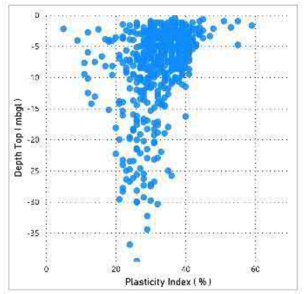
(3) Shear Strength Cu data from triaxial testing are plotted from the results of undisturbed samples as there were no results from triaxial tests undertaken on re-moulded samples.

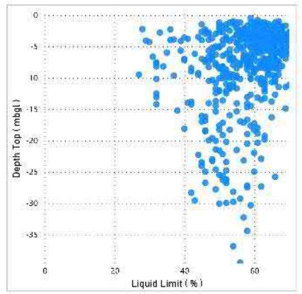
(4) The Geology Code 3 Key does not apply to the either the 2.5 and 4.5 compaction plots, CBR plots, PSD plot or the A-line plot.

(5) All test results shown are from material tested without added stabiliser.







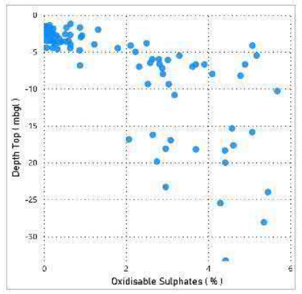


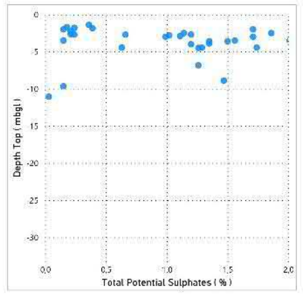
Asset Specific Geotechnical Classification Testing

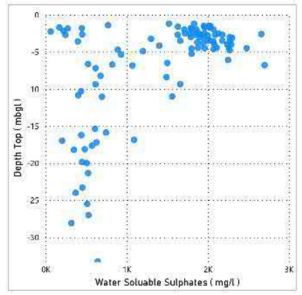
Test	Count	Minimum	Maximum	Average	Standard deviation
Liquid Limit (%)	588	27,00	94,00	58,38	9,25
Moisture Content (%)	1140	0,71	313,00	26,20	10,55
Plastic Limit (%)	587	12,00	41,00	25,92	4,51
Plasticity Index (%)	587	5,00	59,00	32,47	6,76

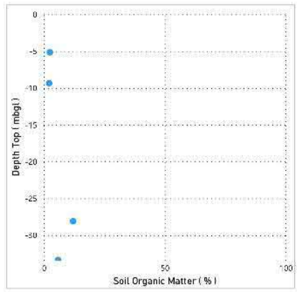
Route Wide Geology Code 3 Geotechnical Classification Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Liquid Limit (%)	588	27,00	94,00	58,38	9,25
Moisture Content (%)	1140	0,71	313,00	26,20	10,55
Plastic Limit (%)	587	12,00	41,00	25,92	4,51
Plasticity Index (%)	587	5,00	59,00	32,47	6,76









Asset Specific Geochemistry Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Oxidisable Sulphates (%)	114	-0,72	19,00	2,07	2,75
Soil Organic Matter (%)	4	2,20	12,10	5,68	3,98
Total Potential Sulphates (%)	171	0,03	24,36	4,38	3,16
Water Soluble Sulphates (mg/l)	99	62,00	2 700,00	1 399,42	737,95

Route Wide Geology Code 3 Geochemistry Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Oxidisable Sulphates (%)	114	-0,72	19,00	2,07	2,75
Soil Organic Matter (%)	4	2,20	12,10	5,68	3,98
Total Potential Sulphates (%)	171	0,03	24,36	4,38	3,16
Water Soluble Sulphates (mg/l)	99	62,00	2 700,00	1 399,42	737,95

Data Source

Data Source	Description
Asset chainages	PMA updated chainages 20190307
C2 Data	C2 v2.0 C2 Combined DataDrop04
C3 Data	C3 v2.0 C3 Combined DataDrop04
Track Elevation & ECL	PMA13 Elevation Comparison

Weathering Class Description

Unified Classification	Weathering class description	Reported Classes in AGS data
0	Unweathered	0, A, I
1	Slightly weathered	1, A/B, B, II
2	Moderately weathered (<50%)	2, B/C, C, III
3	Highly weathered (>50%)	3, C/D, D, IV
4	Completely weathered	4, D/E
5	Residual soil	5, E

EKFB Working in partnership with HS2

Earthworks - Geotechnical Design Report, Geotechnical Parameter Plots for Earthwork Classification – Cohesive Soil

A High-Speed Design Partnership ARCADIS setec COWI

Level 1 Asset Group: Tout

*CTRL+Click to multi select from above filter

Geology Code 3: ALV-C Z

Data Drop: Tout

Material in Zone of Reuse: Tout

Weathering Classification: Tout

*CTRL+Click to multi select from above filter

Chainage Range: 71800 – 82289

Offset Range: -994 – 1508

Depth Top Range: -80,93 – -0,05

Reset Filters

Report Date: vendredi, février 19, 2021

Compaction Data 2.5Kg

Parameter	Average

Compaction Data 4.5Kg

Parameter	Average
Dry Density Max (Mg/m3)	1,80
Moisture Content Optimum (%)	16,49
Particle Density (Mg/m3)	2,64
Proportion retained on 20mm sieve (%)	0,31
Proportion retained on 37.5mm sieve (%)	1,26

Compaction Data 2.5Kg

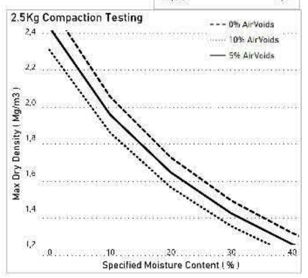
Parameter	Average
Dry Density Max (Mg/m3)	1,76
Moisture Content Optimum (%)	17,44

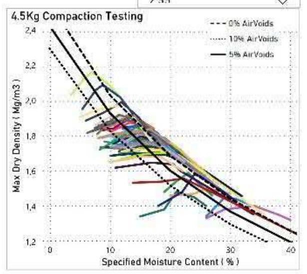
Compaction Data 4.5Kg

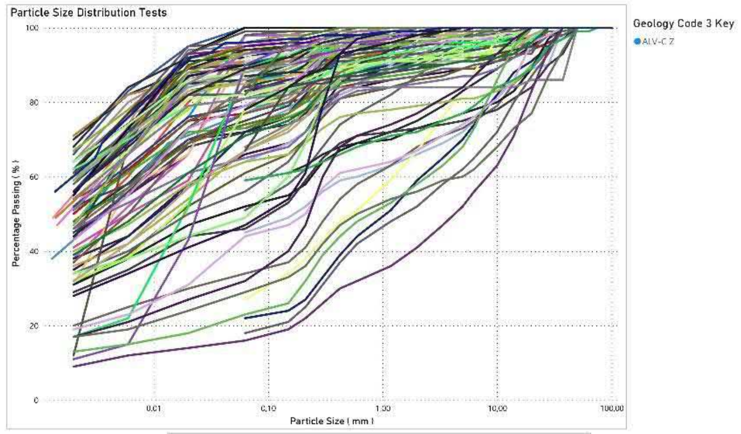
Parameter	Average
Dry Density Max (Mg/m3)	1,76

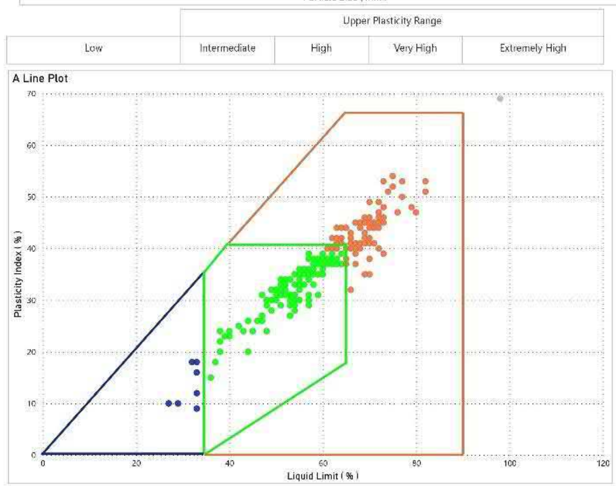
Air Voids Lines 2.5Kg Hammer - Particle Density: 2,55

Air Voids Line 4.5kg Hammer - Particle Density: 2,55









The presented acceptability range of fine grained fill materials on the A-Line plot are taken from Figure 4.3/1 in the Technical Standard – Earthworks (HS2-HS2-GT-STD-000-000001). The specific acceptability ranges for fill materials will be refined through Detailed Design.

Legend	Earthworks Classification	Count	% Count
(green)	May be suitable for HS2 Mainline Earthworks if treated	123	56,42%
(blue)	Suitable for use as General Fill in Offline Works and HS2 Mainline Lower Embankment	8	3,67%
(grey)	Outside Named Zones	1	0,46%
(orange)	Suitable for use as Offline Fill but Excluding from HS2 Mainline Earthwork	86	39,45%

Notes:

(1) The Air Void Lines applied to the Compaction Plots need to be assigned using the Particle Density filter. The value to be used is dependent on the mean Particle Density value shown in the associated summary compaction results table based on the defined filters.

(2) Material in Zone of Reuse is considered based on the following criteria:

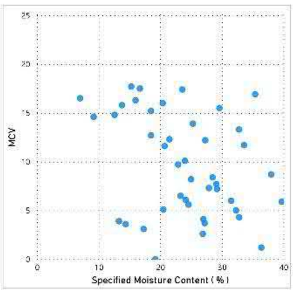
(a) Exploratory holes within 50m of the proposed track centreline.

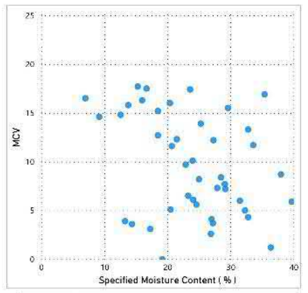
(b) The material tested is taken from samples from depths up to 3m below design level in cuttings or 3 below ground level in Embankments of at least 3m in height.

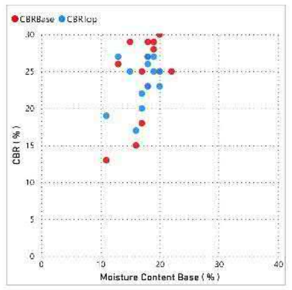
(3) Shear Strength Cu data from triaxial testing are plotted from the results of undisturbed samples as there were no results from triaxial tests undertaken on re-moulded samples.

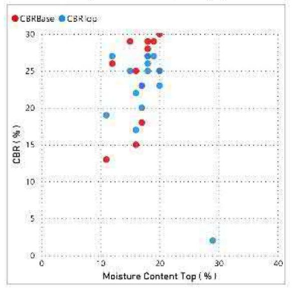
(4) The Geology Code 3 Key does not apply to the either the 2.5 and 4.5 compaction plots, CBR plots, PSD plot or the A-line plot.

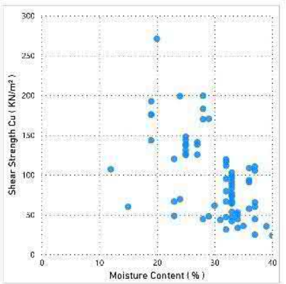
(5) All test results shown are from material tested without added stabiliser.

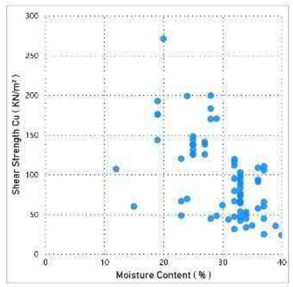


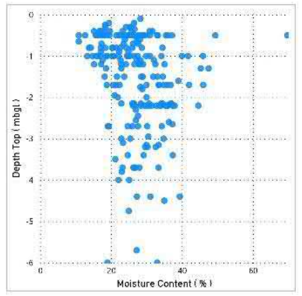


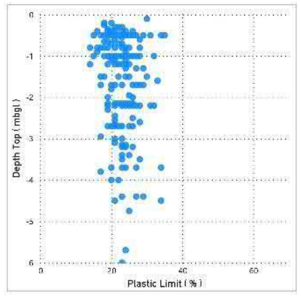


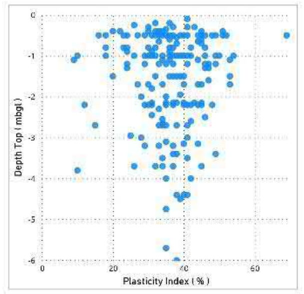


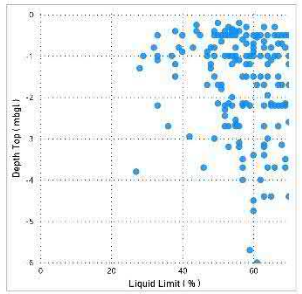










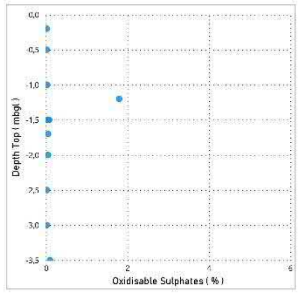


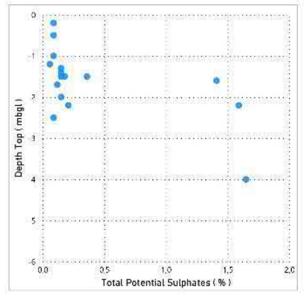
Asset Specific Geotechnical Classification Testing

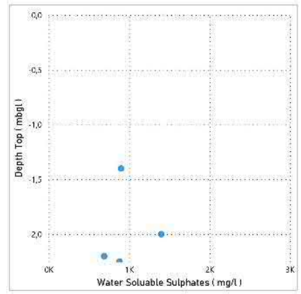
Test	Count	Minimum	Maximum	Average	Standard deviation
Liquid Limit (%)	220	27,00	98,00	58,98	11,10
Moisture Content (%)	350	10,90	72,00	29,13	8,43
Plastic Limit (%)	218	14,00	35,00	22,89	3,88
Plasticity Index (%)	218	9,00	69,00	36,28	8,56

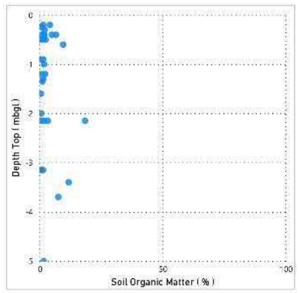
Route Wide Geology Code 3 Geotechnical Classification Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Liquid Limit (%)	220	27,00	98,00	58,98	11,10
Moisture Content (%)	350	10,90	72,00	29,13	8,43
Plastic Limit (%)	218	14,00	35,00	22,89	3,88
Plasticity Index (%)	218	9,00	69,00	36,28	8,56









Asset Specific Geochemistry Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Oxidisable Sulphates (%)	13	-0,20	1,80	0,15	0,48
Soil Organic Matter (%)	31	0,10	18,40	3,05	3,92
Total Potential Sulphates (%)	53	0,06	12,96	4,33	3,46
Water Soluble Sulphates (mg/l)	4	690,00	1 400,00	967,50	262,81

Route Wide Geology Code 3 Geochemistry Testing

Test	Count	Minimum	Maximum	Average	Standard deviation
Oxidisable Sulphates (%)	13	-0,20	1,80	0,15	0,48
Soil Organic Matter (%)	31	0,10	18,40	3,05	3,92
Total Potential Sulphates (%)	53	0,06	12,96	4,33	3,46
Water Soluble Sulphates (mg/l)	4	690,00	1 400,00	967,50	262,81

Data Source

Data Source	Description
Asset chainages	PMA updated chainages 20190307
C2 Data	C2 v2.0 C2 Combined DataDrop04
C3 Data	C3 v2.0 C3 Combined DataDrop04
Track Elevation & ECL	PMA13 Elevation Comparison

Weathering Class Description

Unified Classification	Weathering class description	Reported Classes in AGS data
0	Unweathered	0, A, I
1	Slightly weathered	1, A/B, B, II
2	Moderately weathered (<50%)	2, B/C, C, III
3	Highly weathered (>50%)	3, C/D, D, IV
4	Completely weathered	4, D/E
5	Residual soil	5, E