# SPECIFICATION FOR CIVIL ENGINEERING WORKS

# Series 0600: Earthworks

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# SERIES 600
# EARTHWORKS

**Contents**

# EARTHWORKS

## 601 Classification, Definitions and Uses of Earthworks Materials

### General

**0** This Series is part of the Specification for Civil Engineering Works. Whilst this Series is particularly relevant to the subject matter in its title it must be read in conjunction with the general requirements in Series 000 and 100 and with all other Series relevant to the specification for the particular works to be undertaken.

### General Classification

**1** Earthworks materials shall fall into one or other of the following general classifications:

(i) acceptable material: material excavated from within the site or imported on to the site which meets the requirements of Table 6/1 and contract specific Appendix 6/1 for acceptability for use in the permanent works;

(ii) unacceptable material Class U1A as defined in sub-Clauses 2(i)(a) and 2(i)(b) of this Clause: material excavated from within the site which, unless processed so that it meets the requirements of Table 6/1 and contract specific Appendix 6/1, shall not be used in the permanent works;

(iii) unacceptable material Class U1B as defined in sub-Clause 2(ii)(a) of this Clause: material excavated from within the site which, unless processed so that it meets the requirements of Table 6/1 and contract specific Appendix 6/1, shall not be used in the permanent works; and

(iv) unacceptable material Class U2 as defined in sub-Clause 3(i) of this Clause: material excavated from within the site which shall not be used in the permanent works.

### Unacceptable Materials

**2** Unacceptable material Classes U1A and U1B:

(i) unacceptable material Class U1A shall be:

(a) material which does not comply with the permitted constituents and material properties of Table 6/1 and contract specific Appendix 6/1 for acceptable material; and

(b) material, or constituents of materials, composed of the following unless otherwise described in contract specific Appendix 6/1:

- peat, materials from swamps, marshes and bogs;
- logs, stumps and perishable material;
- materials in a frozen condition;
- clay having a liquid limit determined in accordance with BS 1377: Part 2, exceeding 90 or plasticity index determined in accordance with BS 1377: Part 2, exceeding 65;
- material susceptible to spontaneous combustion except unburnt colliery spoil complying with sub-Clause 15 of this Clause;
- unacceptable plasticity requirements for High Speed Rail (HSR) earthworks are defined in the HS2 Technical Standard – Earthworks (HS2-HS2-GT-STD-000-000001).

(ii) unacceptable material Class U1B shall be contaminated materials, whose level of contamination is above that given either in contract specific Appendix 6/14 or in contract specific Appendix 6/15, including:

(a) controlled wastes (as defined in the Environmental Protection Act 1990 Part IIA);

(b) hazardous wastes (as defined in the Hazardous Waste (England and Wales) Regulations 2005.

**3** Unacceptable material Class U2 shall be:

(i) radioactive waste (as defined in the Radioactive Substances Act 1993).

**4** Tar-bound asphaltic material shall be classed as U1B and, unless proven by testing to be safe and suitable for use, shall be removed from site.

**5** Glass waste is not permitted as a fill material.

**6** Where required in contract specific Appendix 6/1, unacceptable material (other than Class U2) shall be processed by mechanical, chemical or other means to render the material acceptable for use in the permanent works in accordance with the requirements of Table 6/1 and contract specific Appendix 6/1.

**7** Not used.

**Definitions**

**8** HSR earthworks definitions are presented in Section 2 of the Technical Standard – Earthworks (HS2-HS2-GT-STD-000-000001). In this specification the term 'HSR earthworks' shall refer to earthworks cases EW1, EW2, EW4, EW5 and EW7 in Table 2.2/2 of HS2-HS2-GT-STD-000-000001. Upper Embankment Fill (UEF) and Lower Embankment Fill (LEF) are defined in Table 4.2/2 of HS2-HS2-GT-STD-000-000001. The term Environmental Mitigation Earthworks defined in HS2-HS2-GT-STD-000-000001 is comparable with the term Earthwork Environmental Bunds used in this specification. HSR Protection Layer – this is the lowest track bed layer and must not be confused with temporary sacrificial protection layer, used sacrificially to protect earthworks. Topsoil and subsoil (where used for the reinstatement of land for agriculture, landscape planting, seeding, ecology or woodland) are defined in Technical Standard – Soil Handling for Land Reinstatement (HS2-HS2-EV-STD-000-000008).

**9** Where source codes are referred to these shall be for materials from the sources listed in Table 6/7.

**10** Chalk shall mean:

(i) any porous material of natural origin composed essentially of calcium carbonate and identified as chalk on the maps produced by the British Geological Survey;

(ii) material designated as Class 3 in contract specific Appendix 6/1.

**11** Argillaceous rock shall mean shales mudstones siltstones slates and micaceous schists composed of particles of clay and silt and mica. It shall include unburnt colliery spoil. Where argillaceous rock is imported onto the site, it shall be aggregate complying with BS EN 13242 from source codes P (natural aggregates described as shale, siltstone or slate), or G2 (refuse from hard coal mining (black coal shale)). For HSR earthworks use, argillaceous rock (as Class 1 or Class 6) shall only include volumetrically stable, indurated and durable material, see Clause 4.3.8 in HS2-HS2-GT-STD-000-000001. Unburnt colliery spoil shall not be used in HSR earthworks.

**12** Pulverised-fuel ash shall mean solid material extracted by electrostatic and mechanical means from the flue gases of furnaces fired with pulverised bituminous coal. It shall have a maximum particle size of 3 mm. Where pulverised-fuel ash is imported onto the site, it shall be aggregate complying with BS EN 13242 from source code C1 (coal fly ash).

**13** Furnace bottom ash shall mean agglomerated pulverised-fuel ash obtained from the bottom of the power station furnace and having particle size no larger than 10 mm. Where furnace bottom ash is imported onto the site, it shall be aggregate complying with BS EN 13242 from source code C4 (coal bottom ash).

**14** For non-HSR earthworks, Formation shall be the top surface of capping. Where no capping is required formation shall be the top surface of earthworks at the underside of sub-base, unless otherwise shown on the drawings.

**15** For non-HSR earthworks, Sub-formation shall be the top surface of earthworks at the underside of capping.

**16** Stabilisation shall mean the spreading of cement or lime or both on a layer of deposited or intact granular or cohesive material, and the subsequent process of pulverising and mixing followed by appropriate compaction to form the whole or a constituent layer of a capping.

**17** Where 'recycled aggregate' is used in this Series, the material shall be aggregate resulting from the processing of inorganic or mineral material previously used in construction and shall have been tested in accordance with Clause 710. It shall not contain more than 1% other materials (Class X), not more than 50% in Class Ra (bituminous materials) and not more than 25% in Class Rg (crushed glass). Where 'recycled aggregate' is imported onto the site, it shall be aggregate complying with BS EN 13242 from source code A (construction and demolition recycling industries).

Where 'recycled aggregate except recycled asphalt' is used in this Series, the aggregate shall have been tested in accordance with Clause 710. It shall not contain more than 1% other materials (Class X), not more than 1% in Class Ra (bituminous materials) and not more than 5% in Class Rg (crushed glass). Where 'recycled aggregate except recycled asphalt' is imported onto the site, it shall be aggregate complying with BS EN 13242 from source codes A2 (crushed concrete) and/or A3 (crushed bricks, masonry).

**18** 'As dug' shall mean material that has been excavated, transported and placed without any processing. Where imported material undergoes any processing, including cleaning and sorting, it will not be deemed 'as dug' and thus shall

be aggregate complying with BS EN 13242.

**Use of Fill Materials**

**19** In addition to any grading requirements the maximum particle size of any fill material shall be no more than two-thirds of the compacted layer thickness except:

(i) for Class 3 materials where it has been demonstrated to the satisfaction of the Contractor's Engineering Director by compaction trials that larger particle sizes do not prevent the required compaction from being achieved; or

(ii) that cobbles having an equivalent diameter of more than 150 mm shall not be deposited beneath verges or central reserves in highways within 1.30 m, or other distance described in contract specific Appendix 6/3, of the finished surface.

**20** Material shall not be deposited within 500mm, or other distances described in the contract specific Appendix 6/3, of concrete, cement bound materials, other cementitious materials or stabilised capping forming part of the Permanent Works if, when tested in accordance with TRL Report 447 (or equivalent test in accordance with BRE Special Digest 1) either:

(i) the water-soluble sulfate (WS) content exceeds 1500 mg of sulfate (as SO4) per litre (Test No.1); or

(ii) the oxidisable sulfides (OS) content exceeds 0.5 % of sulfate (as SO4) (Test No. 2 and Test No. 4); or

(iii) unless otherwise specified in Table 6/1 or Table 6/3, the 2:1 water to soil extract prepared for the determination of water-soluble sulfate in (i) has a pH value of less than 7.2, when tested using the electrometric method of pH determination in accordance with BS 1377-3.

When determining these parameters, at least five samples of each material shall be tested. The mean of the highest two values shall be used for comparison with the limiting values. This shall also apply if six to nine results are available. If ten or more results are available, the mean of the highest 20% of the results shall be used for comparison with the limiting values.

**21** Material shall not be deposited within 500mm, or other distances described in the contract specific Appendix 6/3, of metallic structural elements forming part of the Permanent Works if, when tested in accordance with TRL Report 447 (or equivalent test in accordance with BRE Special Digest 1) either:

(i) the water-soluble sulfate (WS) content exceeds 300 mg of sulfate (as SO4) per litre (Test No.1); or

(ii) the oxidisable sulfides (OS) content exceeds 0.06 % of sulfate (as SO4) (Test Nos. 2 and 4).

When determining these parameters, the mean of the highest two values shall be used for comparison with the limiting values. This shall also apply if six to nine results are available. If ten or more results are available, the mean of the highest 20% of the results shall be used for comparison with the limiting values.

The requirements in (i) and (ii) above shall not apply to metallic items protected by concrete or ancillary metallic items such as the tops of chambers and gullies.

**22** Unburnt colliery spoil may be used as general fill for non-HSR earthworks provided it is compacted in compliance with Clause 612 and complies with the requirements of contract specific Appendix 6/1.

**23** Pulverised-fuel ash shall not be placed within the dimension described in contract specific Appendix 6/3, below sub-formation or formation. Pulverised Fuel Ash shall not be used in earthworks subjected to flood waters, unless protected both from leaching and from erosion.

**24** Where pulverised-fuel ash is used, the Contractor shall for each consignment, provide within the project records the type and source from which it was obtained and a certificate of results of tests showing that the material complies with the requirements of Table 6/1.

## 602 General Requirements

**1** The Contractor shall employ only plant and working methods which are suited to the materials to be handled and traversed. He shall be responsible for maintaining the nature of the acceptable material so that when it is placed and compacted it remains acceptable in accordance with the contract. Acceptability shall be determined in accordance with Table 6/1 and any special contract specific requirements in Appendix 6/1.

**2** Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition to ensure compliance with Clause 612.

**3** No excavated acceptable material or unacceptable material required to be processed, other than surplus to the

requirements of the contract, shall be removed from the site unless indicated otherwise in contract specific Appendix 6/1. Material which is unacceptable only by reason of being frozen shall be retained on site when in that condition. Where the Contractor is permitted to remove acceptable material, or unacceptable material required to be processed, from the site to suit his operational procedure, then he shall make good any consequent deficit of material arising therefrom. Environmental requirements for processing of Class U1B material, in terms of limiting values of contaminants or other requirements, shall be set out in contract specific Appendix 6/1 in the earthworks Class for which the processed material is to be used.

**4** If any acceptable material or unacceptable material required to be processed is, where permitted by contract specific Appendix 6/1, used by the Contractor for purposes other than for general fill, sufficient acceptable fill material to occupy, after full compaction, a volume corresponding to that which the excavated material occupied shall be provided by the Contractor.

**5** Acceptable material (other than Class 5A or any Class 5B material replacing Class 5A material in accordance with sub-Clause 3 of this Clause) surplus to the total requirements of the permanent works and all unacceptable material Class U1A not required to be processed shall, unless indicated otherwise in contract specific Appendix 6/1, be run to spoil in tips provided by the Contractor. Class U1A and U1B materials not otherwise classified as surplus or waste may be used in mitigation earthworks, where safe and suitable. In the case of unacceptable material, Class U1B deemed not safe and suitable and Class U2, the Contractor shall submit its proposals to the Contractor's Engineering Director and the Project Manager for excavation, treatment, and, if required off-site transportation and disposal including details of all relevant permits, licences, authorisations or notifications required for the proposed works and shall comply with any specific requirements for disposal described in contract specific Appendix 6/2.

**6** All materials for re-use must be demonstrably suitable as detailed in the CL:AIRE Code of Practice (2011) or appropriate environmental permitting scheme and must not give rise to an unacceptable risk to controlled waters and the wider environment, which includes human health.

**7** Where the excavation reveals a combination of acceptable and unacceptable materials the Contractor shall, unless indicated otherwise in contract specific Appendix 6/3, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. Unless otherwise described in the contract classes of fill material required to be deposited separately shall be excavated separately without contamination by other Classes of material.

**8** The Contractor shall make his own arrangements for stockpiling of acceptable material, and unacceptable material to be processed, and for the provision of sites for the purpose.

**9** The Contractor shall ensure that he does not adversely affect the stability of excavations or fills by his methods of stockpiling materials, use of plant or siting of temporary buildings or structures.

**10** Existing topsoil and subsoil material shall be stripped in accordance with the relevant Soil Resource Plan or Soil Management Plan. All areas to be covered by Structural Earthworks (see HS2-HS2-GT-STD-000-000001 for definition) shall be stripped of topsoil. Where stated in contract specific Appendix 6/8 existing topsoil shall be stripped as turf in accordance with sub- Clause 3005.13.

**11** Topsoil and subsoil shall be handled in accordance with Series 3100.

**12** All Class 5A topsoil arising from the site, or any Class 5B material replacing Class 5A material in accordance with sub-Clause 3 of this Clause, in excess of the requirements for topsoiling, shall be subject to the requirements described in the relevant Soil Resource Plan or Soil Management Plan.

**13** Excavations for foundations and trenches shall be adequately supported at all times, and except where otherwise described in contract specific Appendix 6/3, shall not be battered. Where excavations are permitted to be battered they shall be benched as described in contract specific Appendix 6/3 prior to backfilling and compaction. The additional work and materials shall be provided by the Contractor. Sheeting and other excavation supports shall be removed as filling proceeds except where they are required in contract specific Appendix 6/3 to be left in position.

**14** Excavations requiring backfilling shall remain open only for the minimum period necessary.

**15** Excavations requiring backfilling in existing paved or other surfaces, including those paved areas to be reconstructed or repaired, shall be carried out and reinstated in compliance with Clause 706.

**16** The Contractor shall keep earthworks free of water including:

(i) arranging for the rapid removal of water:

(a) shed on to the earthworks;

(b) entering the earthworks from any source;

(ii) lowering and maintaining by appropriate measures, the water level in excavations, sufficiently to enable the permanent works to be constructed.

**17** In carrying out the requirements of sub-Clause 15 of this Clause the Contractor shall:

(i) form and maintain cuttings, embankments and other areas of fill with appropriate falls and gradient and sealed surfaces;

(ii) provide where necessary temporary watercourses, drains, pumping and the like;

(iii) discharge accumulated water and groundwater into the permanent outfalls of the drainage system where practicable;

(iv) provide adequate means for trapping silt on temporary systems discharging into permanent drainage systems.

**18** The Contractor shall carry out and maintain any groundwater lowering or other treatment required in contract specific Appendices 6/1 or 6/13.

**19** Where materials fall into either Class U1B or Class U2, the Contractor shall carry out any special requirements for their handling described in contract specific Appendix 6/2. Where such materials are encountered during the progress of the works, the Contractor shall make all necessary arrangements for their safe handling and disposal after consultation with the appropriate environmental authority.

**20** (P06) Subject to the surface level tolerances given in Clause 613 and sub-Clause 616.1, material shall not be frost susceptible if it is used within 450 mm of the designed final surface of a road or paved central reserve~~, or railway~~, or 350 mm if the annual frost index of the site is less than 50. Material shall be classified as non-frost-susceptible if the mean heave is 15 mm or less, when tested in accordance with BS 812: Part 124 or BS 1924: Part 2 for lime stabilised capping, amended as given in sub-Clause 801.7. ~~For HSR earthworks use, non-frost susceptible means heave is 5mm or less when tested in accordance with this clause.~~

**21** The fill material shall be locally won where possible or imported, with properties complying with the requirements of the following clauses:

a. The Contractor is responsible for determination of acceptability and classification of materials at source and is responsible for preventing any deterioration of condition in transport and deposition. Contract specific Appendix 1/5 lists the required tests.

b. The classification and confirmation of acceptability of the earthwork materials shall be carried out by the Contractor. The classification shall include all materials excavated on site, imported general fill and other imported materials.

c. Classification testing shall be carried out by the Contractor at the source of all materials. Acceptability testing results carried out at the point of placement should include details of chainage and height of embankment (if appropriate).

d. The Contractor shall make all test results and summaries available electronically for viewing, filtering/queries, printout on an open access database within one working day of the completion of the test. All original test sheets shall be filed in the site laboratory after signing in accordance with UKAS requirements.

e. If, in the opinion of the Contractor's Engineering Director, it is considered that any material has altered its classification for whatever reason, the classification and acceptability tests required in Clause 601, Table 6/1 and contract specific Appendix 6/1 shall be repeated.

f. Where there is a delay of more than 24 hours between excavation of on-site materials and deposition in areas of fill, or if in the opinion of the Contractor's Engineering Director the material has altered its classification or is unacceptable for whatever reason, the Contractor shall repeat the classification and acceptability tests if required by the Contractor's Engineering Director.

**Site Records**

**22** Complete records of plant, equipment, materials, rig records, instrumentation test results etc. shall be maintained during all earthworks (including ground improvement) operations to enable validation of design and construction.

**23** All records shall be made available to the Contractor's Engineering Director in an agreed electronic format on a weekly basis unless otherwise specified in the contract specific appendices or Works Information.

**24** The Contractor shall maintain site records of the following information relating to the earthworks:

(i) The transfer location for all waste material disposed of from the site;

(ii) The source and classification of each source of any imported fill material;

(iii) For varying sources or classifications; the location within the Works of each fill source or classification, and the dates over which it was placed.

**Dewatering and/or Recharge Systems**

**25** Where there is a risk of fouling of dewatering and/or recharge systems, appropriate maintenance shall be carried out to ensure the bacterial build up will not impact on the dewatering/recharge scheme.

**Additives**

**26** Where additives are required in construction (e.g. certain types of polymers, flocculants, lubricants etc.), substances that degrade to non-contaminating substances shall be utilised.

**Naturally Occurring Contaminants**

**27** Where the disturbance of ground containing naturally occurring substances which could be contaminative is unavoidable, the contractor shall evaluate the need for, and provide where necessary, appropriate pollution control measures.

**Lining Materials**

**28** Lining materials used in pollution prevention measures shall be suitable for the contamination expected and appropriate documentation provided to the Contractor's Engineering Director for acceptance.

**Archaeology**

**29** The Contractor shall identify locations of archaeological excavation and shall ensure that both the performance requirements of the earthworks and any archaeological requirements are satisfied at these locations.

## 603 Forming of Cuttings and Cutting Slopes

**1** Cuttings shall be excavated to the lines and levels described in contract specific Appendix 6/3.

**2** Cutting slopes or toes of cuttings shall only be undercut when required in the contract for trench or other excavations. Such excavations shall be restricted in extent as described in contract specific Appendix 6/3 and where they require backfilling shall remain open only for the minimum period necessary, so as to prevent risk to the permanent works.

**3** Except where otherwise described in contract specific Appendix 6/3, the excavation of cuttings may be halted at any stage providing at least 300 mm of material as a weather protection is left in place above the formation or above the sub-formation, subject to the requirements of Clauses 613 and 616.

**4** Where pre-split blasting is required or permitted in contract specific Appendix 6/3, it shall comply with Clause 607 and any other requirements in contract specific Appendix 6/3. Full details of the methods and arrangements to be adopted shall be made available to the Contractor's Engineering Director and the Project Manager before commencement of drilling operations.

**5** Final faces of cuttings which are not to receive topsoil shall:

(i) wherever possible be left without scars or damage from construction plant; and

(ii) to achieve a natural appearance, when the stratum permits and when pre-split blasting is not adopted, have the face left irregular within tolerances given in contract specific Appendix 6/3; and

(iii) have boulders or other rock fragments that can be moved by hand without tools, removed; and

(iv) where required in contract specific Appendix 6/3 have material that can be blown away by airline hose, having pressures no greater than those stated therein, so removed; and

(v) have adequate access to enable inspection to be carried out to determine the extent of work required by this sub-Clause.

**6** Where required in contract specific Appendix 6/3, faces of cuttings which are not required to receive topsoil shall

have one or more of the following measures carried out as appropriate:

(i) Isolated patches of soft, fragmented and insecure material shall each be excavated to a depth of at least 200 mm unless other depths are stated in contract specific Appendix 6/3 and replaced as soon as practicable with ST2 concrete to Clause 2602 well rammed into the cleaned out void.

(ii) Areas of cutting face requiring their surface to be made stable shall be trimmed back by a nominal 50 mm or other amount required in contract specific Appendix 6/3 and the resulting surface together with an area of any surrounding intact material as detailed in contract specific Appendix 6/3, shall have a suitable cement based grout or sprayed concrete, applied by pressure to form a total nominal thickness of 40 mm unless the required thickness is stated in contract specific Appendix 6/3. Where required in contract specific Appendix 6/3, reinforcement shall be fixed to the surface before application of the concrete or grout. Weep holes using permanent formers shall be constructed to the requirements of contract specific Appendix 6/3 and at the locations described in contract specific Appendix 6/3.

(iii) Soft or insecure material, interlayered with rock shall be excavated to the depth behind the face described in contract specific Appendix 6/3. The resulting cavity shall be filled with ST2 concrete to Clause 2602 or with masonry infill complying with the Series 2400 and provided with weep holes all in accordance with requirements in contract specific Appendix 6/3.

(iv) Netting or other sheet covering as described in contract specific Appendix 6/3 or rock bolts as described in contract specific Appendix 6/10.

**7** Where required in contract specific Appendix 6/3, faces of cuttings which are to receive topsoil shall have one or more of the following measures carried out as appropriate:

(i) Be benched to retain topsoil as described in contract specific Appendix 6/3.

(ii) Be harrowed to a depth of 50 mm. Such harrowing shall be carried out immediately prior to topsoiling, diagonally, at an angle between 5º to 45º to the line of the toe, measured on the plane of the slope.

(iii) Isolated patches of soft, fragmented or insecure material shall be excavated and either:

(a) filled by well ramming in a Class of fill with similar characteristics as the surrounding intact material; or

(b) excavated and dealt with as described in sub-Clause 6(i) of this Clause.

(iv) Other areas required to be made stable shall be dealt with as stated in contract specific Appendix 6/3.

**8** The concrete, referred to in sub-Clauses 6(i) and 6(iii) of this Clause, permanently exposed on the face of the cutting shall have surface features as nearly as possible matching those of the adjacent intact face. Such concrete and the grout referred to in sub-Clause 6(ii) of this Clause shall have a consistent colour as nearly as possible matching that of the adjacent intact face.

**9** As far as reasonably practicable all cut off drains and ditches specified for cuttings shall be completed and outfalls provided prior to the commencement of the specific earthworks item.

## 604 Excavation for Foundations

**1** The bottom of all foundation excavations shall be formed to the lines and levels shown on the drawings. Pockets of soft soil or loose rock shall be removed and the resulting voids and any natural voids shall be filled with ST1 concrete to Clause 2602 (or other material as required by contract specific Appendix 6/3) except in excavations for corrugated steel buried structures when Class 6K lower bedding fill material complying with Table 6/1 shall be used.

After placing of any blinding concrete shown on the drawings, no trimming of the side faces of the excavation shall be carried out for 24 hours.

**2** The Contractor shall make good:

(i) any lateral overbreak of the excavation above the bottom of the foundation greater than the net volume required for the permanent works with material of the same Class as used for fill above structural concrete foundations to comply with Clause 611 (except that for corrugated steel buried structures Class 6K lower bedding material shall be used) or, where the excavation is too narrow to allow the compaction of earthworks materials, with ST1 concrete to Clause 2602;

(ii) any additional excavation at or below the bottom of foundations, including that resulting from removal of material which the Contractor has allowed to deteriorate, with ST1 concrete to Clause 2602 (or other

material required by contract specific Appendix 6/3) except that under corrugated steel buried structures Class 6K lower bedding material shall be used.

**3** Class 6K lower bedding material referred to in this Clause shall be deposited and compacted in compliance with Clauses 608 and 612 and Table 6/1.

## 605 Special Requirements for Class 3 Material

**1** When contract specific Appendix 6/1 designates a material as Class 3 to be used or to remain intact in the permanent works the following shall apply:

(i) No earthworks involving Class 3 material or trafficking of areas which consist of Class 3 material, unless they are protected, shall be carried out during the periods described in contract specific Appendix 6/4.

(ii) Excavation of Class 3 material shall be by means of a face shovel, which shall excavate, swing and unload without moving the chassis or undercarriage during one operating cycle, or by means of a similar shovel-loading machine, so as to reduce the degradation of the material to a minimum.

(iii) When excavating Class 3 material the Contractor shall arrange his method of working so as to maintain a working face of minimum height 3 m or other height required in contract specific Appendix 6/4within Class 3 material except that where the depth of the cutting is less than 3 m the full height of Class 3 material shall form the working face excluding any protection required to the formation or sub- formation.

(iv) Material other than chalk contained within the volume designated as Class 3 material in the contract shall be excavated and deposited separately from chalk and not be mixed with it.

(v) Trafficking of areas of Class 3 material shall not be permitted by vehicles having a capacity when struck of more than 15 $m^3$ unless otherwise described in contract specific Appendix 6/4.

(vi) Not used.

(vii) Class 3 material shall not, unless required in contract specific Appendix 6/4, be layered with other fill material in the construction of embankments and other areas of fill.

(viii) When required in contract specific Appendix 6/4 embankments and other areas of fill constructed of Class 3 material shall either:

(a) upon reaching a level 600 mm below sub-formation or, where there is no capping, a level 600 mm below formation, be left for a minimum of 4 weeks or other period stated in contract specific Appendix 6/4, before continuing filling which shall, in all cases, be continued in compliance with sub-Clause 608.9; or

(b) be continued above sub-formation or formation with a protective layer in accordance with sub-Clause 608.9(ii) but which shall be of Class 3 material. Such material shall then be left for a minimum of 4 weeks or other period stated in contract specific Appendix 6/4 before removal of the protective layer and shall be immediately continued with the preparation of sub-formation or formation, as appropriate, in accordance with Clauses 613 and 616.

(ix) Where temporary instability occurs in chalk during deposition or compaction due to excessive working by plant or to inclement weather, the Contractor shall delay the further deposition of Class 3 material until the chalk has recovered sufficient strength for work to proceed. A detailed record of the areas of instability shall be made available to the Contractor's Engineering Director and included in the Geotechnical Feedback Report.

(x) At the end of each working day of filling, exposed Class 3 material laid that day shall, unless otherwise stated in contract specific Appendix 6/4 be rolled with two passes of a smooth wheeled roller having a mass per metre width of roll exceeding 2100 kg.

(xi) The other special requirements for Class 3 material described in sub-Clauses 613.11(i), 613.12(i), 616.1(ii) and 616.3 shall also apply, together with any other special requirements described in contract specific Appendix 6/1 or contract specific Appendix 6/4.

## 606 Watercourses

**1** The clearance and modification of existing, or the construction of new watercourses, including ditches, streams, rivers, lagoons and ponds, shall be as described in contract specific Appendix 6/3 including any protection, lining, revetment or other works and shall comply with sub-Clauses 2 to 4 of this Clause.

**2** Clearance of existing watercourses shall include the removal of vegetation, vegetable matter and all other deposits within the watercourse profile. Materials resulting from this clearance shall be dealt with as unacceptable material.

**3** New watercourses and cleared existing watercourses shall be maintained in a clear condition.

**4** Redundant watercourses shall, where required in contract specific Appendix 6/3, be drained and cleared in accordance with sub-Clause 2 of this Clause and material outside the watercourse profile excavated and dealt with as unacceptable material. The excavations shall be to the dimensions stated in the contract and the whole filled with general or selected fills of the Class described in contract specific Appendix 6/3 complying with Table 6/1 deposited and compacted in compliance with Clause 608 and 612. Where the surface is to remain exposed it shall be topsoiled and seeded, or receive other treatment, all as described in contract specific Appendix 6/3.

## 607 Explosives and Blasting for Excavation

**1** Blasting for excavation shall not be employed unless permitted or required in contract specific Appendix 6/3 and such blasting shall be confined to the locations and to within the time limits stated therein.

**2** The Contractor shall:

(i) not carry out plaster shooting;

(ii) for each location where blasting is to be undertaken, give written notice to the Project Manager and Contractor's Engineering Director of the programme of blasting, including trial explosions, at least 10 days before it commences and give written notice of each blasting event as described in (v) below, at least 12 hours beforehand;

(iii) carry out trial explosions starting with reduced quantities of explosive in order to determine the size of the actual explosive charges and their disposition, for use in the main blasting operations, so as not to exceed the values for vibrational amplitude and vibrational peak particle velocity stated in (vi) below at the positions described therein;

(iv) determine danger zones likely to be created by the blasting operations, including trial explosions, within which blasted material may be projected and utilise suitable arrangements including temporary works, to retain such projectiles and ensure that no injury or damage is caused to persons or property thereby;

(v) limit blasting to a small number of events during permitted hours per day, where an event shall comprise a single explosion or a group of explosions each separated by a short time interval, the group lasting less than a minute;

(vi) ensure that:

(a) structures and earthworks, existing or under construction, on and off the site, do not experience, during blasting operations including trial explosions, a vibrational amplitude exceeding 0.2 mm and a resultant peak particle velocity exceeding 50 mm per second, or other limits stated in contract specific Appendix 6/3, at the same time or individually; and

(b) peak overpressures, of magnitude such as to endanger windows and glazed areas of structures, do not occur.

(vii) where instrumentation and monitoring is appropriate:

(a) rigidly fix to structures and insert in earthworks described in (vi)(a) above, suitable instruments to measure the vibrational amplitude and resultant vibrational peak particle velocity, and peak overpressures, experienced during blasting operations including trial explosions;

(b) make available details of the proposed instrumentation within the site;

(c) unless otherwise stipulated in contract specific Appendix 6/3, make his own arrangements for installing instruments on property off the site including negotiating with landowners and other interested parties;

(d) read such instruments and take measurements throughout the period of blasting operations, including trial explosions;

(e) for instruments on structures or earthworks on the site and, where required in contract specific Appendix 6/3, on property off the site, make available the results at the end of each day's blasting.

(viii) take measurements of vibrational amplitude and peak particle velocity in each of three mutually perpendicular planes and determine the peak value, taken as the maximum resultant calculated by vector

summation of the three components of amplitude and velocity respectively, measured as instantaneously as the resolution of the recording instrument permits;

(ix) ensure that noise from blasting operations is controlled in accordance with Clause 109;

(x) use explosives in the quantities and in the manner recommended by the manufacturer;

(xi) store explosives in registered premises in a licensed store or magazine provided with a separate compartment for detonators or use them under an Immediate Use Certificate issued by the police;

(xii) only permit explosives to be used or handled by or under the immediate control of a competent person in accordance with the Explosive Regulations 2014 and subsequent amending Regulations;

(xiii) ensure there is no unauthorised issue or improper use of explosives brought on the site and maintain a strict check on quantities issued and consumed;

(xiv) comply with the requirements of BS 6657 in respect of the use of electrical detonators in the vicinity of static and mobile radio transmitters, including normal radio and television broadcasting stations and radar units associated with aircraft movements, electricity generating plant and transmission lines.

## 608 Construction of Fills

**1** All fills, including embankments, shall be constructed:

(i) in the locations described in contract specific Appendix 6/3 to the lines and levels stated therein;

(ii) of Classes of materials required or permitted in contract specific Appendix 6/1, complying with Table 6/1 with, unless otherwise described in the contract, only Class 6A material deposited into open water;

(iii) by depositing, as soon as practicable after excavation, in layers to meet the compaction requirements of Clause 612 as required for each Class of material in Table 6/1, except that:

(a) material requiring end product compaction shall be deposited in layers not exceeding 250 mm uncompacted thickness;

(b) material placed into open water shall be deposited by end tipping without compaction;

(c) material deposited in areas to receive dynamic compaction complying with Clause 630 shall be deposited and compacted to the requirements therein.

(iv) to the requirements of this Clause and any other requirements for fill in this Series.

**2** Starter layers of Classes 6B, 6C or 6D materials as described in contract specific Appendix 6/3 shall be deposited as the first layer or layers of fill above existing ground level or, if appropriate, above any ground improvement required by contract specific Appendix 6/13. Starter layers below Class 2E pulverised-fuel ash general fill shall be Class 6D material. Plant movement across starter layer material shall be restricted to that plant which is necessary for its deposition, spreading and compaction in compliance with this Clause and Clause 612 and any plant required to carry out any ground improvement beneath it if required by Clause 630. The Contractor shall take all reasonable measures to prevent damage to the underlying strata, which may include use of lighter spreading plant or a reduction of the number of passes of compaction plant. Starter layers of Classes 6B, 6C or 6D materials shall not be used within 2.0m of the HSR Formation where slabtrack is to be used or 1.5m of the HSR Formation where ballasted track is to be used.

**3** Coarse granular material Classes 1C and 6B shall, before compaction, be spread in layers by a crawler tractor of not less than 15 tonnes total mass. After compaction each layer shall, if voids remain, be blinded with a Class of granular material complying with Table 6/1 and accepted by the Contractor's Engineering Director so that all surface voids are filled before the next layer and before any capping or sub-base is constructed.

**4** Embankments and other areas of fill shall, unless otherwise required in the contract, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct constructional plant and other vehicular traffic uniformly over them. Damage by constructional plant and other vehicular traffic shall be made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged and (for HSR earthworks) to a depth of 0.5m below the visible extent of damage.

**5** Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those described in contract specific Appendix 6/3, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material. However any oversteepening or increase in width shall not exceed any limits described in contract specific Appendix 6/3 and shall remain only for the minimum periods necessary consistent with the safety of the permanent works.

**6** Staged construction of fills and any controlled rates of filling, shall be carried out, in accordance with any requirements described in contract specific Appendix 6/3 including installation of instrumentation and its monitoring, in compliance with Clause 629 and contract specific Appendix 6/12.

**7** Where required in contract specific Appendix 6/3 the Contractor shall surcharge embankments or other areas of fill, as described therein for the periods stated. If settlement of surcharged fill results in any surcharging material, which is unacceptable for use in the fill being surcharged, lying below the formation or, where there is a capping, the sub-formation, the Contractor shall remove this unacceptable material and dispose of it in accordance with Clause 602. He shall then bring the resultant level up to formation or sub-formation, as appropriate, with acceptable material.

**8** Where pipes in embankments or in other areas of fill are permitted in contract specific Appendix 5/1 to be constructed other than in a trench, the fill shall be brought up to and over them equally on both sides. The fill shall be deposited in even layers and shall not be heaped above the pipe. Spreading and compaction shall be carried out evenly without dislodging, distorting or damaging the pipe. Power rammers are not to be used within 300 mm of any part of the pipe or joint.

**9** The last 600 mm depth of fill up to sub-formation level, or formation level as appropriate, shall, unless otherwise required in the Contract, be carried out for the full width of embankments, or between the outer extremities of the verges in other areas of fill, in a continuous operation. The Contractor shall then continue without delay to carry out either (i) or (ii) below:

(i) form the sub-formation or formation, all in accordance with Clauses 613 and 616, following immediately either by:

(a) the construction of the full thickness of capping or sub-base as appropriate; or

(b) if permitted in contract specific Appendix 6/3, the construction of a lesser thickness of capping or sub-base as described therein laid as a weather sacrificial protection layer;

(ii) place an additional 300 mm minimum compacted thickness of material above sub-formation level or formation level as appropriate for the full width of the filling to form a weather protection. This weather protection shall be composed of the same material as the sub-formation or formation and compacted in compliance with Table 6/1. The material shall be provided from the Contractor's own resources and the sacrificial protection layer shall be constructed in a continuous operation. For stabilised capping, the protective layer shall consist of unstabilised material.

**10** During construction of embankments and other fills, exposed sides of Classes 2E and 7B pulverised-fuel ash material shall be protected against scour and erosion from any source.

**11** Completed slopes of Classes 2E and 7B fill material shall be covered immediately by Class 5 topsoil as required in contract specific Appendix 6/8 or turf or other material, as required in contract specific Appendix 30/5.

**12** Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cuttings, other fills and excavations, such faces shall be benched or otherwise shaped as required in contract specific Appendix 6/3 immediately before placing the subsequent fill.

**13** All permanent faces of side slopes of embankments and other areas of fill formed in Classes 2 or 7 cohesive materials other than pulverised-fuel ash, shall, subsequent to any trimming operations, be re-worked and sealed by tracking a tracked vehicle, suitable for the purpose, on the slope, or by other suitable methods.

**14** As far as reasonably practicable all cut off drains and ditches specified for each embankment shall be completed and outfalls provided prior to the commencement of the specific earthworks item.

**15** Where fine materials are placed over coarse materials or vice versa, a filter or geotextile used as a separator shall be used to prevent migration of fines, unless the Contractor's Engineering Director is satisfied that its omission will not result in a degraded performance.

## 609 Geotextiles and Geotextile-related Products Used to Separate Earthworks Materials

**1** Geotextiles and geotextile-related products shall conform to the requirements of the product standard BS EN 13251 and other characteristics and locations as set out in contract specific Appendix 6/5. A Declaration of Performance for each product stating compliance with BS EN 13251 and the required levels of performance stated in contract specific Appendix 6/5 shall be submitted to the Contractor's Engineering Director prior to their placement in the works.

**2** Prior to installation geotextiles shall be stored in clean and dry conditions and away from direct sunlight or ultraviolet light. Once placed on site, fill should be placed on the geotextile immediately such that any temporary

exposure of the geotextile to sunlight should not exceed 5 hours, or other value recommended by the manufacturer.

**3** Geotextiles shall not be placed during periods of extreme cold, extreme heat, when frost is likely and or when there is heavy rainfall.

**4** Geotextiles shall be placed in the direction of traffic unless detailed otherwise on the drawings.

**5** The material on which the geotextiles are installed upon shall be free of any sharp protrusions which may damage the fabric. The geotextile shall not be dragged into position or pulled once laid but shall be rolled out across the site such that it shall be in continuous contact with the surface on which it is to be installed and shall not bridge or be stretched over hollows or lumps.

**6** The geotextiles shall be inert to all chemicals naturally found in soils of the type expected on site and shall have no solvents at ambient temperature. It shall not be susceptible to hydrolysis, shall be resistant to aqueous solutions of salts, acids and alkalis, and shall be non-biodegradable.

**7** Adjacent sheets of the geotextiles shall be overlapped or joined according to the Manufacturer's recommendations and with a minimum overlap of 500mm, unless otherwise specified in contract specific Appendix 6/5. Returns for anchorages and turn-ups at edges shall be according to Manufacturer's recommendations and shall be not less than 500mm, unless otherwise specified in contract specific Appendix 6/5.

**8** Fill to be placed upon the geotextile shall not be dropped from a height but should be placed from a height no greater than 0.8m. No trafficking shall take place upon the geotextile until a minimum fill thickness of 500mm has been placed, unless otherwise specified in contract specific Appendix 6/5.

**9** Any geotextile damaged during installation shall be immediately repaired by patching over the damaged section. The area of patching should extend to at least 1m beyond the damaged area of geotextile.

**10** Where geotextiles are used to line drainage/watercourses then the upstream sheet shall overlap the downstream sheet.

**11** Geotextiles that are used to demarcate underlying contaminated materials shall be bright orange.

## 610 Fill to Structures

**1** This Clause shall apply to fill to structures other than:

(i) fill for reinforced earth structures, including associated drainage layers;

(ii) fill for anchored earth structures including associated drainage layers;

(iii) fill for surround and bedding of corrugated steel buried structures;

(iv) fill above structural concrete foundations unless otherwise required in contract specific Appendix 6/6.

**2** Materials, as required or permitted in contract specific Appendix 6/6 of Classes 6N, 6P, 7A or 7B and complying with Table 6/1 shall be used as fill to structures, in the locations described in contract specific Appendix 6/6.

**3** The Contractor shall compact, in compliance with Clause 612, end-product compaction, Class 6N, 6P, 7A and 7B material to satisfy the compaction requirements for those Classes as listed in Table 6/1, but subject to the restrictions in sub-Clauses 4 and 5 of this Clause.

**4** Where fill to structures is required to the same level on more than one side of a structural element or buried structure (except where Clause 623 applies) it shall be maintained at heights not differing by more than 250 mm after compaction on opposing sides of the structural element as filling proceeds.

**5** The Contractor shall restrict compaction plant used on fill to structures, within 2 m of a structure, to the following items as described in sub-Clause 612.10 and listed in Table 6/4:

(i) vibratory roller having a mass per metre width of roll, as determined by sub-Clause 612.10, not exceeding 1,300 kg with a total mass not exceeding 1,000 kg;

(ii) vibrating plate compactor having a mass not exceeding 1,000 kg;

(iii) vibro-tamper having a mass not exceeding 75 kg.

The compacted level of the fill within this zone shall not differ during construction from the compacted level of the remainder of the adjoining fill to structures by more than 250 mm.

**6** Where required in contract specific Appendix 6/6, Class 6N, 6P and 7B material shall be shown, by means of a trial utilising not less than 20 $m^3$ of the material, deposited and compacted in accordance with this Clause, to be stable, when it

is trimmed to a slope of 1 vertical to 1½ horizontal, or other slope described in contract specific Appendix 6/6.

## 611 Fill Above Structural Concrete Foundations

**1** Fill deposited above structural concrete foundations shall be, as shown on the drawings:

(i) Class 6N, 6P, 7A or 7B selected fill material complying with Clause 610 including compaction requirements;

(ii) Class 6M selected fill material, deposited and compacted in accordance with Clause 623, above the foundation of arch profile corrugated steel buried structures;

(iii) another class of selected fill or general fill complying with Table 6/1 deposited and compacted in compliance with Clauses 608 and 612 and in addition be subject to sub-Clauses 610.4 and 5.

## 612 Compaction of Fills

### General

**1** Except for dynamic compaction, which shall comply with Clause 630, and unless otherwise described in contract specific Appendix 6/3, the Contractor shall carry out compaction in compliance with this Clause, as soon as practicable after deposition, on all those Classes of fill in Table 6/1 which require to be compacted.

**2** Compaction shall be either method or end-product as required for the Class of fill in Table 6/1, using plant appropriate to the Class of fill and the site conditions. Method compaction shall not be used for HSR earthworks.

**3** The Contractor shall obtain permission from the Project Manager before carrying out compaction outside normal working hours.

### Method Compaction

**4** Where method compaction is required to be adopted it shall comply with sub-Clauses 5 to 10 of this Clause.

**5** Except as stated in sub-Clause 6 of this Clause, method compaction shall be undertaken using the plant and methods in Table 6/4 appropriate to the compaction requirements as listed in Table 6/1 for the Class of material being compacted.

**6** Plant and methods not included in Table 6/4 shall only be used providing the Contractor demonstrates at site trials that a state of compaction is achieved by the alternative method equivalent to that obtained using the specified method.

**7** Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account when assessing the amount of compaction required for any layer.

**8** If more than one Class of material is being used in such a way that it is not practicable to define the areas in which each Class occurs, the Contractor shall compact with plant operating as if only the material which requires the greater compactive effort is being compacted.

**9** The Contractor or Contractor's Engineering Director may carry out field dry density tests as described in sub-Clause 15 of this Clause on material compacted to method requirements at a frequency defined in contract specific Appendix 6/3. If the results of field tests show densities which indicate the state of compaction to be inadequate, then if this is due to failure of the Contractor to comply with the requirements of the contract, the Contractor shall carry out such further work as is required to comply with the contract.

**10** For the purposes of Table 6/4 the following shall apply:

(i) The minimum number of passes N is the minimum number of times that each point on the surface of the layer being compacted shall be traversed by the item of compaction plant in its operating mode, or struck by power rammers or falling weight compactors. D is the maximum depth of the compacted layer.

(ii) In column headed N # the number of passes shown is to be doubled for material Classes 1A, 1B, 2A, 2B, 2C and 2D when such materials occur within 600 mm of sub-formation (if capping is required) or formation. Such extra compaction shall, unless otherwise described in contract specific Appendix 6/3, either be carried out for the full width of the embankment or, in other areas of fill which are to receive a pavement, between the outer extremities of the verges.

(iii) The compaction plant in Table 6/4 is categorised in terms of static mass. The mass per metre width of roll is the total mass on the roll divided by the total roll width. Where a smooth wheeled roller has more than one axle the category of the machine shall be determined on the basis of the axle giving the highest value of

mass per metre width.

(iv) A grid roller is a machine with a compacting roll or rolls constructed of heavy steel mesh of square pattern.

(v) A deadweight tamping roller is a machine with a roll or rolls from which 'feet' project and where the projected end area of each 'foot' exceeds 0.01 m² and the sum of the areas of the feet exceeds 15% of the area of the cylinder swept by the ends of the feet. The requirements for tamping rollers apply to machines that have 2 rolls in tandem. If only one tamping roll traverses each point on the surface of the layer on any one pass of the machine, the minimum number of passes shall be twice the number given in Table 6/4 plus any further doubling required to satisfy (ii) above.

(vi) For pneumatic-tyred rollers the mass per wheel is the total mass of the roller divided by the number of wheels. In assessing the number of passes of pneumatic-tyred rollers the effective width shall be the sum of the widths of the individual wheel tracks together with the sum of the spacings between the wheel tracks provided that each spacing does not exceed 230 mm. Where the spacings exceed 230 mm the effective width shall be the sum of the widths of the individual wheel tracks only.

(vii) A vibratory tamping roller, which may be self-propelled or towed, is a machine having a means of applying mechanical vibration to one or more rolls. The roll or rolls have projecting feet where the height of each foot exceeds 10% of the radius of the roll drum, the projected end area of each foot exceeds 0.1% of the roll drum surface area, and the sum of the areas of the feet exceeds 10% of the area of the cylinder swept by the ends of the feet.

The requirements for the operation of vibratory tamping rollers shall be the same as those stated for vibratory rollers in sub-Clause (viii) except that vibratory tamping rollers operating without vibration will be classified as deadweight tamping rollers.

(viii) Vibratory rollers are self-propelled or towed smooth-wheeled rollers having means of applying mechanical vibration to one or more rolls except that vibratory rollers employed for Method 5 compaction shall be single roll types.

Vibratory rollers operating without vibration will be classified as smooth-wheeled rollers.

The requirements for vibratory rollers are based on the use of the lowest gear on a self-propelled machine with mechanical transmission and a speed of 1.5 to 2.5 km/h for a towed machine, or a self-propelled machine with hydrostatic transmission. If higher gears or speeds are used an increased number of passes shall be provided in proportion to the increase in speed of travel.

Where the mechanical vibration is applied to two rolls in tandem, the minimum number of passes shall be half the number given in Table 6/4 for the appropriate mass per metre width of one vibrating roll but if one roll differs in mass per metre width from the other the number of passes shall be calculated as for the roll with the smallest value. Alternatively the minimum number of passes may be determined by treating the machine as having a single vibrating roll with a mass per metre width equal to that of the roll with the higher value.

Vibratory rollers shall be operated with their vibratory mechanism operating only at the frequency of vibration recommended by the manufacturers. Where more than one amplitude setting is available and/ or a range of frequencies is recommended, the machine shall be operated at the maximum amplitude setting and at the maximum recommended frequency for that setting.

Vibratory rollers shall be equipped or provided with devices indicating the frequency at which the mechanism is operating and the speed of travel. Both devices shall be capable of being read by an inspector alongside the machine.

(ix) Vibrating-plate compactors are machines having a base-plate to which is attached a source of vibration consisting of one or two eccentrically weighted shafts and:

(a) the mass per square metre of the base-plate of a vibrating-plate compactor is calculated by dividing the total mass of the machine in its working condition by its area in contact with compacted material;

(b) vibrating-plate compactors shall be operated at the frequency of vibration recommended by the manufacturers. They shall normally be operated at travelling speeds of less than 1 km/h but if higher speeds are necessary the number of passes shall be increased in proportion to the increase in speed of travel.

(x) Vibro-tampers are machines in which an engine-driven reciprocating mechanism acts on a spring system through which oscillations are set up in a base-plate.

(xi) Power rammers are machines which are actuated by explosions in an internal combustion cylinder, each explosion being controlled manually by the operator.

(xii) Dropping weight compactors are machines in which a dead weight is dropped from a controlled height using a hoist mechanism and they include self-propelled machines with mechanical traversing mechanisms capable of compacting soil in trenches and close to structures.

(xiii) In the case of power rammers and dropping-weight compactors one pass will be considered as made when the compacting shoe has made one strike on the area in question.

(xiv) For items marked * in the Method 3 column of Table 6/4 the roller shall be towed by track-laying tractors. Self-propelled rollers are unsuitable.

(xv) Where combinations of different types or categories of plant are used, the following shall apply:

(a) the depth of layer shall be that for the type of plant requiring the least depth of layer; and

(b) the number of passes shall be that for the type of plant requiring the greatest number of passes.

**End-product Compaction**

**11** Where end-product compaction is required it shall comply with sub-Clauses 12 to 16 of this Clause.

**12** The Contractor shall at least 28 days before commencement of end-product compaction provide to the Contractor's Engineering Director for acceptance a report detailing:

(i) (P06) the values of maximum dry density and the optimum moisture content obtained in accordance with BS 1377: Part 4 using the 2.5 kg rammer method, 4.5 kg rammer method or vibrating hammer method as appropriate for each of the fills he intends to use which meet the requirements of the permitted Class or Classes (where within any Class of material the fill contains material having different maximum dry densities and optimum moisture contents the Class shall be further sub-divided, by extending the identification system, in order to monitor the compacted density). ~~For HSR earthworks the 4.5kg rammer method shall be used~~;

(ii) a graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined and, for materials where it is needed, a plot of the relevant % air voids curve for each sub-division;

(iii) (P06) for HSR earthworks, confirmation and demonstration (by appropriate means, e.g. field trials) that the end-product and end-performance requirements as specified in the HS2 Technical Standard – Earthworks, HS2-HS2-GT-STD-000-000001 can be met;

(iv) (P06) for HSR earthworks, the field-testing protocols (including shear wave velocity measurements, and Continuous Compaction Control as specified in sub-Clause 16 of this Clause) that will be used to confirm compliance with the end-product and end-performance requirements as specified in the HS2 Technical Standard – Earthworks, HS2-HS2-GT-STD-000-000001.

**13** (P06) Once the information contained in sub-Clause 12 of this Clause has been accepted by the Contractor's Engineering Director it shall form the basis for compaction, and for HSR earthworks shall be specified in contract specific Appendix 6/3.

**14** For non-HSR earthworks, fill compacted to end-product requirements shall have a field dry density, measured in accordance with sub-Clause 15 of this Clause, equal to or greater than the percentage given in Table 6/1 of the maximum dry density for the relevant Class of fill previously made available to the Contractor's Engineering Director in accordance with sub-Clause 12 of this Clause.

(P06) For HSR earthworks, fill compacted to end-product requirements shall meet the compaction criteria specified in contract specific Appendix 6/3, based on the trials reported in sub-Clause 12 of this Clause. ~~end-product and end-performance requirements as specified in the HS2 Technical Standard – Earthworks, HS2-HS2-GT-STD-000-000001 and Table 6/1.~~ The frequency of testing to verify compliance with the end-product and end-performance requirements shall be specified in contract specific Appendix 1/5.

(P06) The Modulus of Deformation ($E_{v2}$) shall be measured using French Standard NF P 94-117.1 using a static test with a plate of diameter of 600mm and a maximum pressure of 250kN/m$^2$. It shall be measured at the upper surface of the earthworks layers (Protection Layer, Prepared Subgrade, Upper Embankment Fill, foundation treatment) and at 1m above Lower Embankment Fill~~and at maximum 1m vertical separation within layers~~. Any results obtained for tests where the thickness of the particular fill material being tested is less than twice the test plate diameter can be used for general

guidance only. The Contractor and Contractor's Engineering Director shall agree the acceptable ratio of Modulus of Deformation $E_{v2}/E_{v1}$ for each type of fill placed.

A longitudinal profile of Rayleigh wave velocity shall be measured at the top of the Prepared Subgrade of all HSR earthworks. Field trials are required in advance of filling operations to define pass/fail criteria.

**15** Field dry density shall be measured in accordance with BS 1377: Part 9. Where nuclear methods are used, the gauge shall be calibrated in accordance with BS 1377: Part 9 and contract specific Appendix 6/3.

**Continuous Compaction Control**

**16** For HSR-supporting earthworks and earthworks that could impact HSR, continuous compaction control (CCC) shall be used in accordance with PD CEN/TS 17006:2016 "Earthworks – Continuous Compaction Control (CCC)" with the following specific requirements:

(a) In PD CEN/TS 17006:2016, where 'contractor' is used this shall refer to the earthworks contractor, and where 'supervisor' is used it shall refer to the Contractor in this specification.

(b) The absolute positional accuracy shall be better than 0.10 m vertically.

(c) CCC plant shall be Global Navigation Satellite System (GNSS)-enabled and shall record positional data correlated with the compaction and stiffness data.

(d) CCC shall be used on all layers placed.

(e) CCC shall be used for QC and QA purposes in all fills (Section 10 of PD CEN/TS 17006:2016).

(f) For all fills, CCC shall be used at least for weak area analysis and documentation (Section 8 of PD CEN/TS 17006:2016).

(g) For granular fills, the Contractor shall undertake compaction trials of proposed materials to confirm the viability of using CCC with calibration for indirect continuous density and stiffness control (Section 7 of PD CEN/TS 17006:2016), and where viable, this method shall be deployed.

(h) When using CCC with calibration for indirect continuous density and stiffness control, the Contractor shall:

i. Calibrate CCC following Section 7.4 of PD CEN/TS 17006:2016 but with the following tests for every 10m of compaction lane: one static plate load test, one density test, one moisture content test, one specific gravity test;

ii. Validate the correlations derived from trials by calibration with conventional earthworks testing at least once for every 10,000$m^3$ of each material type and/or source placed in to the permanent earthworks;

iii. Adopt modified regression requirements of Section 7.5.2 of PD CEN/TS 17006:2016 as shown in Table 612/1. Where these are not achieved, but $r \geq 0.7$, the correlation shall be determined to give a cautious estimate of the desired parameter. Where $r < 0.7$, this method of CCC shall not be used, as per PD CEN/TS 17006:2016.

iv. Evaluate acceptance criteria using the weighted fall-below areas method (Annex B3, PD CEN/TS 17006:2016) using the acceptance parameters presented in Table 612/1.

(i) CCC shall be used as close to structures as is reasonably practicable; in the small areas where CCC is not used, the Contractor shall demonstrate to the Contractor's Engineering Director and the Project Manager that the specified performance requirements have been achieved by other means.

**Table 612/1**

| Type of earthwork | Regression coefficient, r (Section 7.5.2, PD CEN/TS 17006:2016) | Decision limit, q (Annex B3, PD CEN/TS 17006:2016) | Mean fall-below ratio, U (Annex B3, PD CEN/TS 17006:2016) |
|---|---|---|---|
| Lower Embankment Fill, non-HSR earthworks | ≥0.7 | ≥0.010 | ≤10% |
| Upper Embankment Fill | ≥0.8 | ≥0.005 | ≤5% |

## 613 Sub-formation and Capping (non-HSR Earthworks Only)

**1** Capping shall be provided only in those locations, and to the extent, particularly stated in the contract specific Appendix 6/7 to be constructed with capping. It shall comply with this Clause and in addition, for stabilised capping, with Clauses 614, 615 and 643 as appropriate.

**2** Capping shall be constructed with Class 6F1, 6F2, 6F3, 6F4, 6F5, 6S, 9A, 9B, 9C, 9D, 9E or 9F material as required or permitted in contract specific Appendix 6/7 and complying with Table 6/1.

**3** Unless otherwise described in contract specific Appendix 6/7, capping shall either consist of one Class of capping material throughout its depth laid in one or more layers of compacted thickness complying with Clause 612, or be formed of not more than two elements of different capping materials. Each element shall be formed of one or more layers of the same capping material, each of compacted thickness complying with Clause 612. Class 9D or 9E stabilised capping material shall not be placed or constructed above. Class 6F granular capping material or Class 6S granular filter layer material.

**4** Where required in contract specific Appendix 6/7, before commencing the construction of capping in the permanent works, the Contractor shall demonstrate the methods, equipment and materials he proposes to use by constructing an area, or areas as appropriate, of capping on a typical prepared sub-formation to the same thickness as required in the permanent works. The area of each capping construction demonstration shall be not less than 700 m².

**5** The materials placed during the demonstration may form part of the permanent works, provided they meet the requirements of the contract, or the demonstration may be carried out elsewhere on the site where this is detailed in contract specific Appendix 6/7. After completion of each demonstration area the Contractor shall within a period of not greater than 5 days and before commencing the main construction of the appropriate capping in the permanent works, carry out tests on each demonstration area and provide the Contractor's Engineering Director with records for acceptance substantiating compliance with the stipulated criteria of contract specific Appendix 6/7. Where required by contract specific Appendix 6/7 the Contractor shall provide sheeting, to protect the demonstration area.

**6** The demonstration area shall, if it does not meet the requirements for the permanent works or is located elsewhere on site, be removed and the area reinstated in accordance with contract specific Appendix 6/7.

**7** The methods and materials used in the accepted demonstration shall not be changed during the course of the works without the construction of a further demonstration where such demonstrations are required by contract specific Appendix 6/7.

**8** Unless otherwise stated in contract specific Appendix 6/7, the sub-formation shall have the same longitudinal gradient, crossfall and surface level tolerances as the formation.

**9** The Contractor shall limit any unprotected area of sub-formation, which is to receive capping to suit the output of the plant in use and the rate of deposition of capping.

**10** No unprotected sub-formation which is to receive capping shall remain continuously exposed to rain causing degradation, nor be left uncovered overnight.

**11** In cuttings the Contractor shall, as permitted or required in contract specific Appendix 6/7 carry out one of the following procedures:

(i) for Class 6F granular capping material or Class 6S granular filter layer material, excavate below formation level to a depth to accept the capping, trim the surface to form the sub-formation and immediately compact with one pass of a smooth-wheeled roller having a mass per m width of roll not less than 2,100 kg or a vibratory roller having a mass per m width of roll not less than 700 kg or a vibrating plate compactor having a mass per m² of not less than 1,400 kg, except that only smooth wheeled rollers shall be used on Class 3 chalk material, and immediately deposit and compact above it a capping in Class 6F granular capping material or Class 6S granular filter layer material; or

(ii) for Class 9A, 9B, 9C, 9D, 9E or 9F capping material construct the capping by stabilising the intact material, providing it complies with Class 6E, 6R 7E, 7F, 7G or 7I material requirements, immediately below formation to form Class 9A, 9B, 9C, 9D, 9E or 9F material, respectively; or

(iii) excavate below formation to sufficient depth to enable stabilisation of intact Class 6E, 6R, 7E, 7F, 7G or 7I material to be carried out, to produce Class 9A, 9B, 9C, 9D 9E or 9F material forming the lower element of the capping (after stabilisation of this element, the capping shall be completed by depositing a further layer or layers of Class 6E, 6R 7E, 7F, 7G, or 7I material and stabilising it to form Class 9A, 9B, 9C, 9D, 9E or 9F capping or depositing and compacting Class 6F granular capping material to form the upper element of the capping); or

(iv) excavate to sub-formation level and deposit material complying with Classes 6E, 6R, 7E, 7F, 7G, or 7I to be stabilised to form a capping of Class 9A, 9B, 9C, 9D, 9E or 9F layers.

Where a stabilised layer is directly overlain by Class 6F granular capping material the stabilised layer shall be compacted as for a sub-formation in 11(i) above.

**12** On embankments and other areas of fill the Contractor shall, as permitted or required in contract specific Appendix 6/7 carry out one of the following procedures:

(i) complete the embankment to form the sub-formation or remove any sacrificial protection layer and trim the surface to form the sub-formation, and in both cases compact with one pass of a smooth-wheeled roller having
a mass per m width of not less than 2,100 kg or a vibratory roller of not less than 700 kg per m width or a vibrating plate compactor having a mass per m² of not less than 1,400 kg, (except that only smooth-wheeled rollers shall be used on Class 3 chalk material) and immediately construct above it, in one or more layers, Class 6F granular capping material or Class 6S granular filter layer material; or

(ii) construct the embankment to sufficient height and carry out stabilisation to form a capping of Class 9A, 9B, 9C, 9D, 9E or 9F material in one or more layers utilising where appropriate any sacrificial protection layer previously constructed; or

(iii) for multi-element capping, incorporating stabilised material, construct the embankment to sufficient height to carry out the work described in 12(ii) above and immediately construct above it one or more layers of Class 6F granular capping material.

Where a stabilised layer is directly overlain by Class 6F granular capping material the stabilised layer shall be compacted as for a sub-formation in 12(i) above.

**13** For Class 6F3 material Optimum Moisture Content shall be determined according to BS 1377: Part 4 Method 3.7 (vibrating hammer test). Measurements of moisture content both for control purposes and for optimum moisture content determination shall be according to BS 1377: Part 2 Method 3 (oven dry method) but using an oven on a reduced temperature setting of 45 to 50°C.

**14** Filter layers constructed of Class 6S granular filter layer material shall be protected from damage by traffic and construction plant. The Contractor shall so organise work that only the traffic directly engaged in depositing, spreading and compacting the filter layer shall be permitted access to the surface of this layer. At no time shall the Contractor permit the leading edge of the filter layer to extend more than 100 metres beyond the leading edge of the succeeding layer of subbase.

**15** Design CBR values and capping thickness at each location is dependent on the actual materials forming the sub-formation. They may vary in extent from those interpreted in the ground investigation. The Contractor shall ensure that the CBR meets the design requirements.

## 614 Cement Stabilisation to Form Capping (non-HSR Earthworks Only)

**1** Where capping is to consist of, either wholly or in part, cement stabilised material Class 9A, 9B or 9C, this Clause shall apply to the construction of those parts which are stabilised with cement.

**2** Material to be stabilised with cement shall be Class 6E, Class 7F and Class 7G materials all complying with Clause 601 and Table 6/1. Unless otherwise described in contract specific Appendix 6/7 cement shall be Portland cement complying with BS EN 197-1 and requirements given in contract specific Appendix 6/7.

**3** Class 6E, 7F or 7G material to be stabilised shall have added to it, at any point, that quantity of cement measured as a percentage of its dry weight as determined on the demonstration area, to meet the required bearing ratio in contract specific Appendix 6/1, subject to a minimum of 2% cement.

**4** The appropriate quantity of cement shall be uniformly spread, by a suitable spreading machine, on top of the layer to be processed. Using a collecting tray and balance the Contractor shall check the rate of spread of the machine once for every 500 m² of cement spread.

**5** Unless indicated otherwise in contract specific Appendix 6/7, Class 6E, 7F or 7G material shall be stabilised in a single layer if its compacted thickness is 250 mm or less. If its compacted thickness is greater, the material shall be stabilised in layers not less than 130 mm and not more than 250 mm thick, including any cutting-in required by sub-Clause 9 of this Clause.

**6** The Contractor shall not carry out cement stabilisation when the shade temperature is below 3°C unless on a rising

thermometer above 0°C. Cement stabilisation shall not be carried out during periods of rain or when rain is imminent. When cement is spread on material likely to cause premature hydration, processing in accordance with sub-Clause 7 of this Clause shall follow immediately.

**7** Unless indicated otherwise by contract specific Appendix 6/7, Class 6E, 7F or 7G material forming the layer to be stabilised shall be processed by pulverising and mixing in the cement by means of a sufficient number of passes of a suitable mobile stabilising machine until 95% of the silt and clay fraction is reduced to particles or lumps passing a BS 28 mm sieve after dry sieving and the pulverisation complies with Table 6/1.

**8** During processing, sufficient water shall be available in the material to hydrate the cement and enable satisfactory mixing and compaction to be achieved. Any added water shall be through an integral spray-bar on the stabilising machine. Any added water shall have a sulfate content not exceeding 1400 mg/l as $SO_4$, when tested in accordance with Test No. 1 of TRL report 447 (or equivalent test in accordance with BRE Special Digest 1).

**9** The stabilising machine shall be equipped with a device for controlling the depth of processing which shall be maintained at the correct setting at all times. An overlap of 150 mm shall be made between adjacent passes of the stabilising machine. Where a subsequent layer of material is placed on a layer previously stabilised the tines or blades of the stabilising machine shall be set so that they cut into the previously stabilised layer below by at least 20 mm.

**10** Each layer of Class 9A, 9B or 9C processed material shall be compacted as soon as possible after the final pass of the stabilising machine. Compaction shall be completed within 2 hours following the mixing of the cement into the material to be stabilised. Immediately before compaction Class 9B processed material shall have a Moisture Condition Value (MCV) of not greater than 12 nor less than the figure stated in contract specific Appendix 6/1 for Class 9B cement stabilised material, both as determined in accordance with Clause 632. Water shall be added if necessary in a uniform manner to enable this MCV requirement to be met. Any added water shall have a sulfate content not exceeding 1400 mg/l as $SO_4$ when tested in accordance with Test No. 1 of TRL report 447 (or equivalent test in accordance with BRE Special Digest 1).

**11** The compaction of each layer of Class 9A or 9B material shall comply with Clause 612, Table 6/4 Method 6 or Method 7 respectively, except that if layers of Class 9A or 9B greater than 250 mm thickness are to be constructed, the number of passes of the compaction plant shall be determined from the results of a demonstration area as detailed in contract specific Appendix 6/7.

**12** The compaction of Class 9C material shall comply with Clause 612, end product compaction, to satisfy the compaction requirements given in Table 6/1 of this Class.

**13** Class 9A, 9B and 9C materials shall be cured in accordance with Clause 1035. During periods when the air temperature is forecast to drop below 3°C or when ground frost is forecast Class 9A, 9B and 9C material shall be protected, to prevent freezing, for a period of 7 days from the time of completion of compaction. Such protection shall be sealed to prevent the ingress of moisture.

**14** Class 9A, 9B and 9C materials shall not have other material deposited or compacted above them until such time as the required bearing ratio in contract specific Appendix 6/1 has been achieved. The relaxation allowed in sub-Clause 617.2 shall not apply before this time.

## 615 Lime Stabilisation to Form Capping (non-HSR Earthworks Only)

**1** This Clause shall apply only to those capping materials which are to be stabilised with lime to form material Class 9D.

**2** Material to be stabilised with lime shall be Class 7E material complying with Clause 601 and Table 6/1.

**3** The form of lime used for lime stabilisation shall be as required in contract specific Appendix 6/7, the lime shall conform to BS EN 459-1 and meet the performance requirements stated in contract specific Appendix 6/7. This shall be demonstrated by the Declaration of Performance. Unless otherwise stated in contract specific Appendix 6/7 lime shall be either quicklime or hydrated lime conforming to BS EN 459-1. The particle size distribution of all types of quicklime shown in Tables 1 and 8 of BS EN 459-1 shall be of designation P4 as shown in Tables 5 and 12 of BS EN 459-1.

**4** The Contractor shall carry out testing of the lime as installed for available lime in accordance with Clause 641 at weekly intervals unless otherwise required in contract specific Appendix 6/7 during periods when lime stabilisation is carried out. The results shall be provided by the Contractor in the project records. The available lime shall meet the requirements stated in contract specific Appendix 6/7 and the values stated in the Declaration of Performance.

**5** Class 7E material to be stabilised shall have added to it, at any point, the percentage of its dry weight of lime, as determined on the demonstration area, to meet the required bearing ratio in contract specific Appendix 6/1, subject to a minimum of 2½% by weight of 'available lime' as a percentage of the dry weight of the Class 7E material.

**6** Lime of quantity complying with sub-Clause 5 of this Clause shall be uniformly spread by a suitable spreading machine on top of the layer to be stabilised. Using a collecting tray and balance the Contractor shall check the rate of spread by weight, once for every 500 m² of lime spread or a different rate of testing for the rate of spread as described in contract specific Appendix 6/7. At the same time the Contractor shall collect samples of lime deposited on the tray and test them for available lime content in accordance with Clause 641.

**7** Unless indicated otherwise in contract specific Appendix 6/7, the material shall be stabilised in a single layer if its compacted thickness is 250 mm or less. If its compacted thickness is greater, the material shall be stabilised in layers not less than 130 mm and not more than 250 mm thick, including any cutting-in required by sub-Clause 12 of this Clause.

**8** Unless indicated otherwise in contract specific Appendix 6/7 lime stabilisation shall be carried out only during the months of March to September inclusive and when the shade temperature is not below 7°C. Only when the specified bearing ratio is attainable at a shade temperature less than 7°C, may lime stabilisation be carried out at such lower temperature. Lime stabilisation shall be suspended if rainfall will have an adverse effect on the material being stabilised. The spreading of lime shall not be carried out in a manner or under conditions that will result in lime being blown from the site onto adjacent land or property.

**9** Unless indicated otherwise in contract specific Appendix 6/7, the material forming the layers to be stabilised shall be processed by pulverising and mixing in the lime by means of sufficient number of passes of a suitable mobile stabilising machine until 95% of the Class 9D processed material passes a BS 28 mm sieve after dry sieving and the pulverisation complies with Table 6/1.

**10** During processing sufficient water shall be available in the material to slake the quicklime (if used) and to enable satisfactory mixing and compaction to be achieved. Any added water shall be through an integral spray-bar on the stabilising machine. Any added water shall have a sulfate content not exceeding 1400 mg/l as SO4 when tested in accordance with Test No. 1 of TRL report 447 (or equivalent test in accordance with BRE Special Digest 1).

**11** The layer shall receive at least two passes of the stabilising machine to pulverise and mix the lime and soil, after which the processing shall be interrupted by a period of not less than 24 hours and not greater than 72 hours, to enable the lime to react with the soil. Before this period commences the surface of the layer shall be sealed with one pass of a smooth wheeled roller having a mass per metre width of roll of not less than 2700 kg or a pneumatic tyred roller of not less than 1000 kg per wheel. At the end of this period the layer shall receive one further pass of the stabilising machine or more if required to enable the material to comply with sub-Clauses 9 and 13 of this Clause, adding water uniformly if necessary. Any added water shall have a sulfate content not exceeding 1400 mg/l as SO4 when tested in accordance with Test No. 1 of TRL report 447 (or equivalent test in accordance with BRE Special Digest 1).

**12** The stabilising machine shall be equipped with a device for controlling the depth of processing which shall be maintained at the correct setting at all times. An overlap of 150 mm shall be made between adjacent passes of the stabilising machine. Where a subsequent layer of material is placed on a layer previously stabilised the tines or blades of the stabilising machine shall be set so that they cut into the previously stabilised layer below by at least 20 mm.

**13** Each layer of Class 9D processed material shall be compacted as soon as possible after the final pass of the stabilising machine. Immediately before compaction the processed material shall have a Moisture Condition Value (MCV) of not greater than nor less than the figures stated in contract specific Appendix 6/1, for Class 9D lime stabilised material, both as determined in accordance with Clause 632.

**14** If there is a delay following the final pass and before commencement of compaction the surface shall be sealed by not less than 2 passes of a smooth-wheeled roller having a mass per metre width of not less than 2,700 kg or of a pneumatic tyred roller of not less than 1,000 kg mass per wheel. On recommencement and before compaction the layer shall be re-processed without the addition of lime, by a sufficient number of passes of the stabilising machine to meet the MCV requirements of sub-Clause 13 of this Clause adding water uniformly if necessary.

**15** The compaction of each layer shall comply with Clause 612, Table 6/4 Method 7 except that if layers more than 250 mm thick are constructed the number of passes of the compaction plant shall be those determined from results obtained on a demonstration area as detailed in contract specific Appendix 6/7.

**16** Class 9D material shall not have other material deposited or compacted above it until such time as the required bearing ratio in contract specific Appendix 6/1 has been achieved. The relaxation allowed in sub-Clause 617.2 shall not apply before this time.

## 616 Preparation and Surface Treatment of Formation

**Formation**

**1** The formation shall, after completion of any subgrade drainage, and immediately before laying sub-base (for

highways) or the Protection Layer on areas of completed formation, have a surface level tolerance defined in Table 616/1, or other level of tolerance defined in contract specific Appendix 6/7 or 6/7HSR relative to its designed level after completion of the following operations as necessary:

(i) Any sacrificial protection layer shall be removed and any soft or damaged areas shall be rectified by excavating them and replacing with acceptable material having the same characteristics and strength as the surrounding material. The surface of the formation shall be trimmed and immediately cleaned free from mud and slurry which shall be dealt with as unacceptable material in accordance with sub-Clause 601.2.

(ii) The formation shall immediately be compacted, in addition to the compaction required for the fill. For highway earthworks this additional compaction shall for this purpose be assumed to be as for a layer of 250 mm finished thickness compacted in compliance with Clause 612 and Table 6/4 Method 6 except for Class 3 materials where Method 4 shall be used. For HSR earthworks the compaction should be sufficient to satisfy the compaction requirements detailed in Table 6/1. Immediately after the additional compaction the formation shall be trimmed to achieve the tolerances of this sub-Clause.

**Table 616/1 Tolerances**

| Earthwork Element | Surface Tolerance |
|---|---|
| Formation (Highways) | +20mm/-30mm |
| Prepared Subgrade (HSR) | +10mm/-30mm |
| Upper Embankment Fill (HSR) | +20mm/-30mm |
| Lower Embankment Fill (HSR) | +20mm/-30mm |
| Starter Layer | +20mm/-30mm |
| Foundation | +20mm/-30mm |

**2** Where the tolerances in sub-Clause 1 of this Clause are exceeded, the Contractor shall determine the full extent of the area which is out of tolerance and shall make good the formation as follows:

(i) if the surface is too high it shall be re-trimmed and re-compacted in compliance with Clause 612 and sub-Clause 1 of this Clause;

(ii) if the surface is too low it shall be corrected by the addition of acceptable material complying with Table 6/1 having characteristics and strength matching the overlain material, deposited and compacted in compliance with Clause 608 and 612 and sub-Clause 1 of this Clause. In cohesive materials Classes 2 and 7, where this low surface is less than 150 mm below formation, material shall be removed to a depth of at least 150 mm below formation before the additional material is deposited and compacted.

**3** After trimming, or re-trimming if necessary, the formation shall be rolled with one pass of a smooth wheeled roller having a mass per metre width of roll not less than 2100 kg or, except for Class 3 material, a vibratory roller having a mass per metre width of vibrating roll of not less than 700 kg or a vibrating plate compactor having a mass per m² under the base plate of not less than 1,400 kg.

**4** Where required in contract specific Appendix 6/7 or 6/7HSR or where the tolerances in sub-Clause 1 of this Clause cannot be achieved in the preparation of formation in rock then one of the following shall be carried out so as to achieve the above tolerances:

(i) the material shall be excavated below formation to the depth described in contract specific Appendix 6/7 or 6/7HSR. For highways earthworks the excavated material shall be processed as described in contract specific Appendix 6/7 and re- deposited and compacted in compliance with Clauses 608 and 612 and Table 6/4 Method 6 in compacted layers not greater than 250 mm thick. For HSR earthworks the excavated material shall be processed as described in contract specific Appendix 6/7HSR and re- deposited and compacted in compliance with the compaction requirements of Table 6/1 in compacted layers not greater than 250 mm thick; or

(ii) where the rock surface is tabular it shall be regulated by depositing and compacting cement bound material as described in contract specific Appendix 6/7 or 6/7HSR, complying with the 1000 Series, or ST1 concrete to Clause 2602.

**5** The Contractor shall limit any areas of completed formation to suit the output of plant in use and the rate of deposition. No formation of cohesive material Classes 2 and 7 shall remain continuously exposed to rain causing

degradation or be left uncovered overnight.

**6** The preparation of formation on existing sub-base material (highways) shall be completed as described in contract specific Appendix 6/7.

**Protection Layer**

**7** The Protection Layer shall, after completion of any subgrade drainage, and immediately prior to installing the hydraulically bound layer or ballast on areas of completed Protection Layer, have a surface level tolerance defined in Table 616/2 relative to its designed level after completion of the following operations as necessary:

(i) Any sacrificial protection layer shall be removed and any soft or damaged areas shall be rectified by excavating them and replacing with acceptable material having the same characteristics and strength as the surrounding material. The surface of the formation shall be trimmed and immediately cleaned free from mud and slurry which shall be dealt with as unacceptable material in accordance with sub-Clause 601.2.

(ii) If granular the Protection Layer shall immediately be compacted, in addition to the compaction required for the fill. This additional compaction should be sufficient to satisfy the compaction requirements detailed in Table 6/1. Immediately after the additional compaction the formation shall be trimmed to achieve the tolerances of this sub-Clause.

**Table 616/2 Tolerances**

| Earthwork Element | Surface Tolerance |
|---|---|
| Protection Layer | +10mm/-10mm |

**8** Where the tolerances in sub-Clause 7 of this Clause are exceeded, the Contractor shall determine the full extent of the area which is out of tolerance and shall make good the formation as follows:

(i) if the surface is too high it shall be re-trimmed and re-compacted (if granular) in compliance with Clause 612 and sub-Clause 1 of this Clause;

(ii) if the surface is too low it shall be corrected by the addition of acceptable material complying with Table 6/1 having characteristics and strength matching the overlain material, deposited and compacted (if granular) in compliance with Clause 608 and 612 and sub-Clause 7 of this Clause.

**9** After trimming, or re-trimming if necessary, the Protection Layer (if granular) shall be rolled with one pass of a smooth wheeled roller having a mass per metre width of roll not less than 2100 kg or a vibratory roller having a mass per metre width of vibrating roll of not less than 700 kg or a vibrating plate compactor having a mass per m² under the base plate of not less than 1,400 kg.

**10** The Contractor shall limit any unprotected area of completed formation which is to receive the Protection Layer to suit the output of the plant in use and the rate of deposition of the Protection Layer.

## 617 Use of Sub-formation or Formation by Construction Plant

**1** Construction plant and other vehicular traffic (except that required for the construction of capping) shall not be operated on the sub-formation, unless adequate protection, if necessary in addition to any weather protection, is provided.

**2** Construction plant and other vehicular traffic (except for that required for preparation of the formation in compliance with Clause 616) shall not be operated on the formation unless adequate protection, if necessary in addition to any weather protection is provided.

**3** In addition to the requirements of sub-Clauses 1 and 2 of this Clause, the Contractor shall make available to the Contractor's Engineering Director and the Project Manager his proposals for the protection of the sub-formation or formation in areas where they are within 300 mm of the existing ground level, after topsoil (and, as necessary, subsoil) has been stripped, before using construction plant or other vehicular traffic at or above sub-formation or formation.

**4** For HSR earthworks, protection applied to formations (including interim formations within the body of the permanent earthworks and its foundations) shall ensure that no degradation occurs to any part of the underlying earthworks, including insipient damage or cumulative plastic strains arising from cyclic loading by earthworks traffic.

## 618 Topsoiling

**1** Topsoiling requirements are detailed in Series 3000 Landscape and Ecology, Series 3000 contract specific appendices, Series 3100 Soil Handling for Land Restoration and the relevant Soil Resource Plan or Soil Management Plan. All engineered slopes requiring topsoil fall under the requirements of 'seeding for landscape' as set out in Section 8 of Technical Standard – Landscape Maintenance, Management and Monitoring Plan (HS2-HS2-EV-STD-000-000023).

## 619 Earthwork Environmental Bunds

**1** Earthwork environmental bunds shall be constructed in the locations described in contract specific Appendix 6/9 with fill materials complying with the requirements therein and Clause 601 and Table 6/1. Deposition shall be in accordance with Clause 608 and compaction with the requirements of Table 6/1 unless otherwise described in contract specific Appendix 6/9 or the requirements of sub-Clauses 2 or 3 of this Clause apply.

**2** Earthwork environmental bunds formed of reinforced or anchored earth shall be constructed in compliance with Clauses 2502 and 622.

**3** Earthwork environmental bunds formed of strengthened embankments shall be constructed in accordance with Clause 621.

**4** Where required in contract specific Appendix 6/9 earthwork environmental bunds shall be topsoiled in accordance with Clause 618 and seeded, or turfed, all in accordance with Series 3000.

## 620 Landscape Areas

**1** Landscape areas shall be constructed in the locations shown in contract specific Appendix 6/9 with Class 4 material as described therein and complying with Table 6/1.

**2** Unless method compaction to Clause 612 is required in contract specific Appendix 6/9 the degree of compaction of Class 4 material shall be sufficient to remove large voids and to produce a coherent mass whilst preventing over-compaction and any build-up of excess pore pressures.

**3** Following completion of filling of landscape areas, Class 4 material shall where required in contract specific Appendix 6/9, be shaped as described therein.

**4** Class 4 material shall be deposited in landscape areas after any adjoining embankment or other area of fill has been completed. Where permitted in contract specific Appendix 6/9 and provided the adjoining embankment or other area of fill is always kept at least 1 m higher than the landscape area fill, construction of such landscape area may proceed until completion. Landscaping earthworks abutting HSR earthworks shall be constructed taking due account of their effect on ground movements of the HSR earthworks.

**5** Landscape areas shall be topsoiled in accordance with Clause 618 and seeded or turfed in accordance with Series 3000 and to the requirements of contract specific appendices.

## 621 Strengthened Embankments

**1** Strengthened embankments shall be constructed in the locations and to the details described in contract specific Appendix 6/9 with fill materials and strengthening materials described therein.

## 622 Earthworks for Reinforced Soil and Anchored Earth Structures

**1** The construction of earthworks for reinforced soil and anchored earth structures together with assembly and erection of reinforcing and anchor elements and associated components shall be in compliance with this Clause and Clause 2502.

**2** Excavation shall be carried out in compliance with Clause 604.

**3** Fill for reinforced soil structures shall, except for their associated drainage layers, be of Class 6I, 6J, 7B, 7C or 7D selected material complying with Table 6/1 as permitted in contract specific Appendix 6/1 together with any other additional requirements therein. Where Class 7B conditioned pulverised-fuel ash is used for fill, only non-metallic reinforcing elements shall be used and metallic fasteners shall be of stainless steel.

**4** Fill for anchored earth structures shall, except for their associated drainage layers, be of 6I or 6J selected material complying with Table 6/1 as permitted in contract specific Appendix 6/1 together with any other additional requirements therein.

**5** Drainage layers to reinforced soil and anchored earth structures shall be one of the following as appropriate:

(i) Class 6H material complying with Table 6/1 and contract specific Appendix 6/1.

(ii) for use with Class 7B material, uncrushed, partially crushed or crushed gravel sand complying with BS EN 12620, fines content category $f_3$ and sizes 0/4(CP), 0/4(MP) or 0/2(MP) and, when in contact with metallic components, with the properties listed in Table 6/3.

(iii) Type B filter drain material complying with Clause 505 for use only in horizontal drainage layers.

Vertical layers of drainage layer material shall be brought up at the same rate as the adjoining fill material without mixing or contamination.

**6** In addition to the requirements of sub-Clauses 7 and 8 of this Clause, fill for reinforced soil and anchored earth structures shall be deposited and compacted in compliance with Clauses 608 and 612 and Table 6/1, with method compaction for Classes 6H, 6I, 6J, 7C and 7D materials and end-product compaction for Class 7B material. Drainage layer material other than Class 6H shall be deposited in accordance with Clause 608 and compacted as described in contract specific Appendix 6/3.

**7** Reinforced soil and anchored earth structures shall have:

(i) the deposition and compaction carried out so that all layers of reinforcing and anchor elements are fixed at the required levels on top of compacted fill;

(ii) the deposition, spreading, levelling and compaction of the fill carried out generally in a direction parallel to the facing and executed in stages to alternate with the placing and fixing of the reinforcing and anchor elements and the facing elements;

(iii) the reinforcing and anchor elements kept as free as possible from damage or displacement during deposition, spreading, levelling and compaction of the fill (also the programme of filling shall be arranged so that no machines or vehicles run on the reinforcing or anchor elements);

(iv) all construction plant, and all other vehicles, having a mass exceeding 1,000 kg, kept at least 2 m away from the back of the facing;

(v) within 2 m of the back of the facing, the plant used for compacting the fill restricted to the following items as described in sub-Clause 612.10 and listed in Table 6/4:

(a) vibratory roller having a mass per metre width of roll not exceeding 1,300 kg with a total mass not exceeding 1,000 kg;

(b) vibrating plate compactor having a mass not exceeding 1,000 kg;

(c) vibro tamper having a mass not exceeding 75 kg;

(vi) at the Contractor's option, the reinforced soil and anchored earth fill beyond the 2 m zone referred to in (v) above, raised in thicker layers than within the 2 m zone, providing this is compatible with the arrangement of the reinforcing and anchor elements and the difference in compacted level does not exceed 300 mm;

(vii) during construction of the reinforced soil or anchored earth structure the retained fill at the rear of the structure, as defined in sub-Clause 8 of this Clause, maintained at the same level as the adjoining reinforced soil or anchored earth fill;

(viii) if the retained material at the rear of the reinforced soil or anchored earth structure, as defined in sub-Clause 8 of this Clause, is an existing earthwork or natural slope which requires supporting by temporary shoring, this shoring shall be removed progressively as the work proceeds to prevent the formation of voids.

**8** The rear of the reinforced soil or anchored earth structure is the position coinciding with the ends of the reinforcing or anchor elements furthest from the facing units.

## 623 Earthworks for Corrugated Steel Buried Structures

**1** The construction of earthworks for corrugated steel buried structures together with assembly and erection of their components shall be in compliance with this Clause and Clause 2501. Corrugated steel buried structures shall not be used in or below HSR earthworks.

**2** Excavation shall be carried out in compliance with Clause 604 and any additional requirements given in contract specific Appendix 6/3.

**3** Fill for corrugated steel buried structures shall be of the following selected granular materials complying with Table 6/1:

(i) Lower bedding material Class 6K;

(ii) Upper bedding material Class 6L;

(iii) Surround material Class 6M.

and the overlying fill shall be one of the following:

(iv) Well graded, uniformly graded or coarse, granular material Class 6Q; or

(v) Wet, dry, stony or silty cohesive material and chalk Class 7H.

**4** In addition to the requirements of sub-Clauses 5 to 14 of this Clause, Class 6K, 6L and 6M materials shall be deposited in compliance with Clause 608 and shall (except for Class 6L upper bedding material which shall be uncompacted) be end-product compacted in compliance with Clause 612 and Table 6/1, except that the compacted layers shall not exceed 150 mm thickness. The compaction and testing requirements for Class 6K lower bedding and Class 6M surround materials shall also comply with any additional requirements given in contract specific Appendix 6/3.

**5** As far as possible, the Class 6K lower bedding material shall be shaped to fit the invert such that it supports 20% of the circumference of circular structures or the whole of the portion of circumference occupied by the bottom plates of multi-radii structures. In the case of structures of span less than 3 m where this cannot be met and the structure is erected on a flat or partially preshaped bedding, care shall be taken to ensure that the lower bedding material is properly placed and compacted under the haunches. A uniform layer of uncompacted Class 6L upper bedding material shall be deposited before the placing of any part of the steel structure, over the whole width of the shaped lower bedding material and shall be of sufficient depth to fill the corrugations of the underside of the structure.

**6** Class 6M surround material shall be used for filling all excavations above the bedding, except those in hard material for which Class 6K lower bedding material shall be used throughout. Additional requirements for making good are given in Clause 604.

**7** Class 6M surround material shall be deposited and compacted uniformly on either side of the structure. The maximum difference in fill level on opposite sides of the structure shall be no more than 250mm at all times unless otherwise permitted in contract specific Appendix 6/3.

**8** Class 6M surround material shall be deposited and compacted in accordance with sub-Clause 4 of this Clause, above the concrete foundations of arch-profile corrugated steel buried structures.

**9** Class 6M surround material under the structure shall be well compacted by hand using a suitably sized pole or length of rectangular timber between the corrugations, or by another suitable method.

**10** Plant for compaction of Class 6M surround material within 1 m of either side of the structure and up to a height of 1 m, or one fifth of the span if greater, above the crown, shall be restricted to the following items, as described in sub-Clause 612.10 and listed in Table 6/4:

(i) vibratory rollers having a mass per metre width of roll not exceeding 750 kg;

(ii) vibrating plate compactors having mass not exceeding 750 kg;

(iii) vibro-tampers.

**11** Fill placed above the level of the crown of the structure, including Class 6M surround material, shall be deposited, spread and compacted in such a manner that any out of balance forces transmitted to the culvert are kept to a minimum. This will require that trafficking by construction plant is not all in one direction and that the compacted surface of the fill is kept as near horizontal as practicable.

**12** During all operations of filling, compaction, road pavement construction and of any other traffic movements which affect the shape of the structure, the changes in the horizontal and vertical diameters of the structure shall not exceed ± 5% for circular structures and ± 2% for structures of other cross-sections. The longitudinal straightness over any 10 m length of the structure shall not deviate by more than 25 mm, and the rotational displacement in any 10 m length of structure shall not be greater than 25 mm.

**13** Only that compaction plant described in sub-Clause 10 of this Clause, shall be used in the vicinity of the structure unless the depth of compacted Class 6M surround material placed above the crown of the structure is more than 1 m, or one fifth of the span, whichever is the greater. The structure shall not be subjected to a surcharge greater than the depth of fill required in the contract and permitted depth of any sacrificial protection layer given in contract specific Appendix 6/3.

**14** No material shall be placed by tipping either onto the structure or within a distance on either side of the structure of

2 m or half the span of the structure, whichever is the greater.

**15** Method compaction shall be used for the overlying fill (Classes 6Q and 7H) according to Clause 612; the method used being that for the corresponding general fill in Table 6/1.

## 624 Ground Anchorages

**1** The Contractor shall design the ground anchorages required as part of the permanent works and listed in contract specific Appendix 1/10, in accordance with the design requirements described in contract specific Appendix 6/10. The ground anchorages shall be installed and where required in contract specific Appendix 6/10 proof loaded, in accordance with the requirements therein.

**2** Ground anchorages not forming part of the permanent works will only be permitted where such anchorage will not affect the permanent works.

**3** Ground Anchors shall have at least triple corrosion protection to ensure that the design life of 120 years is achieved.

## 625 Crib Walling

**1** The Contractor shall design the crib walling listed in contract specific Appendix 1/10 in accordance with the design specification and procedures in contract specific Appendix 6/10 and Design Manual for Roads and Bridges document BD 68 (DMRB 2.1.3). Crib walls shall not be used to support HSR track loads.

## 626 Gabions

**1** Gabions shall be manufactured and constructed in compliance with this Clause and with requirements stated in contract specific Appendix 6/10. Gabion units shall be assembled in accordance with the manufacturer's instructions. Gabions shall not be used to support HSR track loads, conventional railway loads or highway carriageways.

**2** Unless otherwise stated in contract specific Appendix 6/10 they shall be filled with Class 6G material complying with Table 6/1. The grading of fill shall be as described in Appendix 6/10, the maximum size of fill material shall not exceed two thirds of the minimum dimension of the gabion compartment or 200mm whichever is smaller and the minimum size of the fill material shall be not less than the size of the mesh opening.

Gabion units shall be filled to fully achieve the required minimum cage density and compaction of fill. At no point before, during or after filling shall the cage be deformed by working methods or in use loading. The required cage density shall be as stated in contract specific Appendix 6/10. Internal tie wires shall be inserted and units shall be tensioned in accordance with the manufacturer's instructions. Gabion units shall be constructed so as to maintain tightness of mesh and shall be laced securely with wire, complying with sub-Clause 3 of this Clause.

**3** Gabion wire mesh units shall be woven steel wire conforming to BS EN 10223-3 or welded steel mesh conforming to BS EN 10223-8. The Contractor shall submit documentary evidence to the Contractor's Engineering Director to demonstrate compliance of the gabion units at least four weeks prior to the commencement of gabion work. Documentation that demonstrates compliance with a product acceptance scheme as described in Clause 104 sub- Clauses 15 and 16 can be supplied to meet this requirement where the scheme demonstrates that the gabion units meet the level of performance required by the specification.

Unless otherwise stated in contract specific Appendix 6/10 the site environment level shall be High Aggressive: C4; and the Assumed Working Life shall be 120 years or greater. Coating requirements for all wire shall be as required by Tables 1 and A.1 of BS EN 10223-3 and BS EN 10223-8.

**4** Unless otherwise stated in contract specific Appendix 6/10 woven steel gabions shall be of mesh designation 6x8 or 8x10 with minimum wire diameter of 2.7mm.

**5** Unless otherwise stated in contract specific Appendix 6/10 welded mesh shall be 3mm to 5mm diameter bars with the mesh size 75mm x 75mm maximum.

## 627 Swallow Holes and Other Naturally Occurring Cavities

**1** Infilled swallow holes and other naturally occurring cavities shall where required in contract specific Appendix 6/11 be excavated, filled and capped as described in contract specific Appendix 6/11.

**2** Open swallow holes and other shallow cavities shall, where required in contract specific Appendix 6/11, be flushed, cleared of rubbish where to do so would not endanger operatives, and filled and capped as described in contract specific Appendix 6/11. Any proposed mitigation measures for HSR earthworks must be compliant with the HS2 Earth Structure performance requirements in Table 4.2/1 of Technical Standard Earthworks HS2-HS2-GT-STD-000-000001. Where

possible, any proposed remedial treatment shall be maintenance free for the design life of the route. Where this is not possible low maintenance remedial treatments shall be proposed. Reference shall be made to Technical Note, Chalk Dissolution Feature Mitigation, P1C-ATK-GT-NOT-000-000001.

## 628 Disused Mine Workings

**1** Disused mine workings shall, where required in contract specific Appendix 6/11, be investigated, inspected, monitored, cleared, flushed, filled, capped or have any other treatment carried out, all as described in contract specific Appendix 6/11. Any proposed mitigation measures for HSR earthworks must be compliant with the HS2 Earth Structure performance requirements in Table 4.2/1 of Technical Standard Earthworks HS2-HS2-GT-STD-000-000001. Where possible, any proposed remedial treatment shall be maintenance free for the design life of the route. Where this is not possible low maintenance remedial treatments shall be proposed.

## 629 Instrumentation and Monitoring

**1** Instrumentation, other than that required in compliance with Clause 607, shall be as described in contract specific Appendix 6/12 and shall be installed in the locations shown therein.

**2** Monitoring of instrumentation shall be carried out as required in the contract specific Appendix 6/12 and the results supplied with the project records as required therein.

**3** Instrumentation shall be designed, installed and monitored and records kept, to demonstrate that all HSR geotechnical design elements meet the performance requirements of the Technical Standard – Earthworks (HS2-HS2-GT-STD-000-000001).

## 630 Ground Improvement

**1** For all ground improvement operations the Contractor must submit its proposals to the Contractor's Engineering Director with sufficient time for the acceptance process and the Project Manager for information. Any proposed Load Transfer Platforms must be included in the design submission. The proposal must demonstrate that the required end performance can be met both immediately post construction and also over the design life of the structure. All ground improvement carried out for HSR earthworks shall be to an end product specification that shall meet the end performance requirements. Specifications for ground improvement shall be included in contract specific Appendix 6/13.

**2** Complete records of plant, equipment, materials, rig records, instrumentation test results etc, including all information identified in Table 6/6 and any other information required by contract specific Appendix 6/13, shall be maintained during all ground treatment operations to enable validation of design and construction. All vertically intruding ground improvement (such as and including vibro stone columns, vibro concrete columns, controlled modulus columns, soil mixing (by vertical auger/mixing bar), sand piles etc.) shall comply with the control and reporting requirements of the ICE Specification for Piling and Embedded Retaining Walls 3rd Edition.

**3** The Contractor shall report immediately to the Contractor's Engineering Director and the Project Manager any circumstance which indicates that in the Contractor's opinion the ground conditions differ from those expected from its interpretation of the ground investigation reports and include details in the Geotechnical Feedback Report.

**Dynamic Compaction and High Energy Impact Compaction (HEIC)**

**4** Dynamic Compaction and High Energy Impact Compaction (HEIC) shall not be used under HSR Earthworks.

**5** Dynamic compaction, carried out to either method or end-product as required in contract specific Appendix 6/13 and achieved by dropping a free-falling heavy mass (pounder) a number of times at pre- determined spacings on the surface of the ground or fill, shall be applied to the areas described in contract specific Appendix 6/13.

**6** Dynamic compaction shall be completed before the commencement of construction of any permanent works, or work on the placement or diversion of Statutory Undertaker's equipment, within that part of the site defined in the contract specific Appendix 6/13 which contains the area to be dynamically compacted.

**7** The Contractor shall ensure that no damage or injury is caused to persons or property on or off the site as a result of the dynamic compaction.

**Vibrated Stone Columns**

**8** Vibrated stone columns in existing natural soils or fill by vibroreplacement or vibrodisplacement shall be formed in the manner and in the areas described in contract specific Appendix 6/13.

**9** Unless otherwise described in contract specific Appendix 6/13, materials shall comply with sub-Clause 11 of this

Clause.

**10** Columns shall be installed as shown on the drawings and within the permitted tolerances stated in contract specific Appendix 6/13.

**11** The material used to form the columns shall be clean, hard, inert material and shall be natural sand, gravel, crushed rock other than argillaceous rocks, crushed hardcore, crushed concrete, crushed slag or well burnt non-plastic shale. The material shall be appropriate to the ground conditions in which the stone columns are formed and its use shall not be detrimental to any other work on site. The material shall be nominally single sized coarse aggregate with a value of upper (D) sieve size in the range 10 mm to 40 mm or a graded material complying with Clause 804 (Type 2 unbound mixtures for subbase) except the material passing the 0.425 mm sieve shall be non- plastic when tested in accordance with BS1377: Part 2.

**12** Ground treatment by vibrated stone columns can use either the wet or dry process. The former method is more appropriate in weak silts and clay soils.

**13** Where the wet process is used, the vibrator must be kept in the hole continuously during backfilling in order to ensure the stability of the walls of the hole.

**14** Where the dry process is used, the ground to be treated must be sufficiently strong to keep the hole open until the backfilling process is complete. The Contractor shall demonstrate that the hole is kept open whilst backfilling takes place, ensuring clean placement of a vibrated stone column from the base of the hole to the working surface. Alternatively, the Contractor shall demonstrate that he has plant and equipment which allow feeding of backfill material to the base of the hole without removing the vibrator.

**15** Where vibrated stone columns are proposed under HSR, an instrumented trial shall be undertaken prior to construction of the main works to demonstrate compliance with the end-performance requirements.

**Other Methods**

**16** Other methods of ground improvement shall be carried out where required in contract specific Appendix 6/13 and as described therein.

**17** Where shallow soil mixing is proposed, the Contractor shall carry out sufficient laboratory tests with particular reference to binder mixes to demonstrate compliance with heave tolerances in the Technical Standard – Earthworks (HS2-HS2-GT-STD-000-000001).

**18** Where surcharging, wick drains or vacuum consolidation are proposed the Contractor shall undertake appropriate monitoring to record the responses of the underlying strata including settlement and changes in pore water pressure. The Contractor should allow sufficient contingency in planning and placement, for lost/damaged instruments.

**19** Soil nails used as permanent works shall have at least triple corrosion protection to ensure that the design life of 120 years is achieved. Self-drilling soil nails into HSR earthworks shall not be permitted.

**20** Results from soil nail pull out tests in accordance with BS EN 14490 shall be provided within the project records after verification of the test.

**21** Where grouting is proposed as part of the ground improvement strategy, reference shall be made to the Series 4071 on grouting.

**22** Not used.

**Testing of Ground Treatment**

**23** Testing of ground shall be undertaken for control purposes prior to treatment, during the treatment and on completion of the ground treatment in accordance with contract specific Appendix 6/13. The performance criteria for treated ground are given in contract specific Appendix 6/13.

**24** Improvement in treated ground shall be measured in accordance with the criteria stated in contract specific Appendix 6/13.

**Types of Test**

**25** The following tests or alternatives permitted in contract specific Appendix 6/13 shall be carried out at the positions and frequency given in contract specific Appendix 6/13. For HSR earthworks, the types of test shall also include those

required by the Technical Standard - Earthworks (HS2-HS2-GT-STD-000-000001).

**Plate tests**

**26** Plate bearing tests for non-HSR earthworks are loading tests carried out using a plate on treated ground. The test is described in BS 1377: Part 9: 1990 Method 4.1. Plate loading tests for HSR earthworks to derive $E_{v2}$ values shall be in accordance with Clause 612.14.

**Zone Tests**

**27** Zone tests are loading tests carried out with a slab, intended to test bearing pressure over a wider and deeper zone than in the plate tests. The test is described in BS 1377: Part 9: 1990 Method 4.2.

**Penetration Tests**

**28** In granular soils the static cone (Dutch cone) penetration test, the standard penetration test (SPT) or dynamic cone penetration tests shall be employed as described in contract specific Appendix 6/13.

**Trial Areas**

**29** Trial areas are to be treated and tested where required in contract specific Appendix 6/13. Trial areas which meet the performance requirements may form part of the permanent works.

**30** Equipment and materials used in trial areas shall be identical to those proposed for the permanent works.

**31** Testing in trial areas shall be carried out as given in contract specific Appendix 6/13.

**32** Detailed reports shall be prepared for all testing as defined in Table 6/6 and contract specific Appendix 6/13.

## 631 Earthworks Materials Tests

**1** Unless otherwise described in the contract sampling and testing of earthworks materials shall be carried out in accordance with BS 1377: Part 1 to Part 9 inclusive.

**Sulphate testing of imported aggregates**

**(P06) 2** Where this specification requires testing in accordance with TRL 447, if the materials to be tested are imported aggregates, then BS EN 1744 may be used instead. The following conditions are placed on the use of BS EN 1744 (based on Czerewko et al., 2016):

(i) BS EN 1744-1 Clause 10.2 shall not be used for assessment of water-soluble sulphate in recycled aggregates;

(ii) BS EN 1744-1 Clause 11.1 shall not be used for total sulphur (TS) determination;

(iii) BS EN 1744-1 Clause 13 shall not be used to determine total reduced sulphur;

(iv) If BS EN 1744-1 Clause 13 is used to determine monosulphide sulphur (MS), a longer digestion period of 30 minutes shall be used.

## 632 Determination of Moisture Condition Value (MCV) of Earthworks Materials

**1** Where the Moisture Condition Value (MCV) is to be determined, the determination shall be carried out in accordance with BS 1377: Part 4.

**2** The determination of the MCV/moisture content relation in accordance with BS 1377: Part 4 shall be carried out when required in contract specific Appendix 6/1.

**3** Where permitted in contract specific Appendix 6/1 the rapid assessment procedure for material acceptability also given in BS 1377: Part 4 may be used.

## 633 Determination of Undrained Shear Strength of Remoulded Cohesive Material

**1** Where required in contract specific Appendix 6/1, the undrained shear strength of cohesive soil under total stress conditions shall be determined from triaxial compression tests performed on remoulded specimens and tested under conditions where the lateral pressure is maintained constant and there is no change in total water content of the specimens. Unless otherwise required in contract specific Appendix 6/1, the tests shall be in accordance with BS 1377: Part 7 and the additional requirements of sub-Clauses 2 to 4 of this Clause.

**2** The specimens shall be prepared in accordance with BS 1377: Part 7 using remoulded material compacted into a split mould of nominal diameter 100 mm and nominal height 200 mm. The soil shall be at its natural moisture content and compacted in accordance with BS 1377: Part 1 using the 2.5 kg rammer method described in BS 1377: Part 4.

**3** The specimens shall be tested at an operating cell pressure of 200 ± 10 kN/m² and an axial strain rate of 1% per minute. Where contract specific Appendix 6/1 requires c and φ to be determined, the test shall be modified to enable Mohr circles to be plotted and c and φ reported.

**4** Where stated and described in contract specific Appendix 6/1, other tests may be used during construction to supplement the test described above, provided the results have been correlated to ensure compatibility.

## 634 Determination of Intact Lump Dry Density (IDD) of Chalk

**1** The intact lump dry density (IDD) of chalk lumps shall be determined in accordance with BS 1377: Part 2.

## 635 Los Angeles and Other Tests for Particle Soundness

**Resistance to Fragmentation – Los Angeles Coefficient (LA)**

**1** The value of Los Angeles coefficient shall be determined in accordance with BS EN 1097-2.

**Other Tests for Particle Soundness**

**2** Where this specification requires magnesium sulfate soundness tests to be carried out, they shall be carried out in accordance with BS EN 1367-2. Where contract specific Appendix 6/1 requires slake durability, point load or other tests for soundness to be carried out, they shall be carried out in accordance with the procedures given therein.

## 636 Determination of Effective Angle of Internal Friction (φ') and Effective Cohesion (c') of Earthworks Materials

**1** The effective angle of internal friction φ' and effective cohesion c' shall be determined by shear box or triaxial tests as required in Table 6/1 and contract specific Appendix 6/1. Unless otherwise required in contract specific Appendix 6/1, the tests shall be in accordance with the requirements in sub-Clauses 2 to 6 of this Clause.

**Shear Box Tests**

**2** For Classes 6N, 6P, 6I and 6J granular materials, the tests shall be carried out in accordance with BS 1377: Part 7 and the following:

(i) The plan size of the shear box shall be nominally 300 mm square.

(ii) Three samples shall be tested, each sample occupying the full depth of the shear box and shall be compacted at the optimum moisture content to a dry density of 92% ± 2% of the maximum dry density determined in accordance with BS 1377: Part 4 using the vibrating hammer method. The samples shall not be immersed in water.

(iii) Each of the samples shall be subjected to a different normal stress equal to the maximum vertical pressure in the fill at the base, quarter height and mid-height of the structure respectively. Each of the samples shall be sheared in a single stage test within one hour of compaction and the rate of shearing shall be such that no pore water pressure is generated.

(iv) The values of c' and φ' reported shall be those corresponding to the maximum strength envelope.

**3** For Classes 7A, 7C and 7D cohesive materials, the tests shall be carried out in accordance with BS 1377: Part 7 and the following:

(i) The shear boxes shall be nominally 300 mm square and nominally 60 mm square.

(ii) For the initial determination of fill properties three samples shall be tested in each size of shear box. The samples shall occupy the full depth of the shear box and shall be compacted at the optimum moisture content to a dry density of 92% ± 2% of the maximum dry density determined in accordance with BS 1377: Part 4 using the 4.5 kg rammer method. To allow the samples to soften, the shear box assembly shall then be immersed in water for a minimum period of 24 hours.

(iii) Each of the three samples in a set shall be subjected to a different effective normal stress equal to the maximum vertical pressure in the fill at the base, quarter height and mid-height of the structure respectively. Normal stresses shall be applied to the softened sample for a minimum period of 24 hours

prior to shearing in a single stage test. The rate of shearing shall be such that no pore water pressure is generated.

(iv) The values of c' and φ' reported shall be those corresponding to the maximum strength envelope.

(v) The test results obtained using the 300 mm square box shall be taken as the properties of the fill. The initial test results obtained using the 60 mm square box shall be used for the subsequent quality control of the fill.

**4** For Class 7B pulverised-fuel ash material, the procedure shall be as for sub-Clause 3 of this Clause except that:

(i) The maximum dry density and optimum moisture content shall be determined in accordance with BS 1377: Part 4 using the 2.5 kg rammer method.

(ii) An additional sample in each set shall be subjected to an effective normal stress equal to the maximum vertical pressure in the fill at three quarters of the height of the structure or the lowest attainable normal stress, whichever is the greater.

(iii) As soon as the shear box has been filled and the sample compacted, the normal stress shall be applied and the sample immersed in water. This concurrent loading and immersion of the sample shall continue for a period of 24 hours and the sample shall then be sheared without further delay.

**Triaxial Tests**

**5** Where Class 7A cohesive fill to structures is to be tested by a consolidated drained triaxial test, the test shall be in accordance with BS 1377: Part 8 using the sample size and preparation procedure in Clause 633 and the requirements of contract specific Appendix 6/1.

## 637 Determination of Resistivity ($r_s$) to Assess Corrosivity of Soil, Rock or Earthworks Materials

**Method of Test**

**1** Where the resistivity of the ground or of material to be used in the permanent works is required to be determined, this shall be obtained by in situ tests as described in sub-Clause 2 of this Clause or, when required in contract specific Appendix 6/1, by laboratory tests on samples in accordance with BS 1377: Part 3.

**In Situ Resistivity Tests**

**2** In situ resistivity shall be determined at the site of the structure or the cutting or the proposed borrow pit or on stockpiles in accordance with BS 1377: Part 9 and the requirements of contract specific Appendix 6/1.

**3** Details of the area and volume of material to be tested shall be made available to the Contractor's Engineering Director together with the arrangement of electrodes in each test. The Contractor's Engineering Director shall be given notice of the date, time and location of each test.

**4** At any test location, at each selected depth, two measurements shall be made such that the electrode alignment for the second measurement is approximately at right angles to the electrode alignment for the first measurement.

**5** At any test location, the first selected depth shall be no more than 1.5 m below the ground surface or no more than 1.5 m below the upper surface of the material to be tested, whichever is appropriate. Following the measurements at the first selected depth, further measurements shall be made at selected depths increasing by approximately 2 m each time until measurements have been carried out on the full depth of ground or material to be tested.

**6** Where the depth of material to be tested is too great to be tested from the surface within the confines of the site, the Contractor shall undertake all necessary arrangements for testing such material, including subsequent tests which may be required at a lower level following excavation. Details of his arrangements shall be made available to the Contractor's Engineering Director.

## 638 Determination of Redox Potential ($E_h$) to Assess Corrosivity of Earthworks Materials for Reinforced Soil and Anchored Earth Structures

**Method of Test**

**1** Where the redox potential of material to be incorporated into reinforced earth or anchored earth structures is required to be determined, this shall be obtained by in situ tests as described in sub-Clauses 2 to 6 of this Clause or, when required in contract specific Appendix 6/1, by laboratory tests on samples in accordance with BS 1377: Part 3.

**In Situ Redox Potential Tests**

**2** In situ redox potential shall be determined in undisturbed ground at the site of the cutting or the proposed borrow pit or on stockpiles in accordance with BS 1377: Part 9 and the requirements of contract specific Appendix 6/1.

**3** Details of the area and volume of material to be tested shall be made available to the Contractor's Engineering Director together with the locations of the test pits.

**4** The Contractor's Engineering Director shall be given notice of the date, time and location of each test.

**5** At each test location the tests shall be carried out in a test pit not less than 600 mm square in plan excavated to a depth given in contract specific Appendix 6/1.

**6** At each test location, a sample shall be taken from the base of the excavation and kept in a hermetically sealed container for determining the pH value of the fill which shall be obtained in accordance with BS 1377: Part 3.

## 639 Determination of Coefficient of Friction and Adhesion Between Fill and Reinforcing Elements or Anchor Elements for Reinforced Soil and Anchored Earth Structures

**Reinforcing Elements**

**1** The coefficient of friction and the adhesion shall be determined by tests carried out in a 300 mm size shear box with the element material fixed at the top of the lower half of the box and the fill sample occupying the top half only.

**2** The test shall be carried out following the procedure given in Clause 636 for the determination of the effective angle of internal friction and effective cohesion of earthworks materials except that:

(i) The apparatus shall in addition include a steel block fitting closely inside the lower half of the shear box and equal in height to it less the thickness of the reinforcing element material. (The flat toothed grid fitting the bottom of the shear box is not required).

(ii) The preparation of test specimens shall be as follows:

Element material shall be cut to fit the interior plan shape of the shear box using a sufficient number of strips of such material abutting to completely fill the interior plan area without overlap. They shall be firmly fixed to the top of the steel block so that the top face of the material is flush with the top edge of the lower half of the box and aligned so that shearing occurs in a direction parallel to the longitudinal axis of a reinforcing element.

A sample of the fill material to be used in the permanent works, of sufficient size to carry out the tests, and within the range of moisture contents permitted in Table 6/1 for such material, shall be sieved to obtain a test sample passing the 20 mm BS sieve, of sufficient quantity after compaction to fill the top half of the shear box. The top and bottom of the shear box shall be fixed together and the test sample of the sieved fill materials immediately placed and compacted in the top half of the box as described in Clause 636.

**3** The value of the coefficient of friction between the fill and the reinforcing element shall be obtained by plotting the values of peak shear stress, obtained in the tests, against applied normal stress and by measuring the slope of the resulting straight line graph. The adhesion between the fill and the reinforcement shall be obtained by taking the shear stress corresponding with zero normal stress.

**4** The following additional information shall be recorded for each test:

(i) Normal stress applied ($kN/m^2$).

(ii) Peak shear stress ($kN/m^2$).

(iii) Strain at peak shear stress (%).

(iv) Moisture content of fill after test (Classes 7B, 7C and 7D).

**Anchor Elements**

**5** Where required in contract specific Appendix 6/1, tests shall be carried out as described therein to assess the interaction between the fill and the element.

## 640 Determination of Permeability of Earthworks Materials

**1** Where required in Table 6/1 or contract specific Appendix 6/1 the permeability of earthworks materials shall be determined as described in contract specific Appendix 6/1.

## 641 Determination of Available Lime Content of Lime for Lime Stabilised Capping or HSR Earthworks Material

**1** Contract compliance testing shall be carried out by the Contractor to determine the available lime content of lime as installed for lime or lime and cement stabilised capping or HSR Earthworks. This compliance testing shall be carried out in accordance with BS EN 459-2 except that the sample increments shall be taken from the collecting tray used to check the rate of spread at intervals of one increment per 500 m per lane.

**2** The available lime content shall be determined as required by BS EN 459-2, it shall be reported and categorised as required in BS EN 459-1.

## 642 Determination of the Constrained Soil Modulus (M*) of Earthworks Materials for Corrugated Steel Buried structures (non-HSR Earthworks Only)

### General

**1** When required in contract specific Appendix 6/1, the constrained soil modulus M* shall be determined by one of the following methods:

(i) From plate loading tests in accordance with BS 1377: Part 9.

(ii) From the results of Standard Penetration resistance tests (SPT) on non-cohesive materials in accordance with BS 1377: Part 9.

(iii) From the values of the coefficient of volume compressibility ($m_v$) from one-dimensional consolidation tests on undisturbed soil specimens of cohesive materials, in accordance with BS 1377: Part 5.

### Plate Loading Tests

**2** When testing compacted granular fill materials the test surface shall be prepared by either:

(i) removing the surface layer carefully using hand tools to perform the test at a depth of 100 mm below the surface; or

(ii) compacting the surface, after the required compaction has been applied, with two additional passes with no vibration to remove the overstressing in the surface layer.

If necessary, the plate shall be bedded onto the fill using a small quantity of dry sand to remove any slight unevenness of the surface of the fill. The field dry density and moisture content shall be determined at the position of each plate loading test in accordance with Clause 612 and BS 1377: Part 2 or equivalent, respectively.

**3** When using the plate loading test to determine M* of the material existing on site a smooth surface shall be prepared by careful hand excavation and the plate bedded onto the soil using either sand or quick setting gypsum plaster depending on whether the soil is granular or cohesive.

**4** The loading test shall be carried out under a series of maintained loads. The maximum load shall be such that the average pressure applied to the plate is in excess of 350 kN/m². The elastic modulus $E_s$ shall be determined as the secant modulus between average pressures applied to the plate of 150 and 350 kN/m² in the first load cycle.

**5** A value of Poisson's ratio of 0.3 shall be assumed. A second load cycle testing shall also be conducted and the results of this test compared with the first load cycle to check that the plate was seated satisfactorily during the first load cycle. If the results of the first load cycle suggest that the plate was not seated satisfactorily, then the procedure shall be repeated at a new location. Second load cycle results shall not be used to demonstrate the adequacy of the material being tested.

**6** The constrained soil modulus M* shall be determined from the elastic modulus $E_s$ using the equation:

$$M^* = \frac{(1 - \nu)E_s}{(1 + \nu)(1 - 2\nu)} \ (N/mm^2)$$

where $\nu$ = Poisson's ratio to be taken as 0.3 and $E_s$ = Elastic modulus of the soil (N/mm$^2$)

**Standard Penetration resistance Tests**

**7** The constrained soil modulus M* of non-cohesive materials existing on site shall be determined from the relationship:

$$M^* = \frac{0.39N^{1.4}}{\gamma_m} \quad (N/mm^2)$$

Where N = uncorrected SPT value and $\gamma_m = 1.3$

**One-dimensional Consolidation Tests**

**8** The constrained soil modulus M* of undrained cohesive materials existing on site shall be determined from the formula:

$$M^* = \frac{1}{m_v} \quad (N/mm^2)$$

where $m_v$ (mm$^2$/N) is the coefficient of volume compressibility

The value of $m_v$ to be used in the formula is that calculated from the test results for the loading increment in the consolidation test corresponding to the in situ effective overburden pressure at the level of the crown of the structure.

**Number of Tests**

**9** Three tests for M* shall be carried out on the soil occurring on each side of the structure, one of which is to be at the level of the maximum span, unless otherwise described in contract specific Appendix 6/1.

## 643 Lime and Cement Stabilisation to Form Capping (non-HSR Earthworks Only)

**1** Where capping is to consist of, either wholly or in part, lime and cement stabilised material Class 9E or 9F, this Clause shall apply to the construction of those parts which are stabilised with lime and cement.

**2** Material to be stabilised with lime and cement shall be Class 6R or 7I material all complying with Clause 601 and Table 6/1.

**3** The form of lime used for lime and cement stabilisation shall be as required in contract specific Appendix 6/7, the lime shall conform to BS EN 459-1 and meet the performance requirements stated in contract specific Appendix 6/7. This shall be demonstrated by the Declaration of Performance. Unless otherwise stated in contract specific Appendix 6/7 lime shall be either quicklime or hydrated lime conforming to BS EN 459-1. The particle size distribution of all types of quicklime shown in Tables 1 and 8 of BS EN 459-1 shall be of designation P4 as shown in Tables 5 and 12 of BS EN 459-1.

**4** The Contractor shall carry out testing of the lime as installed for available lime in accordance with Clause 641 at weekly intervals unless otherwise required in contract specific Appendix 6/7 during periods when lime and cement stabilisation is carried out. The results shall be provided by the Contractor in the project records. The available lime shall meet the requirements stated in contract specific Appendix 6/7 and the values stated in the Declaration of Performance.

**5** Cement for lime and cement stabilisation shall be Portland cement complying with BS EN 197-1, unless otherwise described in contract specific Appendix 6/7.

**6** Classes 6R and 7I material to be stabilised shall have added to it, at any point, the percentage of its dry weight of lime and cement as determined on the demonstration area, to meet the required bearing ratio in contract specific Appendix 6/1, subject to a minimum of 1% by weight of 'available lime' and 2% cement as a percentage of the dry weight of the 6R and 7I materials.

**7** The Contractor shall not carry out lime and cement stabilisation when the shade temperature is below 3°C unless on a rising thermometer above 0°C. Lime and cement stabilisation shall not be carried out during periods of rain or when rain is imminent. When cement is spread on material likely to cause premature hydration, processing in accordance with sub-Clause 16 of this Clause shall follow immediately.

**8** Lime of quantity complying with sub-Clause 6 of this Clause shall be uniformly spread by a suitable spreading machine on top of the layer to be stabilised. Using a collecting tray and balance the Contractor shall check the rate of spread by weight, once for every 500 m$^2$ of lime spread or a different rate of testing for the rate of spread as described in

contract specific Appendix 6/7. At the same time the Contractor shall collect samples of lime deposited on the tray and test them for available lime content in accordance with Clause 641.

**9** Unless indicated otherwise in contract specific Appendix 6/7, the material shall be stabilised in a single layer if its compacted thickness is 250 mm or less. If its compacted thickness is greater, the material shall be stabilised in layers not less than 130 mm and not more than 250 mm thick, including any cutting-in required by sub-Clause 13 of this Clause.

**10** Unless indicated otherwise in contract specific Appendix 6/7, the material forming the layer to be stabilised shall be processed by pulverising and mixing in the lime by means of sufficient number of passes of a suitable mobile stabilising machine until 95% of the Class 9E or 95% of the silt and clay fraction of Class 9F processed material passes a BS 28 mm sieve after dry sieving and the pulverisation complies with Table 6/1.

**11** During processing sufficient water shall be available in the material to slake the quicklime (if used) and to enable satisfactory mixing and compaction to be achieved. Any added water shall be through an integral spray-bar on the stabilising machine. Any added water shall have a sulfate content not exceeding 1400 mg/l as SO4 when tested in accordance with Test No. 1 of TRL report 447 (or equivalent text in accordance with BRE Special Digest 1).

**12** The layer shall receive at least two passes of the stabilising machine to pulverise and mix the lime and soil, after which the processing shall be interrupted by a period of not less than 24 hours and not greater than 72 hours to enable the lime to react with the soil. Before this period commences the surface of the layer shall be sealed with one pass of a smooth wheeled roller having a mass per metre width of roll of not less than 2700 kg or a pneumatic tyred roller of not less than 1000 kg per wheel. At the end of this period the layer shall receive one further pass of the stabilising machine or more if required to enable the material to comply with sub-Clauses 10 of this Clause.

**13** The stabilising machine shall be equipped with a device for controlling the depth of processing which shall be maintained at the correct setting at all times. An overlap of 150 mm shall be made between adjacent passes of the stabilising machine. Where a subsequent layer of material is placed on a layer previously stabilised the tines or blades of the stabilising machine shall be set so that they cut into the previously stabilised layer below by at least 20 mm.

**14** The appropriate quantity of cement shall be uniformly spread, by a suitable spreading machine, on top of the layer previously processed with lime. Using a collecting tray and balance the Contractor shall check the rate of spread of the machine once for every 500 $m^2$ of cement spread.

**15** Unless indicated otherwise in contract specific Appendix 6/7, the material previously mixed with lime shall be stabilised with cement in a single layer or in layers of the same compacted thickness as for the lime mixed material layers, including any cutting-in required by sub-Clause 13 of this Clause.

**16** Unless indicated otherwise in contract specific Appendix 6/7, the material forming the layer to be stabilised shall be processed by pulverising and mixing in the cement by means of a sufficient number of passes of a suitable mobile stabilising machine until 95% of the silt and clay fraction is reduced to particles or lumps passing a BS 28 mm sieve after dry sieving and the pulverisation complies with Table 6/1.

**17** During processing, sufficient water shall be available in the material to hydrate the cement and enable satisfactory mixing and compaction to be achieved. Any added water shall be through an integral spray-bar on the stabilising machine. Any added water shall have a sulfate content not exceeding 1400 mg/l as SO4 when tested in accordance with Test No. 1 of TRL report 447 (or equivalent text in accordance with BRE Special Digest 1).

**18** The stabilising machine shall be equipped with a device for controlling the depth of processing which shall be maintained at the correct setting at all times. An overlap of 150 mm shall be made between adjacent passes of the stabilising machine. Where a subsequent layer of material is placed on a layer previously stabilised the tines or blades of the stabilising machine shall be set so that they cut into the previously stabilised layer below by at least 20 mm.

**19** Each layer of Class 9E or 9F processed material shall be compacted as soon as possible after the final pass of the stabilising machine. Compaction shall be completed within 2 hours following the mixing of the cement into the material to be stabilised. Immediately before compaction Class 9E processed material shall have a Moisture Condition Value (MCV) of not greater than 12 nor less than the figure stated in contract specific Appendix 6/1 both as determined in accordance with Clause 632. Water shall be added if necessary in a uniform manner to enable this MCV requirement to be met. Any added water shall have a sulfate content not exceeding 1400 mg/l as SO4 when tested in accordance with Test No. 1 of TRL report 447 (or equivalent text in accordance with BRE Special Digest 1.

**20** The compaction of each layer of Class 9E or 9F material shall comply with Clause 612, Table 6/4 Method 7, except that if layers of Class 9E or 9F greater than 250 mm thickness are to be constructed, the number of passes of the compaction plant shall be determined from the results of a demonstration area as detailed in contract specific Appendix 6/7.

**21** Class 9E and 9F materials shall be cured in accordance with Clause 1035. During periods when the air temperature

is forecast to drop below 3°C or when ground frost is forecast Class 9E and 9F material shall be protected, to prevent freezing, for a period of 7 days from the time of completion of compaction. Such protection shall be sealed to prevent the ingress of moisture.

**22** Class 9E and 9F materials shall not have other material deposited or compacted above them until such time as the required bearing ratio in contract specific Appendix 6/1 has been achieved. The relaxation allowed in sub-Clause 617.2 shall not apply before this time.

## 644 Determination of Sulfate Content

**1** Where required in Table 6/1 or contract specific Appendix 6/1, the effects of water-soluble sulfate, oxidisable sulfides and total potential sulfate shall be assessed in accordance with TRL Report 447, Test Nos. 1 to 5 and BRE Special Digest 1 as appropriate.

**2** Test results and limiting values for sulfate shall be given as $SO_4$.

**3** At least five samples of each material shall be tested for WS, OS, TPS and sulphides. The mean of the highest two values shall be used for comparison with the limiting values. This also applies if six to nine results are available. If ten or more results are available, the mean of the highest 20% of the results shall be used for comparison with the limiting values.

**4** Determination of acid-soluble sulphate shall not be made using BS1377-5.

## 645 HSR Foundation

**1** The Foundation to HSR earthworks shall meet the end-product and end-performance requirements as specified in the HS2 Technical Standard – Earthworks, HS2-HS2-GT-STD-000-000001 and the contract specific Appendix 6/3.

**2** Contract specific Appendix 6/3 describes the testing required of the Foundation to demonstrate that the requirement of sub-Clause 1 of this Clause have been met.

## 646 Prepared Subgrade and Protection Layer

**1** Prepared Subgrade and the Protection Layer shall be provided only in those locations, and to the extent, particularly stated in contract specific Appendix 6/7HSR to be constructed with Prepared Subgrade and the Protection Layer. They shall comply with this Clause.

**2** Where this Clause refers to the Protection Layer, it is only applicable if a granular (rather than bituminous) Protection Layer is used.

**3** (P06) Prepared Subgrade shall be constructed with Class 6F8 or~~and~~ 6F9 material complying with Table 6/1 or CBGM as required or permitted in contract specific Appendix 6/7HSR~~ and complying with Table 6/1~~. The Protection Layer shall be constructed with Class 6F6 or~~and~~ 6F7 ~~and~~ complying with Table 6/1 or CBGM as required or permitted in contract specific Appendix 6/7HSR.~~ Stabilised materials shall not be used for the Prepared Subgrade and Protection Layer.~~ For the Prepared Subgrade and the Protection Layer, CBGM is cement bound granular material complying with the requirements of SCEW Series 800 Clause 821, 822 or 823 with the additional requirement that the aggregate shall have a Los Angeles abrasion value ≤50%.

**4** (P06) Outside of locations where CBGM is specified, Prepared Subgrade shall consist of one Class/type of aggregate of Prepared Subgrade material throughout its depth, laterally and between consecutive underbridges or viaducts, laid in one or more layers of compacted thickness complying with Clause 612.

**5** Where required in contract specific Appendix 6/7HSR, before commencing the construction of the Prepared Subgrade and the Protection Layer in the permanent works, the Contractor shall demonstrate the methods, equipment and materials he proposes to use by constructing an area, or areas as appropriate, of Prepared Subgrade and the Protection Layer on a typical prepared sub-formation to the same thickness as required in the permanent works. The area of each construction demonstration shall be not less than 700 m².

**6** The materials placed during the demonstration may form part of the permanent works, provided they meet the requirements of the contract, or the demonstration may be carried out elsewhere on the site where this is detailed in contract specific Appendix 6/7HSR. After completion of each demonstration area the Contractor shall within a period of not greater than 5 days and before commencing the main construction of the appropriate prepared Subgrade and the Protection Layer in the permanent works, carry out tests on each demonstration area and provide the Contractor's Engineering Director with records for acceptance substantiating compliance with the performance requirements (Technical Standard – Earthworks, HS2-HS2-GT-STD-000-000001). Where required by contract specific Appendix 6/7HSR the Contractor shall provide sheeting, to protect the demonstration area.

**7** The demonstration area shall, if it does not meet the requirements for the permanent works or is located elsewhere on site, be removed and the area reinstated in accordance with contract specific Appendix 6/7HSR.

**8** The methods and materials used in the accepted demonstration shall not be changed during the course of the works without the construction of a further demonstration meeting the requirements of this Clause.

**9** Unless otherwise stated in contract specific Appendix 6/7HSR, the sub-formation shall have the same longitudinal gradient, crossfall and surface level tolerances as the formation.

**10** The Contractor shall limit any unprotected area of sub-formation, which is to receive Prepared Subgrade to suit the output of the plant in use and the rate of deposition of Prepared Subgrade.

**11** No unprotected sub-formation which is to receive Prepared Subgrade shall remain continuously exposed to rain causing degradation, nor be left uncovered overnight.

**12** In cuttings the Contractor shall excavate below formation level to a depth to accept the Prepared Subgrade, trim the surface to form the sub-formation and immediately compact with one pass of a smooth-wheeled roller having a mass per m width of roll not less than 2,100 kg or a vibratory roller having a mass per m width of roll not less than 700 kg or a vibrating plate compactor having a mass per m² of not less than 1,400 kg, except that only smooth wheeled rollers shall be used on Class 3 chalk material, and immediately deposit and compact above it Prepared Subgrade material.

**13** On embankments and other areas of fill the Contractor shall complete the embankment to form the sub-formation or remove any sacrificial protection layer and trim the surface to form the sub-formation, and in both cases compact with one pass of a smooth-wheeled roller having a mass per m width of not less than 2,100 kg or a vibratory roller of not less than 700 kg per m width or a vibrating plate compactor having a mass per m² of not less than 1,400 kg, (except that only smooth- wheeled rollers shall be used on Class 3 chalk material) and immediately construct above it, in one or more layers, Prepared Subgrade material.

**14** Filter layers constructed of Class 6S granular filter layer material shall be protected from damage by traffic and construction plant. The Contractor shall so organise work that only the traffic directly engaged in depositing, spreading and compacting the filter layer shall be permitted access to the surface of this layer. At no time shall the Contractor permit the leading edge of the filter layer to extend more than 100 metres beyond the leading edge of the succeeding layer of subbase.

## 647 Cement Stabilisation to Form HSR Earthworks Materials

**1** Where HSR Earthworks are to consist of, either wholly or in part, cement stabilised material Class 9G, 9H or 9I, this Clause shall apply to the construction of those parts which are stabilised with cement.

**2** Material to be stabilised with cement shall be Class 6E, Class 7F and Class 7G materials all complying with Clause 601 and Table 6/1. Cement for cement stabilisation shall be either Portland cement (CEM I), Portland-slag cement (CEM II/A-S) or Portland-fly ash cement (CEM II/A-V) complying with BS EN 197-1 and shall also meet the requirements given in contract specific Appendix 6/3.

**3** Class 6E, 7F or 7G material to be stabilised shall have added to it, at any point, that quantity of cement measured as a percentage of its dry weight as determined by laboratory and/or field investigations, to meet the end-performance requirements, subject to a minimum of 2% cement unless shown to the satisfaction of the Contractor's Engineering Director by field trials that a smaller percentage gives the required performance.

**4** The appropriate quantity of cement shall be uniformly spread, by a suitable spreading machine, on top of the layer to be processed. Using a collecting tray and balance the Contractor shall check the rate of spread of the machine once for every 500 m² of cement spread.

**5** (P06)~~Unless indicated otherwise in contract specific Appendix 6/3,~~ Class 6E, 7F or 7G material ~~shall be stabilised in a single layer if its compacted thickness is 250 mm or less. If its compacted thickness is greater, the material~~ shall be stabilised in layers of compacted thickness not less than 130 mm and not more than 250 mm thick, including any cutting-in required by sub-Clause 9 of this Clause. The upper limit of 250mm may be increased if field trials confirm that a greater thickness can be placed whilst meeting the specified performance requirements, to the satisfaction of the Contractor's Engineering Director.

**6** The Contractor shall not carry out cement stabilisation when the shade temperature is below 3°C unless on a rising thermometer above 0°C and the materials to be stabilised are frost free. Cement stabilisation shall not be carried out during periods of rain or when rain is imminent. When cement is spread on material likely to cause premature hydration, processing in accordance with sub-Clause 7 of this Clause shall follow immediately.

**7** Unless indicated otherwise by contract specific Appendix 6/3, Class 6E, 7F or 7G material forming the layer to be stabilised shall be processed by pulverising and mixing in the cement by means of a sufficient number of passes of a

suitable mobile stabilising machine until 95% of the silt and clay fraction is reduced to particles or lumps passing a BS 28 mm sieve after dry sieving and the pulverisation complies with Table 6/1.

**8** During processing, sufficient water shall be available in the material to hydrate the cement and enable satisfactory mixing and compaction to be achieved. Any added water shall be through an integral spray-bar on the stabilising machine. Any added water shall have a sulfate content not exceeding 1400 mg/l as SO4, when tested in accordance with Test No. 1 of TRL Report 447 (or equivalent test in accordance with BRE Special Digest 1).

**9** The stabilising machine shall be equipped with a device for controlling the depth of processing which shall be maintained at the correct setting at all times. An overlap of 150 mm shall be made between adjacent passes of the stabilising machine. Where a subsequent layer of material is placed on a layer previously stabilised the tines or blades of the stabilising machine shall be set so that they cut into the previously stabilised layer below by at least 20 mm.

**10** Each layer of Class 9G, 9H or 9I processed material shall be compacted as soon as possible after the final pass of the stabilising machine. Compaction shall be completed within 2 hours following the mixing of the cement into the material to be stabilised. Any added water shall have a sulfate content not exceeding 1400 mg/l as $SO_4$ when tested in accordance with Test No. 1 of TRL Report 447 (or equivalent test in accordance with BRE Special Digest 1).

**11** The compaction of Class 9G, 9H or 9I shall comply with Clause 612, end product compaction, to satisfy the compaction requirements given in Table 6/1 of that Class.

**12** On completion of compaction the Contractor shall take measures to prevent drying to ensure adequate curing takes place, in accordance with a Method Statement that has been agreed in advance with the Contractor's Engineering Director. During periods when the air temperature is forecast to drop below 3°C or when ground frost is forecast Class 9G, 9H and 9I material shall be protected, to prevent freezing, for a period of 7 days from the time of completion of compaction. Such protection shall be sealed to prevent the ingress of moisture.

**13** Class 9G, 9H and 9I materials shall not have other material deposited or compacted above them, or be trafficked, either (i) until such time as the required end-product and end-performance requirements have been achieved, or (ii) interim target values demonstrated by field trials to the satisfaction of the Contractor's Engineering Director have been achieved provided that end product compaction and air voids compliance are demonstrated.

## 648 Lime Stabilisation to Form HSR Earthworks Materials

**1** This Clause shall apply only to those HSR Earthworks materials which are to be stabilised with lime to form material Class 9J.

**2** Material to be stabilised with lime shall be Class 7E material complying with Clause 601 and Table 6/1.

**3** The form of lime used for lime stabilisation shall be as required in contract specific Appendix 6/3, the lime shall conform to BS EN 459-1 and meet the performance requirements stated in contract specific Appendix 6/3. This shall be demonstrated by the Declaration of Performance. Unless otherwise stated in contract specific Appendix 6/3 lime shall be either quicklime or hydrated lime conforming to BS EN 459-1. The particle size distribution of all types of quicklime shown in Tables 1 and 8 of BS EN 459-1 shall be of designation P4 as shown in Tables 5 and 12 of BS EN 459-1.

**4** The Contractor shall carry out testing of the lime as installed for available lime in accordance with Clause 641 at weekly intervals unless otherwise required in contract specific Appendix 6/3 during periods when lime stabilisation is carried out. The results shall be provided by the Contractor in the project records. The available lime shall meet the requirements stated in contract specific Appendix 6/3 and the values stated in the Declaration of Performance.

**5** Class 7E material to be stabilised shall have added to it, at any point, the percentage of its dry weight of lime, as determined on the demonstration area, to meet end product compaction requirements, as defined in Table 6/1, subject to a minimum of 2½% by weight of 'available lime' as a percentage of the dry weight of the Class 7E material unless shown to the satisfaction of the Contractor's Engineering Director by field trials that a lesser percentage gives the required performance.

**6** Lime of quantity complying with sub-Clause 5 of this Clause shall be uniformly spread by a suitable spreading machine on top of the layer to be stabilised. Using a collecting tray and balance the Contractor shall check the rate of spread by weight, once for every 500 m² of lime spread or a different rate of testing for the rate of spread as described in contract specific Appendix 6/3. At the same time the Contractor shall collect samples of lime deposited on the tray and test them for available lime content in accordance with Clause 641.

**7** (P06) ~~Unless indicated otherwise in contract specific Appendix 6/3, the material shall be stabilised in a single layer if its compacted thickness is 250 mm or less. If its compacted thickness is greater, t~~The material shall be stabilised in layers of compacted thickness not less than 130 mm and not more than 250 mm thick, including any cutting-in required by sub-Clause 12 of this Clause. The upper limit of 250mm may be increased if field trials confirm that a greater

thickness can be placed whilst meeting the specified performance requirements, to the satisfaction of the Contractor's Engineering Director.

**8** Unless indicated otherwise in contract specific Appendix 6/3 lime stabilisation shall be carried out only during the months of March to September inclusive and when the shade temperature is not below 7°C. Only when the specified bearing ratio is attainable at a shade temperature less than 7°C, may lime stabilisation be carried out at such lower temperature. Lime stabilisation shall be suspended if rainfall will have an adverse effect on the material being stabilised. The spreading of lime shall not be carried out in a manner or under conditions that will result in lime being blown from the site onto adjacent land or property.

**9** Unless indicated otherwise in contract specific Appendix 6/3, the material forming the layers to be stabilised shall be processed by pulverising and mixing in the lime by means of sufficient number of passes of a suitable mobile stabilising machine until 95% of the Class 9J processed material passes a BS 28 mm sieve after dry sieving and the pulverisation complies with Table 6/1.

**10** (P06) During processing sufficient water shall be available in the material to slake the quicklime (if used) and to enable satisfactory mixing and compaction to be achieved. Any added water shall be through an integral spray- bar on the stabilising machine when added during mixing. Any added water shall have a sulfate content not exceeding 1400 mg/l as SO4 when tested in accordance with Test No. 1 of TRL Report 447 (or equivalent test in accordance with BRE Special Digest 1).

**11** Field trials, and laboratory trials as appropriate, shall be undertaken to confirm requirements for pulverization, mellowing and compaction to achieve the performance requirements (see Beetham et al, 2015, "Lime stabilisation for earthworks: a UK perspective", Proceedings of the Institution of Civil Engineers - Ground Engineering, Vol 168, Issue 2). Any added water shall have a sulfate content not exceeding 1400 mg/l as SO4 when tested in accordance with Test No. 1 of TRL Report 447 (or equivalent test in accordance with BRE Special Digest 1).

**12** The stabilising machine shall be equipped with a device for controlling the depth of processing which shall be maintained at the correct setting at all times. An overlap of 150 mm shall be made between adjacent passes of the stabilising machine. Where a subsequent layer of material is placed on a layer previously stabilised the tines or blades of the stabilising machine shall be set so that they cut into the previously stabilised layer below by at least 20 mm.

**13** Each layer of Class 9J processed material shall be compacted as soon as possible after the final pass of the stabilising machine. Immediately before compaction the processed material shall have a Moisture Condition Value (MCV) of not greater than nor less than the figures stated in contract specific Appendix 6/1, for Class 9J lime stabilised material, both as determined in accordance with Clause 632.

**14** If there is a delay following the first pass and before commencement of compaction the surface shall be sealed by not less than 2 passes of a smooth-wheeled roller having a mass per metre width of not less than 2,700 kg or of a pneumatic tyred roller of not less than 1,000 kg mass per wheel. On recommencement, and before compaction, the layer shall be re-processed without the addition of lime, by a sufficient number of passes of the stabilising machine to meet the MCV requirements of sub-Clause 13 of this Clause adding water uniformly if necessary.

**15** The compaction of Class 9J shall comply with Clause 612, end product compaction, to satisfy the compaction requirements given in Table 6/1 of the Class.

**16** Class 9J material shall not have other material deposited or compacted above them, or be trafficked, either (i) until such time as the required end-product and end-performance requirements have been achieved, or (ii) interim target values demonstrated by field trials to the satisfaction of the Contractor's Engineering Director have been achieved provided that end product compaction and air voids compliance are demonstrated.

## 649 Lime and Cement Stabilisation to Form HSR Earthworks Materials

**1** Where HSR Earthworks are to consist of, either wholly or in part, lime and cement stabilised material Class 9K or 9L, this Clause shall apply to the construction of those parts which are stabilised with lime and cement.

**2** Material to be stabilised with lime and cement shall be Class 6R or Class 7I material complying with Clause 601 and Table 6/1.

**3** The form of lime used for lime and cement stabilisation shall be as required in contract specific Appendix 6/3, the lime shall conform to BS EN 459-1 and meet the performance requirements stated in contract specific Appendix 6/3. This shall be demonstrated by the Declaration of Performance. Unless otherwise stated in contract specific Appendix 6/3 lime shall be either quicklime or hydrated lime conforming to BS EN 459-1. The particle size distribution of all types of quicklime shown in Tables 1 and 8 of BS EN 459-1 shall be of designation P4 as shown in Tables 5 and 12 of BS EN 459-1.

**4** The Contractor shall carry out testing of the lime as installed for available lime in accordance with Clause 641 at weekly intervals unless otherwise required in contract specific Appendix 6/3 during periods when lime and cement stabilisation is carried out. The results shall be provided by the Contractor in the project records. The available lime shall meet the requirements stated in contract specific Appendix 6/3 and the values stated in the Declaration of Performance.

**5** Cement for lime and cement stabilisation shall be either Portland cement (CEM I), Portland-slag cement (CEM II/A-S) or Portland-fly ash cement (CEM II/A-V) complying with BS EN 197-1 and shall also meet the requirements given in contract specific Appendix 6/3.

**6** Classes 6R and 7I material to be stabilised shall have added to it, at any point, the percentage of its dry weight of lime and cement as determined on the demonstration area, to meet the performance requirements in Table 6/1, subject to a minimum of 1% by weight of 'available lime' and 2% cement as a percentage of the dry weight of the 6R and 7I materials, unless shown to the satisfaction of the Contractor's Engineering Director by field trials that a lesser percentage gives the required performance.

**7** The Contractor shall not carry out lime and cement stabilisation when the shade temperature is below 3°C unless on a rising thermometer above 0°C and the materials to be stabilised are frost free. Lime and cement stabilisation shall not be carried out during periods of rain or when rain is imminent. When cement is spread on material likely to cause premature hydration, processing in accordance with sub-Clause 16 of this Clause shall follow immediately.

**8** Lime of quantity complying with sub-Clause 6 of this Clause shall be uniformly spread by a suitable spreading machine on top of the layer to be stabilised. Using a collecting tray and balance the Contractor shall check the rate of spread by weight, once for every 500 $m^2$ of lime spread or a different rate of testing for the rate of spread as described in contract specific Appendix 6/3. At the same time the Contractor shall collect samples of lime deposited on the tray and test them for available lime content in accordance with Clause 641.

**9** (P06) ~~Unless indicated otherwise in contract specific Appendix 6/3, the material shall be stabilised in a single layer if its compacted thickness is 250 mm or less. If its compacted thickness is greater, t~~The material shall be stabilised in layers of compacted thickness not less than 130 mm and not more than 250 mm thick, including any cutting-in required by sub-Clause 13 of this Clause. The upper limit of 250mm may be increased if field trials confirm that a greater thickness can be placed whilst meeting the specified performance requirements, to the satisfaction of the Contractor's Engineering Director.

**10** Unless indicated otherwise in contract specific Appendix 6/3, the material forming the layer to be stabilised shall be processed by pulverising and mixing in the lime by means of sufficient number of passes of a suitable mobile stabilising machine until 95% of the Class 9K or 95% of the silt and clay fraction of Class 9L processed material passes a BS 28 mm sieve after dry sieving and the pulverisation complies with Table 6/1.

**11** During processing sufficient water shall be available in the material to slake the quicklime (if used) and to enable satisfactory mixing and compaction to be achieved. Any added water shall be through an integral spray- bar on the stabilising machine. Any added water shall have a sulfate content not exceeding 1400 mg/l as SO4 when tested in accordance with Test No. 1 of TRL Report 447 (or equivalent test in accordance with BRE Special Digest 1).

**12** Field trials, and laboratory trials as appropriate, shall be undertaken to confirm requirements for pulverization, mellowing and compaction to achieve the performance requirements (see Beetham et al, 2015, "Lime stabilisation for earthworks: a UK perspective", Proceedings of the Institution of Civil Engineers - Ground Engineering, Vol 168, Issue 2).

**13** The stabilising machine shall be equipped with a device for controlling the depth of processing which shall be maintained at the correct setting at all times. An overlap of 150 mm shall be made between adjacent passes of the stabilising machine. Where a subsequent layer of material is placed on a layer previously stabilised the tines or blades of the stabilising machine shall be set so that they cut into the previously stabilised layer below by at least 20 mm.

**14** The appropriate quantity of cement shall be uniformly spread, by a suitable spreading machine, on top of the layer previously processed with lime. Using a collecting tray and balance the Contractor shall check the rate of spread of the machine once for every 500 $m^2$ of cement spread.

**15** Unless indicated otherwise in contract specific Appendix 6/3, the material previously mixed with lime shall be stabilised with cement in a single layer or in layers of the same compacted thickness as for the lime mixed material layers, including any cutting-in required by sub-Clause 13 of this Clause.

**16** Unless indicated otherwise in contract specific Appendix 6/3, the material forming the layer to be stabilised shall be processed by pulverising and mixing in the cement by means of a sufficient number of passes of a suitable mobile stabilising machine until 95% of the silt and clay fraction is reduced to particles or lumps passing a BS 28 mm sieve after dry sieving and the pulverisation complies with Table 6/1.

**17** During processing, sufficient water shall be available in the material to hydrate the cement and enable satisfactory

mixing and compaction to be achieved. Any added water shall be through an integral spray-bar on the stabilising machine. Any added water shall have a sulfate content not exceeding 1400 mg/l as SO4 when tested in accordance with Test No. 1 of TRL Report 447 (or equivalent test in accordance with BRE Special Digest 1).

**18** The stabilising machine shall be equipped with a device for controlling the depth of processing which shall be maintained at the correct setting at all times. An overlap of 150 mm shall be made between adjacent passes of the stabilising machine. Where a subsequent layer of material is placed on a layer previously stabilised the tines or blades of the stabilising machine shall be set so that they cut into the previously stabilised layer below by at least 20 mm.

**19** Each layer of Class 9K or 9L processed material shall be compacted as soon as possible after the final pass of the stabilising machine. Compaction shall be completed within 2 hours following the mixing of the cement into the material to be stabilised. Any added water shall have a sulfate content not exceeding 1400 mg/l as SO4 when tested in accordance with Test No. 1 of TRL Report 447 (or equivalent test in accordance with BRE Special Digest 1).

**20** The compaction of Class 9K or 9L material shall comply with Clause 612, end product compaction, to satisfy the compaction requirements given in Table 6/1 of the Class.

**21** On completion of compaction the Contractor shall take measures to prevent drying to ensure adequate curing takes place, in accordance with a Method Statement that has been agreed in advance with the Contractor's Engineering Director. During periods when the air temperature is forecast to drop below 3°C or when ground frost is forecast Class 9K and 9L material shall be protected, to prevent freezing, for a period of 7 days from the time of completion of compaction. Such protection shall be sealed to prevent the ingress of moisture.

**22** Class 9K and 9L material shall not have other material deposited or compacted above them, or be trafficked, either (i) until such time as the required end-product and end-performance requirements have been achieved, or (ii) interim target values demonstrated by field trials to the satisfaction of the Contractor's Engineering Director have been achieved provided that end product compaction and air voids compliance are demonstrated.

## 650 Stabilisation to Form HSR Earthworks Materials Using Other Combinations of Binders

**1** Where HSR Earthworks are to consist of, either wholly or in part, materials stabilized with other binders or other combinations of binders, the Contractor shall designate new material classes, and shall prepare specification clauses in contract specific Appendix 6/3 for their processing and compaction based on laboratory and field trials to the satisfaction of the Project Manager and Contractor's Engineering Director. The performance and compaction requirements of these materials shall be in accordance with HS2-HS2-GT-STD-000-000001 Technical Standard – Earthworks. The specification shall address at least all the aspects raised in Clause 649.

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: | | | | | |
| | | | | | | | | | Lower | Upper | | | | |
| GENERAL GRANULAR FILL | 1 | A | – | Well graded granular material | General Fill (non HSR earthworks) | Any material, or combination of materials, other than material designated as Class 3 in the Contract or glass waste. (Properties (i), (ii) and (iv) in next column, shall not apply to chalk). Recycled aggregate.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9, and 10:<br>P (natural aggregates);<br>A (construction and demolition recycling industries);<br>B1 (municipal incinerator bottom ash (MIBA));<br>D2 (air cooled blast furnace slag);<br>D3 (basic oxygen furnace slag);<br>D4 (electric arc furnace slag (EAF C));<br>E (non-ferrous steel industry – except E2 molybdenum slag);<br>G (mining and quarry industry). | (i) grading | BS 1377: Part 2 or BS EN 13242 | Tab 6/2 | Tab 6/2 | Tab 6/4 Method 2 | 1 | A | – |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | 10 | – | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 2<br>See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (v) IDD of chalk | Clause 634 | – | App 6/1 | | | | |
| | 1 | A | 1 | Well graded granular material | General Fill for HSR earthworks | Any material, or combination of materials, other than material designated as Class 3 in the Contract, umetamorphosed mudstone or glass waste. (Properties (i), (ii) and (iv) in next column, shall not apply to chalk). Recycled aggregate.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9, and 10:<br>P (natural aggregates);<br>A (construction and demolition recycling industries);<br>B1 (municipal incinerator bottom ash, MIBA);<br>G (mining and quarry industry).<br>Property (vii) only applies to materials whose grading includes particle sizes appropriate for testing. Weak rocks may be tested after processing. See also Clause 4.3.10 in HS2-HS2-GT-STD-000-000001. | (i) grading | BS 1377: Part 2 or BS EN 13242 | Tab 6/2 | Tab 6/2 | (P06) End product compaction App 6/3<br>UEF:<br>$E_{v2}$>60MPa at surface of UEF; $E_{v2}$>45MPa at 1m above LEF (see Note 13) | 1 | A | 1 |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | 10 | – | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 2<br>See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (v) IDD of chalk | Clause 634 | – | App 6/1 | | | | |
| | | | | | | | (vi) optimum mc | BS 1377: Part 4<br>(4.5kg rammer method) | – | – | | | | |
| | | | | | | | (vii) Slake durability index | ISRM (2007) | 60% | - | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| GENERAL GRANULAR FILL | 1 | B | – | Uniformly graded granular material | General Fill (non HSR earthworks) | Any material, or combination of materials, other than chalk or glass waste. Recycled aggregate.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9, and 10:<br>P (natural aggregates – except chalk);<br>A (construction and demolition recycling industries);<br>B1 (municipal incinerator bottom ash (MIBA));<br>C1 (coal fly ash); C4 (coal bottom ash);<br>D2 (air cooled blast furnace slag);<br>D3 (basic oxygen furnace slag);<br>D4 (electric arc furnace slag (EAF C));<br>E (non ferrous steel industry – except E2 molybdenum slag);<br>F (foundry industry);<br>G (mining and quarry industry);<br>H1 (dredge spoil sand). | (i) grading | BS 1377: Part 2 or BS EN 13242 | Tab 6/2 | Tab 6/2 | Tab 6/4 Method 3 | 1 | B | - |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | – | 10 | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 2<br>See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | 1 | B | 1 | Uniformly graded granular material | General Fill (HSR earthworks) | Any material, or combination of materials, other than chalk, umetamorphosed mudstone or glass waste. Recycled aggregate.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9, and 10:<br>P (natural aggregates – except chalk);<br>A (construction and demolition recycling industries);<br>B1 (municipal incinerator bottom ash (MIBA));<br>C1 (coal fly ash); C4 (coal bottom ash);<br>E (non ferrous steel industry – except E2 molybdenum slag);<br>F (foundry industry);<br>G (mining and quarry industry);<br>H1 (dredge spoil sand).<br>Property (vi) only applies to materials whose grading includes particle sizes appropriate for testing. Weak rocks may be tested after processing. See also Clause 4.3.10 in HS2-HS2-GT-STD-000-000001. | (i) grading | BS 1377: Part 2 or BS EN 13242 | Table 6/2 | Tab 6/2 | (P06) End product compaction App 6/3<br>UEF:<br>$E_{v2}$>60MPa at surface of UEF;<br>$E_{v2}$>45MPa at 1m above LEF (see Note 13). | 1 | B | 1 |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | – | 10 | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 2<br>See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (v) optimum mc | BS 1377: Part 4<br>(4.5kg rammer method) | – | – | | | | |
| | | | | | | | (vi) Slake durability index | ISRM (2007) | 60% | - | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| GENERAL GRANULAR FILL | 1 | C | – | Coarse granular material | General Fill (non HSR earthworks) | Any material, or combination of materials, other than material designated as Class 3 in the Contract or glass waste. (Properties (i) and (ii) in next column, shall not apply to chalk). Recycled aggregate.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9, and 10:<br>P (natural aggregates);<br>A (construction and demolition recycling industries);<br>D2 (air cooled blast furnace slag);<br>G (mining and quarry industry). | (i) grading | BS 1377: Part 2 or BS EN 13242 | Tab 6/2 | Tab 6/2 | Tab 6/4 Method 5 | 1 | C | – |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | 5 | – | | | | |
| | | | | | | | (iii) Los Angeles coefficient | Clause 635 | – | 50 | | | | |
| | 1 | C | 1 | Not used | | | | | | | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| GENERAL COHESIVE FILL | 2 | A | – | Wet cohesive material | General Fill and HSR Lower Embankment Fill (see Note 12) | Any material, or combination of materials, other than chalk | (i) grading | BS 1377: Part 2 | Tab 6/2 | Tab 6/2 | Non HSR Earthworks: Tab 6/4 Method 1 except for materials with liquid limit greater than 50, determined by BS 1377: Part 2, only deadweight tamping or vibratory tamping rollers or grid rollers shall be used.<br><br>HSR Earthworks (P06) End product compaction App 6/3 | 2 | A | – |
| | | | | | | | (ii) plastic limit (PL) | BS 1377: Part 2 | – | – | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 2 See Note 4 | PL -4% | App 6/1 | | | | |
| | | | | | | | (iv) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (v) Undrained shear strength of remoulded material | Clause 633 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (vi) optimum mc (HSR LEF only) | BS 1377: Part 4 (4.5kg rammer method) | - | - | | | | |
| | | | | | | | (vii) Argillaceous particles >20mm diameter (HSR LEF only) | BS 1377: Part 2 including description | - | 50 | | | | |
| | | | | | | | (viii) liquid limit (HSR LEF only) | BS 1377: Part 2 | - | 35 See Note 14 | | | | |
| | | | | | | | (ix) CBR Swell Limit (HSR LEF only) | Cl. 7.3 BS1377: Part 4 | - | 3% | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| GENERAL COHESIVE FILL | 2 | B | – | Dry cohesive material | General Fill and HSR Lower Embankment Fill (see note 12) | Any material, or combination of materials, other than chalk | (i) grading | BS 1377: Part 2 | Tab 6/2 | Tab 6/2 | Non HSR Earthworks: Tab 6/4 Method 2<br><br>HSR Earthworks (P06) End product compaction App 6/3 | 2 | B | – |
| | | | | | | | (ii) plastic limit (PL) | BS 1377: Part 2 | – | – | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 2 See Note 4 | App 6/1 | PL -4% | | | | |
| | | | | | | | (iv) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (v) undrained shear strength of remoulded material | Clause 633 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (vi) optimum mc (HSR LEF only) | BS 1377: Part 4 (4.5kg rammer method) | – | - | | | | |
| | | | | | | | (viii) argillaceous particles >20mm diameter (HSR LEF only) | BS 1377: Part 2 including description | - | 50 | | | | |
| | | | | | | | (ix) liquid limit (HSR LEF only) | BS 1377: Part 2 | - | 35 See Note 14 | | | | |
| | | | | | | | (x) CBR Swell Limit (HSR LEF only) | Cl. 7.3 BS1377: Part 4 | - | 3% | | | | |
| | 2 | C | - | Stony cohesive material | General Fill and HSR Lower Embankment Fill (see note 12) | Any material, or combination of materials, other than chalk | (i) grading | BS 1377: part 2 | Tab 6/2 | Tab 6/2 | Non HSR Earthworks: Tab 6/4 Method 2<br><br>HSR Earthworks (P06) End product compaction App 6/3 | 2 | C | - |
| | | | | | | | (ii) plastic limit (PL) | BS 1377: part 2 | – | – | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) MCV | Clause 632 | App 6/1 | – | | | | |
| | | | | | | | (v) undrained shear strength of remoulded material | Clause 633 | App 6/1 | – | | | | |
| | | | | | | | (vi) optimum mc (HSR LEF only) | BS 1377: Part 4 (4.5kg rammer method) | – | - | | | | |
| | | | | | | | (vii) argillaceous particles >20mm diameter (HSR LEF only) | BS 1377: Part 2 including description | - | 50% | | | | |
| | | | | | | | (viii) liquid limit (HSR LEF only) | BS 1377: Part 2 | - | 35 See Note 14 | | | | |
| | | | | | | | (ix) CBR Swell Limit (HSR LEF only) | Cl. 7.3 BS1377: Part 4 | - | 3% | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| GENERAL COHESIVE FILL | 2 | D | – | Silty cohesive material | General Fill and HSR Lower Embankment Fill (see Note 12) | Any material, or combination of materials, other than chalk | (i) grading | BS 1377: Part 2 | Tab 6/2 | Tab 6/2 | Non HSR Earthworks: Tab 6/4 Method 3<br><br>HSR Earthworks (P06) End product compaction App 6/3 | 2 | D | – |
| | | | | | | | (ii) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iii) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) undrained shear strength of remoulded material | Clause 633 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (v) optimum mc (HSR LEF only) | BS 1377: Part 4 (4.5kg rammer method) | - | - | | | | |
| | | | | | | | (vi) Argillaceous particles >20mm diameter (HSR LEF only) | BS 1377: Part 2 including description | - | 50% | | | | |
| | | | | | | | (vii) liquid limit (HSR LEF only) | BS 1377: Part 2 | - | 35 See Note 14 | | | | |
| | | | | | | | (viii) CBR Swell Limit (HSR LEF only) | Cl. 7.3 BS1377: Part 4 | - | 3% | | | | |
| | 2 | E | - | Reclaimed pulverised fuel ash cohesive material | General Fill and HSR Lower Embankment Fill (see Note 12) | Reclaimed material from lagoon or stockpile containing not more than 20% furnace bottom ash | (i) mc | BS 1377: Part 2 See Note 4 | To enable compaction to Clause 612 | | Non HSR Earthworks: End product 95% of maximum dry density of BS 1377: Part 4 (2.5 kg rammer method)<br><br>HSR Earthworks (P06) End product compaction App 6/3 | 2 | E | - |
| | | | | | | | (ii) bulk density | BS 1377: Part 9 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iii) optimum mc (HSR LEF only) | BS 1377: Part 4 (4.5kg rammer method) | - | - | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| GENERAL CHALK FILL | 3 | – | – | Chalk | General Fill | Chalk and associated materials all designated as Class 3 in the Contract | (i) mc | BS 1377: Part 2 See Note 4 | – | App 6/1 | Non HSR earthworks Tab 6/4 Method 4, or Method 1 if required in App 6/1. All types of vibratory rollers of Categories over 1800 kg shall not be used.<br><br>HSR earthworks: (P06) End product compaction App 6/3 (see Note 11). $E_{v2}$>60MPa at surface of UEF; $E_{v2}$>45MPa at 1m above LEF (see Note 13). | 3 | – | – |
| | | | | | | | (ii) IDD | Clause 634 | App 6/1 | App 6/1 | | | | |
| GENERAL LANDSCAPE FILL | 4 | – | – | Various | Fill to landscape areas | See App 6/1 | (i) grading | BS 1377: Part 2 | App 6/1 | App 6/1 | See Clause 620 and App 6/1 | 4 | – | – |
| | | | | | | | (ii) mc | BS 1377: Part 2 See Note 4 | – | App 6/1 | | | | |
| | | | | | | | (iii) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| TOPSOIL | 5 | A | – | Topsoil, or turf, existing on site | Topsoiling | In accordance with Technical Standard – Soil Handling for Land Restoration HS2-HS2-EV-STD-000-000008 | - | - | – | - | – | 5 | A | – |
| | 5 | B | – | Imported topsoil | Topsoiling | General purpose grade complying with BS 3882 | – | – | – | – | – | 5 | B | – |
| | 5 | S | - | Agricultural Subsoil | Subsoil underlying topsoil | In accordance with Technical Standard – Soil Handling for Land Restoration HS2-HS2-EV-STD-000-000008 | – | – | – | – | – | 5 | S | - |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | A | – | Selected well graded granular material | Below water | Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock, crushed concrete, chalk, well burnt colliery spoil or any combination thereof. (Properties (i) and (ii) in next column, shall not apply to chalk.) Recycled aggregate.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9, and 10:<br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br>A (construction and demolition recycling industries);<br>G1 (red coal shale) – not HSR earthworks;<br>G3 (pre-selected all-in from quarrying/mining).<br>Glass waste is not permitted. | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | No compaction | 6 | A | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) uniformity | See Note 5 | 10 | – | | | | |
| | | | | | | | (iii) SMC of chalk index | Clause 634 | – | 20% | | | | |
| | | | | | | | (iv) plasticity index | BS 1377: Part 2 | Non-plastic | | | | | |
| | 6 | B | – | Selected coarse granular material | (P06) Flood protection, starter layer (not to be used as a starter layer for HSR earthworks) | Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, chalk, well burnt colliery spoil, slag or any combination thereof. (Properties (ii) and (iii) in next column, shall not apply to chalk.) Recycled aggregate.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9, and 10:<br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br>A (construction and demolition recycling industries);<br>D2 (air cooled blast furnace slag) – not HSR earthworks;<br>D3 (basic oxygen furnace slag) – not HSR earthworks;<br>D4 (electric arc furnace slag (EAF C)) – not HSR earthworks;<br>G1 (red coal shale) – not HSR earthworks;<br>G3 (pre-selected all-in from quarrying/mining).<br>Glass waste is not permitted. | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | (P06) ~~Non-HSR earthworks~~ Tab 6/4 Method 5<br>~~HSR earthworks Max thickness 500mm~~ | 6 | B | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) plasticity index | BS 1377: Part 2 | Non-plastic | | | | | |
| | | | | | | | (iii) Los Angeles coefficient | Clause 635 | – | 50 | | | | |
| | | | | | | | (iv) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | C | – | Selected uniformly graded granular material | Starter layer | Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock, crushed concrete, chalk, well burnt colliery spoil, slag or any combination thereof. (Property (iii) in next column, shall not apply to chalk.) Recycled aggregate.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9, and 10:<br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br>A (construction and demolition recycling industries);<br>D2 (air cooled blast furnace slag) – not HSR earthworks;<br>D3 (basic oxygen furnace slag) – not HSR earthworks;<br>D4 (electric arc furnace slag (EAF C)) – not HSR earthworks;<br>G1 (red coal shale) – not HSR earthworks;<br>G3 (pre-selected all-in from quarrying/mining).<br>Glass waste is not permitted. | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | (P06) ~~Non-HSR earthworks:~~ Tab 6/4 Method 3<br>~~HSR earthworks: Max thickness 500mm~~ | 6 | C | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | – | 10 | | | | |
| | | | | | | | (iii) plasticity index | BS 1377: Part 2 | Non-plastic | | | | | |
| | | | | | | | (iv) Los Angeles coefficient | Clause 635 | – | 50 | | | | |
| | | | | | | | (v) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | | | | |
| | 6 | D | – | Selected uniformly graded granular material | Starter layer below pulverised fuel ash | Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock, crushed concrete, chalk, well burnt colliery spoil, slag or any combination thereof. Recycled aggregate.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9, and 10:<br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br>A (construction and demolition recycling industries);<br>D2 (air cooled blast furnace slag) – not HSR earthworks;<br>D3 (basic oxygen furnace slag) – not HSR earthworks;<br>D4 (electric arc furnace slag (EAF C)) – not HSR earthworks;<br>G1 (red coal shale) – not HSR earthworks.<br>Glass waste is not permitted. | (i) grading | BS 1377: Part 2 (On site) | Tab 6/2 | Tab 6/2 | (P06) ~~Non-HSR earthworks:~~ Tab 6/4 Method 4<br>~~HSR earthworks: Max thickness 500mm~~ | 6 | D | – |
| | | | | | | | | BS EN 933-2 Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | – | 10 | | | | |
| | | | | | | | (iii) plasticity index | BS 1377: Part 2 | Non-plastic | | | | | |
| | | | | | | | (iv) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (v) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECETED GRANULAR FILL | 6 | E | – | Selected granular material (Class 9A) or HSR embankment fill (Class 9G) | For stabilisation with cement to form capping (Class 9A) or HSR embankment fill (Class 9G). | Any material, or combination of materials, other than unburnt colliery spoil and argillaceous rock. (Properties (i), (ii) and (iii) in next column, shall not apply to chalk.) Recycled aggregate<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9, and 10:<br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br>A (construction and demolition recycling industries);<br>D2 (air cooled blast furnace slag);<br>G (mining and quarry industry – except G2 (black coal shale)).<br>Glass waste is not permitted. | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | Not applicable | 6 | E | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) mc | BS 1377: Part 2 See Note 4 | – | App 6/1 | | | | |
| | | | | | | | (iii) liquid limit | BS 1377: Part 2 | – | 45 | | | | |
| | | | | | | | (iv) plasticity index | BS 1377: Part 2 | – | 20 | | | | |
| | | | | | | | (v) organic matter | BS 1377: Part 3 | – | App 6/1 | | | | |
| | | | | | | | (vi) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | 3000 mg/l as $SO_4$ | | | | |
| | | | | | | | (vii) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | 0.6% as $SO_4$ | | | | |
| | | | | | | | (viii) SMC of chalk | Clause 634 | – | 20% | | | | |
| | 6 | F | 1 | Selected granular material (fine grading) | Capping | Any material, or combination of materials – including recycled aggregates with not more than 50% by mass of recycled bituminous planings and granulated asphalt, but excluding materials contaminated with tar and tar- bitumen binders, unburnt colliery spoil, argillaceous rock and chalk.<br>Property (vi) in the next column shall not apply if the Class Ra (asphalt) content of any recycled aggregate is 20% or less.<br>Where material in this Class is imported onto site it shall be classified as Class 6F4 and comply with the requirements for that material.<br>Glass waste is not permitted. | (i) grading | BS 1377: Part 2 (On site materials only) | Tab 6/2 | Tab 6/2 | Tab 6/4 Method 6 | 6 | F | 1 |
| | | | | | | | (ii) optimum mc | BS 1377: Part 4 (vibrating hammer method) | – | – | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 2 See Note 4 | Optimum mc - 2% | Optimum mc | | | | |
| | | | | | | | (iv) Los Angeles coefficient | Clause 635 | – | 60 | | | | |
| | | | | | | | (v) Class Ra (asphalt) content | Clause 710 | – | 50% | | | | |
| | | | | | | | (vi) bitumen content | BS EN 12697-1 or BS EN 12697-39 | – | 2.0% | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | F | 2 | Selected granular material (coarse grading) | Capping | Any material, or combination of materials - including recycled aggregates with not more than 50% by mass of recycled bituminous planings and granulated asphalt, but excluding materials contaminated with tar and tar- bitumen binders, unburnt colliery spoil and argillaceous rock.<br>Property (i) in the next column shall not apply to chalk.<br>Property (vi) in the next column shall not apply if the Class Ra (asphalt) content of any recycled aggregate is 20% or less.<br>Where material in this Class is imported onto site it shall be classified as Class 6F5 and comply with the requirements for that material.<br>Glass waste is not permitted. | (i) grading | BS 1377: Part 2 (On site materials only) | Tab 6/2 | Tab 6/2 | Tab 6/4 Method 6 | 6 | F | 2 |
| | | | | | | | (ii) optimum mc | BS 1377: Part 4 (vibrating hammer method) | – | | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 2 See Note 4 | Optimum mc - 2% | Optimum mc | | | | |
| | | | | | | | (iv) Los Angeles coefficient | Clause 635 | – | 50 | | | | |
| | | | | | | | (v) Class Ra (asphalt) content | Clause 710 | – | 50% | | | | |
| | | | | | | | (vi) bitumen content | BS EN 12697-1 or BS EN 12697-39 | – | 2.0% | | | | |
| | 6 | F | 3 | Selected granular material | Capping | Any material, or combination of materials with not less than 50% by mass of recycled bituminous planings and granulated asphalt, but excluding materials contaminated with tar and tar-bitumen binders, unburnt colliery spoil and argillaceous rock.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from the following source codes, see Notes 8, 9 and 10:<br>A1 (reclaimed asphalt);<br>A4 (mixed recycled aggregate);<br>Aggregates from source code A4 shall contain at least 50% of constituents in Class Ra (bituminous materials).<br>Glass waste is not permitted. | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | Tab 6/4 Method 6 Maximum Compacted layer thickness shall be 200 mm | 6 | F | 3 |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) optimum mc | Clause 613 | – | – | | | | |
| | | | | | | | (iii) mc | Clause 613 See Note 4 | Optimum mc -2% | Optimum mc | | | | |
| | | | | | | | (iv) Class Ra (asphalt) content | Clause 710 | 50% | – | | | | |
| | | | | | | | (v) bitumen content | BS EN 12697-1 or BS EN 12697-39 | – | 10% | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECETED GRANULAR FILL | 6 | F | 4 | Selected granular material (fine grading) – imported on to the Site | Capping | Unbound mixture complying with BS EN 13285 containing aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br>P (natural aggregates – except chalk, shale, siltstone or slate, see Note 7);<br>A2 (crushed concrete);<br>A3 (crushed bricks, masonry);<br>A4 (mixed recycled aggregate);<br>B1 (municipal incinerator bottom ash (MIBA));<br>D2 (air cooled blast furnace slag);<br>D3 (basic oxygen furnace slag);<br>D4 (electric arc furnace slag (EAF C));<br>G (mining and quarry industry – except G2 (black coal shale)).<br>Aggregates from source code A4 shall contain not more than 50% of constituents in Class Ra (bituminous materials).<br>Property (x) in the next column shall not apply if the Class Ra (asphalt) content of any recycled aggregate is 20% or less.<br>Glass waste is not permitted. | (i) Size designation and overall grading category | BS EN 13285 – 0/31.5 and $G_E$ (P06) See Note 15 | Tab 6/5 | Tab 6/5 | Tab 6/4 Method 6 | 6 | F | 4 |
| | | | | | | | (ii) Maximum fines and oversize categories | BS EN 13285 – $UF_{15}$ and $OC_{75}$ | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (iii) Los Angeles coefficient | BS EN 13242 – $LA_{60}$ | – | 60 | | | | |
| | | | | | | | (iv) Volume stability of blast furnace slag | BS EN 13242 – free from dicalcium silicate and iron disintegration | – | – | | | | |
| | | | | | | | (v) Volume stability of steel (BOF) and EAF) slag | BS EN 13242 – $V_5$ | – | – | | | | |
| | | | | | | | (vi) Other aggregate requirements | BS EN 13242 – $Category_{NR}$ (no requirement) | – | – | | | | |
| | | | | | | | (vii) Laboratory dry density and optimum water content | BS EN 13285, Clause 5.3 – declared values | – | – | | | | |
| | | | | | | | (viii) Water content | BS EN 1097-5 | Optimum wc – -2% | Optimum wc | | | | |
| | | | | | | | (ix) Class Ra (asphalt) content | Clause 710 | – | 50% | | | | |
| | | | | | | | (x) bitumen content | BS EN 12697-1 or BS EN 12697-39 | – | 2.0% | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRABULAR FILL | 6 | F | 5 | Selected granular material (coarse grading) – imported on to the Site | Capping | Unbound mixture complying with BS EN 13285 containing aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br>P (natural aggregates – except chalk, shale, siltstone or slate, see Note 7);<br>A2 (crushed concrete);<br>A3 (crushed bricks, masonry);<br>A4 (mixed recycled aggregate);<br>B1 (municipal incinerator bottom ash (MIBA));<br>D2 (air cooled blast furnace slag);<br>D3 (basic oxygen furnace slag);<br>D4 (electric arc furnace slag (EAF C));<br>G (mining and quarry industry – except G2 (black coal shale)).<br>Aggregates from source code A4 shall contain not more than 50% of constituents in Class Ra (bituminous materials).<br>Property (x) in the next column shall not apply if the Class Ra (asphalt) content of any recycled aggregate is 20% or less.<br>Glass waste is not permitted. | (i) Size designation and overall grading category | BS EN 13285 – 0/80 and $G_E$ (P06) See Note 15 | Tab 6/5 | Tab 6/5 | Tab 6/4 Method 6 | 6 | F | 5 |
| | | | | | | | (ii) Maximum fines and oversize categories | BS EN 13285 – $UF_{12}$ and $OC_{75}$ | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (iii) Los Angeles coefficient | BS EN 13242 – $LA_{50}$ | – | 50 | | | | |
| | | | | | | | (iv) Volume stability of blast furnace slag | BS EN 13242 – free from dicalcium silicate and iron disintegration | – | – | | | | |
| | | | | | | | (v) Volume stability of steel (BOF) and EAF) slag | BS EN 13242 – $V_5$ | – | – | | | | |
| | | | | | | | (vi) Other aggregate requirements | BS EN 13242 – Category NR (no requirement) | – | – | | | | |
| | | | | | | | (vii) Laboratory dry density and optimum water content | BS EN 13285, Clause 5.3 – declared values | – | – | | | | |
| | | | | | | | (viii) Water content | BS EN 1097-5 | Optimum wc – -2% | Optimum wc | | | | |
| | | | | | | | (ix) Class Ra (asphalt) content | Clause 710 | – | 50% | | | | |
| | | | | | | | (x) bitumen content | BS EN 12697-1 or BS EN 12697-39 | – | 2.0% | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | F | 6 | Selected granular material | Protection Layer (Granular) | Natural gravel, crushed rock, crushed concrete or any combination thereof. None of these constituents shall include any argillaceous rock.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9, and 10:<br>P (natural aggregates – except chalk shale, siltstone or slate).<br>Glass waste is not permitted. | (i) grading | BS 1377: part 2 or BS EN 13242 | Site won - Tab 6/2<br>Imported Tab 6/5 | Site won -Tab 6/2<br>Imported Tab 6/5 | End product >100% of maximum dry density and <8% Air Voids BS 1377: Part 4 (4.5kg rammer method), Modulus of deformation 120MPa<$E_{v2}$<500 MPa (see Note 13) | 6 | F | 6 |
| | | | | | | | (ii) plasticity index | BS 1377: part 2 | Non-plastic | | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 2<br>See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) optimum mc | BS 1377: Part 4 (4.5kg rammer method) | – | – | | | | |
| | | | | | | | (v) flakiness index | BS EN 933-3 | - | 35 | | | | |
| | | | | | | | (vi) Los Angeles abrasion | Clause 635 | - | 20 | | | | |
| | | | | | | | (vii) Micro-Deval | BS EN 1097-1 | - | 15% | | | | |
| | | | | | | | (viii) Freeze-thaw (magnesium sulphate soundness test) Where the source rock is any of those identified in BS EN 13242:2002+A1: 2007, Clause B2.2 | BS EN 1367-2 | - | 35 | | | | |
| | 6 | F | 7 | Bituminous Material | Protection Layer (Bituminous) | Bituminous Protection Layers shall be asphalt concretes conforming to the requirements of BS EN 13108-1: 2006. | (i) Modulus of deformation $E_{v2}$ (see Note 13) | French Standard NF P 94-117.1 and UIC 719R clause 2.3.3 | (P06) 170 MPa (10°C≤T≤ 20 °C) or 150 MPa (20°C≤T≤ 30 °C) | 500 MPa | Density ≥ 98 % of the reference density value | 6 | F | 7 |
| | | | | | | | (ii) Dynamic Modulus Value | BS EN 12697-26: 2012. | 3,700 MPa | 7,100 MPa | | | | |
| | | | | | | | (P06) (iii) Deformation value (one million cycles) | Annex D of BS EN 12697-24: 2012 | 120 µm/m | | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | F | 8 | Selected granular material (fine grading) | Prepared Subgrade for HSR earthworks | Any material, or combination of materials – including crushed concrete, but excluding materials contaminated with tar and tar-bitumen binders, unburnt colliery spoil, red shale, crushed bricks, masonry, recycled bituminous planings and granulated asphalt, argillaceous rock and chalk, slag, municipal incinerator bottom ash, mining and quarry industry waste.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br>P (natural aggregates – except chalk, shale, siltstone or slate);<br>A2 (crushed concrete).<br>Glass waste is not permitted. | (i) grading | BS EN 13285 (P06) See Note 15 | Table 8//1 (Sub-Base Type 1) $G_P$ Overall Grading | Table 8//1 (Sub-Base Type 1) $G_P$ Overall Grading | End product >100% of maximum dry density and <8% Air Voids BS 1377: Part 4 (4.5kg rammer). Modulus of deformation $E_{v2}$ (see Note 13): >60 MPa (slabtrack); >80 MPa (ballast); <500MPa. | 6 | F | 8 |
| | | | | | | | (ii) optimum mc | BS 1377: Part 4 (4.5kg rammer) | – | – | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 2 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) Los Angeles coefficient | Clause 635 | – | 60 (Combined LA + MDE) | | | | |
| | | | | | | | (v) Micro Deval Value (MDE) | BS EN 1097-1 10-14mm sample grading | - | | | | | |
| | | | | | | | (vi) Flakiness Index | BS EN 933-3 | – | 30% | | | | |
| | | | | | | | (vii) Methylene Blue Value | BS EN 933-9 | - | 2 | | | | |
| | | | | | | | (P06) (viii) not used | | | | | | | |
| | | | | | | | (ix) plasticity of fraction of material passing 425 micron sieve | BS 1377: Part2 | Non-plastic | | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | F | 9 | Selected granular material (coarser grading) | Prepared Subgrade for HSR earthworks | Any material, or combination of materials – including crushed concrete, but excluding materials contaminated with tar and tar-bitumen binders, unburnt colliery spoil, red shale, crushed bricks, masonry, recycled bituminous planings and granulated asphalt, argillaceous rock and chalk, slag, municipal incinerator bottom ash, mining and quarry industry waste.<br><br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br><br>P (natural aggregates – except chalk, shale, siltstone or slate);<br><br>A2 (crushed concrete);<br><br>Glass waste is not permitted. | (i) grading | BS 1377: Part 2 (site won)<br><br>BS EN 933-2 (imported) | Site won - Table 6/2 (as per Class 6F2)<br><br>Imported - Table 6/5 (as per Class 6F5) | Site won - Table 6/2 (as per Class 6F2)<br><br>Imported - Table 6/5 (as per Class 6F5) | End product >100% of maximum dry density and <8% Air Voids BS 1377: Part 4 (4.5kg rammer method). Modulus of deformation $E_{v2}$ (see Note 13): >60 MPa (slabtrack); >80 MPa (ballast); <500MPa. | 6 | F | 9 |
| | | | | | | | (ii) optimum mc | BS 1377: Part 4 (4.5kg rammer) | – | – | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 2 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) Los Angeles coefficient | Clause 635 | – | 60 (Combined LA + MDE) | | | | |
| | | | | | | | (v) Micro Deval Value (MDE) | BS EN 1097-1 10-14mm sample grading | - | | | | | |
| | | | | | | | (vi) Flakiness Index | BS EN 933-3 | – | 30% | | | | |
| | | | | | | | (vii) Methylene Blue Value | BS EN 933-9 | - | 2 | | | | |
| | | | | | | | (P06) (viii) Not used | | | | | | | |
| | | | | | | | (ix) plasticity of fraction of material passing 425 micron sieve | BS 1377: Part2 | Non-plastic | | | | | |
| | 6 | G | – | Selected granular material | Gabion filling | Natural gravel, crushed rock, crushed concrete or any combination thereof. None of these constituents shall include any argillaceous rock.<br><br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br><br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br><br>A2 (crushed concrete). | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | None | 6 | G | - |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) Los Angeles coefficient | Clause 635 | – | 50 | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRABULAR FILL | 6 | H | – | Selected granular material | Drainage layer to reinforced soil and anchored earth structures | Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, chalk, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. (Properties (vi), (vii), (viii), (ix), (x), (xi) and (xii) in next column only apply when metallic reinforcing or anchor elements, facing units or fastenings are used.) (Properties (ii) and (v) in next column shall not apply to chalk.) Recycled aggregate except recycled asphalt.<br><br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br><br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br><br>A2 (crushed concrete);<br><br>A3 (crushed bricks, masonry);<br><br>G1 (red coal shale) – not HSR earthworks. | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | Tab 6/4 Method 3 | 6 | H | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) plasticity index | BS 1377: Part 2 | Non-plastic | | | | | |
| | | | | | | | (iii) Los Angeles coefficient | Clause 635 | – | 50 | | | | |
| | | | | | | | (iv) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (v) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (vi) pH value | BS 1377: Part 3 | Tab 6/3 | Tab 6/3 | | | | |
| | | | | | | | (vii) chloride ion content | BS EN 1744-1 or equivalent test in accordance with BRE Special Digest 1 | – | Tab 6/3 | | | | |
| | | | | | | | (viii) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | Tab 6/3 | | | | |
| | | | | | | | (ix) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | Tab 6/3 | | | | |
| | | | | | | | (x) resistivity | Clause 637 | Tab 6/3 | – | | | | |
| | | | | | | | (xi) redox potential | Clause 638 | Tab 6/3 | – | | | | |
| | | | | | | | (xii) organic content | BS 1377: Part 3 | – | Tab 6/3 | | | | |
| | | | | | | | (xiii) microbial activity index | Table 6/3 | – | Tab 6/3 | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | I | – | Selected well graded granular material | Fill to reinforced soil and anchored earth structures | Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, chalk, well burnt colliery spoil or any combination thereof except that chalk shall not be combined with any other constituent. None of these constituents shall include any argillaceous rock. (Properties (i), (ii) and (v) in next column shall not apply to chalk.) (Properties (viii), (ix), (x), (xi), (xii), (xiii) and (xiv) only apply when metallic reinforcing or anchor elements, facing units or fastenings are used.) Recycled aggregate except recycled asphalt.<br><br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br><br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br><br>A2 (crushed concrete);<br><br>A3 (crushed bricks, masonry);<br><br>D2 (air cooled blast furnace slag) – not HSR earthworks;<br><br>G1 (red coal shale) – not HSR earthworks. | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | Tab 6/4 Method 2 | 6 | I | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | 10 | – | | | | |
| | | | | | | | (iii) SMC of chalk | Clause 634 | – | 20% | | | | |
| | | | | | | | (iv) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (v) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (vi) effective angle of friction (φ') and effective cohesion (c') | Clause 636 | App 6/1 | – | | | | |
| | | | | | | | (vii) coefficient of friction and adhesion (fill/ elements) | Clause 639 | App 6/1 | – | | | | |
| | | | | | | | (viii) pH value | BS 1377: Part 3 | Tab 6/3 | Tab 6/3 | | | | |
| | | | | | | | (ix) chloride ion content | BS EN 1744-1 or equivalent test in accordance with BRE Special Digest 1 | – | Tab 6/3 | | | | |
| | | | | | | | (x) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | Tab 6/3 | | | | |
| | | | | | | | (xi) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | Tab 6/3 | | | | |
| | | | | | | | (xii) resistivity | Clause 637 | Tab 6/3 | – | | | | |
| | | | | | | | (xiii) redox potential | Clause 638 | Tab 6/3 | – | | | | |
| | | | | | | | (xiv) organic content | BS 1377: Part 3 | – | Tab 6/3 | | | | |
| | | | | | | | (xv) microbial activity index | Table 6/3 | – | Tab 6/3 | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | J | – | Selected uniformly graded granular material | Fill to reinforced soil and anchored earth | Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, chalk, well burnt colliery spoil or any combination thereof, except that chalk shall not be combined with any other constituent. None of these constituents shall include any argillaceous rock. (Properties (viii), (ix), (x), (xi), (xii), (xiii) and (xiv) in next column only apply when metallic reinforcing or anchor elements, facing units or fastenings are used.) (Properties (i), (ii) and (v) in next column shall not apply to chalk.) Recycled aggregate except recycled asphalt.<br><br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br><br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br><br>A2 (crushed concrete);<br><br>A3 (crushed bricks, masonry);<br><br>D2 (air cooled blast furnace slag) – not HSR earthworks;<br><br>G1 (red coal shale) – not HSR earthworks | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | Tab 6/4 Method 3 | 6 | J | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | 5 | 10 | | | | |
| | | | | | | | (iii) SMC of chalk | Clause 634 | – | 20% | | | | |
| | | | | | | | (iv) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (v) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (vi) effective angle of friction (φ') and effective cohesion (c') | Clause 636 | App 6/1 | – | | | | |
| | | | | | | | (vii) coefficient of friction and adhesion (fill/ elements) | Clause 639 | App 6/1 | – | | | | |
| | | | | | | | (viii) pH value | BS 1377: Part 3 | Tab 6/3 | Tab 6/3 | | | | |
| | | | | | | | (ix) chloride ion content | BS EN 1744-1 or equivalent test in accordance with BRE Special Digest 1 | – | Tab 6/3 | | | | |
| | | | | | | | (x) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | Tab 6/3 | | | | |
| | | | | | | | (xi) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | Tab 6/3 | | | | |
| | | | | | | | (xii) resistivity | Clause 637 | Tab 6/3 | – | | | | |
| | | | | | | | (xiii) redox potential | Clause 638 | Tab 6/3 | – | | | | |
| | | | | | | | (xiv) organic content | BS 1377: Part 3 | – | Tab 6/3 | | | | |
| | | | | | | | (xv) microbial activity index | Table 6/3 | – | Tab 6/3 | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | K | – | Selected granular material | Lower bedding for corrugated steel buried structures | Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt.<br><br>Where material is imported onto which is not 'as dug' site it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br><br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br><br>A2 (crushed concrete);<br><br>A3 (crushed bricks, masonry);<br><br>G1 (red coal shale) – not HSR earthworks. | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | End product 90% of maximum dry density of BS 1377: Part 4 (Vibrating hammer method) | 6 | K | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | 5 | – | | | | |
| | | | | | | | (iii) plasticity index | BS 1377: Part 2 | – | 6 | | | | |
| | | | | | | | (iv) optimum mc | BS 1377: Part 4 (vibrating hammer method) | – | – | | | | |
| | | | | | | | (v) mc | BS 1377: Part 2 See Note 4 | Optimum mc -2% | Optimum mc +1% | | | | |
| | | | | | | | (vi) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (vii) Los Angeles coefficient | Clause 635 | – | 40 | | | | |
| | | | | | | | (viii) resistivity | Clause 637 | 2000 ohm cm | – | | | | |
| | | | | | | | (ix) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | 300 mg/ l as $SO_4$ | | | | |
| | | | | | | | (x) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | 0.06% as $SO_4$ | | | | |
| | | | | | | | (xi) chloride ion content | BS EN 1744-1 or equivalent test in accordance with BRE Special Digest 1 | – | 0.025% | | | | |
| | | | | | | | (xii) pH value | BS 1377: Part 3 | 6 | 9 | | | | |
| | | | | | | | (xiii) sulfide and hydrogen sulfide | Standard textbook of qualitative inorganic analysis | – | Rapid blackening of lead acetate paper | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | L | – | Selected uniformly graded granular material | Upper bedding for corrugated steel buried structures | Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br>A2 (crushed concrete);<br>A3 (crushed bricks, masonry);<br>G1 (red coal shale) – not HSR earthworks. | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | | 6 | L | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) resistivity | Clause 637 | 2000 ohm cm | – | | | | |
| | | | | | | | (iii) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | 300 mg/ l as $SO_4$ | | | | |
| | | | | | | | (iv) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | 0.06% as $SO_4$ | | | | |
| | | | | | | | (v) chloride ion content | BS EN 1744-1 or equivalent test in accordance with BRE Special Digest 1 | – | 0.025% | | | | |
| | | | | | | | (vi) pH value | BS 1377: Part 3 | 6 | 9 | | | | |
| | | | | | | | (vii) sulfide and hydrogen sulfide | Standard textbook of qualitative inorganic analysis | – | Rapid blackening of lead acetate paper | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | M | – | Selected granular material | Surround to corrugated steel buried structures | Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br>A2 (crushed concrete);<br>A3 (crushed bricks, masonry);<br>G1 (red coal shale) – not HSR earthworks. | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | End product 90% of maximum dry density of BS 1377: Part 4 (Vibrating hammer method) unless otherwise stated in App 6/1 | 6 | M | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | 5 | – | | | | |
| | | | | | | | (iii) plasticity index | BS 1377: Part 2 | – | 6 | | | | |
| | | | | | | | (iv) optimum mc | BS 1377: Part 4 (vibrating hammer method) | – | – | | | | |
| | | | | | | | (v) mc | BS 1377: Part 2 See Note 4 | Optimum mc -2% | Optimum mc +1% | | | | |
| | | | | | | | (vi) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (vii) Los Angeles coefficient | Clause 635 | – | 40 | | | | |
| | | | | | | | (viii) resistivity | Clause 637 | 2000 ohm cm | – | | | | |
| | | | | | | | (ix) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | 300 mg/ l as $SO_4$ | | | | |
| | | | | | | | (x) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | 0.06% as $SO_4$ | | | | |
| | | | | | | | (xi) chloride ion content | BS EN 1744-1 or equivalent test in accordance with BRE Special Digest 1 | – | 0.025% | | | | |
| | | | | | | | (xii) pH value | BS 1377: Part 3 | 6 | 9 | | | | |
| | | | | | | | (xiii) sulfide and hydrogen sulfide | Standard textbook of qualitative inorganic analysis | – | Rapid blackening of lead acetate paper | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | N | – | Selected well graded granular material | Fill to structures | Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, well-burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt.<br><br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br><br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br><br>A2 (crushed concrete);<br><br>A3 (crushed bricks, masonry);<br><br>G1 (red coal shale) - not HSR earthworks. | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | Non HSR: End product 95% of maximum dry density of BS 1377: Part 4 (vibrating hammer method)<br><br>HSR: End product 98% of maximum dry density of BS 1377: Part 4 (vibrating hammer method) | 6 | N | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | 10 | – | | | | |
| | | | | | | | (iii) Los Angeles coefficient | Clause 635 | – | 40 | | | | |
| | | | | | | | (iv) undrained shear parameters (c and φ) | Clause 633 | App 6/1 | – | | | | |
| | | | | | | | (v) effective angle of internal friction (φ') and effective cohesion (c') | Clause 636 | App 6/1 | – | | | | |
| | | | | | | | (vi) permeability | Clause 640 | App 6/1 | – | | | | |
| | | | | | | | (vii) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (viii) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (ix) slope stability test (where required in App 6/6) | Clause 610 | App 6/6 | | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | P | – | Selected granular material | Fill to structures | Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, chalk, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. (Properties (i), (ii) and (ix) in next column shall not apply to chalk.) Recycled aggregate except recycled asphalt.<br><br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br><br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br><br>A2 (crushed concrete);<br><br>A3 (crushed bricks, masonry);<br><br>G1 (red coal shale) – not HSR earthworks. | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | Non HSR: End product 95% of maximum dry density of BS 1377: Part 4 (vibrating hammer method)<br><br>HSR: End product 98% of maximum dry density of BS 1377: Part 4 (vibrating hammer method) | 6 | P | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | 5 | – | | | | |
| | | | | | | | (iii) IDD of chalk | Clause 634 | – | App 6/1 | | | | |
| | | | | | | | (iv) Los Angeles coefficient | Clause 635 | – | 60 | | | | |
| | | | | | | | (v) undrained shear parameters (c and φ) | Clause 633 | App 6/1 | – | | | | |
| | | | | | | | (vi) effective angle of internal friction (φ') and effective cohesion (c') | Clause 636 | App 6/1 | – | | | | |
| | | | | | | | (vii) permeability | Clause 640 | App 6/1 | – | | | | |
| | | | | | | | (viii) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (ix) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (x) slope stability test (where required in App 6/6) | Clause 610 | App 6/6 | | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | Q | – | Selected granular material | Overlying fill to corrugated steel buried structures – not for use on HSR | Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, chalk, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. (Properties (i), (ii) and (ix) in next column shall not apply to chalk.) Recycled aggregate except recycled asphalt.<br><br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br><br>P (natural aggregates – except shale, siltstone or slate, see Note 7);<br><br>A2 (crushed concrete);<br><br>A3 (crushed bricks, masonry);<br><br>D2 (air cooled blast furnace slag) – not HSR earthworks;<br><br>G1 (red coal shale) – not HSR earthworks. | As for Class 1A, 1B or 1C with the addition of the following: | | | | End product 95% of maximum dry density of BS 1377: Part 4 (vibrating hammer method)<br><br>(P06) ~~HSR: End product 98% of maximum dry density of BS 1377: Part 4 (vibrating hammer method)~~ | 6 | Q | – |
| | | | | | | | (i) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | 300 mg/ l as $SO_4$ | | | | |
| | | | | | | | (ii) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | 0.06% as $SO_4$ | | | | |
| | | | | | | | (iii) chloride ion content | BS EN 1744-1 or equivalent test in accordance with BRE Special Digest 1 | – | 0.025% | | | | |
| | | | | | | | (iv) pH value | BS 1377: Part 3 | 6 | 9 | | | | |
| | | | | | | | (v) sulfide and hydrogen sulfide | Standard textbook of qualitative inorganic analysis | – | Rapid blackening of lead acetate paper | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED GRANULAR FILL | 6 | R | – | Selected granular material | For stabilisation with lime and cement to form capping (Class 9F) or HSR embankment fill (Class 9L) | Any material, or combination of materials, other than unburnt colliery spoil and argillaceous rock. (Properties (i), (ii) and (iii) in next column, shall not apply to chalk.)<br>Glass waste is not permitted. | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | Not applicable | 6 | R | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) mc | BS 1377: Part 2 See Note 4 | App 6/1 | – | | | | |
| | | | | | | | (iii) liquid limit | BS 1377: Part 2 | – | 45 | | | | |
| | | | | | | | (iv) plasticity index | BS 1377: Part 2 | – | 20 | | | | |
| | | | | | | | (v) organic matter | BS 1377: Part 3 | – | App 6/1 | | | | |
| | | | | | | | (vi) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | 3000 mg/ l as $SO_4$ | | | | |
| | | | | | | | (vii) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | 0.6% as $SO_4$ | | | | |
| | | | | | | | (viii) IDD of chalk | Clause 634 | – | App 6/1 | | | | |
| | 6 | S | – | Selected well graded granular material | Filter layer below subbase | Crushed rock or sand.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br>P (natural aggregates – except chalk, shale, siltstone or slate, see Note 7). | (i) grading | BS 1377: Part 2 (On-site) | Tab 6/2 | Tab 6/2 | – | 6 | S | – |
| | | | | | | | | BS EN 933-2 (Imported onto site) | Tab 6/5 | Tab 6/5 | | | | |
| | | | | | | | (ii) plasticity index | BS 1377: Part 2 | – | Non-plastic | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED COHESIVE FILL | 7 | A | – | Selected cohesive material | Fill to structures | (P06) Any material or combination of materials, other than argillaceous rock and materials designated as Class 3 in the Contract. If chalk is used it shall form 100% of constituents. (Properties (i) and (iii) shall not apply to chalk.) (For non-HSR properties (vii) and (viii) may be increased to 54% and 31% respectively for Lias Clay only and subject to the requirements of contract specific Appendix 6/6). | (i) grading | BS 1377: Part 2 | Tab 6/2 | Tab 6/2 | (P06) For HSR, end product compaction App 6/3. For non-HSR, end product: 100% of maximum dry density of BS 1377 : Part 4 (2.5 kg rammer method) or a dry density corresponding to 5% air voids at field mc whichever is lower | 7 | A | – |
| | | | | | | | (ii) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iii) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) undrained shear parameters (c and φ) | Clause 633 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (v) effective angle of internal friction (φ') and effective cohesion (c') | Clause 636 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (vi) IDD of chalk | Clause 634 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (vii) liquid limit | BS 1377: Part 2 | – | 45 for non-HSR 35 for HSR | | | | |
| | | | | | | | (viii) plasticity index | BS 1377: Part 2 | – | 25 | | | | |
| | 7 | B | – | Selected conditioned pulverised fuel ash cohesive material | Fill to structures and to reinforced soil | Conditioned material direct from power station dust collection system and to which a controlled quantity of water has been added. | (i) mc | BS 1377: Part 2 See Note 4 | To enable compaction to Clause 612 | | (P06) For HSR, end product compaction App 6/3. For non-HSR, end product: 95% of maximum dry density of BS 1377: Part 4 (2.5 kg rammer method) | 7 | B | – |
| | | | | | | | (ii) bulk density | BS 1377: Part 9 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iii) undrained shear parameters (c and φ) | Clause 633 | App 6/1 | – | | | | |
| | | | | | | | (iv) effective angle of internal friction (φ') and effective cohesion (c') | Clause 636 | App 6/1 | – | | | | |
| | | | | | | | (v) coefficient of friction and adhesion (fill/ elements) | Clause 639 | App 6/1 | – | | | | |
| | | | | | | | (vi) permeability | Clause 640 | App 6/1 | – | | | | |
| | | | | | | | (vii) slope stability test (where required in App 6/6) | Clause 610 | App 6/6 | | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED COHESIVE FILL | 7 | C | – | Selected wet cohesive material | Fill to reinforced soil | Any material, or combination of materials, other than unburnt colliery spoil, argillaceous rock and chalk. (Properties (viii), (ix), (x), (xi) and (xii) in next column only apply when metallic reinforcing elements, facing units or fastenings are used). | (i) grading | BS 1377: Part 2 | Tab 6/2 | Tab 6/2 | Tab 6/4 Method 1 | 7 | C | – |
| | | | | | | | (ii) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iii) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) effective angle of internal friction (φ') and effective cohesion (c') | Clause 636 | App 6/1 | – | | | | |
| | | | | | | | (v) coefficient of friction and adhesion (fill/ elements) | Clause 639 | App 6/1 | – | | | | |
| | | | | | | | (vi) liquid limit | BS 1377: Part 2 | – | 45 for non-HSR<br>35 for HSR | | | | |
| | | | | | | | (vii) plasticity index | BS 1377: Part 2 | – | 25 | | | | |
| | | | | | | | (viii) pH value | BS 1377: Part 3 | Tab 6/3 | Tab 6/3 | | | | |
| | | | | | | | (ix) chloride ion content | BS EN 1744-1 or equivalent test in accordance with BRE Special Digest 1 | – | Tab 6/3 | | | | |
| | | | | | | | (x) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | Tab 6/3 | | | | |
| | | | | | | | (xi) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | Tab 6/3 | | | | |
| | | | | | | | (xii) resistivity | Clause 637 | Tab 6/3 | – | | | | |
| | | | | | | | (xiii) redox potential | Clause 638 | Tab 6/3 | – | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED COHESIVE FILL | 7 | D | – | Selected stony cohesive material | Fill to reinforced soil | Any material, or combination of materials, other than unburnt colliery spoil, argillaceous rock and chalk. (Properties (vi), (vii), (viii), (ix), (x), (xi) and (xii) in next column only apply when metallic reinforcing elements, facing units or fastenings are used). | (i) grading | BS 1377: Part 2 | Tab 6/2 | Tab 6/2 | Tab 6/4 Method 2 | 7 | D | – |
| | | | | | | | (ii) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iii) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) effective angle of internal friction (φ') and effective cohesion (c') | Clause 636 | App 6/1 | – | | | | |
| | | | | | | | (v) coefficient of friction and adhesion (fill/ elements) | Clause 639 | App 6/1 | – | | | | |
| | | | | | | | (vi) liquid limit | BS 1377: Part 2 | – | 45 for non-HSR<br>35 for HSR | | | | |
| | | | | | | | (vii) plasticity index | BS 1377: Part 2 | – | 25 | | | | |
| | | | | | | | (viii) pH value | BS 1377: Part 3 | Tab 6/3 | Tab 6/3 | | | | |
| | | | | | | | (ix) chloride ion content | BS EN 1744-1 or equivalent test in accordance with BRE Special Digest 1 | – | Tab 6/3 | | | | |
| | | | | | | | (x) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | Tab 6/3 | | | | |
| | | | | | | | (xi) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | Tab 6/3 | | | | |
| | | | | | | | (xii) resistivity | Clause 637 | Tab 6/3 | – | | | | |
| | | | | | | | (xiii) redox potential | Clause 638 | Tab 6/3 | – | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED COHESIVE FILL | 7 | E | – | Selected cohesive material | For stabilisation with lime to form capping (Class 9D) or HSR embankment fill (Class 9J) | Any material, or combination of materials, other than unburnt colliery spoil.<br>Glass waste is not permitted. | (i) grading | BS 1377: Part 2 | Tab 6/2 | Tab 6/2 | Not applicable | 7 | E | – |
| | | | | | | | (ii) mc | BS 1377: Part 2 See Note 4 | – | App 6/1 | | | | |
| | | | | | | | (iii) MCV | Clause 632 | App 6/1 | – | | | | |
| | | | | | | | (iv) plasticity index | BS 1377: Part 2 | 10 | – | | | | |
| | | | | | | | (v) organic matter | BS 1377: Part 3 | – | App 6/1 | | | | |
| | | | | | | | (vi) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | App 6/1 | | | | |
| | | | | | | | (vii) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | App 6/1 | | | | |
| | | | | | | | (viii) total potential sulfate (TPS) content | TRL Report 477, Test No. 4 | – | App 6/1 | | | | |
| | | | | | | | (ix) liquid limit (HSR emb fill only) | BS 1377: Part 2 | - | 65 | | | | |
| | | | | | | | (x) plasticity index (HSR emb fill only) | BS 1377: Part 2 | - | 40 | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED COHESIVE FILL | 7 | F | – | Selected silty cohesive material | For stabilisation with cement to form capping (Class 9B) or HSR embankment fill (Class 9H) | Any material, or combination of materials, other than chalk, unburnt colliery spoil and argillaceous rock.<br>Glass waste is not permitted. | (i) grading | BS 1377: Part 2 | Tab 6/2 | Tab 6/2 | Not applicable | 7 | F | – |
| | | | | | | | (ii) uniformity coefficient | See Note 5 | 5 | – | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 2<br>See Note 4 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (v) liquid limit | BS 1377: Part 2 | – | 45 | | | | |
| | | | | | | | (vi) plasticity index | BS 1377: Part 2 | – | 20 | | | | |
| | | | | | | | (vii) organic matter | BS 1377: Part 3 | – | App 6/1 | | | | |
| | | | | | | | (viii) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | App 6/1 | | | | |
| | | | | | | | (ix) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | App 6/1 | | | | |
| | | | | | | | (x) total potential sulfate (TPS) content | TRL Report 477, Test No. 4 | – | App 6/1 | | | | |
| | | | | | | | (xi) liquid limit (HSR emb fill only) | BS 1377: Part 2 | - | 65 | | | | |
| | | | | | | | (xii) plasticity index (HSR emb fill only) | BS 1377: Part 2 | - | 40 | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED COHESIVE FILL | 7 | G | – | Selected conditioned pulverised fuel ash cohesive material | For stabilisation with cement to form capping (Class 9C) or HSR embankment fill (Class 9I) | Conditioned material direct from power station dust collection system and to which a controlled quantity of water has been added. | (i) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | Not applicable | 7 | G | – |
| | | | | | | | (ii) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | 3000 mg/l as $SO_4$ | | | | |
| | | | | | | | (iii) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | 0.6% as $SO_4$ | | | | |
| | | | | | | | (iv) total potential sulfate (TPS) content | TRL Report 477, Test No. 4 | – | 1.2% as $SO_4$ | | | | |
| | 7 | H | – | Wet, dry, stony or silty cohesive material and chalk | Overlying fill for corrugated steel buried structures | As Class 2A, 2B, 2C, 2D general cohesive fill material or Class 3 chalk fill material, except that argillaceous rock, slag, PFA or any combination thereof shall not be used. | As for Class 2A, 2B, 2C, 2D or 3 with the addition of the following | | | | As for Class 2A, 2B, 2C, 2D or 3 | 7 | H | – |
| | | | | | | | (i) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | 300 mg/l as $SO_4$ | | | | |
| | | | | | | | (ii) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | 0.06% as $SO_4$ | | | | |
| | | | | | | | (iii) chloride ion content | BS EN 1744-1 or equivalent test in accordance with BRE Special Digest 1 | – | 0.025% | | | | |
| | | | | | | | (iv) pH value | BS 1377: Part 3 | 6 | 9 | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| SELECTED COHESIVE FILL | 7 | I | – | Selected cohesive material | For stabilisation with lime and cement to form capping (Class 9E) or HSR embankment fill (Class 9K) | Any material, or combination of materials, other than unburnt colliery spoil. | (i) grading | BS 1377: Part 2 | Tab 6/2 | Tab 6/2 | Not applicable | 7 | I | – |
| | | | | | | | (ii) mc | BS 1377: Part 2 See Note 4 | – | App 6/1 | | | | |
| | | | | | | | (iii) MCV | Clause 632 | App 6/1 | – | | | | |
| | | | | | | | (iv) plasticity index | BS 1377: Part 2 | 10 | – | | | | |
| | | | | | | | (v) organic matter | BS 1377: Part 3 | – | App 6/1 | | | | |
| | | | | | | | (vi) water soluble (WS) sulfate content | TRL Report 477, Test No. 1 (suitable for sands, silts, clays, weak rocks and aggregates) or BS1377-3 Clause 5 (not suitable for aggregates) | – | App 6/1 | | | | |
| | | | | | | | (vii) oxidisable sulfides (OS) content | TRL Report 477, Test No. 2 and 4 | – | App 6/1 | | | | |
| | | | | | | | (viii) total potential sulfate (TPS) content | TRL Report 477, Test No. 4 | – | App 6/1 | | | | |
| | | | | | | | (ix) liquid limit (HSR emb fill only) | BS 1377: Part 2 | - | 65 | | | | |
| | | | | | | | (x) plasticity index (HSR emb fill only) | BS 1377: Part 2 | - | 40 | | | | |
| MISCELLENEOUS FILL | 8 | – | – | Class 1, Class 2 or Class 3 material | Lower trench fill | Any material; except no stones or lumps of clay shall be retained on the 40mm test sieve. Recycled aggregate.<br>Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10:<br>P (natural aggregates);<br>A (construction and demolition recycling industries);<br>B1 (municipal incinerator bottom ash (MIBA)) D2 (air cooled blast furnace slag) – not HSR earthworks;<br>D3 (basic oxygen furnace slag) – not HSR earthworks;<br>D4 (electric arc furnace slag (EAF C)) – not HSR earthworks;<br>G (mining and quarry industry).<br>Glass waste is not permitted. | (i) mc | BS 1377: Part 2 See Note 4 | App 6/1 | App 6/1 | Tab 6/4 | 8 | - | - |
| | | | | | | | (ii) MCV | Clause 632 | App 6/1 | App 6/1 | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| STABILISED MATERIALS | 9 | A | – | Cement stabilised well graded granular material | Capping | Class 6E with addition of cement according to Clause 614 | (i) pulverisation | BS EN 13286-48 | 60% | – | Tab 6/4 Method 6 | 9 | A | – |
| | | | | | | | (ii) bearing ratio | BS EN 13286-47 | App 6/1 | – | | | | |
| | | | | | | | (iii) mc | BS EN 13286-2 | App 6/1 | App 6/1 | | | | |
| | 9 | B | – | Cement stabilised silty cohesive material | Capping | Class 7F with addition of cement according to Clause 614 | (i) pulverisation | BS EN 13286-48 | App 6/1 | – | Tab 6/4 Method 7 | 9 | B | – |
| | | | | | | | (ii) MCV immediately before compaction | Clause 632 | App 6/1 | 12 | | | | |
| | | | | | | | (iii) bearing ratio | BS EN 13286-47 | App 6/1 | – | | | | |
| | | | | | | | (iv) mc | BS EN 13286-2 | App 6/1 | App 6/1 | | | | |
| | 9 | C | – | Cement stabilised conditioned pulverised fuel ash cohesive material | Capping | Class 7G with addition of cement according to Clause 614 | (i) pulverisation | BS EN 13286-48 | 60% | – | End product 95% of maximum dry density BS EN 13286-47 (2.5kg rammer method) | 9 | C | – |
| | | | | | | | (ii) bearing ratio | BS EN 13286-47 | App 6/1 | – | | | | |
| | | | | | | | (iii) mc | BS EN 13286-2 | App 6/1 | – | | | | |
| | 9 | D | – | Lime stabilised cohesive material | Capping | Class 7E with addition of lime according to Clause 615 | (i) pulverisation | BS EN 13286-48 | 30% | – | Tab 6/4 Method 7 | 9 | D | – |
| | | | | | | | (ii) MCV immediately before compaction | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iii) bearing ratio | BS EN 13286-47 | App 6/1 | – | | | | |
| | | | | | | | (iv) mc | BS EN 13286-2 | App 6/1 | App 6/1 | | | | |
| | 9 | E | – | Lime and cement stabilised cohesive material | Capping | Class 7I with addition of lime and cement according to Clause 643 | (i) pulverisation | BS EN 13286-48 | 30% | – | Tab 6/4 Method 7 | 9 | E | – |
| | | | | | | | (ii) MCV immediately before completion | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iii) bearing ratio | BS EN 13286-47 | App 6/1 | – | | | | |
| | | | | | | | (iv) mc | BS EN 13286-2 | App 6/1 | App 6/1 | | | | |
| | 9 | F | – | Lime and cement stabilised well graded granular material | Capping | Class 6R with addition of lime and cement according to Clause 643 | (i) pulverisation | BS EN 13286-48 | 60% | – | Tab 6/4 Method 6 | 9 | F | – |
| | | | | | | | (ii) bearing ratio | BS EN 13286-47 | App 6/1 | – | | | | |
| | | | | | | | (iii) mc | BS EN 13286-2 See Note 4 | App 6/1 | App 6/1 | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| STABILISED MATERIALS | 9 | G | – | Cement stabilised well graded granular material | HSR embankment fill (including transitions) | Class 6E with addition of cement according to Clause 647 | (i) pulverisation | BS EN 13286-48 | 60% | – | (P06) End product compaction App 6/3<br><br>UEF:<br>$E_{v2}$>60MPa at surface of UEF, $E_{v2}$>45MPa at 1m above LEF (see Note 13). | 9 | G | – |
| | | | | | | | (ii) mc | BS EN 13286-2 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iii) optimum mc | BS 1377: Part 4 (4.5kg rammer method) | - | - | | | | |
| | 9 | H | – | Cement stabilised silty cohesive material | HSR embankment fill (including transitions) | Class 7F with addition of cement according to Clause 647 | (i) pulverisation | BS EN 13286-48 | App 6/1 | – | (P06) End product compaction App 6/3<br><br>UEF:<br>$E_{v2}$>60MPa at surface of UEF, $E_{v2}$>45MPa at 1m above LEF (see Note 13). | 9 | H | - |
| | | | | | | | (ii) MCV immediately before compaction | Clause 632 | App 6/1 | 12 | | | | |
| | | | | | | | (iii) mc | BS EN 13286-2 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) optimum mc | BS 1377: Part 4 (4.5kg rammer method) | - | - | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| STABILISED MATERIALS | 9 | I | – | Cement stabilised conditioned pulverised fuel ash cohesive material | HSR embankment fill (including transitions) | Class 7G with addition of cement according to Clause 647 | (i) pulverisation | BS EN 13286-48 | 60% | – | (P06) End product compaction App 6/3<br><br>UEF:<br>$E_{v2}$>60MPa at surface of UEF, $E_{v2}$>45MPa at 1m above LEF (see Note 13). | 9 | I | - |
| | | | | | | | (ii) bearing ratio | BS EN 13286-47 | App 6/1 | - | | | | |
| | | | | | | | (iii) mc | BS EN 13286-2 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iv) optimum mc | BS 1377: Part 4 (4.5kg rammer method) | - | - | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| STABILISED MATERIALS | 9 | J | – | Lime stabilised cohesive material | HSR embankment fill (including transitions) | P(06) Class 7E with addition of lime according to Clause 648 | (i) pulverisation | BS EN 13286-48 | 30% | – | (P06) End product compaction App 6/3<br><br>UEF:<br>$E_{v2}$>60MPa at surface of UEF, $E_{v2}$>45MPa at 1m above LEF (see Note 13). | 9 | J | - |
| | | | | | | | (ii) MCV immediately before compaction | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iii) optimum mc | BS 1377: Part 4 (4.5kg rammer method) | - | - | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| STABILISED MATERIALS | 9 | K | – | Lime and cement stabilised cohesive material | HSR embankment fill (including transitions) | Class 7I with addition of lime and cement according to Clause 649 | (i) pulverisation | BS EN 13286-48 | 30% | – | (P06) End product compaction App 6/3<br><br>UEF:<br>$E_{v2}$>60MPa at surface of UEF, $E_{v2}$>45MPa at 1m above LEF (see Note 13). | 9 | K | - |
| | | | | | | | (ii) MCV immediately before compaction | Clause 632 | App 6/1 | App 6/1 | | | | |
| | | | | | | | (iii) mc | BS 1377: Part 4 (4.5kg rammer method) | - | - | | | | |
| | | | | | | | (iv) optimum mc | BS 1377: Part 4 (4.5kg rammer method) | - | - | | | | |

## TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

| Class | | | | General Material Description | Typical Use | Permitted Constituents (All Subject to Requirements of Clause 601 and contract specific Appendix 6/1) | Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631) | | | | Compaction Requirements in Clause 612 | Class | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Property (See Exceptions in Previous Column) | Defined and Tested in Accordance with: | Acceptable Limits Within: Lower | Acceptable Limits Within: Upper | | | | |
| STABILISED MATERIALS | 9 | L | – | Lime and cement stabilised well graded granular material | HSR embankment fill (including transitions) | Class 6R with addition of lime and cement according to Clause 649 | (i) pulverisation | BS EN 13286-48 | 60% | – | (P06) End product compaction App 6/3<br><br>UEF:<br>$E_{v2}$>60MPa at surface of UEF, $E_{v2}$>45MPa at 1m above LEF (see Note 13). | 9 | L | – |

## Footnotes to TABLE 6/1

| | |
|---|---|
| 1 | App = contract specific Appendix |
| 2 | Tab = Table |
| 3 | Where in the Acceptable Limits column reference is made to App 6/1, only those properties having limits ascribed to them in contract specific Appendix 6/1 shall apply. Where contract specific Appendix 6/1 gives limits for other properties not listed in this Table such limits shall also apply. |
| 4 | Where BS 1377: Part 2 is specified for mc, this shall mean BS 1377: Part 2 where the material is a soil or BS EN 1097-5 where the material is required to conform to a harmonised European Standard. |
| 5 | Uniformity coefficient is defined as the ratio of the particle diameters $D_{60}$ to $D_{10}$ on the particle-size distribution curve, where: $D_{60}$ = particle diameter at which 60% of the soil by weight is finer<br>$D_{10}$ = particle diameter at which 10% of the soil by weight is finer |
| 6. | The limiting values for Class U1B material are given in contract specific Appendix 6/14 and contract specific Appendix 6/15. |
| 7 | Not Used |
| 8 | Where material source codes are referenced these are as listed in Table 6/7. |
| 9 | Where materials are required to be aggregates conforming to BS EN 13242 materials certificated as being compliant with BS EN 13285 are acceptable for use provided that they meet all the specification requirements and the Declaration of Performance for constituent parts to BS EN 13242 are provided to the Contractor's Engineering Director. |
| 10 | Materials shall comply with the current Environmental Regulations at the time of use. Reference shall be made to Annex ZA (informative) of BS EN 13242. |
| 11 | The compaction acceptability criteria for chalk shall be confirmed by relationship testing for the particular form of chalk proposed in order to achieve the required stiffness and deformation performance requirements. |
| 12 | General Cohesive fill with > 15% passing the 63µm sieve is not to be used for HSR earthworks Upper Embankment Fill. |
| 13 | The Modulus of Deformation shall be measured following the requirements in Clause 612.14. |
| 14 | Liquid limit of cohesive fills for use as Lower Embankment Fill shall be nominally less than 35%. However, this is subject to a source approval process described in Table 4.3.1 in the Technical Standard – Earthworks HS2-HS2-GT-STD-000-000001, and the actual values to be used shall be specified by the Designer in contract specific Appendix 6/1. |
| 15 | (P06) When testing imported coarse Class 6 materials for particle size distribution it is acceptable to follow the method described in BS 1377-2 in lieu of BS EN 13285 and/or BS EN 933-2, provided the sieve sizes required by BS EN 13285 are used. |

## TABLE 6/2: Grading Requirements for Acceptable Earthworks Materials Other Than Classes 6F4, 6F5 and 6S

| Percentage by Mass Passing the Size Shown | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Class** | **Size (mm)** | | **Size (mm) BS Series** | | | | | | | | | | | | | **Size (microns) BS Series** | | | | **Size (micr-ons)** | **Class** |
| | **500** | **300** | **125** | **90** | **75** | **37.5** | **28** | **20** | **14** | **10** | **6.3** | **5** | **3.35** | **2** | **1.18** | **600** | **300** | **150** | **63** | **2** | |
| 1A & 1A1 | | 100 | 95-100 | | | | | | | | | | | | | | | | <15 | | 1A & 1A1 |
| 1B & 1B1 | | | 100 | | | | | | | | | | | | | | | | <15 | | 1B & 1B1 |
| 1C & 1C1 | 100 | | 10-95 | | | | | | | | | | | | | 0-25 | | | 15 | | 1C & 1C1 |
| 2A & 2B | | | 100 | | | | | | | | | | | 80-100 | | | | | 15-100 | | 2A & 2B |
| 2C | | | 100 | | | | | | | | | | | 15-80 | | | | | 15-80 | | 2C |
| 2D | | | 100 | | | | | | | | | | | | | | | | 80-100 | 0-20 | 2D |
| 6A | 100 | | | | | | | | | 0-100 | | 0-85 | | | | 0-45 | | | 0-5 | | 6A |
| 6B | 100 | | 0-10 | | | | | | | | | | | | | | | | | | 6B |
| 6C | | | 100 | | | 0-100 | | | | | 0-100 | | 0-35 | 0-10 | | 0-2 | | | | | 6C |
| 6D | | | | | | | | | | 100 | | 89-100 | | 60-100 | 30-100 | 15-80 | 5-48 | 0-15 except 0-20 for crushed rock | | | 6D |
| 6E & 6R | | | 100 | 85-100 | | | | | | 25-100 | | | | | | 10-100 | | | | <15 | 6E & 6R |
| 6F1 | | | | | 100 | 75-100 | | | | 40-95 | | 30-85 | | | | 10-50 | | | <15 | | 6F1 |
| 6F2 & 6F9 | | | 100 | 80-100 | 65-100 | 45-100 | | | | 15-60 | | 10-45 | | | | 0-25 | | | 0-12 | | 6F2 & 6F9 |
| 6F3 | | | 100 | 80-100 | 65-100 | 45-100 | | | | 15-60 | | 10-45 | | | | 0-25 | | | 0-12 | | 6F3 |
| 6F6 Note 1 | | | | | | 100 | | 85-100 | | 40-70 | | 25-45 | | | | 8-22 | | | <8 | | 6F6 |
| 6H | | | | | | | | 100 | | | | 60-100 | | | 15-45 | 0-25 | | 0-5 | | | 6H |
| 6I & 6J | | | 100 | | 85-100 | | | | 25-100 | | | | | 15-100 | | 9-100 | | | <15 | | 6I & 6J |
| 6K | | | | | | | | 100 | | | | | | | | | | | 0-10 | | 6K |
| 6L | | | | | | | | | | 100 | | 89-100 | | 60-100 | 30-100 | 15-100 | 5-70 | 0-15 except 0-20 for crushed rock | | | 6L |

## TABLE 6/2: Grading Requirements for Acceptable Earthworks Materials (continued)

| Percentage by Mass Passing the Size Shown | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Class** | **Size (mm)** | | **Size (mm) BS Series** | | | | | | | | | | | | | **Size (microns) BS Series** | | | | **Size (micr-ons)** | **Class** |
| | **500** | **300** | **125** | **90** | **75** | **37.5** | **28** | **20** | **14** | **10** | **6.3** | **5** | **3.35** | **2** | **1.18** | **600** | **300** | **150** | **63** | **2** | |
| 6M | | | | | 100 | | | | | | | | | | | | | | 0-10 | | 6M |
| 6N & 6P | | | | | 100 | | | | | | | | | | | | | | <15 | | 6N & 6P |
| 6S | | | | | 100 | | | | | | | | | 60-100 | | 30-90 | | 4-45 | 0-16 | | 6S |
| 7A | | | | | 100 | | | | | | | | | | | | | | 15-100 | | 7A |
| 7C | | | 100 | | 85-100 | | | | 83-100 | | | | | 80-100 | | 60-100 | | | 15-45 | 0-20 | 7C |
| 7D | | | 100 | | 85-100 | | | | 40-90 | | | | | 15-79 | | 15-75 | | | 15-45 | 0-20 | 7D |
| 7E | | | | | 100 | | 95-100 | | | | | | | | | | | | 15-100 | | 7E |
| 7F | | | 100 | | | | | | | | | | | | | | | | 15-100 | | 7F |
| 7I | | | | | 100 | | 95-100 | | | | | | | | | | | | 15-100 | | 7I |

## Footnotes to TABLE 6/2

| | |
|---|---|
| 1 | The grading analysis for 6F6 must also include sieve sizes 150um, 212um, 425um, 1.18mm, 2mm, 3.35mm and 6.3mm. When plotted the grading curves must be smooth and contain only a single point of inflection |

**TABLE 6/3: Limits of Material Properties of Fill for Use With Metal Components in Reinforced Soil and Anchored Earth Structures for Class 6H, 6I, 6J, 7C and 7D Materials**

| Reinforcing Element Material | Properties of Fill | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | pH Value | | Max Chloride Ion Content % | Max Organic Content % | Max Water Soluble (WS) Sulfate Content mg/l as $SO_4$ | Maximum Oxidisable Sulfides (OS) Content % as $SO_4$ | Minimum Restivity Ohm.cm | Minimum Redox Potential volts | Microbial Activity Index |
| | Min | Max | | | | | | | |
| Galvanised Steel | 5 | 10 | 0.02 | 0.2 | 300 | 0.06 | 5000 | 0.40 | Less than 5 |
| Stainless Steel | 5 | 10 | 0.025 | 0.2 | 600 | 0.12 | 3000 | 0.35 | Less than 5 |

**Notes:**

**1** A method of calculating the Microbial Activity Index may be obtained by reference to TRRL Contractor Report 54 'Soil Corrosivity Assessment'.

**2** The corrosion potential of frictional fill shall be assessed from resistivity, pH, chloride, water soluble sulfate and oxidisable sulfides tests. For cohesive soil it will be necessary to test additionally for organic content. Should either organic content or sulfate be in excess of the specified levels, then tests shall also be included for Redox Potential and Microbial Activity Index.

**3** The water soluble sulfate content and oxidisable sulfides content shall be determined in accordance with the methods described in TRL Report 447, Tests Nos 1, 2 and 4.

**4** Methods of test (except for Microbial Activity Index, water soluble sulfate content and oxidisable sulfides content) are given in BS 1377: Part 3.

## TABLE 6/4: Method Compaction for Earthworks Materials: Plant and Methods (Method 1 to Method 6)
## This Table is to be read in conjunction with sub-Clause 612.10)

| Type of Compaction Plant | Ref No. | Category | Method 1 | | Method 2 | | Method 3 | | Method 4 | | Method 5 | | Method 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | D | N# | D | N# | D | N# | D | N | D | N | N for D = 110 mm | N for D = 150 mm | N for D = 250 mm |
| Smoothed wheeled roller (or vibratory roller operating without vibration) | | Mass per metre width of roll: | | | | | | | | | | | | | |
| | 1 | over 2100 kg up to 2700 kg | 125 | 8 | 125 | 10 | 125 | 10* | 175 | 4 | unsuitable | | unsuitable | unsuitable | unsuitable |
| | 2 | over 2700 kg up to 5400 kg | 125 | 6 | 125 | 8 | 125 | 8* | 200 | 4 | unsuitable | | 16 | unsuitable | unsuitable |
| | 3 | over 5400 kg | 150 | 4 | 150 | 8 | unsuitable | | 300 | 4 | unsuitable | | 8 | 16 | unsuitable |
| Grid roller | | Mass per metre width of roll: | | | | | | | | | | | | | |
| | 1 | over 2700 kg up to 5400 kg | 150 | 10 | unsuitable | | 150 | 10 | 250 | 4 | unsuitable | | unsuitable | unsuitable | unsuitable |
| | 2 | over 5400 kg up to 8000 kg | 150 | 8 | 125 | 12 | unsuitable | | 325 | 4 | unsuitable | | 20 | unsuitable | unsuitable |
| | 3 | over 8000 kg | 150 | 4 | 150 | 12 | unsuitable | | 400 | 4 | unsuitable | | 12 | 20 | unsuitable |
| Deadweight tamping roller | | Mass per metre width of roll: | | | | | | | | | | | | | |
| | 1 | over 4000 kg up to 6000 kg | 225 | 4 | 150 | 12 | 250 | 4 | 350 | 4 | unsuitable | | 12 | 20 | unsuitable |
| | 2 | over 6000 kg | 300 | 5 | 200 | 12 | 300 | 3 | 400 | 4 | unsuitable | | 8 | 12 | 20 |
| Pneumatic-tyred roller | | Mass per wheel: | | | | | | | | | | | | | |
| | 1 | over 1000 kg up to 1500 kg | 125 | 6 | unsuitable | | 150 | 10* | 240 | 4 | unsuitable | | unsuitable | unsuitable | unsuitable |
| | 2 | over 1500 kg up to 2000 kg | 150 | 5 | unsuitable | | unsuitable | | 300 | 4 | unsuitable | | unsuitable | unsuitable | unsuitable |
| | 3 | over 2000 kg up to 2500 kg | 175 | 4 | 125 | 12 | unsuitable | | 350 | 4 | unsuitable | | unsuitable | unsuitable | unsuitable |
| | 4 | over 2500 kg up to 4000 kg | 225 | 4 | 125 | 10 | unsuitable | | 400 | 4 | unsuitable | | unsuitable | unsuitable | unsuitable |
| | 5 | over 4000 kg up to 6000 kg | 300 | 4 | 125 | 10 | unsuitable | | unsuitable | | unsuitable | | 12 | unsuitable | unsuitable |
| | 6 | over 6000 kg up to 8000 kg | 350 | 4 | 150 | 8 | unsuitable | | unsuitable | | unsuitable | | 12 | unsuitable | unsuitable |
| | 7 | over 8000 kg up to 12000 kg | 400 | 4 | 150 | 8 | unsuitable | | unsuitable | | unsuitable | | 10 | 16 | unsuitable |
| | 8 | over 12000 kg | 450 | 4 | 175 | 6 | unsuitable | | unsuitable | | unsuitable | | 8 | 12 | unsuitable |
| Vibratory tamping roller | | Mass per metre width of a vibrating roll: | | | | | | | | | | | | | |
| | 1 | over 700 kg up to 1300 kg | 100 | 12 | 100 | 12 | 150 | 12 | 100 | 10 | unsuitable | | unsuitable | unsuitable | unsuitable |
| | 2 | over 1300 kg up to 1800 kg | 125 | 12 | 125 | 12 | 175 | 12* | 175 | 8 | unsuitable | | 12 | unsuitable | unsuitable |
| | 3 | over 1800 kg up to 2300 kg | 150 | 12 | 150 | 12 | 200 | 12* | unsuitable | | unsuitable | | 8 | 12 | unsuitable |
| | 4 | over 2300 kg up to 2900 kg | 150 | 9 | 150 | 9 | 250 | 12* | unsuitable | | 400 | 5 | 6 | 10 | unsuitable |
| | 5 | over 2900 kg up to 3600 kg | 200 | 9 | 200 | 9 | 275 | 12* | unsuitable | | 500 | 6 | 6 | 10 | unsuitable |
| | 6 | over 3600 kg up to 4300 kg | 225 | 9 | 225 | 9 | 300 | 12* | unsuitable | | 600 | 6 | 4 | 8 | unsuitable |
| | 7 | over 4300 kg up to 5000 kg | 250 | 9 | 250 | 9 | 300 | 9* | unsuitable | | 700 | 6 | 3 | 7 | 12 |
| | 8 | over 5000 kg | 275 | 9 | 275 | 9 | 300 | 7* | unsuitable | | 800 | 6 | 3 | 6 | 10 |

## TABLE 6/4: Method Compaction for Earthworks Materials: Plant and Methods (Method 1 to Method 6)
## This Table is to be read in conjunction with sub-Clause 612.10) (Continued)

| Type of Compaction Plant | Ref No. | Category | Method 1 | | Method 2 | | Method 3 | | Method 4 | | Method 5 | | Method 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | D | N# | D | N# | D | N# | Δ | N | D | N | N for D = 110 mm | N for D = 150 mm | N for D = 250 mm |
| Vibratory roller | | Mass per metre width of vibratory roll: | | | | | | | | | | | | | |
| | 1 | over 270 kg up to 450 kg | unsuitable | | 75 | 16 | 150 | 16 | unsuitable | | unsuitable | | unsuitable | unsuitable | unsuitable |
| | 2 | over 450 kg up to 700 kg | unsuitable | | 75 | 12 | 150 | 12 | unsuitable | | unsuitable | | unsuitable | unsuitable | unsuitable |
| | 3 | over 700 kg up to 1300 kg | 100 | 12 | 125 | 10 | 150 | 6 | 125 | 10 | unsuitable | | 16 | unsuitable | unsuitable |
| | 4 | over 1300 kg up to 1800 kg | 125 | 8 | 150 | 8 | 200 | 10* | 175 | 4 | unsuitable | | 6 | 16 | unsuitable |
| | 5 | over 1800 kg up to 2300 kg | 150 | 4 | 150 | 4 | 225 | 12* | unsuitable | | unsuitable | | 4 | 6 | 12 |
| | 6 | over 2300 kg up to 2900 kg | 175 | 4 | 175 | 4 | 250 | 10* | unsuitable | | 400 | 5 | 3 | 5 | 11 |
| | 7 | over 2900 kg up to 3600 kg | 200 | 4 | 200 | 4 | 275 | 8* | unsuitable | | 500 | 5 | 3 | 5 | 10 |
| | 8 | over 3600 kg up to 4300 kg | 225 | 4 | 225 | 4 | 300 | 8* | unsuitable | | 600 | 5 | 2 | 4 | 8 |
| | 9 | over 4300 kg up to 5000 kg | 250 | 4 | 250 | 4 | 300 | 6* | unsuitable | | 700 | 5 | 2 | 4 | 7 |
| | 10 | over 5000 kg | 275 | 4 | 275 | 4 | 300 | 4* | unsuitable | | 800 | 5 | 2 | 3 | 6 |
| Vibrating plate compactor | | Mass per m2 of base plate: | | | | | | | | | | | | | |
| | 1 | over 880 kg up to 1100 kg | unsuitable | | unsuitable | | 75 | 6 | unsuitable | | unsuitable | | unsuitable | unsuitable | unsuitable |
| | 2 | over 1100 kg up to 1200 kg | unsuitable | | 75 | 10 | 100 | 6 | 75 | 10 | unsuitable | | unsuitable | unsuitable | unsuitable |
| | 3 | over 1200 kg up to 1400 kg | unsuitable | | 75 | 6 | 150 | 6 | 150 | 8 | unsuitable | | unsuitable | unsuitable | unsuitable |
| | 4 | over 1400 kg up to 1800 kg | 100 | 6 | 125 | 6 | 150 | 4 | unsuitable | | unsuitable | | 8 | unsuitable | unsuitable |
| | 5 | over 1800 kg up to 2100 kg | 150 | 6 | 150 | 5 | 200 | 4 | unsuitable | | unsuitable | | 5 | 8 | unsuitable |
| | 6 | over 2100 kg | 200 | 6 | 200 | 5 | 250 | 4 | unsuitable | | unsuitable | | 3 | 6 | 12 |
| Vibro-tamper | | Mass: | | | | | | | | | | | | | |
| | 1 | over 50 kg up to 65 kg | 100 | 3 | 100 | 3 | 150 | 3 | 125 | 3 | unsuitable | | 4 | 8 | unsuitable |
| | 2 | over 65 kg up to 75 kg | 125 | 3 | 125 | 3 | 200 | 3 | 150 | 3 | unsuitable | | 3 | 6 | 12 |
| | 3 | over 75 kg up to 100 kg | 150 | 3 | 150 | 3 | 225 | 3 | 175 | 3 | unsuitable | | 2 | 4 | 10 |
| | 4 | over 100 kg | 225 | 3 | 200 | 3 | 225 | 3 | 250 | 3 | unsuitable | | 2 | 4 | 10 |
| Power rammer | | Mass: | | | | | | | | | | | | | |
| | 1 | 100 kg up to 500 kg | 150 | 4 | 150 | 6 | unsuitable | | 200 | 4 | unsuitable | | 5 | 8 | unsuitable |
| | 2 | over 500 kg | 275 | 8 | 275 | 12 | unsuitable | | 400 | 4 | unsuitable | | 5 | 8 | 14 |
| Dropping-weight compactor | | Mass of rammer over 500 kg weight drop: | | | | | | | | | | | | | |
| | 1 | over 1 m up to 2 m | 600 | 4 | 600 | 8 | 450 | 8 | unsuitable | | unsuitable | | unsuitable | unsuitable | unsuitable |
| | 2 | over 2 m | 600 | 2 | 600 | 8 | unsuitable | | unsuitable | | unsuitable | | unsuitable | unsuitable | unsuitable |

## TABLE 6/4: Method Compaction for Earthworks Materials: Plant and Methods (Method 7) (This Table is to be read in conjunction with sub-Clause 612.10) (Continued)

| Type of Compaction Plant | Ref~ No. | Category | Method 7 | |
|---|---|---|---|---|
| | | | N for D = 150 mm | N for D = 250mm |
| Smooth wheeled roller (or vibratory roller operating without vibration) | | Mass per metre width of roll: | | |
| | 1 | over 2100 kg up to 2700 kg | unsuitable | unsuitable |
| | 2 | over 2700 kg up to 5400 kg | unsuitable | unsuitable |
| | 3 | over 5400 kg | 12 | unsuitable |
| Grid roller | | Mass per metre width of roll: | | |
| | 1 | over 2700 kg up to 5400 kg | unsuitable | unsuitable |
| | 2 | over 5400 kg up to 8000 kg | 16 | unsuitable |
| | 3 | over 8000 kg | 8 | unsuitable |
| Deadweight tamping roller | | Mass per metre width of roll: | | |
| | 1 | over 4000 kg up to 6000 kg | 4 | 8 |
| | 2 | over 6000 kg | 3 | 6 |
| Pneumatic-tyred roller | | Mass per wheel: | | |
| | 1 | over 1000 kg up to 1500 kg | unsuitable | unsuitable |
| | 2 | over 1500 kg up to 2000 kg | 12 | unsuitable |
| | 3 | over 2000 kg up to 2500 kg | 6 | unsuitable |
| | 4 | over 2500 kg up to 4000 kg | 5 | unsuitable |
| | 5 | over 4000 kg up to 6000 kg | 4 | 16 |
| | 6 | over 6000 kg up to 8000 kg | unsuitable | 8 |
| | 7 | over 8000 kg up to 12000 kg | unsuitable | 4 |
| | 8 | over 12000 kg | unsuitable | 4 |
| Vibratory tamping roller | | Mass per metre width of vibrating roll: | | |
| | 1 | over 700 kg up to 1300 kg | unsuitable | unsuitable |
| | 2 | over 1300 kg up to 1800 kg | unsuitable | unsuitable |
| | 3 | over 1800 kg up to 2300 kg | 16 | unsuitable |
| | 4 | over 2300 kg up to 2900 kg | 12 | unsuitable |
| | 5 | over 2900 kg up to 3600 kg | 10 | unsuitable |
| | 6 | over 3600 kg up to 4300 kg | 8 | 16 |
| | 7 | over 4300 kg up to 5000 kg | 7 | 14 |
| | 8 | over 5000 kg | 6 | 12 |
| Vibratory roller | | Mass per metre width of vibrating roll: | | |
| | 1 | over 270 kg up to 450 kg | unsuitable | unsuitable |
| | 2 | over 450 kg up to 700 kg | unsuitable | unsuitable |
| | 3 | over 700 kg up to 1300 kg | unsuitable | unsuitable |
| | 4 | over 1300 kg up to 1800 kg | unsuitable | unsuitable |
| | 5 | over 1800 kg up to 2300 kg | 12 | unsuitable |
| | 6 | over 2300 kg up to 2900 kg | 10 | unsuitable |
| | 7 | over 2900 kg up to 3600 kg | 10 | unsuitable |
| | 8 | over 3600 kg up to 4300 kg | 8 | unsuitable |
| | 9 | over 4300 kg up to 5000 kg | 8 | unsuitable |
| | 10 | over 5000 kg | 6 | 12 |
| Vibratory plate compactor | | Mass per $m^2$ of base plate: | | |
| | 1 | over 880 kg up to 1100 kg | unsuitable | unsuitable |
| | 2 | over 1100 kg up to 1200 kg | unsuitable | unsuitable |
| | 3 | over 1200 kg up to 1400 kg | unsuitable | unsuitable |
| | 4 | over 1400 kg up to 1800 kg | 10 | unsuitable |
| | 5 | over 1800 kg up to 2100 kg | 8 | unsuitable |
| | 6 | over 2100 kg | 6 | unsuitable |
| Vibro-tamper | | Mass: | | |
| | 1 | over 50 kg up to 65 kg | unsuitable | unsuitable |
| | 2 | over 65 kg up to 75 kg | unsuitable | unsuitable |
| | 3 | over 75 kg up to 100 kg | unsuitable | unsuitable |
| | 4 | over 100 kg | 8 | unsuitable |
| Power rammer | | Mass: | | |
| | 1 | 100 kg up to 500 kg | 8 | unsuitable |
| | 2 | over 500 kg | 6 | 10 |
| Dropping weight compactor | | Mass of rammer over 500 kg height drop: | | |
| | 1 | over 1 m up to 2 m | unsuitable | unsuitable |
| | 2 | over 2 m | unsuitable | unsuitable |

## TABLE 6/5: Imported Onto Site Grading Requirements for Class 6 Acceptable Earthworks Materials

| Percentage by Mass Passing the Size Shown | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Class** | **Size (mm)** | | **Size (mm) BS EN 933-2 Series** | | | | | | | | | | | | | **Size (microns) BS EN 933-2 Series** | | | | **Class** |
| | **500** | **300** | **125** | **80** | **63** | **40** | **31.5** | **20** | **16** | **10** | **8** | **6.3** | **4** | **2** | **1** | **500** | **250** | **125** | **63** | **0** |
| 6A | 100 | | | | | | | | | 0-100 | | 0-85 | | | | 0-45 | | | 0-5 | 6A |
| 6B | 100 | | 0-10 | | | | | | | | | | | | | | | | | 6B |
| 6C | | | 100 | | | 0-100 | | | | | | 0-100 | 0-35 | 0-10 | | 0-2 | | | | 6C |
| 6D | | | | | | | | | | 100 | | | 85-100 | 60-100 | 30-100 | 15-80 | 5-48 | 0-15 except 0-20 for crushed rock | | 6D |
| 6E & 6R | | | 100 | 85-100 | | | | | | 25-100 | | | | | | 10-100 | | | <15 | 6E & 6R |
| 6F3 | | | 100 | 75-99 | | 50-90 | | 30-75 | | 15-60 | | | | 0-35 | | | | | 0-12 | 6F3 |
| 6F4 | | | | | 100 | | 75-99 | | 50-90 | | 30-75 | | 15-60 | | 0-35 | | | | <15 | 6F4 |
| 6F5 & 6F9 | | | 100 | 75-99 | | 50-90 | | 30-75 | | 15-60 | | | | 0-35 | | | | | 0-12 | 6F5 & 6F9 |
| 6F6 Note1 | | | | | | 100 | | 85-100 | | 40-70 | | | 25-45 | | | 8-22 | | | <8 | 6F6 |
| 6H | | | | | | | | 100 | | | | 60-100 | | | 15-45 | 0-25 | | 0-5 | | 6H |
| 6I & 6J | | | 100 | 85-100 | | | | | 25-100 | | | | | 15-100 | | 9-100 | | | <15 | 6I & 6J |
| 6K | | | | | | | | 100 | | | | | | | | | | | 0-10 | 6K |
| 6L | | | | | | | | | | 100 | | | 85-100 | 60-100 | 30-100 | 15-100 | 5-70 | 0-15 except 0-20 for crushed rock | | 6L |
| 6M | | | | 100 | | | | | | | | | | | | | | | 0-10 | 6M |
| 6N & 6P | | | | 100 | | | | | | | | | | | | | | | <15 | 6N & 6P |
| 6S | | | | | 100 | | | | | | | | | 60-100 | | 30-90 | | 8-45 | 0-16 | 6S |

## Footnotes to TABLE 6/5

| | |
|---|---|
| 1 | The grading analysis for 6F6 must also include sieve sizes 150um, 212um, 425um, 1.18mm, 2mm, 3.35mm and 6.3mm. When plotted the grading curves must be smooth and contain only a single point of inflection |

## TABLE 6/6*:* Records and Reports - Information Required

| |
|---|
| **Ground Treatment (General)**<br>For each area treated:<br><br>Date<br>Contract title<br>Area identification<br>Unique grid location<br>Ground level at commencement |
| **In-situ Testing (General)**<br>For each area tested:<br><br>Date<br>Contract Title<br>Area identification<br>Test position, co-ordinates and level<br>Method of test used<br>All information required by appropriate British Standard test procedure |
| **Ground Treatment (Vibro stone columns)**<br>For each column/area treated:<br><br>Material used<br>Approximate column diameter<br>Depth of penetration of each compaction point Vibrator power consumption during operation Jetting pressure (where applicable)<br>Duration of penetration Duration of compaction Obstructions and delays<br>Number and type of tests carried out |

## TABLE 6/7 Material Sources and Source Codes for Imported Materials

This table is taken from BS EN 13242:2013 which was published on 31st May 2013 and subsequently withdrawn on 10th January 2014. All other specification requirements which reference BS EN 13242 shall be taken as reference to the version of that standard current at the Contract Reference Document Date unless otherwise detailed in the contract specific specification.

| Source Code | Source | Sub-Code | Specific Material |
|---|---|---|---|
| P | Natural Aggregates | P | All petrographic types included in BS EN 932-3 |
| A | Construction and demolition recycling industries | A1 | Reclaimed asphalt |
| | | A2 | Crushed concrete |
| | | A3 | Crushed bricks, masonry |
| | | A4 | Mix of A1, A2 and A3 |
| B | Municipal solid waste incineration industry | B1 | Municipal incinerator bottom ash (excluding fly ash) (MIBA) |
| | | B2 | Municipal incinerator fly ash (MIFA) |
| C | Coal Power Generation Industry | C1 | Coal fly ash |
| | | C2 | Fluidised bed combustion fly ash (FBCFA) |
| | | C3 | Boiler slag |
| | | C4 | Coal bottom ash |
| | | C5 | Fluidised bed combustion bottom ash (FBC bottom ash) |
| D | Iron and steel industry | D1 | Granulated blast furnace slag (GBS) |
| | | D2 | Air-cooled blast furnace slag (ABS) |
| | | D3 | Basic oxygen furnace slag (converter slag, BOS) |
| | | D4 | Electric arc furnace slag (from carbon steel production, EAF C) |
| | | D5 | Electric arc furnace slag (from stainless/high alloy steel production, EAF S) |
| | | D6 | Ferrochromium slag |
| E | Non ferrous steel industry | E1 | Copper slag |
| | | E2 | Molybdenum slag |
| | | E3 | Zinc slag |
| | | E4 | Phosphorous slag |
| F | Foundry industry | F1 | Foundry sand |
| | | F2 | Foundry cupola furnace slag |
| G | Mining and quarry industry | G1 | Red coal shale |
| | | G2 | Refuse from hard coal mining (black coal shale) |
| | | G3 | Pre-selected all-in from quarry/mining |
| | | G4 | Spent oil shale |
| H | Maintenance dredging works | H1 | Dredge spoil sand |
| | | H2 | Dredge spoil clay |
| I | Miscellaneous | I1 | Excavated soil |
| | | I2 | Paper sludge ash |
| | | I3 | Sewage sludge incineration ash (municipal) |
| | | I4 | Biomass ash |
| | | I5 | Crushed glass |
| | | I6 | Expanded clay |