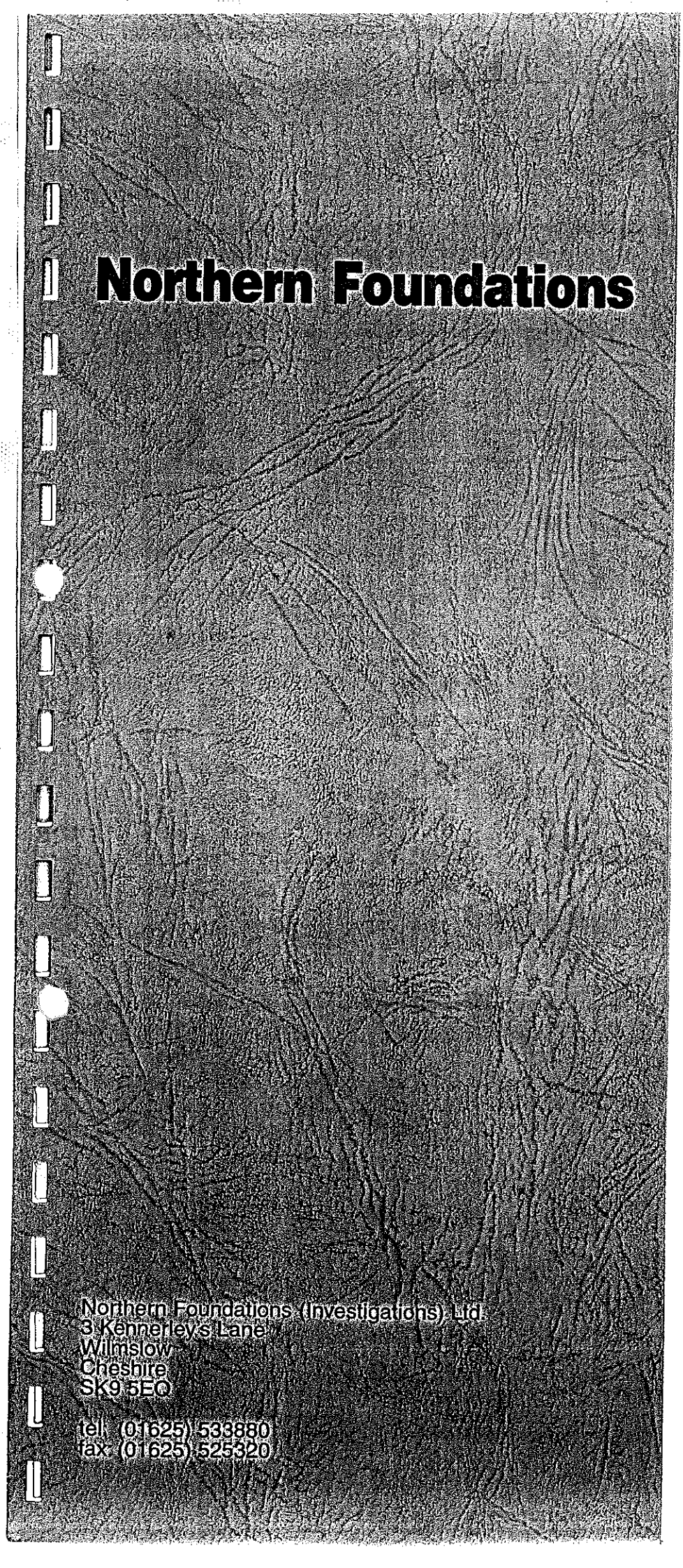


S.I.6911

WOLSTENHOLME INTERNATIONAL

DARWEN

Northern Foundations (Investigations) Ltd.
3 Kennerley's Lane
Wilmslow
Cheshire
SK9 5EQ
tel. (01625) 533880
fax. (01625) 525320

Our Ref: 02-2825/01/DCS

23rd September 2002

Wolstenholme International Limited
Springfield House
Lower Eccleshill Road
Darwin
Lancashire
BB3 0RP

For the Attention of Mr. L. Campbell.

Dear Sirs,

RE: BLOCK 'B' FLOOR SLAB REFURBISHMENT, WOLSTENHOLME INTERNATIONAL LTD.

Thank you for appointing us to look at the problems with the ground floor slab to your Block 'B' Mill Building.

Having reviewed your archive files we retrieved the following documentation:

- Northern Foundations Report - Report on Investigations at Wolstenholme International
- Bradshaw Gass & Hope - Slab Level Monitoring Data
- Branlows Letter 21.01.98 - Budget costing for pile installation
- Bradshaw Gass & Hope Drawing - Proposed Arrangement of Piles Grnd Beams & Floor Slab

We have perused the above information and can confirm that we are happy with the detail of this information and we therefore do not consider it necessary to undertake any further investigation works.

The report by Northern Foundations and also the slab level monitoring data shows that the slab as risen by up to 150mm. A trial hole investigation was carried out revealing a fill material and also obstructions thought to be concrete. The report includes a sub-report by Thomas Research Services Limited of New Holland, South Humberside commenting on their laboratory testing of samples retrieved during the trial hole investigations. The report revealed blast furnace slag and foundry material containing high concentrations of free lime and it concluded that this, along with the prevailing environmental conditions, had been the most likely cause of the movement in the slab. It also suggested that the concentrations still present might well give rise to further expansion in the future.

In our experience a fill material of this nature would be considered unsuitable as a bearing strata on which to place structures. We are of the opinion that the movement of the slab has occurred as a result of the environmental conditions causing expansion of the fill material directly below the ground slab. We also feel that the expansion of the fill material is not complete and further movement of the slab is likely to occur.

Due to the nature of the building and its current and possible future uses we would consider a piled solution to be the most suitable solution for replacing the slab. Removal of the existing fill material and replacement with an inert fill must be carried out prior to the installation of the piles and replacement of the slab. It will also be necessary to remove any obstructions to prevent problems during the driving of the piles.

We are currently putting together a tender package for issue to three contractors. The tender documentation will include a Schedule of Works and drawings / sketches as appropriate. We propose to send the tender documentation to the following contractors:

1. JET Mechanical & Civil Engineering Contractors, Widnes.
2. Doughty Construction.
3. Connaught Property Services Limited, Manchester.

We hope this is satisfactory to yourselves.

Yours faithfully,

D C Sparkes.
For and on behalf of
Steve Hunt Partnership.

S.I.6911

FEB. - APRIL 1997

REPORT ON INVESTIGATIONS
AT
WOLSTENHOLME INTERNATIONAL LTD
LOWER DARWEN, LANCASHIRE

Engineers: Bradshaw Gass & Hope
19 Silverwell Street
Bolton
Lancashire

CONTENTS

REPORT ON INVESTIGATIONS
AT
WOLSTENHOLME INTERNATIONAL LTD
LOWER DARWEN, LANCASHIRE

1. BRIEF

Part of the floor slab in one of the main factory buildings has risen over a period of years, at the time of writing being up to 150mm above the general slab level. The Engineers report that the problem appears to be of long-standing origin and that there is a possibility that the building may have been constructed over iron foundry slag, a material which is known to be susceptible to expansion in certain circumstances, notably the presence of water or raised temperatures.

2. INVESTIGATION

To the Engineer's instructions three trialholes have been excavated through the floor slab in the affected areas.

The existing floor slab was cut out by 'stitch-drilling' a series of cores. After lifting the slab excavation then proceeded using hand-tools. The observed conditions in each pit have been shown on the attached log sheets. Some inclusions of slag were found in the fill materials below the slab but the most significant features were the variations in the constituents of the sub-floor fill and also the unexpected presence of buried ducts and concrete slabs. Excavation was both difficult and slow and the base of the fill could not be reached at any of the three positions.

WHY?

In trialhole 1 excavation was not possible below 1.15m: probing below this depth encountered very dense conditions with an impassible obstruction, thought to be concrete, at 1.75m.

Trialhole 2 encountered loose fill to 1.17m at which depth concrete was met: this was cored to 1.70m without reaching the base of the concrete.

In trialhole 3 excavation had to be terminated at 1.35m, following which a probe was driven with difficulty to 1.70m.

3. SAMPLING

Bulk samples of the various fill materials were taken, sealed on site and then brought to our laboratory for inspection.

4. TESTING

4.1. Procedure

From the bulk samples brought into the laboratory three samples were selected on the basis that they appeared to contain slag or foundry waste.

The samples were as follows:

TH1	:	Bag 2 :	1.00 - 1.15m
TH3	:	Bag 5 :	1.10 - 1.20m
TH3	:	Bag 7 :	1.30 - 1.35m

4.2. Testing

Thomas Research Services Ltd of New Holland, South Humberside are the foremost laboratory in the country for analysing iron and steel industry slags with particular reference to volumetric stability and have developed a series of tests and staged approach to the testing of such materials. The three samples listed above were dispatched to their laboratory with initial instructions to carry out Phase 1 of their recommended test programme.

4.3. Test results

A copy of Thomas Research Services's report has been attached. The significant points of the sample description (TRS Appendix A) are:

Sample 1

'*Blast furnace slag occurs in medium amount...One or two particles of much altered basic steel slag are also present...*'

Sample 2

'*...mostly sand...used foundry material*'

Sample 3

'...blast furnace slag'

In their report on this phase of testing Thomas Research Services state that....'*The presence of basic steel slag together with the high degree of variability between samples is "bad news" in so far as reliability of volumetric stability is concerned*'

We discussed the results of the tests with Mr. Thomas and the Engineers. Mr. Thomas's view was that whilst the presence of steel slag had been identified in two out of the three samples submitted it was not possible to state categorically whether or not the slag could be the main cause of the uplift, nor was it possible to give positive advice as to whether further expansion could occur. Mr. Thomas's advice, however, was to remove the present fill and replace with an inert material. In view of the uncertainties, particularly with respect to future performance it was agreed that 'Phase 2' testing should be carried out on the two samples that had been identified as containing slag.

4.4. Test results : phase 2

The objective of 'phase 2' testing is to identify components that may indicate whether past volumetric instability is evident or whether it is a possibility in the future.

The results of the chemical and thermochemical analyses are again described in Mr. Thomas's report (copy attached). The results indicate a widely varying concentration of free lime and basic steel slag.

5. CONCLUSIONS

We have discussed the results of the analyses with Mr. Thomas, whom we regard as the authority in such matters. It is his conclusion that the variable but occasionally high concentrations of free lime and basic steel slag are the most likely cause of past expansion of the fill, producing uplift of the floor: in our experience this may also have been exacerbated by the relatively high temperature within the building.

Mr. Thomas has stated that the concentrations of free lime and basic steel slag still present '*may well give rise to further expansion in the future*'. Based on this conclusion it would appear that the only method of ensuring completely the stability of the floor would be to remove the existing slab in the affected areas and also the

fill below, replacing the latter with inert fill such as well-compacted clean crushed stone hardcore before casting a new slab on the prepared surface.

F.D. HALL SM(Harvard) BSc(Hons) CEng MICE FGS

Checked by:

C.P. DODD BSc (Hons) MSc

For NORTHERN FOUNDATIONS (INVESTIGATIONS) LIMITED

The recommendations made and the opinions expressed in this report are based on the borehole and/or trial pit records, examination of samples and the results of site and laboratory tests. The report is issued on the condition that Northern Foundations (Investigations) Limited will in no circumstances be liable for any loss arising directly or indirectly from ground conditions between the boreholes or trial pits which have not been shown by the borehole, trial pits or other tests carried out during the investigation, nor for any loss whatsoever arising directly or indirectly from any opinion given on the possible configuration of strata both between the borehole and/or trial pit positions and/or below the maximum depth of the investigation : such opinions, where given, are for guidance only.

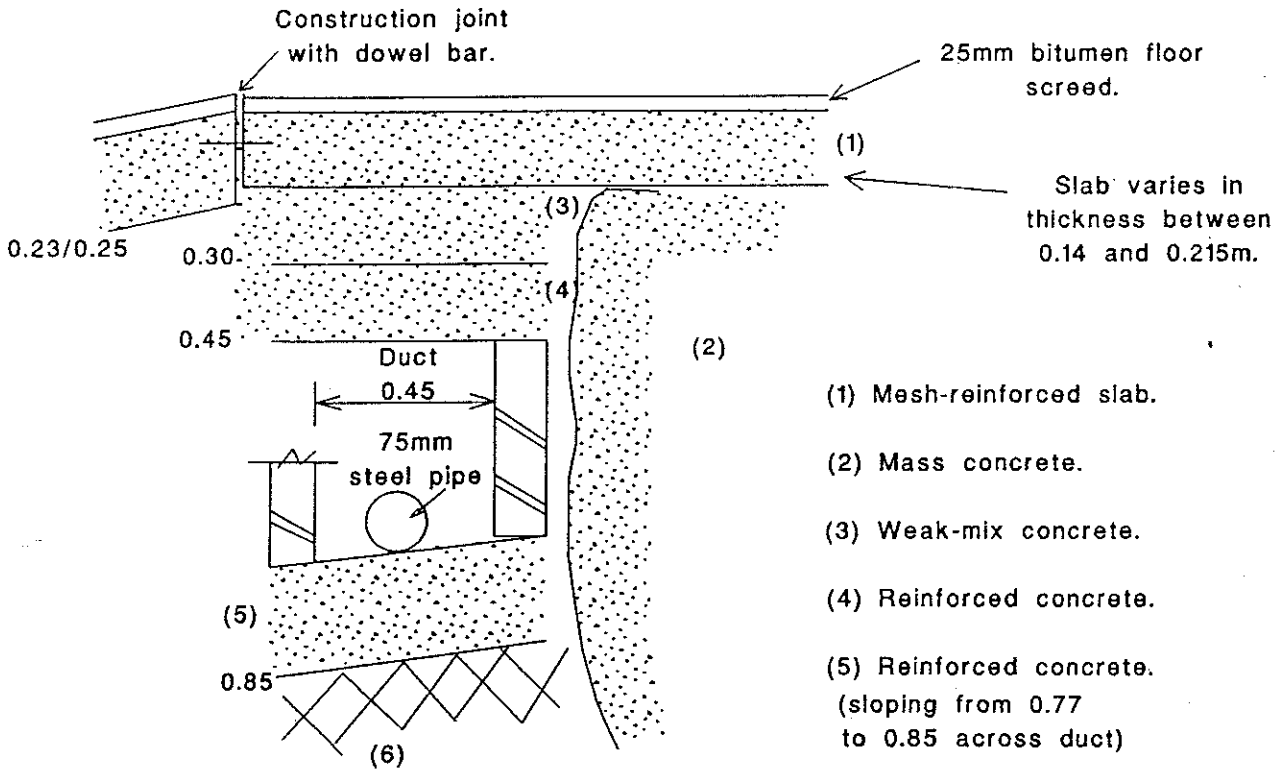
TRIALHOLE LOG SHEETS

Site WOLSTENHOLME INTERNATIONAL LTD. Job No. SI 6911

Client Bradshaw Gass and Hope. Date Feb.1997

Block B floor slab.
Trialhole details.
Sketch only : not to scale.

TH 1



(1) Mesh-reinforced slab.

(2) Mass concrete.

(3) Weak-mix concrete.

(4) Reinforced concrete.

(5) Reinforced concrete. (sloping from 0.77 to 0.85 across duct)

(6) Made ground - see below.

MADE GROUND : concrete pieces with some signs of vitrification together with occasional stone and possible foundry waste.

1.75

Note : probed with difficulty below 1.15m. - very dense (possible concrete) obstruction at 1.75m.

Trialhole Log

Site	WOLSTENHOLME INTERNATIONAL LTD.	Job No	S.I.6911
Client	Bradshaw Gass and Hope.	Date	Feb.1997
Trialhole No	3	Diameter	
Grid Ref		Method	Hand excavation.
Ground Level	Existing floor slab.	Scale	1:20

Description	Depth m	Legend	O.D. Level m	Samples and in situ tests: Depth m	Type	Vane kN/m²	Cu kN/m² unconfined		Groundwater
	0.00								
CONCRETE floor slab overlain by 30mm fine concrete screed with 20mm bitumen surface. – mesh reinforcement at bottom of concrete.	0.18								
MADE GROUND : crushed stone, brick and weak–mix concrete.	0.40			0.40	D1				
MADE GROUND : initially very ashy sand with stone and brick fragments becoming mainly sand with some ashy inclusions – some inclusions of slag below 1.10				0.60 0.75 0.85 1.10	D2 D3 D4 D5				
	1.20			1.20	D6				
MADE GROUND : fine light brown sand.	1.25			1.25	D7				
	1.35								
MADE GROUND : sand, stone and foundry waste with some vitrification, aeration and variable density. – probe driven with difficulty between 1.35 and 1.70									No entry noted.

Remarks
Mass concrete foundation/sub–structure exposed from underside of slab to 1.20m.

Key
U – undisturbed
B – bulk
D – disturbed
W – water
V – vane

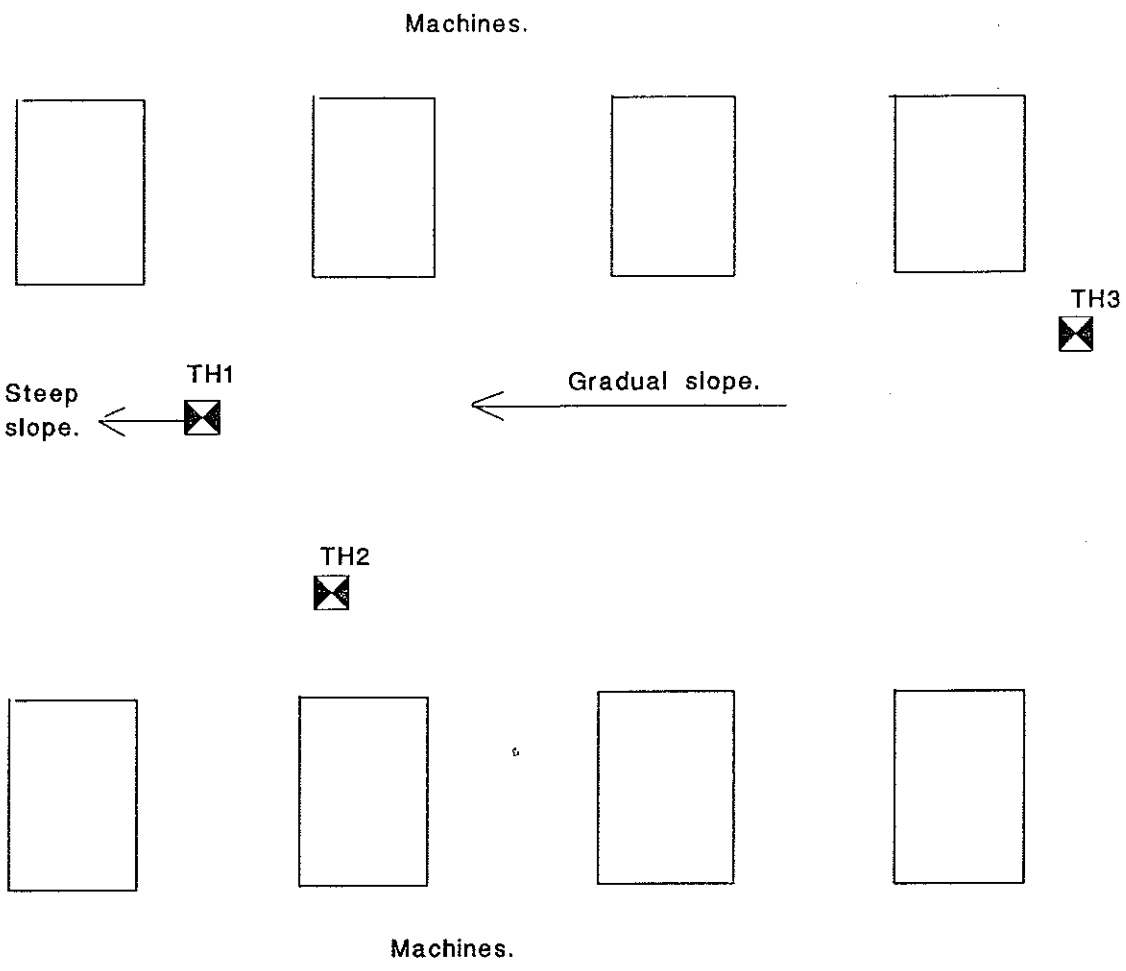
Northern Foundations

LOCATION PLAN

Site WOLSTENHOLME INTERNATIONAL LTD. Job No. SI 6911

Client Bradshaw Gass and Hope. Date Feb.1997

KEYPLAN : showing trialhole locations.
Sketch only : not to scale.



NORTHERN FOUNDATIONS

TESTING
BY
THOMAS RESEARCH SERVICES LTD

ANALYSIS ON THREE "SLAG" SAMPLES

FOR WOLSTENHOLME INTERNATIONAL LTD

INSTRUCTING CONSULTING ENGINEERS

NORTHERN FOUNDATIONS

1) BACKGROUND

Three "slag" samples supplied by Northern Foundations were submitted for "phase I" assessment by petrological microscopy. The results are summarised in appendix A.

The client reference and corresponding TRS references are as follows :-

Client Ref	TRS Ref
TH1 (Bag 2) 1.0-1.5m	AK7D01
TH3 (Bag 5) 1.1-1.2m	AK7D02
TH3 (Bag 7) 1.3-1.35m	AK7D03

2) SAMPLE PREPARATION

The samples were primary crushed, dried at low temperature, stage crushed and quartered to provide the fractions required for the programme.

3) PROGRAMME

Initially only petrology by optical microscopy (phase I) was carried out. However, in the light of phase I results the client authorised the following phase II programme :-

Samples AK7D01 & 3

Chemical analysis for water soluble sulphate
Chemical analysis for acid soluble sulphate
Chemical analysis for total sulphur
Thermal analysis (D.T.A. & T.G.A.)

In addition chemical analyses for free CaO and free MgO were included for sample AK7D01.

In the light of the petrology no phase II work was necessary for sample AK7D02.

4) RESULTS

The petrology results are summarised in appendix A whilst table 1 lists phase II results.

5) DISCUSSION OF RESULTS

5.1) Petrology

The three samples all consist of what appears to be iron and steelwork waste. However the compositions differ markedly with only the third sample (AK7D03) containing dominant quantities of "slag".

Sample AK7D01 has a large proportion of "quartz, sandstone", a "medium" amount of blastfurnace slag, and a "very small" amount of basic steel slag.

Sample AK7D02 shows no slag and is predominantly "quartz, sandstone".

The third sample, AK7D03 consists essentially of blastfurnace slag, with only small quantities of "quartz, sandstone", metal, rust, scale, fume and coke.

The presence of basic steel slag together with the high degree of variability between samples is "bad news" in so far as reliability of volumetric stability is concerned.

5.2) Chemical and Thermochemical Analyses

The results of total sulphur and sulphate analyses are relatively normal for slag fill excepting the total sulphur and acid soluble sulphate values for sample AK7D03 are low for a sample dominated in composition by blastfurnace slag. It is possible that the slag in sample AK7D03 is more heavily weathered than on AK7D01.

The most relevant results from the thermal analyses are the zero values for both ettringite and gypsum. No ettringite suggests that there has been no past expansion attributable to sulphoaluminate activity in the blastfurnace slag. The absence of gypsum indicates that one of the essential ingredients for further expansion is missing!

Sample AK7D01 showed a free CaO content of 0.3 percent. This is most likely to be attributable to the basic steel

slag identified in the petrology. Although this level of both basic steel slag and free CaO is very low, the highly variable nature of the fill as indicated by the petrological results in appendix A suggests that higher concentrations of basic steel slag and associated free lime may well be present in other parts of the fill. Such concentrations are the most likely cause of past expansion and may well give rise to further expansion in the future.

6) CONCLUSIONS

The main features of the results may be summarised as follows :-

i) Analyses of the three samples suggest that the fill consists largely of iron and steelworks waste. The composition of the product appears to be extremely variable.

ii) The blastfurnace slag analysis suggest the material is likely to be volumetrically stable although this cannot be assured with results from only three samples from such a variable product.

iii) The most likely source of volumetric instability is the presence of free lime

containing basic steel slag which may well exist in higher concentrations in some parts of the fill.

In the opinion of the writer high variability combined with the presence of basic steel slag makes an unsatisfactory fill on which to place structures.

G.H. Thomas
4 Tattershall Castle Court
New Holland
North Lincolnshire
DN19 7PZ.

Tel : 01469 532929
Fax : 01469 535053

15th May 1997

Table 1 -

CHEMICAL AND THERMOCHEMICAL

ANALYSIS RESULTS

a) CHEMICAL ANALYSES	AK7D01	AK7D03
WATER SOLUBLE SULPHATE (g/l)	0.54	0.10
ACID SOLUBLE SULPHATE (%)	0.50	0.15
TOTAL SULPHUR (%)	0.57	0.95
FREE CaO (ORIGINAL)	0.3	-
FREE CaO (CORRECTED)	0.3	-
FREE MgO (ORIGINAL)	0.0	-
FREE MgO (CORRECTED)	0.0	-

b) THERMAL ANALYSES		
LOSS-ON-IGNITION %	7.05	3.89
ETTRINGITE %	0.0	0.0
GYPSUM %	0.0	0.0
CALCITE %	6.3	4.8
$Ca(OH)_2$ %	0.0	0.0
$Mg(OH)_2$ %	0.0	0.0
OTHERS	QUARTZ	QUARTZ

APPENDIX A

PETROLOGICAL REPORT ON SAMPLES AK7D 01-03

A petrological examination has been carried out of three samples, AK7D 01-03.

Polished blocks were prepared using particulate material, crushed to a nominal size of -5 mm and dedusted. Representative material was made up into resin-bonded blocks. One face of each of these were ground flat using silicon carbide papers and polished using diamond pastes. In addition a final buff was given using alumina powder and the surfaces were selectively etched, when appropriate, with water, 10% $MgSO_4$ and 0.1%N HCl in order to help with the phase identification.

The detailed results are given in the accompanying Table.

Sample 1 This consists mainly of quartz (mostly sand) and cementitious material including much (used) Portland cement. Blast furnace slag occurs in medium amount. It is mainly crystalline and shows some secondary alteration especially to calcite. One or two particles of much altered basic steel slag are also present.

Sample 2 This consists of quartz (mostly sand) that is aggregated together in pockets by rust. There is some, largely rusted, metal and coke. The sample is believed to represent used foundry material.

Sample 3 This consists of brownish to grey blast furnace slag. It is partly crystalline and partly glassy and the main phases are melilite (CaMgAl silicate) and merwinite ($Ca_3MgSi_2O_8$). Secondary alteration is small and is mostly to calcite, with the merwinite being preferentially attacked.

TRS SAMPLES AK7D 01-03. PETROLOGY

	01	02	03
BLAST FURNACE SLAG			
Amount	m	-	L
Phases present:			
Melilite	L	-	m/l
Merwinite	s	-	m/l
Larnite & bredigite	s	-	s
Matrix	s	-	s
Ca & Fe,Mn sulphides	vs	-	vs
Metal, rust, etc.	vs	-	vs
Glassy slag	s	-	l
Ceramic slag	s	-	s
Alteration products	s	-	s
BASIC STEELMAKING SLAG			
Amount	vs	-	-
Phases present:			
Dicalcium silicate	l	-	-
RO phase	m	-	-
RF phase	s	-	-
Lime phase	-	-	-
Periclase	-	-	-
Metal, scale & rust	-	-	-
Alteration products	l	-	-
BASIC REFRACTORIES	-	-	-
OTHER CONSTITUENTS			
Aluminosilicate brick	m	-	-
Quartz, sandstone, etc.	l	L	s
Acid steel slag	vs	-	-
Metal, rust, scale & fume	vs	s	s
Iron ore & iron ore sinter	-	s	-
Coal & char	-	vs	-
Coke	vs	s	s
Cementitious material	m/l	vs	-

EXPLANATION: L = very large, l = large, m = medium, s = small and vs = very small amounts.

Melilite is $Ca_2Al_2SiO_7$-$Ca_2MgSi_2O_7$, merwinite is $Ca_3MgSi_2O_8$, larnite is ß-Ca_2SiO_4 and bredigite is Ca_2SiO_4 with some Mg in solid solution. The ceramic slag is very finely crystalline. RO phase is Fe,Mn,Mg,Ca oxide and RF phase is a complex Ca alumino-ferrite. Lime phase is CaO with some Mg, Fe and Mn in solid solution and periclase is MgO. The alteration products and cementitious material are difficult to identify specifically under the microscope but include some calcite. The acid steel slag consists of Fe-rich silicate and cristobalite (high temperature SiO_2).

Trialhole Log

Site	WOLSTENHOLME INTERNATIONAL LTD.	Job No	S.I.6911
Client	Bradshaw Gass and Hope.	Date	Feb.1997
Trialhole No	2	Diameter	
Grid Ref		Method	Hand excavation.
Ground Level	Existing floor slab.	Scale	1:20

Description	Depth m	Legend	O.D. Level m	Samples and in situ tests: Depth m	Type	Vane kN/m²	Cu kN/m² unconfined		Groundwater
	0.00								
Mesh reinforced CONCRETE floor slab with 25mm bitumen screed.	0.15								
MADE GROUND : crushed gritstone with occasional brick and concrete pieces. – generally loosely compacted.				0.17	D1				
				0.50	D2				
				0.90	D3				
	1.17								
CONCRETE. – cored to 1.70				1.20	D4				
	1.70								No entry noted.

Remarks
Floor slab varies in thickness between 0.15 and 0.17m.

Key U – undisturbed
B – bulk
D – disturbed
W – water
V – vane

Northern Foundations