Rotary Drilling

22 CROWLEES ROAD
MIRFIELD

for

Mr. D. Hayman

Report Number 4401

August 2024

Michael D Joyce Associates LLP
Geotechnical and Geoenvironmental Consultants
Registered Office: 531 Denby Dale Road West, Calder Grove, Wakefield, WF4 3ND UK
T +44(0)1924 360458 **E** mdja@geoenvironmental.co.uk **W** www.geoenvironmental.co.uk

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22 CROWLEES ROAD, MIRFIELD

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1 INTRODUCTION

1.1 At the request of Mr. D. Hayman, a Coal Mining Risk Assessment (CMRA) has previously been carried out for a proposed new detached dwelling at 22 Crowlees Road in Mirfield, following demolition of the existing bungalow. The CMRA report, (Michael D Joyce Associates LLP Report No. 4388) recommended rotary drilling be carried out to prove or disprove potential workings beneath the site. This report presents the findings of the drilling.

2 THE SITE

2.1 The property is located at 22 Crowlees Road, approximately 1½km northeast of the centre of Mirfield. The Ordnance National Survey Grid Reference is E420605, N420215. Figure 1 shows the general site location.

2.2 At present, the site comprises a brick-built bungalow, and driveway leading to a single detached garage. There is a small lawned area to the front of the property. To the rear is a patio area and artificial pond.

2.3 The southern half of the site comprises a large lawned area with a number of mature and semi-mature trees along the boundaries, and within the site.

3 GEOLOGY AND COAL MINING RISK ASSESSMENT

3.1 Geology

3.1.1 Maps of the British Geological Survey (BGS) record the site as being underlain by Undifferentiated mudstones, siltstones and sandstones of the Carboniferous Pennine Lower Coal Measures.

3.1.2 The site is shown to be unaffected by faulting, and no recent Drift deposits are recorded.

3.2 Coal Mining Risk Assessment

3.2.1 The site lies within a "Development High Risk Area" as defined by the Coal Authority. A Consultant's Coal Mining Report has been obtained from the Coal Authority, and is reproduced in Appendix 2 of Report No. 4388. It states that the Black Bed Coal seam has been worked at a depth of 126m below the site, with the last date of working being 1931. As such, any subsidence from this seam will have ceased by now.

3.2.2 The report does also state that unrecorded shallow workings are probable. The geological maps show the Blocking Bed Coal seam to outcrop to the southeast of the site (at No. 8 Crowlees Road). It dips in a northeasterly direction beneath the site. The Blocking Bed is underlain by the Top Lousey Coal seam.

3.2.3 The geological memoir for Huddersfield, published in 1930, states that the Blocking Bed Coal was of fair quality and extracted very widely by underground mining. At

Mirfield Moor, the memoir records the seam to comprise three leaves of coal as follows, although it is probable that only the upper leaf would have been extracted;

Coal	69cm
Seatearth	170cm
Coal	3cm
Black Shale	13cm
Coal	13cm

3.2.4 By contrast the underlying Top Lousey Coal seam was of variable quality and extent. It is not regarded by the Coal Authority of sufficient concern to be included within the Development High Risk Area, and as such is very unlikely to have been extracted from beneath the site.

3.2.5 Whilst no recorded shafts are recorded on the site itself, or within the vicinity, the possibility of an unrecorded shaft(s) being present cannot be entirely precluded.

3.2.6 The Coal Authority report found none of the following below or in the vicinity of the site.

- Spine roadways at shallow depth
- Geological faults, fissures or breaklines
- Opencast mines
- Coal Authority managed tips
- Site investigations
- Remediated sites

- Coal Mining subsidence
- Mine water treatment schemes
- Future underground mining
- Coal mining licensing
- Court Orders
- Section 46 Orders
- Withdrawal of support notices
- Payments to owners

Initial Conclusions of the Coal Mining Risk Assessment

3.2.7 The Blocking Bed Coal was believed to outcrop close to the site, and to dip below it at shallow depth. This seam was previously of some value, and the Coal Authority consider it may have been worked. As such, it has designated the site to lie in a "Development High Risk Area".

3.2.8 It was therefore recommended that rotary openhole drilling be carried out to confirm or preclude such workings. It was envisaged that one day of drilling should be sufficient at this stage.

3.3 GroundSure Geo-Insight

3.3.1 A GroundSure Geo-Insight Report has been obtained for the site and is reproduced in Appendix 1. The report is based on the British Geological Survey (BGS) geological maps, GroundSure data and miscellaneous other geological sources.

3.3.2 None of the following are recorded beneath the site.

Geology
Artificial and Made Ground Artificial ground permeability Superficial geology Superficial permeability Landslip Landslip permeability Bedrock faults and other linear features

Boreholes
BGS Boreholes

Mining, Ground Workings and Natural Cavities
Natural Cavities BritPits Underground workings Historical Mineral Planning Areas Non-coal mining Mining cavities JPB mining areas Brine areas Gypsum areas Tin mining Clay mining

In respect of natural ground subsidence, the BGS reports the following risk ratings.

Natural Ground Subsidence	Risk
Shrink-Swell Clay	Very Low
Running Sand	Negligible
Compressible Deposits	Negligible
Collapsible Deposits	Very Low
Landslide	Very Low
Ground Dissolution of Soluble Rocks	Negligible

3.3.3 A number of boreholes have been sunk in the vicinity of the site. The nearest are approximately 50m to the east of the site. These boreholes were located above the former railway cutting, which is recorded to have been around 5m depth. The backfill is described as inert soils.

4 THE INVESTIGATION

4.1 The investigation was designed to provide information on shallow coal seams under the site, together with identifying any potential mineworkings. The investigation was undertaken in accordance with the principles of BS5930: 2015 Code of Practice for Site Investigations and CIRIA's Abandoned Mine Workings Manual (C758D).

4.2 The investigation was carried out on the 5th August 2024 and comprised two rotary open-hole boreholes (R1 and R2). The exploratory borehole positions are shown on figure 1.

4.3 The rotary drilling was carried out using a Beretta T25 rig, using a water flush technique. The openhole technique meant that logging was carried out by inspecting the arisings that were brought to the surface in the water flush. On completion the boreholes were backfilled with bentonite and arisings.

4.4 Supervision and logging was provided by a Chartered Engineer from Michael D Joyce Associates LLP.

5 STRATA PROFILE

5.1 Both boreholes encountered a very similar sequence of strata. The full borehole records are presented in Appendix 1.

5.2 Topsoil was present in borehole R1 at the surface, with reinforced concrete hardstanding and an underlying clay (Made Ground) in borehole R2.

5.3 The boreholes then recorded a blue-grey clay to 2.5m, overlying a grey-brown very silty mudstone to 5.0m depth. This was underlain by a fine to medium grained sandstone to 7.0m depth in borehole R1.

5.4 A 100mm thick band of intact coal was encountered at a depth of 7.0m in borehole R1, and at 5.0m depth in borehole R2.

5.5 This was underlain by a sequence of mudstones, with bands of sandstone to a depth of 29.1m in borehole R1, and 29.2m in borehole R2. At these depths, a second thin band of coal was encountered. This was 200mm thick, and underlain by further mudstone, with the boreholes terminating at 30.0m depth.

5.6 It should be noted that both horizons of coal are far too thin to be of any economic value. No evidence was found of the Blocking Bed Coal seam, or any other significant coal seams. Further, there was no evidence of any former coal workings or broken ground.

5.7 Gas monitoring was carried out throughout and no mine gases were detected.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 No significant coal seams were encountered in either of the two boreholes, and there was no evidence of former workings.

6.2 In conclusion, the site is not at risk from shallow or deep mining, and as such, no special precautions are necessary.

A D Joyce

BSc MSc ARSM CEng CGeol CEnv MICE FGS SiLC SQP

August 2024

Procedure Notes

The desk study and/or ground investigation have been carried out using reasonable skill and care in accordance with the principles of Ground Investigation and Testing", BS5930: 2013 and BS10175:2011+A1:2013, and the terms of the client's brief. The report has been prepared for the specific purposes notified at the time of the initial enquiry.

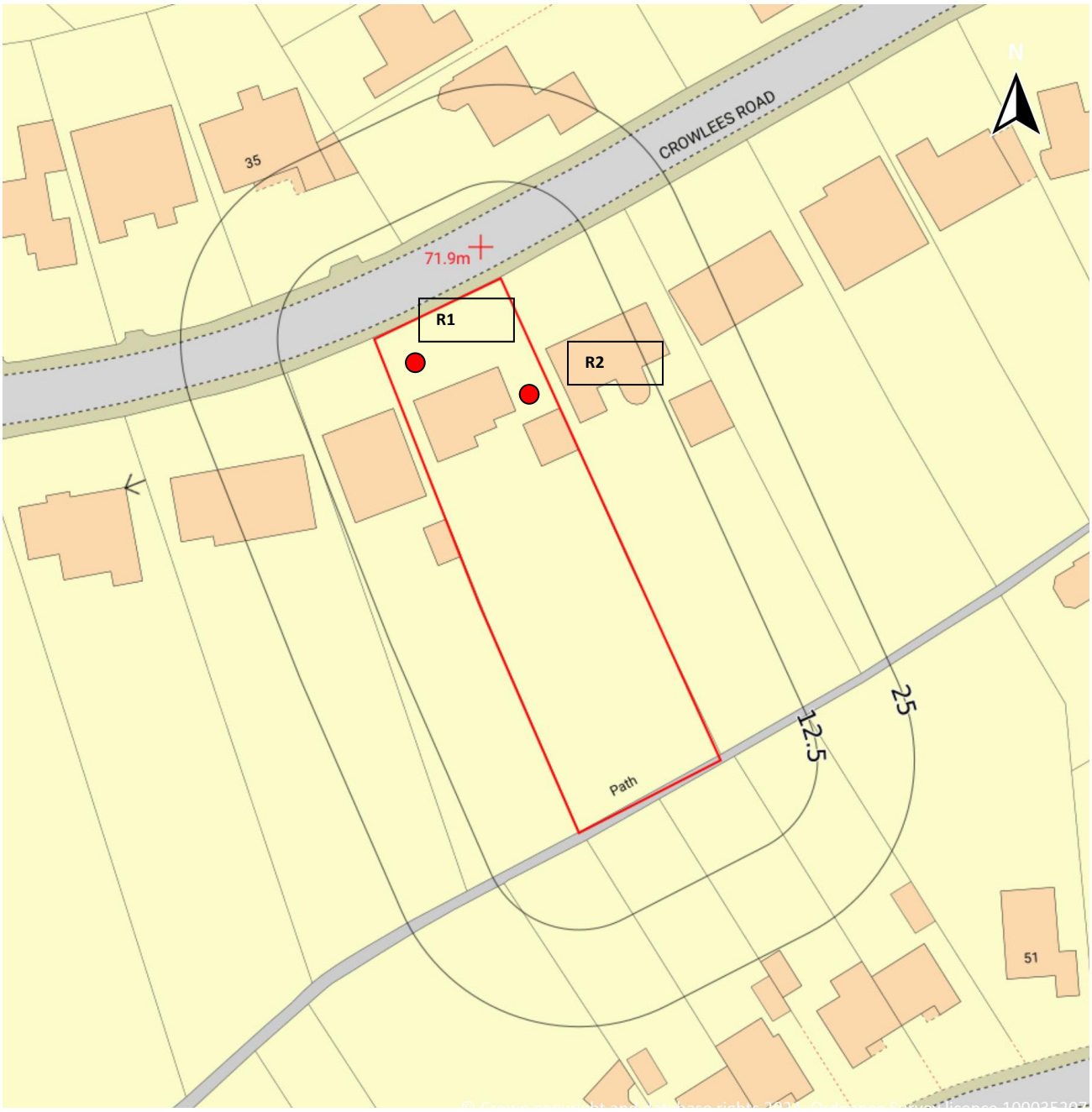
By its very nature any ground investigation only encounters and samples a small percentage of the ground. Consequently changes in ground conditions and soil properties can occur between any two exploratory points, for example local features such as soft ground, pockets of contamination and faults. This is also true of the exploration of mineworkings and such features can extend beneath parts of the site not investigated. Unrecorded bell pits and shafts can also exist between exploratory points. The ground investigation is designed to minimize such risks. Conclusions and recommendations are based on the information presented in this report, but unforeseen features may exist. No liability can be accepted for conditions not revealed by the exploratory holes. Therefore, actual ground conditions should be noted during construction and further advice sought if they differ from those predicted. Michael D. Joyce LLP reserves the right to amend the conclusions and recommendations in the light of further information. Actual methods of construction or alternative designs should be notified to Michael D. Joyce Associates LLP, such that the recommendations made can be reconsidered in the light of any changes.

Further investigation can be carried out to further reduce uncertainty and risk but ultimately these risks cannot be eliminated. Similarly a desk study normally only considers readily available information and further information could be held by other sources. In commissioning further research or investigation the cost/benefit of doing so must be considered.

It is assumed that groundlevels will not change significantly from those at present. The groundwater conditions are based on observations made at the time of the investigation, unless stated otherwise. It should be noted that the observations are subject to the method of the boring or excavation and that groundwater levels will vary due to seasonal or other effects.

Where buildings are present on a site, structural and asbestos surveys have not been carried out, unless specifically stated. An Unexploded Ordnance Survey has not been carried out unless specifically stated. In relevant situations it would be prudent to commission such surveys.

Where information has been obtained from Third Parties, no liability can be accepted for the accuracy or completeness of this information. Where anecdotal evidence or speculations are presented, they must be treated as such and cannot be relied upon.



22 Crowlees Road, Mirfield

Site Location and Rotary Borehole Positions

Michael D Joyce Associates LLP

Geotechnical and Geoenvironmental Consultants

Scale: NTS

Figure: 1

Appendix 1

Borehole Records

Site: 22 CROWLEES ROAD (4401)

Location: MIRFIELD

Method: Rotary openhole

Date: 5th August 2024

Client: Mr. D. Hayman

Borehole No: R1

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Depth (mAOD)	Reduced Level (m)	Description	Legend
						0	0	Ground level.	
								Topsoil.	
						-0.4			
								Blue-grey CLAY.	
							1		
							2		
						-2.5			
								Grey-brown very silty MUDSTONE.	
							3		
							4		
						-5			
							5	Grey and brown fine to medium grained SANDSTONE.	
							6		
						-7			
							7	Intact COAL.	
								Grey and brown silty MUDSTONE.	
							8		
							9		
							10		

Equipment: Beretta T25 Rig.

Flush: Water

Groundwater: Not encountered.

Returns: Good.

Remarks:

Site: 22 CROWLEES ROAD (4401)

Location: MIRFIELD

Method: Rotary openhole

Date: 5th August 2024

Client: Mr. D. Hayman

Borehole No: R1

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Depth (mAOD)	Reduced Level (m)	Description	Legend
							11	Grey and brown silty MUDSTONE.	
						-11.3		Dark grey and black shaly MUDSTONE.	
						-12	12	Grey and brown silty MUDSTONE.	
							13		
							14		
							15	Fractured ground from 16.5m to 16.7m. Temporary loss of flush.	
							16		
							17		
							18		
							19		
						-20	20	Dark grey and black shaly MUDSTONE.	
						-20.5		Grey and brown silty MUDSTONE.	

Equipment: Beretta T25 Rig.

Flush: Water

Groundwater: Not encountered.

Returns: Good.

Remarks:

Site: 22 CROWLEES ROAD (4401)

Location: MIRFIELD

Method: Rotary openhole

Date: 5th August 2024

Client: Mr. D. Hayman

Borehole No: R1

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Depth (mAOD)	Reduced Level (m)	Description	Legend
							21	Grey and brown silty MUDSTONE.	
							22		
							23		
							24		
							25		
							26		
							27		
							28		
						-29.1	29		
						-29.3		Intact COAL.	
								Grey silty MUDSTONE.	
						-30	30		
								End of Borehole	
							31		

Equipment: Beretta T25 Rig.

Flush: Water

Groundwater: Not encountered.

Returns: Good.

Remarks:

Site: 22 CROWLEES ROAD (4401)

Location: MIRFIELD

Method: Rotary openhole

Date: 5th August 2024

Client: Mr. D. Hayman

Borehole No: R2

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Depth (mAOD)	Reduced Level (m)	Description	Legend
						0	0	Ground level.	
						-0.2		MADE GROUND: Reinforced concrete hardstanding.	
								MADE GROUND: Dark grey silty clay.	
						-0.7		Blue-grey CLAY.	
							1		
							2		
						-2.5		Grey-brown very silty MUDSTONE.	
							3		
							4		
						-5	5	Intact COAL.	
								Grey and brown MUDSTONE interbedded with fine to medium grained sandstone.	
							6		
							7		
							8		
							9		
							10		
						-10.3		Dark grey and black shaly MUDSTONE.	

Equipment: Beretta T25 Rig.

Flush: Water

Groundwater: Not encountered.

Returns: Good.

Remarks:

Site: 22 CROWLEES ROAD (4401)

Location: MIRFIELD

Method: Rotary openhole

Date: 5th August 2024

Client: Mr. D. Hayman

Borehole No: R2

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Depth (mAOD)	Reduced Level (m)	Description	Legend
						-10.8	11	Dark grey and black shaly MUDSTONE.	
								Grey and brown silty MUDSTONE.	
							12		
							13		
							14		
							15	Fractured ground from 16.0m to 16.5m. Temporary loss of flush.	
							16		
							17		
							18		
							19		
						-20	20	Dark grey and black shaly MUDSTONE.	
						-20.5		Grey and brown silty MUDSTONE.	

Equipment: Beretta T25 Rig.

Flush: Water

Groundwater: Not encountered.

Returns: Good.

Remarks:

Site: 22 CROWLEES ROAD (4401)

Location: MIRFIELD

Method: Rotary openhole

Date: 5th August 2024

Client: Mr. D. Hayman

Borehole No: R2

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Depth (mAOD)	Reduced Level (m)	Description	Legend
							21	Grey and brown silty MUDSTONE.	
							22		
							23		
							24		
							25		
							26		
							27		
							28		
							29		
						-29.2			
						-29.4		Intact COAL.	
								Grey silty MUDSTONE.	
						-30	30	End of Borehole	
							31		

Equipment: Beretta T25 Rig.

Flush: Water

Groundwater: Not encountered.

Returns: Good.

Remarks:

Standard Appendix A

STANDARD APPENDIX A

NOTES ON SITE INVESTIGATION PROCEDURE (Dec 2023)

1. **GENERAL.** The ground investigation has been carried out in accordance with the requirements of BS5930: 2015 and A1: 2020 and BS10175: 2011+A1: 2017. By its very nature, any ground investigation only samples a small percentage of the ground. Consequently, changes in ground conditions and soil properties can occur between any two exploratory points, for example local features such as soft ground, pockets of contamination and faults. This is also true of the exploration of mineworkings and such features can extend beneath parts of the site not investigated. Unrecorded bell pits and shafts can also exist between exploratory points. The ground investigation is designed to minimise such risks but they cannot be eliminated.

2. **GROUND INVESTIGATION.**

2.1 **BOREHOLE AND TRIAL PIT RECORDS.** These illustrate the ground conditions only at the location of the particular borehole or trial pit. Correlation between boreholes is for guidance only and its accuracy cannot be guaranteed.

2.2 **SHELL AND AUGER BORING.** This technique uses a tripod winch and an essentially percussive action using a variety of tools. Disturbed and undisturbed samples can be taken. This is the most suitable method for soft ground investigation, enabling the maximum amount of information to be obtained. However, minor changes in lithology may be overlooked unless continuous undisturbed sampling is used.

2.3 **GROUNDWATER**. Groundwater levels vary seasonally and the details given on the borehole logs relate only to the dates and the conditions described in the borehole records. The rate of boring may not have allowed an equilibrium water level to be established and the use of casing may seal off certain seepages.

2.4 **SAMPLING.** Disturbed samples of soils are taken for identification and classification purposes. In cohesive soils 'undisturbed' samples 100mm in diameter are taken by open drive sampler for laboratory testing of strength, permeability and consolidation characteristics.

2.5 **STANDARD PENETRATION TESTS**. S.P.T tests are used in granular and cohesive materials and in soft or weathered rocks. Difficulties in obtaining true 'N' values mean they must only be used as a guide and not as an absolute value in foundation design.

2.6 **ROTARY DRILLING.** Two main types of rotary drilling are carried out in rock. Rock coring using diamond or tungsten carbide tipped core bits provides samples and information on rock types, fissuring and weathering. Openhole drilling only produces small particles for identification purposes and the information gained is therefore limited. The latter is, however, useful as a quick method for detecting major strata changes and for the location of coal seams and old workings. Water, air, foam or drilling muds may be used as the flushing medium in either case.

2.7 **PERMEABILITY TESTS.** These can be carried out in boreholes or trial pits and gives a good indication of in-situ permeability.

2.8 **TRIAL PITTING.** This enables soil conditions to be closely examined at any specific point and samples taken. It also gives useful information on the stability of excavations and ingress of water.

2.9 **WINDOW SAMPLING**. Window sampling consists of driving a series of 1m-long tubes into the ground using a dropping weight. On completion of each 1m run, the tube is withdrawn. The next tube is then inserted and the process repeated to provide a continuous profile of the ground. On each run the tube diameter is reduced in order to assist in its recovery.

2.10 **GAS MONITORING.** This is routinely carried out in trial pits or probe holes to check for elevated levels of methane and carbon dioxide or oxygen deficiency, particularly since risks can exist from natural gases, landfill sites and rising groundwater levels in mine workings below ground. Longer term monitoring is carried out with gas monitoring standpipes.

3. **SOIL DESCRIPTION.** Samples from borings or trial pits are described as specified in the standard procedure outlined in the British Standards. The description includes colour, consistency, structure, weathering, lithological type, inclusions and origin. All descriptions are based on visual and manual identification.

Fire Soils (Cohesive Soils)

The following field terms are used:

Soil Type	Description
Very soft	Exudes between fingers
Soft	Moulded by light finger pressure
Firm	Cannot be moulded by the fingers but can be rolled in hand to 3mm threads.
Stiff	Crumbles and breaks when rolled to 3mm threads but can be remoulded to a lump.
Very stiff	No longer moulded but crumbles under pressure. Can be indented with thumbs.

The following terms are used in accordance with the results of laboratory and field tests.

Description	Undrained Shear Strength Cu (kPa)
Extremely Low	<10
Very Low	10 - 20
Low	20 - 40
Medium	40 - 75
High	75 - 150
Very High	150 - 300

Fine soils can also be classified according to their sensitivity, which is the ratio between undisturbed and remoulded undrained shear strength.

Sensitivity	Ratio
Low	8
Medium	8 - 30
High	>30
Quick	>50

Granular Soils (Non-Cohesive)

The following descriptions are used for granular soils.

Description	Normalised Blow Count (N_1) 60
Very Loose	0 - 4
Loose	4 - 10
Medium	10 - 30
Dense	30 - 50
Very Dense	>50

4. **NATURAL OR IN-SITU MOISTURE CONTENT**. The natural or in-situ moisture content of a soil is defined as the weight of water contained in the pore space, expressed as a percentage of the dry weight of solid matter present in the soil. Soil properties are greatly affected by the moisture content and the test can help to give an indication of likely engineering behaviour.

5. **LIQUID AND PLASTIC LIMITS**. Two simple classification tests are known as the liquid and plastic limits. If a cohesive soil is remoulded with increasing amounts of water, a point will be reached at which it ceases to behave as a plastic material and becomes essentially a viscous fluid. The moisture content corresponding to this change is arbitrarily determined by the liquid limit test. 'Fat' clays, which have high contents of colloidal particles, have high liquid limits; 'lean' clays, having low colloidal particle contents have correspondingly low liquid limits. An increase in the organic content of a clay is reflected by an increase in the liquid and plastic limits.

   If a cohesive soil is allowed to dry progressively, a point is reached at which it ceases to behave as a plastic material, which can be moulded in the fingers, and it becomes friable. The moisture content of the soil at this point is known as the 'plastic limit' of the soil.

   The range of water content over which a cohesive soil behaves plastically, i.e. the range lying between the liquid and plastic limits, is defined as the plasticity index.

   A cohesive soil with a natural water content towards its liquid limit will, in general, be an extremely soft material whereas a cohesive soil with a natural water content below its plastic limit will tend to be a stiff material.

6. **PARTICLE-SIZE DISTRIBUTION.** A knowledge of particle-size distribution is used to classify soils and to indicate likely engineering behaviour. British Standards define soils in relation to their particle-size as shown below:-

Boulders	>200mm	Coarse Sand	2.0 to 0.63mm
Cobbles	200 to 63mm	Medium Sand	0.63 to 0.2mm
		Fine Sand	0.2 to 0.063mm
Coarse Gravel	63 to 20mm	Coarse Silt	0.063 to 0.02mm
Medium Gravel	20 to 6.3mm	Medium Silt	0.02 to 0.0063mm
Fine Gravel	6.3 to 2mm	Fine Silt	0.0063 to 0.002mm
		Clay	<0.002mm

7. **BULK DENSITY.** The bulk density of a material is the weight of that material per unit volume and includes the effects of voids whether filled with air or water. The 'dry density' of a soil is defined as the weight of solids contained in a unit volume of the soil.

8. **PERMEABILITY.** The permeability of a material is defined as the rate at which water flows through it per unit area of soil under unit hydraulic gradient.

9. **CONSOLIDATION CHARACTERISTICS.** When subjected to pressure, a soil tends to consolidate as the air or water in the pore space is forced out and the grains assume a denser state of packing. The decrease in volume per unit of pressure is defined as the 'compressibility' of the soil, and a measure of the rate at which consolidation proceeds is given by the 'coefficient of consolidation' of the soil. These two characteristics Mv and Cv are determined in the consolidation test and the results are used to determine settlement of structures or earthworks.

10. **STRENGTH CHARACTERISTICS.** The strength of geological materials is generally expressed as the maximum resistance that they offer to deformation or fracture by applied shear or compressive stress. The strength characteristics of geological materials depend to an important degree on their previous history and on the conditions under which they will be stressed in practice. Consequently, it is necessary to simulate in the laboratory tests the conditions under which the material will be stressed in the field.

In general, the only test carried out on hard rocks is the determination of their compressive strength but consideration must be given to fissuring, jointing and bedding planes.

The tests at present in use for soils and soft rocks fall into two main categories. Firstly, those in which the material is stressed under conditions of no moisture content change, and secondly those in which full opportunity is permitted for moisture content changes under the applied stresses. Tests in the first category are known as undrained (immediate or quick) tests, while those in the second category are known as drained (slow or equilibrium) tests. The tests are normally carried out in the triaxial compression apparatus but granular materials may be tested in the shear box apparatus.

The undrained triaxial test gives the apparent cohesion C_u and the angle of shearing resistance $\emptyset_u$. In dry sands, $C_u = 0$ and $\emptyset_u$ is equal to the angle of internal friction whereas with saturated non-fissured clays $\emptyset u$ tends to 0 and the apparent cohesion C_u is equal to one-half the unconfined compression strength qu. On site the vane test gives an approximate measure of shear strength.

For some stability problems use is made of a variant of the undrained triaxial test in which the specimen is allowed to consolidate fully under the hydrostatic pressure and is then tested to failure under conditions of no moisture content change. This is known as the consolidated undrained triaxial test. Pore water pressures may be measured during this test or a fully drained test may be carried out. In either case the effective shear strength parameters C' and $\emptyset'$ can be obtained which can be used to calculate shear strength at any given pore water pressure.

11. **COMPACTION.** The density at which any soil can be placed in an earth dam, embankment or road depends on its moisture content and on the amount of work which is used in compaction. The influence of these two factors can be studied in compaction tests, which can determine the maximum dry density (MDD) achievable at a certain optimum moisture content (OMC).

12. **CALIFORNIA BEARING RATIO TEST.** In flexible pavement design a knowledge of the bearing capacity of the subgrade is necessary to enable the thickness of pavement for any particular combination of traffic and site conditions to be determined. The quality of the subgrade can be assessed by means of the California Bearing Ratio Test or approximately by the MEXE cone penetrometer.

13. **ROCK DESCRIPTION.** This is based on;

(i) Strength

Term	**Field Identification**	**Unconfined Compressive Strength (MPa)**
Extremely Weak[a]	Indented by thumbnail.	Less than 1
Very Weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife.	1 to 5
Weak	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer.	5 to 25
Medium Strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer.	25 to 50
Strong	Specimen required more than one blow of geological hammer to fracture it.	50 to 100
Very Strong	Specimen requires many blows of geological hammer to fracture it.	100 to 250
Extremely Strong	Specimen can only be chipped with geological hammer.	Greater than 250

[a] Some extremely weak rocks will behave as soils and should be described as soils.

(ii) Structure

Thickness Term	**Spacing Term**	**Thickness or spacing**
Very thickly	Extremely wide	>6m
Very thickly	Very wide	2m – 6m
Thickly	Wide	600mm – 2m
Medium	Medium	200mm – 600mm
Thinly	Close	60mm – 200mm
Very thinly	Very close	20mm – 60mm
Thickly laminated (Sedimentary)		
Narrowly (Metamorphic and Igneous	Extremely close	6mm – 20mm
Thinly laminated (Sedimentary)		
Very narrowly (Metamorphic and Igneous)	Extremely close	<6mm

(iii) Colour
(iv) Texture
(v) Grain size

Description	Predominate Grain Size (mm)
Conglomerate	>2
Coarse - grained	2 - 0.63
Medium - grained	0.63 - 0.20
Fine - grained	0.20 - 0.063
Siltstone	0.063 - 0.002
Mudstone	<0.002

(vi) Rock Name
(vii) Stability
(viii) Weathering

Term	Description	Grades
Fresh/unweathered	No visible sign of rock material weathering; perhaps slight discolouration on major discontinuity surfaces.	0
Slightly weathered	Slight discolouration indicates weathering of rock material and discontinuity surfaces.	1
Moderately weathered/Distinctly weathered	Less than half of the rock material is decomposed or disintegrated. Fresh or discoloured rock is present either as a continuous framework or as core stones.	2
Highly weathered/ Destructed	More than half of the rock material is decomposed or disintegrated. Fresh or discoloured rock is present either as a continuous framework or as core stones.	3
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still apparent.	4
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soils has not been significantly transported.	5

(ix) Discontinuities
(x) Weathered of Rock Mass

14. **CHEMICAL TESTS.** A knowledge of water soluble sulphate content and pH of soils and groundwater is important in determining the protection required for concrete or steel in contact with the ground. Other specialist tests may be carried out on sites suspected of being contaminated (see standard appendix B).

15. **REFERENCES**

BS5930: 2015+A1:2020 British Standard Code of Practice for Site Investigations
BS10175: 2011+A1:2017 British Standard Code of Practice for the Investigation of Potentially Contaminated Sites
BS EN ISO 14688-1: 2018 Geotechnical Investigation and Testing: Identification and Classification of Soil
BS EN ISO 14688-2: 2018 Geotechnical Investigation and Testing: Identification and Classification of Soil