

**MANUAL OF CONTRACT DOCUMENTS FOR HIGHWAY WORKS  
VOLUME 1 SPECIFICATION FOR HIGHWAY WORKS**

**SERIES 600  
EARTHWORKS**

**Contents**

Clause	Title	Page	Clause	Title	Page
#601	Classification, Definitions and Uses of Earthworks Materials	2	637	Determination of Resistivity (rs) to Assess Corrosivity of Soil, Rock or Earthworks Materials	26
602	General Requirements	4	638	Determination of Redox Potential (Eh) to Assess Corrosivity of Earthworks Materials for Reinforced Soil and Anchored Earth Structures	27
603	Forming of Cuttings and Cutting Slopes	5	639	Determination of Coefficient of Friction and Adhesion Between Fill and Reinforcing Elements or Anchor Elements for Reinforced Soil and Anchored Earth Structures	27
604	Excavation for Foundations	6	640	Determination of Permeability of Earthworks Materials	28
605	Special Requirements for Class 3 Material	7	641	Determination of Available Lime Content of Lime for Lime Stabilised Capping	28
606	Watercourses	7	642	Determination of the Constrained Soil Modulus (M*) of Earthworks Materials for Corrugated Steel Buried Structures	28
#607	Explosives and Blasting for Excavation	8	643	(05/01) Lime and Cement Stabilisation to Form Capping	29
608	Construction of Fills	9	644	(11/03) Determination of Sulfate Content	30
609	Geotextiles Used to Separate Earthworks Materials	10	(05/04) Tables 6/1 to 6/6		31
610	Fill to Structures	11			
611	Fill Above Structural Concrete Foundations	12			
612	Compaction of Fills	12			
613	Sub-formation and Capping	14			
614	Cement Stabilisation to Form Capping	16			
615	Lime Stabilisation to Form Capping	17			
616	Preparation and Surface Treatment of Formation	18			
617	Use of Sub-formation or Formation by Construction Plant	19			
618	(05/01) Topsoiling	19			
619	Earthwork Environmental Bunds	20			
620	Landscape Areas	20			
621	Strengthened Embankments	20			
622	Earthworks for Reinforced Soil and Anchored Earth Structures	20			
623	Earthworks for Corrugated Steel Buried Structures	21			
624	Ground Anchorages	22			
625	Crib Walling	22			
626	Gabions	23			
627	Swallow Holes and Other Naturally Occurring Cavities	23			
628	Disused Mine Workings	23			
629	Instrumentation and Monitoring	23			
630	Ground Improvement	23			
631	Earthworks Materials Tests	24			
#632	Determination of Moisture Condition Value (MCV) of Earthworks Materials	24			
633	Determination of Undrained Shear Strength of Remoulded Cohesive Material	25			
634	(11/05) Determination of Intact Lump Dry Density (IDD) of Chalk	25			
635	(05/04) Los Angeles and Other Tests for Particle Soundness	25			
636	Determination of Effective Angle of Internal Friction (j) and Effective Cohesion (c/) of Earthworks Materials	25			

**NATIONAL ALTERATIONS OF THE  
OVERSEEING ORGANISATIONS OF  
SCOTLAND, WALES AND NORTHERN  
IRELAND**

**Scotland**

Clause	Title	Page
601TS	(11/06) Classification, Definitions and Uses of Earthworks Materials	S1
632TS	(11/06) Determination of Moisture Condition Value (MCV) of Earthworks Materials in Scotland	S3

**Northern Ireland**

601NI	Classification, Definitions and Uses of Earthworks Materials	N1
607NI	Explosives and Blasting for Excavation	N3

# denotes a Clause or Sample Appendix which has a substitute National Clause or Sample Appendix for one or more of the Overseeing Organisations of Scotland, Wales or Northern Ireland.

# EARTHWORKS

## #601 Classification, Definitions and Uses of Earthworks Materials

### 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 Appendix 6/1 for acceptability for use in the Permanent Works;
- (ii) (11/04) 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 Appendix 6/1, shall not be used in the Permanent Works;
- (iii) (11/04) 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 Appendix 6/1, shall not be used in the Permanent Works; and
- (iv) (11/04) 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.

### (11/04) Unacceptable Materials

2 (11/04) Unacceptable material Classes U1A and U1B:

- (i) (11/04) unacceptable material Class U1A shall be:
  - (a) (11/04) material which does not comply with the permitted constituents and material properties of Table 6/1 and Appendix 6/1 for acceptable material; and
  - (b) (11/04) material, or constituents of materials, composed of the following unless otherwise described in 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;

- (ii) (11/04) unacceptable material Class U1B shall be:
  - (a) (11/05) contaminated materials, including controlled wastes (as defined in the Environmental Protection Act 1990 Part IIA) whose level of contamination is above that given either in Appendix 6/14 or in Appendix 6/15, but excluding all hazardous wastes (as defined in the Hazardous Waste (England and Wales) Regulations 2005) and radioactive wastes (as defined in the Radioactive Substances Act 1993).

3 Unacceptable material Class U2 shall be:

- (i) (11/05) hazardous waste (as defined in the Hazardous Waste (England and Wales) Regulations 2005) and radioactive waste (as defined in the Radioactive Substances Act 1993).

4 (11/04) Where required in 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 Appendix 6/1.

### Definitions

5 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 Appendix 6/1.

**6** 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.

**7** 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.

**8** 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.

**9** 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.

**10** Sub-formation shall be the top surface of earthworks at the underside of capping.

**11** (05/01) 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.

**12** (11/07) Where 'recycled aggregate' is used in this Series, the material shall be aggregate resulting from the processing of material used in a construction process. The aggregate shall have been tested in accordance with Clause 710, and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass. Where 'recycled aggregate except recycled asphalt' is used in this Series, the aggregate shall have been tested in accordance with Clause 710. Content of asphalt (mineral aggregate with a bituminous binder) shall not exceed 2% by mass, and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass.

### Use of Fill Materials

**13** (05/01) 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 that cobbles having an equivalent diameter of more than 150 mm shall not be deposited beneath verges or central reserves within 1.30 m of the finished surface.

**14** (11/07) Material shall not be deposited within 500 mm, or other distances described in 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 either:

- (i) (11/05) the water-soluble sulfate (WS) content exceeds 1500 mg of sulfate (as  $\text{SO}_4$ ) per litre (Test No.1); or
- (ii) (11/09) the oxidisable sulfides (OS) content exceeds 0.5 % of sulfate (as  $\text{SO}_4$ ) (Test No. 2 and Test No. 4); or
- (iii) (11/09) 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.

(11/09) At least five samples of each material shall be tested for WS, OS and pH value. 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.

**15** (11/07) Material shall not be deposited within 500 mm, or other distances described in Appendix 6/3, of metallic structural elements forming part of the Permanent Works if, when tested in accordance with TRL Report 447 either:

- (i) (11/05) the water-soluble sulfate (WS) content exceeds 300 mg of sulfate (as  $\text{SO}_4$ ) per litre (Test No.1); or
- (ii) the oxidisable sulfides (OS) content exceeds 0.06 % of sulfate (as  $\text{SO}_4$ ) (Test Nos. 2 and 4).

(11/05) At least five samples of each material shall be tested for WS and OS. 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.

(11/07) The requirements in (i) and (ii) above shall not apply to metallic items protected by concrete and ancillary metallic items such as the tops of chambers and gullies.

**16** (05/01) Unburnt colliery spoil may be used as general fill provided it is compacted in compliance with Clause 612 and complies with the requirements of Appendix 6/1.

**17** (05/01) Pulverised-fuel ash shall not be placed within the dimension described in Appendix 6/3, below sub-formation or formation.

**18** (05/01) Where pulverised-fuel ash is used, the Contractor shall for each consignment, make available to the Overseeing Organisation a record of the type and source of the material and the name of the power station 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 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** (11/04) 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 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 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 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** (11/04) 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 Appendix 6/1, be run to spoil in tips provided by the Contractor. In the case of unacceptable material, Class U1B and Class U2, the Contractor shall comply with any specific requirements for disposal described in Appendix 6/2.

**6** Where the excavation reveals a combination of acceptable and unacceptable materials the Contractor shall, unless indicated otherwise in 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.

**7** 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.

**8** 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.

**9** (05/01) Existing topsoil material shall, except where it is to be left in place in the locations described in Appendix 6/8, be stripped to depths as described in Appendix 6/8 for Class 5A material from all areas of cutting and from all areas to be covered by embankment or by other areas of fill. Where stated in Appendix 6/8 existing topsoil shall be stripped as turf in accordance with sub-Clause 3005.13.

**10** (05/01) Topsoil shall wherever practicable be used immediately after its stripping and if not shall be stored in stockpiles of heights not exceeding 2 m or other heights stated in Appendix 6/8. Unless otherwise stated in Appendix 6/8, topsoil shall not be stockpiled for more than two years. Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

**11** 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 Appendix 6/8.

**12** Excavations for foundations and trenches shall be adequately supported at all times, and except where otherwise described in Appendix 6/3, shall not be battered. Where excavations are permitted to be battered they shall be benched as described in Appendix 6/3

prior to backfilling and compaction. The additional work and materials shall be provided by the Contractor. Sheet piling and other excavation supports shall be removed as filling proceeds except where they are required in Appendix 6/3 to be left in position.

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

**14** 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.

**15** 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.

**16** 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.

**17** The Contractor shall carry out and maintain any groundwater lowering or other treatment required in Appendix 6/1.

**18** (11/04) Where materials are designated in the Contract as either Class U1B or Class U2, the Contractor shall carry out any special requirements for their handling described in 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.

**19** (05/04) 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 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 : 1989, or BS 1924 : Part 2 : 1990 for lime stabilised capping, amended as given in sub-Clause 801.7.

## **603 Forming of Cuttings and Cutting Slopes**

**1** Cuttings shall be excavated to the lines and levels described in 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 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 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 Appendix 6/3, it shall comply with Clause 607 and any other requirements in Appendix 6/3. Full details of the methods and arrangements to be adopted shall be made available to the Overseeing Organisation 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 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 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 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) (11/03) 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 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 Appendix 6/3 and the resulting surface together with an area of any surrounding intact material as detailed in 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 Appendix 6/3. Where required in 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 Appendix 6/3 and at the locations described in Appendix 6/3.
- (iii) (11/03) Soft or insecure material, interlayered with rock shall be excavated to the depth behind the face described in 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 Appendix 6/3.
- (iv) Netting or other sheet covering as described in Appendix 6/3 or rock bolts as described in Appendix 6/10.

**7** (05/01) Where required in 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 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 5° to 45° 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 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.

## 604 Excavation for Foundations

**1** (11/09) 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 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) (11/09) 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) (11/09) 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 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 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 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 Appendix 6/4 within 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<sup>3</sup> unless otherwise described in Appendix 6/4.
- (vi) Class 3 material shall not be stockpiled or be subjected to multiple handling.
- (vii) Class 3 material shall not, unless required in Appendix 6/4, be layered with other fill material in the construction of embankments and other areas of fill.
- (viii) When required in 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 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 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 Overseeing Organisation.
- (x) At the end of each working day of filling, exposed Class 3 material laid that day shall, unless otherwise stated in 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 Appendix 6/1 or 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 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 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 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 Appendix 6/3.

### #607 Explosives and Blasting for Excavation

1 Blasting for excavation shall not be employed unless permitted or required in 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 Overseeing Organisation 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 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 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 Appendix 6/3, on property off the Site, make available the results to the Overseeing Organisation 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 Construction (General Provisions) Regulations 1961 (Regulation 19) 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.
- (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 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 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.

**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 an approved Class of granular material complying with Table 6/1 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.

**5** Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those described in 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 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 Appendix 6/3 including

## 608 Construction of Fills

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

- (i) in the locations described in Appendix 6/3 to the lines and levels stated therein;
- (ii) of Classes of materials required or permitted in 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;

installation of instrumentation and its monitoring, in compliance with Clause 629.

**7** Where required in 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 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 Appendix 6/3, the construction of a lesser thickness of capping or sub-base as described therein laid as a weather 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 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** (05/01) Completed slopes of Classes 2E and 7B fill material shall be covered immediately by Class 5 topsoil as required in Appendix 6/8 or turf or other material, as required in 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 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.

## **609 Geotextiles Used to Separate Earthworks Materials**

**1** Geotextiles required as part of the Permanent Works to separate earthworks materials at locations described in Appendix 6/5 shall be manufactured from synthetic or other fibres as required therein and be in the form of thin permeable membranes.

**2** The Contractor shall provide evidence to the Overseeing Organisation, before the geotextile is incorporated in the Permanent Works, that the geotextile will be sufficiently durable, when installed in contact with the materials to be separated, to maintain its integrity for at least the life period required in Appendix 6/5.

**3** Geotextiles shall be protected at all times against mechanical or chemical damage. Those susceptible to damage by light shall not be uncovered between manufacture and incorporation in the Permanent Works. Temporary exposure shall not exceed 5 hours.

**4** The method of selection and the required number of samples are as described in Appendix 6/5. Samples shall be taken from the consignment of geotextile to be used in the Permanent Works. Samples and test pieces cut from them shall comply with sub-Clause 7 of this Clause and test pieces shall be tested at a laboratory to prove that the geotextile meets the following criteria or other criteria described in Appendix 6/5:

- (i) The geotextile shall sustain a tensile load of not less than that value given in Appendix 6/5, determined in a 'wide strip'

tensile test carried out in accordance with BS 6906 : Part 1. The characteristic strength shall be taken as the value of the strength of the material below which not more than 5% of the test results may be expected to fall. This represents the strength at 1.64 standard deviations below the mean strength.

- (ii) The geotextile shall allow water to flow through it, at right angles to its principal plane, in either direction, at a rate of not less than 10 litres/m<sup>2</sup>/s under a constant head of water of 100 mm, determined in accordance with BS 6906 : Part 3. The flow rate determined in the test shall be corrected to that applicable to a temperature of 15°C using published data on variation in viscosity of water with temperature.
- (iii) The geotextile shall have a size distribution of pore openings such that the mean  $O_{90}$  is between 100 microns and 300 microns, determined in accordance with BS 6906 : Part 2.

**5** The geotextile shall be laid and lapped as described in this Clause or as described in Appendix 6/5 and where lapping is employed adjacent sheets or strips of geotextile shall be overlapped by at least 300 mm, or other dimension described in Appendix 6/5.

**6** The layer of material on which the geotextile is to be placed shall not have protrusions or sharp projections which are likely to damage the geotextile during installation or in service. The method of installation shall ensure that the geotextile is in continuous contact with the surface on which it is to be placed and the geotextile shall not be stretched or bridged over hollows or humps. Operation of construction plant directly on the installed geotextile will not be permitted and its covering with fill material shall take place immediately after its laying.

**7** All samples and test pieces cut from them shall be maintained in a clean and dry condition, except for normal contamination and wetting during testing, and shall be retained by the Contractor in accordance with Appendix 6/5. Prior to determination of pore size and tensile strength, test pieces shall be conditioned and brought into equilibrium at a temperature of  $20^{\circ} \pm 2^{\circ}\text{C}$ , and a relative humidity of  $65 \pm 5\%$ . The dry weight of the geotextile tested shall be quoted in g/m<sup>2</sup>.

**8** The number of tests on samples shall be as required in Appendix 6/5.

## 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 Appendix 6/6.

**2** Materials, as required or permitted in 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 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 Appendix 6/6, Class 6N, 6P and 7B material shall be shown, by means of a trial utilising not less than 20 m<sup>3</sup> 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 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 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.

3 The Contractor shall obtain permission from the Overseeing Organisation 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 Overseeing Organisation 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 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 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 m<sup>2</sup> 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:
- the depth of layer shall be that for the type of plant requiring the least depth of layer; and
  - 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 15 of this Clause.

**12** (05/01) The Contractor shall at least 7 days before commencement of end-product compaction make available the following to the Overseeing Organisation:

- 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 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);
  - 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 Class 7A material, a plot of the 5% air voids curve for each sub-division.
- 13** Once the information contained in sub-Clause 12 of this Clause has been made available to the Overseeing Organisation it shall form the basis for compaction.
- 14** 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 Overseeing Organisation in accordance with sub-Clause 12 of this Clause.
- 15** The field dry density referred to in sub-Clause 14 of this Clause shall be measured in accordance with BS 1377 : Part 9, except that nuclear methods shall only be used where required or permitted in Appendix 6/3. Where nuclear methods are used, the gauge shall be calibrated in accordance with BS 1377 : Part 9.

### 613 Sub-formation and Capping

**1** (05/01) Capping shall be provided only in those locations, and to the extent, particularly stated in 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** (05/04) 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 Appendix 6/7 and complying with Table 6/1.

**3** (05/04) Unless otherwise described in 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 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 m<sup>2</sup>.

**5** (05/01) The materials placed during the demonstration may form part of the Permanent Works, provided they meet the requirements of the Contract, or be carried out elsewhere on the Site where this is detailed in 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 Overseeing Organisation with records substantiating compliance with the stipulated criteria of Appendix 6/7. Where required by 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 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 Appendix 6/7.

**8** Unless otherwise stated in 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** (05/01) In cuttings the Contractor shall, as permitted or required in Appendix 6/7 carry out one of the following procedures:

- (i) (05/04) 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 m<sup>2</sup> 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) (05/04) 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) (05/04) 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** (05/01) On embankments and other areas of fill the Contractor shall, as permitted or required in Appendix 6/7 carry out one of the following procedures:

- (i) (05/04) complete the embankment to form the sub-formation or remove any 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 m<sup>2</sup> 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 protection layer previously constructed; or
- (iii) (05/04) 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** (05/04) 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.

## 614 Cement Stabilisation to Form Capping

**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 Appendix 6/7 cement shall be Portland cement complying with Clause 1001.

**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 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 m<sup>2</sup> of cement spread.

**5** Unless indicated otherwise in 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 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** (11/05) 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<sub>4</sub>, when tested in accordance with Test No. 1 of TRL Report 447.

**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** (11/05) 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



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<sub>4</sub> when tested in accordance with Test No. 1 of TRL Report 447.

**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 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 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**

**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** (11/03) Lime for lime stabilisation shall, as required in Appendix 6/7, be either quicklime or hydrated lime complying with BS EN 459-1. Quicklime shall when sieved have 100% passing a BS 10 mm sieve and at least 95% by mass passing a BS 5 mm sieve.

**4** The Contractor shall make available to the Overseeing Organisation for each source of lime a report of a chemical analysis for 'available lime' made in accordance with sub-Clause 641.2. Such reports shall be made available to the Overseeing Organisation prior to the incorporation of lime in the Permanent Works at weekly or other intervals defined in Appendix 6/7 during periods when lime stabilisation is carried out.

**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 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 m<sup>2</sup> of lime spread or a different rate of testing for the rate of spread as described in 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 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 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 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** (11/05) 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 SO<sub>4</sub> when tested in accordance with Test No. 1 of TRL Report 447.

**11** (11/05) 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 SO<sub>4</sub> when tested in accordance with Test No. 1 of TRL Report 447.

**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 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 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 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

**1** The formation shall, after completion of any subgrade drainage, and immediately before laying sub-base on areas of completed formation, have a surface level tolerance within +20 mm and -30 mm, or other level of tolerance defined in Appendix 6/7 relative to its designed level after completion of the following operations as necessary:

- (i) (11/04) Any 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. 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. Immediately after the additional compaction the formation shall be trimmed to achieve the tolerances of this sub-Clause.

**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 m<sup>2</sup> under the base plate of not less than 1,400 kg.

**4** Where required in Appendix 6/7 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 Appendix 6/7. The excavated material shall be processed as described in 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; or
- (ii) (11/03) where the rock surface is tabular it shall be regulated by depositing and compacting cement bound material as described in Appendix 6/7, complying with the 1000 Series, or ST1 concrete to Clause 2062.

**5** The Contractor shall limit any areas of completed formation to suit the output of plant in use and the rate of deposition of sub-base. 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 shall be completed as described in Appendix 6/7.

### **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 Overseeing Organisation 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 has been stripped, before using construction plant or other vehicular traffic at or above sub-formation or formation.

### **618 (05/01) Topsoiling**

**1** Topsoiling shall be carried out using Class 5 material complying with Table 6/1.

**2** Imported topsoil, Class 5B material, shall only be imported when required in Appendix 6/8, or Appendix 30/6.

**3** When required in Appendix 6/8 topsoil shall not be excavated from stockpiles, whether on site or imported:

- (i) which have been exposed to a cumulative rainfall exceeding 100 mm, or other figure stated in Appendix 6/8, over the preceding 28 days measured at a point detailed in Appendix 6/8; or
- (ii) when heavy rain is falling; or
- (iii) with a tracked vehicle; or
- (iv) which have been stockpiled for more than 2 years; or
- (v) which are frozen; or
- (vi) in the case of topsoil which has been stockpiled for more than 6 months, unless the stockpile has been treated with a total, non-residual herbicide as recently as is seasonally possible (allowing the period of time recommended by the manufacturer to elapse prior to excavation).

**4** Topsoil shall:

- (i) be deposited and spread on the areas, to the thicknesses described in Appendix 6/8, in layers not exceeding 150 mm. Each layer shall be firmed before spreading the next. The thickness shall be reduced where necessary to allow for any subsequent turfing required in Appendix 30/5 (it shall not be spread using a tracked vehicle, when so stipulated in Appendix 6/8);
- (ii) have stones and other debris removed and disposed off Site which have:
  - (a) dimensions greater than 100 mm equivalent diameter, unless otherwise permitted in Appendix 6/8; and
  - (b) dimensions greater than 50 mm equivalent diameter which lie within 50 mm of the surface;

- (iii) be graded to smooth contours, eliminating all mounds and depressions where water may collect;
- (iv) not have stones or other debris protruding above the surface by more than 30 mm, and comply with the further requirements of Clauses 3004 and 3005.

## 619 Earthwork Environmental Bunds

1 Earthwork environmental bunds shall be constructed in the locations described in 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 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 (05/01) Where required in Appendix 6/9 earthwork environmental bunds shall be topsoiled in accordance with Clause 618 and seeded, or turfed, all in accordance with Clause 3005.

## 620 Landscape Areas

1 Landscape areas shall be constructed in the locations shown in 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 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 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 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.

5 (05/01) Landscape areas shall be topsoiled in accordance with Clause 618 and seeded or turfed in accordance with Clause 3005 to the requirements of Appendix 30/5.

## 621 Strengthened Embankments

1 Strengthened embankments shall be constructed in the locations and to the details described in 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 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 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 Appendix 6/1.
- (ii) (05/04) 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 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.

**2** Excavation shall be carried out in compliance with Clause 604 and any additional requirements given in 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.
  - (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 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 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  $\pm 5\%$  for circular structures and  $\pm 2\%$  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 protection layer given in 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 Appendix 1/11, in accordance with the design requirements described in Appendix 6/10. The ground anchorages shall be installed and where required in 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.

## **625 Crib Walling**

**1** The Contractor shall design the crib walling listed in Appendix 1/10 in accordance with the design specification and procedures in Appendix 6/10 and Standard BD 68.

## 626 Gabions

- 1 Gabions shall be constructed in compliance with this Clause and with any additional requirements in Appendix 6/10.
- 2 Gabion units shall be assembled in accordance with the manufacturer's instructions and shall be sufficiently filled with Class 6G material complying with Table 6/1 and any other requirements in Appendix 6/1, with an allowance for consolidation of fill, so as to minimise distortion during construction. Gabion units shall, where appropriate, be maintained square and with vertical sides during filling. 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(i) of this Clause.
- 3 The gabion mesh shall be one of the following unless otherwise described in Appendix 6/10:
  - (i) A mesh manufactured from wire complying with BS 1052 having a minimum core diameter of 2.0 mm, unless otherwise described in Appendix 6/10.
  - (ii) A geomesh, being a grid of plastic material suitable for use in earthworks, having the properties described in Appendix 6/10.
- 4 (11/03) All wire shall be galvanized in compliance with BS EN 10244-2 and be coated with a minimum thickness of 0.55 mm of PVC for extruded coatings and 0.25 mm of PVC for bonded coatings. The PVC shall be capable of resisting the effects of immersion in sea water, exposure to ultra violet light and abrasion, when tested for a period not less than 3000 hours in accordance with BS 2782 : Part 5 : Method 540B (ISO 4892).
- 5 The size of mesh openings and grading of fill shall be as described in Appendix 6/10, but the maximum size of fill material shall not exceed two thirds of the minimum dimension of the gabion compartment or 200 mm whichever is smaller and the minimum size of the fill, unless otherwise stated in Appendix 6/10, shall be not less than the size of the mesh opening.
- 6 Mechanical equipment may only be used for filling gabion units provided that the results are equivalent to filling by hand.

## 627 Swallow Holes and Other Naturally Occurring Cavities

- 1 Infilled swallow holes and other naturally occurring cavities shall where required in Appendix 6/11 be

excavated, filled and capped as described in Appendix 6/11.

- 2 Open swallow holes and other shallow cavities shall where required in Appendix 6/11 be flushed, cleared of rubbish where to do so would not endanger operatives, and filled and capped as described in Appendix 6/11.

## 628 Disused Mine Workings

- 1 Disused mine workings shall, where required in Appendix 6/11 be investigated, inspected, monitored, cleared, flushed, filled, capped or have any other treatment carried out, all as described in Appendix 6/11.

## 629 Instrumentation and Monitoring

- 1 Instrumentation, other than that required in compliance with Clause 607, shall be as described in Appendix 6/12 and shall be installed in the locations shown therein.
- 2 Monitoring of instrumentation shall be carried out as required in Appendix 6/12 and the results supplied to the Overseeing Organisation as required therein.

## 630 Ground Improvement

### Dynamic Compaction

- 1 Dynamic compaction, carried out to either method or end-product as required in 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 Appendix 6/13.
- 2 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 Appendix 6/13 which contains the area to be dynamically compacted.
- 3 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

- 4 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 Appendix 6/13.
- 5 Unless otherwise described in Appendix 6/13, materials shall comply with the Series 600 and the Series 800 as appropriate.

**6** The Contractor shall report immediately to the Overseeing Organisation any circumstance which indicates that in the Contractor's opinion the ground conditions differ from those expected from his interpretation of the ground investigation reports.

**7** Columns shall be installed as shown on the Drawings and within the permitted tolerances stated in Appendix 6/13.

### Materials

**8** (05/04) 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.

### Testing of Ground Treatment

**9** Testing of treated ground shall be undertaken for control purposes during the treatment and on completion of the ground treatment. The performance criteria for treated ground are given in Appendix 6/13.

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

### Types of Test

**11** The following tests or alternatives permitted in Appendix 6/13 shall be carried out at the positions and frequency given in Appendix 6/13.

#### Plate tests

**12** Plate bearing tests are loading tests carried out using a plate on treated ground. The test is described in BS 1377 : Part 9 : 1990 Method 4.1.

#### Zone Tests

**13** 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

**14** 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 Appendix 6/13.

### Trial Areas

**15** Trial areas are to be treated and tested where required in Appendix 6/13. Trial areas which meet the performance requirements may form part of the Permanent Works.

**16** Equipment and materials used in trial areas shall be identical to those proposed for the Permanent Works.

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

**18** Detailed reports shall be prepared for all testing as defined in Table 6/6.

### Records and Reports

**19** Complete records of plant, equipment and materials shall be maintained during all ground treatment operations.

**20** Records shall be made available to the Overseeing Organisation including all information identified in Table 6/6 and any other information required by Appendix 6/13. All records pertaining to a particular day's operations shall be made available to the Overseeing Organisation at the start of the following day's operations.

### Other Methods

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

## 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.

## #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 Appendix 6/1.

**3** Where permitted in 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 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 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  $200 \pm 10$  kN/m<sup>2</sup> and an axial strain rate of 1% per minute. Where Appendix 6/1 requires  $c$  and  $\phi$  to be determined, the test shall be modified to enable Mohr circles to be plotted and  $c$  and  $\phi$  reported.

4 Where stated and described in 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 (11/05) Determination of Intact Lump Dry Density (IDD) of Chalk

1 (11/05) The intact lump dry density (IDD) of chalk lumps shall be determined in accordance with BS 1377 : Part 2.

### 635 (05/04) Los Angeles and Other Tests for Particle Soundness

#### (05/04) Resistance to Fragmentation - Los Angeles Coefficient (LA)

1 (05/04) The value of Los Angeles coefficient shall be determined in accordance with BS EN 1097-2.

#### Other Tests for Particle Soundness

2 (05/04) Where Appendix 6/1 requires magnesium sulfate soundness tests to be carried out, they shall be carried out in accordance with BS EN 1367-2. Where 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 ( $\phi'$ ) and Effective Cohesion ( $c'$ ) of Earthworks Materials

1 The effective angle of internal friction  $\phi'$  and effective cohesion  $c'$  shall be determined by shear box or triaxial tests as required in Table 6/1 and Appendix 6/1. Unless otherwise required in 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  $92\% \pm 2\%$  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  $\phi'$  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  $92\% \pm 2\%$  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  $\phi'$  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 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 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 Appendix 6/1.

**3** Details of the area and volume of material to be tested shall be made available to the Overseeing Organisation together with the arrangement of electrodes in each test. The Overseeing Organisation 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 Overseeing Organisation.

### **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 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 Appendix 6/1.

3 Details of the area and volume of material to be tested shall be made available to the Overseeing Organisation together with the locations of the test pits.

4 The Overseeing Organisation 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 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 ( $\text{kN/m}^2$ ).
- (ii) Peak shear stress ( $\text{kN/m}^2$ ).
- (iii) Strain at peak shear stress (%).
- (iv) Moisture content of fill after test (Classes 7B, 7C and 7D).

#### **Anchor Elements**

5 Where required in 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 Appendix 6/1 the permeability of earthworks materials shall be determined as described in Appendix 6/1.

### 641 Determination of Available Lime Content of Lime for Lime Stabilised Capping

1 (11/03) The available lime content of lime for lime or lime and cement stabilised capping to be determined on Site shall be carried out as described in BS 6463 : Part 101 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.

2 (11/03) The available lime content shall be determined as calcium oxide in accordance with BS 6463 : Part 102, Method 20, and the results reported as:

Available lime (as CaO) = .....% by mass.

### 642 Determination of the Constrained Soil Modulus ( $M^*$ ) of Earthworks Materials for Corrugated Steel Buried structures

#### General

1 When required in 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 (11/03) 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/m<sup>2</sup>. The elastic modulus  $E_s$  shall be determined as the secant modulus between average pressures applied to the plate of 150 and 350 kN/m<sup>2</sup> in the first load cycle. 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.

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

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

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

#### Standard Penetration resistance Tests

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

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

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

### One-dimensional Consolidation Tests

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

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

where  $m_v$  (mm<sup>2</sup>/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

8 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 Appendix 6/1.

## 643 (05/01) Lime and Cement Stabilisation to Form Capping

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 (11/09) Lime for lime and cement stabilisation shall, as required in Appendix 6/7, be either quicklime or hydrated lime complying with BS EN 459-1. Quicklime shall when sieved have 100% passing a BS 10 mm sieve and at least 95% by mass passing a BS 5 mm sieve.

4 The Contractor shall make available to the Overseeing Organisation for each source of lime a report of a chemical analysis for 'available lime' made in accordance with sub-Clause 641.2. Such reports shall be submitted to the Overseeing Organisation prior to the incorporation of lime in the Permanent Works at weekly or other intervals defined in Appendix 6/7 during periods when lime and cement stabilisation is carried out.

5 Cement for lime and cement stabilisation shall be Portland cement complying with Clause 1001, unless otherwise described in 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 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 an approved 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<sup>2</sup> of lime spread or a different rate of testing for the rate of spread as described in 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 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 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 an approved 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 (11/05) 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 SO<sub>4</sub> when tested in accordance with Test No. 1 of TRL Report 447.

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<sup>2</sup> of cement spread.

**15** Unless indicated otherwise in 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 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 an approved 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** (11/05) 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<sub>4</sub> when tested in accordance with Test No. 1 of TRL Report 447.

**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** (11/05) 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 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 SO<sub>4</sub> when tested in accordance with Test No. 1 of TRL Report 447.

**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 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 Appendix 6/1 has been achieved. The relaxation allowed in sub-Clause 617.2 shall not apply before this time.

#### (11/03) **644 Determination of sulfate content**

**1** Where required in Table 6/1 or 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.

**2** Test results and limiting values for sulfate shall be given as SO<sub>4</sub>. Further information on sulfur compounds is given in NG 644.

**3** (11/05) At least five samples of each material shall be tested for WS, OS and TPS. 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.

**TABLE 6/1: (11/05) 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 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	1	A	-
									Lower	Upper						
G E N E R A L	1	A	-	Well graded granular material	General Fill	Any material, or combination of materials, other than material designated as Class 3 in the Contract. (Properties (i), (ii) and (iv) in next column, shall not apply to chalk). Recycled aggregate	(i) grading	BS 1377 : part 2	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	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						
G R A N U L A R	1	B	-	Uniformly graded granular material	General Fill	Any material, or combination of materials, other than chalk. Recycled aggregate	(i) grading	BS 1377 : Part 2	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	App 6/1	App 6/1						
							(iv) MCV	Clause 632	App 6/1	App 6/1						
F I L L	1	C	-	Coarse granular material	General Fill	Any material, or combination of materials, other than material designated as Class 3 in the Contract. (Properties (i) and (ii) in next column, shall not apply to chalk). Recycled aggregate	(i) grading	BS 1377 : Part 2	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						

**TABLE 6/1: (11/05) 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 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					
G E N E R A L	2	A	-	Wet cohesive material	General Fill	Any material, or combination of materials, other than chalk.	(i) grading	BS 1377 : part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 1 except for materials with liquid limit greater than 50, determined by BS1377 : Part 2, only deadweight tamping or vibratory tamping rollers or grid rollers shall be used.	2	A	-
							(ii) plastic limit (PL)	BS 1377 : part 2	-	-				
							(iii) mc	BS 1377 : Part 2	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				
C O H E S I V E	2	B	-	Dry cohesive material	General Fill	Any material, or combination of materials, other than chalk	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	2	B	-
							(ii) plastic limit (PL)	BS 1377 : Part 2	-	-				
							(iii) mc	BS 1377 : Part 2	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				
F I L L														



**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 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					
G E N E R A L	2	C	-	Stony cohesive material	General Fill	Any material, or combination of materials, other than chalk	(i) grading	BS 1377 : part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	2	C	-
							(ii) plastic limit (PL)	BS 1377 : part 2	-	-				
							(iii) mc	BS 1377 : Part 2	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	-				
C O H E S I V E	2	D	-	Silty cohesive material	General Fill	Any material, or combination of materials, other than chalk	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	2	D	-
							(ii) mc	BS 1377 : Part 2	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				
F I L L	2	E	-	Reclaimed pulverised fuel ash cohesive material	General Fill	Reclaimed material from lagoon or stockpile containing not more than 20% furnace bottom ash	(i) mc	BS 1377 : Part 2	To enable compaction to Clause 612		End product 95% of maximum dry density of BS 1377 : Part 4 (2.5 kg rammer method)	2	E	-
							(ii) bulk density	BS 1377 : Part 9	App 6/1	App 6/1				

**TABLE 6/1: (11/05) 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 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	3	-	-
						Lower	Upper						
G F E I N L L C H A L K	3 - - Chalk	General Fill	Chalk and associated materials all designated as Class 3 in the Contract	(i) mc	BS 1377 : Part 2	-	App 6/1	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	3	-	-		
				(ii) IDD	Clause 634	App 6/1	App 6/1						
L F A I N L D L S C A P E	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	-	App 6/1						
				(iii) MCV	Clause 632	App 6/1	App 6/1						
T O P S O I L	5 A - Topsoil, or turf, existing on site	Topsoiling	Topsoil or turf designated as Class 5A in the Contract	(i) grading	Clause 618	-	Clause 618	-	5	A	-		
	5 B - Imported topsoil	Topsoiling	General purpose grade complying with BS 3882	-	-	-	-	-	5	B	-		

**TABLE 6/1: (11/05) 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 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	6	A	-	
						Lower	Upper							
S E L E C T E D  G R A N U L A R  F I L L	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	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	No compaction	6	A	-
							(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	Starter layer	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	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 5	6	B	-
							(ii) plasticity index	BS 1377 : Part 2	Non-plastic					
							(iii) Los Angeles coefficient	Clause 635	-	50				

**TABLE 6/1: (11/05) 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 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			
S E L E C T E D  G R A N U L A R  F I L L	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	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	6	C	-	
								BS EN 933-2 (Off-site)	Table 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	App 6/1	App 6/1					
S E L E C T E D  G R A N U L A R  F I L L	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	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 4	6	D	-	
								BS EN 933-2 (Off-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	App 6/1	App 6/1					
							(v) MCV	Clause 632	App 6/1	App 6/1					

**TABLE 6/1: (11/08) 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 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:			6	E	-
									Lower	Upper				
S E L E C T E D  G R A N U L A R F I L L	6	E	-	Selected granular material (Class 9A)	For stabilisation with cement to form capping	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	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Not applicable			
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) mc	BS 1377 : Part 2	-	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	-	3000 mg/l as SO <sub>4</sub>				
							(vii) oxidisable sulfides (OS) content	TRL Report 477, Tests No. 2 and 4	-	0.6% as SO <sub>4</sub>				
(viii) SMC of chalk	Clause 634		20%											

**TABLE 6/1: (11/09) 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 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:			6	F	1	
Lower	Upper													
SELECTED GRANULAR	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 that contain tar and tar-bitumen binders, unburnt colliery spoil, argillaceous rock and chalk.  Property (vi) in the next column shall not apply if the Class Ra (asphalt) content of any recycled aggregate is 20% or less.	(i) grading	BS 1377 : Part 2	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	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%				
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 that contain tar and tar-bitumen binders, unburnt colliery spoil and argillaceous rock.  Property (i) in the next column shall not apply to chalk.  Property (vi) in the next column shall not apply if the Class Ra (asphalt) content of any recycled aggregate is 20% or less.	(i) grading	BS 1377 : Part 2	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	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%				

TABLE 6/1: (11/09) 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 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:			6	F	3	
Lower	Upper													
S E L E C T E D	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 that contain tar and tar-bitumen binders, unburnt colliery spoil and argillaceous rock	(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 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) optimum mc	Clause 613	-	-				
							(iii) mc	Clause 613	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%				
G R A N U L A R	6	F	4	Selected granular material (fine grading) - imported on to the Site	Capping	Unbound mixture complying with BS EN 13285.  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 that contain tar and tar-bitumen binders, unburnt colliery spoil, argillaceous rock and chalk.  Property (x) in the next column shall not apply if the Class Ra (asphalt) content of any recycled aggregate is 20% or less.	(i) Size designation and overall grading category	BS EN 13285 - 0/31.5 and $G_E$	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	-	-				

**TABLE 6/1: (11/09) 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 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				
S E L E C T E D  G R A N U L A R  F I L L	6	F	4	(contd)			(v) Volume stability of steel (BOF) and EAF) slag	BS EN 13242 - $V_5$	-	-				
							(vi) Other aggregate requirements	BS EN 13242 - Category <sub>NR</sub> (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) Clas Ra (asphalt) content	Clause 710	-	50%				
							(x) bitumen content	BS EN 12697-1 or BS EN 12697-39	-	2.0%				



**TABLE 6/1: (11/09) 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 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:			6	F	5
									Lower	Upper				
S E L E C T E D  G R A N U L A R  F I L L	6	F	5	Selected granular material (coarse grading)  - imported on to the Site	Capping	Unbound mixture complying with BS EN 13285.  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 that contain tar and tar-bitumen binders, unburnt colliery spoil, argillaceous rock and chalk.  Property (x) in the next column shall not apply if the Class Ra (asphalt) content of any recycled aggregate is 20% or less.	(i) Size designation and overall grading category	BS EN 13285 - 0/80 and $G_E$	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 <sub>NR</sub> (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) Clas Ra (asphalt) content	Clause 710	-	50%				
							(x) bitumen content	BS EN 12697-1 or BS EN 12697-39	-	2.0%				

**TABLE 6/1: (11/05) 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 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	6	G	-
								Lower	Upper						
S E L E C T E D	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..	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	None	6	G	-		
							BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5						
						(ii) Los Angeles coefficient	Clause 635	-	50						
G R A N U L A R  F I L L	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	(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 (Off-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	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	-	Tab 6/3						
						(viii) water soluble (WS) sulfate content	TRL Report 447, Tests No. 1	-	Tab 6/3						
						(ix) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	Tab 6/3						
						(x) restivity	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: (11/05) 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 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				
S E L E C T E D  G R A N U L A R  F I L L	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	(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 (Off-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	App 6/1	App 6/1				
							(v) MCV	Clause 632	App 6/1	App 6/1				
							(vi) effective angle of friction ( $\phi'$ ) 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	-	Tab 6/3				
							(x) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	Tab 6/3				
							(xi) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 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: (11/05) 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 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:			6	J	-			
						Lower	Upper							
S E L E C T E D  G R A N U L A R  F I L L	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	(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 (Off-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	App 6/1	App 6/1				
							(v) MCV	Clause 632	App 6/1	App 6/1				
							(vi) effective angle of friction ( $\phi'$ ) 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	-	Tab 6/3				
							(x) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	Tab 6/3				
							(xi) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos 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: (11/05) 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 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				
S E L E C T E D  G R A N U L A R  F I L L	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	(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 (Off-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	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 447, Test No. 1	-	300 mg/l as SO <sub>4</sub>				
							(x) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos 2 and 4	-	0.06% as SO <sub>4</sub>				
							(xi) chloride ion content	BS EN 1744-1	-	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: (11/05) 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 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:			6	L	-			
						Lower	Upper							
S F E I L L E L C T E D  G R A N U L A R	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	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	None	6	L	-
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
							(ii) resistivity	Clause 637	2000 ohm cm	-				
							(iii) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	300 mg/l as SO <sub>4</sub>				
							(iv) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	0.06% as SO <sub>4</sub>				
							(v) chloride ion content	BS EN 1744-1	-	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: (11/05) 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 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:			6	M	-
									Lower	Upper				
S E L E C T E D  G R A N U L A R  F I L L	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	(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 (Off-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	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 447 Test No. 1	-	300 mg/l as SO <sub>4</sub>				
							(x) oxidisable sulfides (OS) content	TRL Report 447 Tests Nos. 2 and 4	-	0.06% as SO <sub>4</sub>				
							(xi) chloride ion content	BS EN 1744-1	-	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: (11/05) 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 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:			6	N	-			
						Lower	Upper							
S F E I L L E L C T E D  G R A N U L A R	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	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	End product 95% of maximum dry density of BS 1377 : Part 4 (vibrating hammer method)	6	N	-
								BS EN 933-2 (Off-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 $\phi$ )	Clause 633	App 6/1	-				
							(v) effective angle of internal friction ( $\phi'$ ) and effective cohesion (c')	Clause 636	App 6/1	-				
							(vi) permeability	Clause 640	App 6/1	-				
							(vii) mc	BS 1377 : Part 2	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: (11/05) 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 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:			6	P	-			
						Lower	Upper							
S E L E C T E D  G R A N U L A R  F I L L	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	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	End product 95% of maximum dry density of BS 1377 : Part 4 (vibrating hammer method)	6	P	-
								BS EN 933-2 (Off-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 $\phi$ )	Clause 633	App 6/1	-				
							(vi) effective angle of internal friction ( $\phi'$ ) and effective cohesion ( $c'$ )	Clause 636	App 6/1	-				
							(vii) permeability	Clause 640	App 6/1	-				
							(viii) mc	BS 1377 : Part 2	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: (11/08) 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 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:			6	Q	-		
						Lower	Upper						
S E L E C T E D  G R A N U L A R  F I L L	6	Q	-	Well graded uniformly graded or coarse granular material	Overlying fill for corrugated steel buried structures	As Class 1A, 1B or 1C granular fill materials, but not to include argillaceous rock, slag or PFA in any proportions. Recycled aggregate except recycled asphalt	As for Class 1A, 1B or 1C with the addition of the following:				6	Q	-
							(i) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	300 mg/l as SO <sub>4</sub>			
							(ii) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	0.06% as SO <sub>4</sub>			
							(iii) chloride ion content	BS EN 1744-1	-	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			
6	R	-	Selected granular material	For stabilisation with lime and cement to form capping (Class 9F)	Any material, or combination of materials, other than unburnt colliery spoil and argillaceous rock. (Properties (i), (ii) and (iii) in text column, shall not apply to chalk.)	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	Not applicable	6	R	-
							BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5				
						(ii) mc	BS 1377 : Part 2	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 447, Test No. 1	-	3000 mg/l as SO <sub>4</sub>				
						(vii) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	0.6% as SO <sub>4</sub>				
						(viii) IDD of chalk	Clause 634	-	App 6/1				

**TABLE 6/1: (11/05) 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 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	6	S	-
									Lower	Upper						
S E L E C T E D	6	S	-	Selected well graded granular material	Filter layer below subbase	Crushed rock or sand	(i) grading	BS 1377 : Part 2 (On-site)	Tab 6/2	Tab 6/2	-	6	S	-		
								BS EN 933-2 (Off-site)	Tab 6/5	Tab 6/5						
							(ii) plasticity index	BS 1377 : Part 2	-	Non-plastic						

G  
R  
A  
N  
U  
L  
A  
R

F  
I  
L  
L

**TABLE 6/1: (11/05) 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 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:			7	A	-			
						Lower	Upper							
S F E I L L E L C T E D  C O H E S I V E	7	A	-	Selected cohesive material	Fill to structures	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.) (Properties (vii) and (viii) may be increased to 54% and 31% respectively for Lias Clay only and subject to the requirements of Appendix 6/6)	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	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	App 6/1	App 6/1				
							(iii) MCV	Clause 632	App 6/1	App 6/1				
							(iv) undrained shear parameters (c and $\phi$ )	Clause 633	App 6/1	App 6/1				
							(v) effective angle of internal friction ( $\phi'$ ) 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				
							(viii) plasticity index	BS 1377 : Part 2	-	25				

**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 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	7	B	-	
S F E I L L E L C T E D  C O H E S I V E	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	To enable compaction to Clause 612		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 $\phi$ )	Clause 633	App 6/1	-				
							(iv) effective angle of internal friction ( $\phi'$ ) 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: (05/04) 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 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	7	C	-	
						Lower	Upper							
S E L E C T E D  C O H E S I V E  F I L L	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	App 6/1	App 6/1				
							(iii) MCV	Clause 632	App 6/1	App 6/1				
							(iv) effective angle of internal friction ( $\phi'$ ) 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				
							(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	-	Tab 6/3				
							(x) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	Tab 6/3				
							(xi) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	Tab 6/3				
							(xii) resistivity	Clause 637	Tab 6/3	-				
							(xiii) redox potential	Clause 638	Tab 6/3	-				

**TABLE 6/1: (05/04) 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 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:			7	D	-			
						Lower	Upper							
S E L E C T E D  C O H E S I V E  F I L L	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	App 6/1	App 6/1				
							(iii) MCV	Clause 632	App 6/1	App 6/1				
							(iv) effective angle of internal friction ( $\phi'$ ) 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				
							(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	-	Tab 6/3				
							(x) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	Tab 6/3				
							(xi) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	Tab 6/3				
							(xii) resistivity	Clause 637	Tab 6/3	-				
							(xiii) redox potential	Clause 638	Tab 6/3	-				

**TABLE 6/1: (11/03) 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 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:			7	D	-			
						Lower	Upper							
S E L E C T E D  C O H E S I V E	7	E	-	Selected cohesive material	For stabilisation with lime to form capping (Class 9D)	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	D	-
							(ii) mc	BS 1377 : Part 2	-	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 447, Test No. 1	-	App 6/1				
							(vii) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	App 6/1				
							(viii) total potential sulfate (TPS) content	TRL Report 447, Test No. 4	-	App 6/1				
F I L L	7	F	-	Selected silty cohesive material	For stabilisation with cement to form capping (Class 9B)	Any material, or combination of materials, other than chalk, unburnt colliery spoil and argillaceous rock	(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	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 447, Test No. 1	-	App 6/1				
							(ix) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	App 6/1				
							(x) total potential sulfate (TPS) content	TRL Report 447, Test No. 4	-	App 6/1				



**TABLE 6/1: (11/05) 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 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:			7	G	-			
						Lower	Upper							
S E L E C T E D  C O H E S I V E  F I L L	7	G	-	Selected conditioned pulverised fuel ash cohesive material	For stabilisation with cement to form capping (Class 9C)	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	App 6/1	App 6/1	Not applicable	7	G	-
							(ii) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	3000 mg/l as SO <sub>4</sub>				
							(iii) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	0.6% as SO <sub>4</sub>				
							(iv) total potential sulfate (TPS) content	TRL Report 447, Test No. 4	-	1.2% as SO <sub>4</sub>				
S E L E C T E D  C O H E S I V E  F I L L	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				7	H	-	
							(i) water soluble (WS) sulfate content	TRL Report 447, Test No. 1	-	300 mg/l as SO <sub>4</sub>				
							(ii) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	0.06% as SO <sub>4</sub>				
							(iii) chloride ion content	BS EN 1744-1	-	0.025%				
							(iv) pH value	BS 1377 : Part 3	6	9				

**TABLE 6/1: (11/03) 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 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:			7	I				
						Lower	Upper							
S E L E C T E D  C O H E S I V E  F I L L	7	I	-	Selected cohesive material	For stabilisation with lime and cement to form capping (Class 9E)	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	-	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 447, Test No. 1	-	App 6/1				
							(vii) oxidisable sulfides (OS) content	TRL Report 447, Tests Nos. 2 and 4	-	App 6/1				
							(viii) total potential sulfate (TPS) content	TRL Report 447, Test No. 4	-	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 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						
M F I L S L C L	8	-	-	Class 1, Class 2 or Class 3 material	Lower trench fill	Any; except there shall not be any stones or lumps of clay >40 mm nominal diameter. Recycled aggregate	(i) mc	BS 1377 : Part 2	App 6/1	App 6/1	Tab 6/4	8	-	-	
							(ii) MCV	Clause 632	App 6/1	App 6/1					
S T A B I L I S E D	9	A	-	Cement stabilised well graded granular material	Capping	Class 6E with addition of cement according to Clause 614	(i) pulverisation	BS 1924 : Part 2	60%	-	Tab 6/4 Method 6	9	A	-	
							(ii) bearing ratio	BS 1924 : Part 2	App 6/1	-					
							(iii) mc	BS 1924 : Part 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 1924 : Part 2	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 1924 : Part 2	App 6/1	-					
							(iv) mc	BS 1924 : Part 2	App 6/1	App 6/1					
	M A T E R I A L S	9	C	-	Cement stabilised conditioned pulverised fuel ash cohesive material	Capping	Class 7G with addition of cement according to Clause 614	(i) pulverisation	BS 1924 : Part 2	60%	-	End product 95% of maximum dry density of BS 1924 : Part 2 (2.5 kg rammer method)	9	C	-
								(ii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
								(iii) mc	BS 1924 : Part 2	To enable compaction to Clause 612					
	9	D	-	Lime stabilised cohesive material	Capping	Class 7E with addition of lime according to Clause 615	(i) pulverisation	BS 1924 : Part 2	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 1924 : Part 2	App 6/1	-						
(iv) mc							BS 1924: Part 2	App 6/1	App 6/1						

**TABLE 6/1: (11/04) Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)**

S M T A A T B E I R L I A S S E S D	9	E	-	Lime and cement stabilised cohesive material	Capping	Class 7I with addition of lime and cement according to Clause 643	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:			9	E	-
									Lower	Upper				
							(i) pulverisation	BS 1924 : Part 2	30%	-	Tab 6/4 Method 7			
							(ii) MCV immediately before completion	Clause 632	App 6/1	App 6/1				
							(iii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iv) mc	BS 1924 : Part 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 1924 : Part 2	60%	-	Tab 6/4 Method 6	9	F	-
							(ii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iii) mc	BS 1924 : Part 2	App 6/1	App 6/1				

**Footnotes to Table 6/1**

1. App = 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 Appendix 6/1 shall apply. Where Appendix 6/1 gives limits for other properties not listed in this Table such limits shall also apply.
4. (05/04) Where BS 1377 : Part 2 is specified for mc, this shall mean BS 1377 : Part 2 or BS EN 1097-5 as appropriate.
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  
 $D_{10}$  = particle diameter at which 10% of the soil by weight is finer
6. (11/04) The limiting values for Class U1B material are given in Appendix 6/14 and Appendix 6/15.

**TABLE 6/2: (05/04) 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 (microns)	Class
	500	300	125	90	75	37.5	28	20	14	10	6.3	5	3.35	2	1.18	600	300	150	63		
1A		100	95-100																<15		1A
1B			100																<15		1B
1C	100		10-95													0-25			<15		1C
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 & 2R
6F1					100	75-100			40-95		30-85					10-50			<15		6F1
6F2			100	80-100	65-100	45-100			15-60		10-45				0-25				0-12		6F2
6F3			100	80-100	65-100	45-100			15-60		10-45				0-25				0-12		6F3
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: (11/05) 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 (microns)	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

**TABLE 6/3: (11/05) 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	Maximum Oxidisable Sulfides (OS) Content	Minimum Resistivity	Minimum Redox Potential	Microbial Activity Index
	Min	Max	%	%	mg/l as SO <sub>4</sub>	% as SO <sub>4</sub>	Ohm.cm	volts	
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	) )

**NOTES:**

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

**2** (11/03) 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. Further information may be obtained by reference to TRRL Contractor Report 54.

**3** (11/03) 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** (11/03) 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)	1	Mass per metre width of roll: over 2100 kg up to 2700 kg over 2700 kg up to 5400 kg over 5400 kg	125	8	125	10	125	10*	175	4	unsuitable		unsuitable	unsuitable	unsuitable
	2		125	6	125	8	125	8*	200	4	unsuitable	16	unsuitable	unsuitable	unsuitable
	3		150	4	150	8	unsuitable		300	4	unsuitable	8	16	unsuitable	unsuitable
Grid roller	1	Mass per metre width of roll: over 2700 kg up to 5400 kg over 5400 kg up to 8000 kg over 8000 kg	150	10	unsuitable		150	10	250	4	unsuitable		unsuitable	unsuitable	unsuitable
	2		150	8	125	12	unsuitable		325	4	unsuitable	20	unsuitable	unsuitable	unsuitable
	3		150	4	150	12	unsuitable		400	4	unsuitable	12	20	unsuitable	unsuitable
Deadweight tamping roller	1	Mass per metre width of roll: over 4000 kg up to 6000 kg over 6000 kg	225	4	150	12	250	4	350	4	unsuitable	12	20	unsuitable	unsuitable
	2		300	5	200	12	300	3	400	4	unsuitable	8	12	20	unsuitable
Pneumatic-tyred roller	1	Mass per wheel: over 1000 kg up to 1500 kg over 1500 kg up to 2000 kg over 2000 kg up to 2500 kg over 2500 kg up to 4000 kg over 4000 kg up to 6000 kg over 6000 kg up to 8000 kg over 8000 kg up to 12000 kg over 12000 kg	125	6	unsuitable		150	10*	240	4	unsuitable		unsuitable	unsuitable	unsuitable
	2		150	5	unsuitable		unsuitable		300	4	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable
	3		175	4	125	12	unsuitable		350	4	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable
	4		225	4	125	10	unsuitable		400	4	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable
	5		300	4	125	10	unsuitable		unsuitable		unsuitable	12	unsuitable	unsuitable	unsuitable
	6		350	4	150	8	unsuitable		unsuitable		unsuitable	12	unsuitable	unsuitable	unsuitable
	7		400	4	150	8	unsuitable		unsuitable		unsuitable	10	16	unsuitable	unsuitable
	8		450	4	175	6	unsuitable		unsuitable		unsuitable	8	12	unsuitable	unsuitable
Vibratory tamping roller	1	Mass per metre width of a vibrating roll: over 700 kg up to 1300 kg over 1300 kg up to 1800 kg over 1800 kg up to 2300 kg over 2300 kg up to 2900 kg over 2900 kg up to 3600 kg over 3600 kg up to 4300 kg over 4300 kg up to 5000 kg over 5000 kg	100	12	100	12	150	12	100	10	unsuitable		unsuitable	unsuitable	unsuitable
	2		125	12	125	12	175	12*	175	8	unsuitable	12	unsuitable	unsuitable	unsuitable
	3		150	12	150	12	200	12*	unsuitable		unsuitable	8	12	unsuitable	unsuitable
	4		150	9	150	9	250	12*	unsuitable		400	5	6	10	unsuitable
	5		200	9	200	9	275	12*	unsuitable		500	6	6	10	unsuitable
	6		225	9	225	9	300	12*	unsuitable		600	6	4	8	unsuitable
	7		250	9	250	9	300	9*	unsuitable		700	6	3	7	12
	8		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)**

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	
Vibratory roller	1	Mass per metre width of a vibratory roll: over 270 kg up to 450 kg over 450 kg up to 700 kg over 700 kg up to 1300 kg over 1300 kg up to 1800 kg over 1800 kg up to 2300 kg over 2300 kg up to 2900 kg over 2900 kg up to 3600 kg over 3600 kg up to 4300 kg over 4300 kg up to 5000 kg over 5000 kg	unsuitable	75	16	150	16	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	
	2		unsuitable	75	12	150	12	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable
	3		100	12	125	10	150	6	125	10	unsuitable	16	unsuitable	unsuitable	unsuitable	unsuitable
	4		125	8	150	8	200	10*	175	4	unsuitable	6	16	unsuitable	unsuitable	unsuitable
	5		150	4	150	4	225	12*	unsuitable	unsuitable	4	6	12	unsuitable	unsuitable	unsuitable
	6		175	4	175	4	250	10*	unsuitable	400	5	3	5	11	unsuitable	unsuitable
	7		200	4	200	4	275	8*	unsuitable	500	5	3	5	10	unsuitable	unsuitable
	8		225	4	225	4	300	8*	unsuitable	600	5	2	4	8	unsuitable	unsuitable
	9		250	4	250	4	300	6*	unsuitable	700	5	2	4	7	unsuitable	unsuitable
	10		275	4	275	4	300	4*	unsuitable	800	5	2	3	6	unsuitable	unsuitable
Vibrating plate compactor	1	Mass per m <sup>2</sup> of base plate: over 880 kg up to 1100 kg over 1100 kg up to 1200 kg over 1200 kg up to 1400 kg over 1400 kg up to 1800 kg over 1800 kg up to 2100 kg over 2100 kg	unsuitable	unsuitable	75	6	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	
	2		unsuitable	75	10	100	6	75	10	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	
	3		unsuitable	75	6	150	6	150	8	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	
	4		100	6	125	6	150	4	unsuitable	unsuitable	8	unsuitable	unsuitable	unsuitable	unsuitable	
	5		150	6	150	5	200	4	unsuitable	unsuitable	5	8	unsuitable	unsuitable	unsuitable	
	6		200	6	200	5	250	4	unsuitable	unsuitable	3	6	12	unsuitable	unsuitable	
Vibro-tamper	1	Mass: over 50 kg up to 65 kg over 65 kg up to 75 kg over 75 kg up to 100 kg over 100 kg	100	3	100	3	150	3	125	3	unsuitable	4	8	unsuitable	unsuitable	
	2		125	3	125	3	200	3	150	3	unsuitable	3	6	12	unsuitable	
	3		150	3	150	3	225	3	175	3	unsuitable	2	4	10	unsuitable	
	4		225	3	200	3	225	3	250	3	unsuitable	2	4	10	unsuitable	
Power rammer	1	Mass: 100 kg up to 500 kg over 500 kg	150	4	150	6	unsuitable	200	4	unsuitable	5	8	unsuitable	unsuitable	unsuitable	
	2		275	8	275	12	unsuitable	400	4	unsuitable	5	8	14	unsuitable	unsuitable	
Dropping-weight compactor	1	Mass of rammer over 500 kg weight drop: over 1 m up to 2 m over 2 m	600	4	600	8	450	8	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	
	2		600	2	600	8	unsuitable	unsuitable	unsuitable	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)

Type of Compaction Plant	Ref No.	Category	Method 7	
			N for D = 150 mm	N for D = 250 mm
Smooth wheeled roller (or vibratory roller operating without vibration)	1	Mass per metre width of roll: 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	1	Mass per metre width of roll: 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	1	Mass per metre width of roll: over 4000 kg up to 6000 kg	4	8
	2	over 6000 kg	3	6
Pneumatic-tyred roller	1	Mass per wheel: 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	1	Mass per metre width of vibrating roll: 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	1	Mass per metre width of vibrating roll: 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	1	Mass per m <sup>2</sup> of base plate: 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	1	Mass: 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	1	Mass: 100 kg up to 500 kg	8	unsuitable
	2	over 500 kg	6	10
Dropping weight compactor	1	Mass of rammer over 500 kg height drop: over 1 m up to 2 m	unsuitable	unsuitable
	2	over 2 m	unsuitable	unsuitable

**TABLE 6/5: (11/05) Off-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	
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 & 2R
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			100	75-99		50-90		30-75		15-60				0-35					0-12	6F5
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

**TABLE 6/6 : (05/04) Records and Reports - Information Required**

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

# NATIONAL ALTERATIONS OF THE OVERSEEING ORGANISATION OF SCOTLAND

## #601TS (11/06) Classification, Definitions and Uses of Earthworks Materials

### 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 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 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 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 Appendix 6/1 for acceptable material; and
  - (b) material, or constituents of materials, composed of the following unless otherwise described in 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;

(ii) unacceptable material Class U1B shall be:

- (a) contaminated materials, including controlled wastes (as defined in the Environmental Protection Act 1990 Part IIA) whose level of contamination is above that given either in Appendix 6/14 or in Appendix 6/15, but excluding all special wastes (as defined in the Special Waste Amendment (Scotland) Regulations 2004) and radioactive wastes (as defined in the Radioactive Substances Act 1993).

3 Unacceptable material Class U2 shall be:

- (i) special waste (as defined in the Special Waste Scotland (Amendment) Regulations 2004) and radioactive waste (as defined in the Radioactive Substances Act 1993).

4 Where required in 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 Appendix 6/1.

### Definitions

5 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 Appendix 6/1.

**6** 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.

**7** 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.

**8** 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.

**9** 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.

**10** Sub-formation shall be the top surface of earthworks at the underside of capping.

**11** 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.

**12** (11/07) Where 'recycled aggregate' is used in this Series, the material shall be aggregate resulting from the processing of material used in a construction process. The aggregate shall have been tested in accordance with Clause 710, and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass. Where 'recycled aggregate except recycled asphalt' is used in this Series, the aggregate shall have been tested in accordance with Clause 710. Content of asphalt (mineral aggregate with a bituminous binder) shall not exceed 2% by mass, and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass.

### Use of Fill Materials

**13** 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 that cobbles having an equivalent diameter of more than 150 mm shall not be deposited beneath verges or central reserves within 1.30 m of the finished surface.

**14** (11/07) Material shall not be deposited within 500 mm, or other distances described in 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 either:

- (i) the water-soluble sulfate (WS) content exceeds 1500 mg of sulfate (as  $\text{SO}_4$ ) per litre (Test No.1); or
- (ii) (11/09) the oxidisable sulfides (OS) content exceeds 0.5 % of sulfate (as  $\text{SO}_4$ ) (Test No. 2 and Test No. 4); or
- (iii) (11/09) 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.

(11/09) At least five samples of each material shall be tested for WS, OS and pH value. 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.

**15** (11/07) Material shall not be deposited within 500 mm, or other distances described in Appendix 6/3, of metallic structural elements forming part of the Permanent Works if, when tested in accordance with TRL Report 447 either:

- (i) the water-soluble sulfate (WS) content exceeds 300 mg of sulfate (as  $\text{SO}_4$ ) per litre (Test No.1); or
- (ii) the oxidisable sulfides (OS) content exceeds 0.06 % of sulfate (as  $\text{SO}_4$ ) (Test Nos. 2 and 4).

At least five samples of each material shall be tested for WS and OS. 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.

(11/07) The requirements in (i) and (ii) above shall not apply to metallic elements protected by concrete and ancillary metallic items such as the tops of chambers and gullies.

**16** Unburnt colliery spoil may be used as general fill provided it is compacted in compliance with Clause 612 and complies with the requirements of Appendix 6/1.

**17** Pulverised-fuel ash shall not be placed within the dimension described in Appendix 6/3, below sub-formation or formation.

**18** Where pulverised-fuel ash is used, the Contractor shall for each consignment, make available to the Overseeing Organisation a record of the type and source of the material and the name of the power station from which it was obtained and a certificate of results of tests showing that the material complies with the requirements of Table 6/1.

### **632TS (11/06) Determination of Moisture Condition Value (MCV) of Earthworks Materials in Scotland**

**1** Where the Moisture Condition Value (MCV) is required in Appendix 6/1, the MCV determination shall be carried out in accordance with TRL Report 273, Appendix A, Sections 1 to 3.

**2** Where the natural moisture content MCV is required in Appendix 6/1, the MCV determination shall be carried out in accordance with TRL Report 273, Appendix A, Sections 1 to 3.

**3** Where the MCV of saturated materials is required in Appendix 6/1, the MCV determination shall be carried out in accordance with TRL Report 273, Appendix A, Sections 1, 2 and 4.

**4** When required in Appendix 6/1, the determination of the MCV/moisture content relation shall be carried out in accordance with TRL Report 273, Appendix A, Sections 1, 2 and 5.

**5** An alternative procedure is given in Appendix A, Sections 1, 2 and 6 of TRL Report 273. The rapid assessment procedure for material acceptability may be used when permitted in Appendix 6/1.

**6** (11/03) The Contractor shall provide, for each Moisture Condition Apparatus (MCA) to be used, a test certificate to show that the MCA is functioning correctly. The tests for correct function shall be carried out as described in Appendix D of TRL Report 273 and the results recorded on form MCA3 (TRL Report 273, Appendix B), or similar. All equipment used shall be traceable to national standards.

**7** (11/03) The Contractor shall provide, for each operator of the MCA, a certificate which shows the operator has completed an appropriate course of training approved by the Overseeing Organisation. The Overseeing Organisation shall be contacted for details of those organisations able to provide such training.

# NATIONAL ALTERATIONS OF THE OVERSEEING ORGANISATION OF NORTHERN IRELAND

## 601NI Classification, Definitions and Uses of Earthworks Materials

### 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 Appendix 6/1 for acceptability for use in the Permanent Works;
- (ii) (11/04) 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 Appendix 6/1, shall not be used in the Permanent Works;
- (iii) (11/04) 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 Appendix 6/1, shall not be used in the Permanent Works; and
- (iv) (11/04) 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.

### (11/04) Unacceptable Materials

2 (11/04) Unacceptable material Classes U1A and U1B:

- (i) (11/04) unacceptable material Class U1A shall be:
  - (a) (11/04) material which does not comply with the permitted constituents and material properties of Table 6/1 and Appendix 6/1 for acceptable material; and
  - (b) material, or constituents of materials, composed of the following unless otherwise described in 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;

- (ii) (11/04) unacceptable material Class U1B shall be:
  - (a) (11/05) contaminated materials, including controlled wastes (as defined in the Waste and Contaminated Land (Northern Ireland) Order 1997 whose level of contamination is above that given either in Appendix 6/14 or in Appendix 6/15, but excluding all hazardous wastes (as defined in the Hazardous Waste Regulations (Northern Ireland) 2005) and radioactive wastes (as defined in the Radioactive Substances Act 1993).

3 Unacceptable material Class U2 shall be:

- (i) (11/05) hazardous waste (as defined in the Hazardous Waste Regulations (Northern Ireland) 2005) and radioactive waste (as defined in the Radioactive Substances Act 1993).

4 (11/04) Where required in 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 Appendix 6/1.



## Definitions

**5** 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 Geological Survey of Northern Ireland;
- (ii) material designated as Class 3 in Appendix 6/1.

**6** Argillaceous rock shall mean shales mudstones siltstones slates and micaceous schists composed of particles of clay silt and mica. It shall include unburnt colliery spoil.

**7** Pulverized-fuel ash shall mean solid material extracted by electrostatic and mechanical means from the flue gases of furnaces fired with pulverized bituminous coal. It shall have a maximum particle size of 3 mm.

**8** Furnace bottom ash shall mean agglomerated pulverized-fuel ash obtained from the bottom of the power station furnace and having particle size no larger than 10 mm.

**9** 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.

**10** Sub-formation shall be the top surface of earthworks at the underside of capping.

**11** (05/01) 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.

**12** (11/07) Where 'recycled aggregate' is used in this Series, the material shall be aggregate resulting from the processing of material used in a construction process. The aggregate shall have been tested in accordance with Clause 710, and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass. Where 'recycled aggregate except recycled asphalt' is used in this Series, the aggregate shall have been tested in accordance with Clause 710. Content of asphalt (mineral aggregate with a bituminous binder) shall not exceed 2% by mass, and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass.

## Use of Fill Materials

**13** (05/01) 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 that cobbles having an equivalent diameter of more than 150 mm shall not be deposited beneath verges or central reserves within 1.30 m of the finished surface.

**14** (11/07) Material shall not be deposited within 500 mm, or other distances described in 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 either:

- (i) (11/05) the water soluble (WS) sulfate content exceeds 1500 mg of sulfate (as  $\text{SO}_4$ ) per litre (Test No. 1); or
- (ii) (11/09) the oxidisable sulfides (OS) content exceeds 0.5% of sulfate (as  $\text{SO}_4$ ) (Test No. 2 and Test No. 4); or
- (iii) (11/09) 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.

(11/09) At least five samples of each material shall be tested for WS, OS and pH value. 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.

**15** (11/07) Material shall not be deposited within 500 mm, or other distances described in Appendix 6/3, of metallic structural elements forming part of the Permanent Works if, when tested in accordance with TRL Report 447 either:

- (i) (11/05) the water soluble (WS) sulfate content exceeds 300 mg of sulfate (as  $\text{SO}_4$ ) per litre (Test No. 1); or
- (ii) the oxidisable sulfides (OS) content exceeds 0.06 % of sulfate (as  $\text{SO}_4$ ) (Test Nos. 2 and 4).

(11/05) At least five samples of each material shall be tested for WS and OS. 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.

(11/07) The requirements in (i) and (ii) above shall not apply to metallic elements protected by concrete and

ancillary metallic items such as the tops of chambers and gullies.

**16** (05/01) Unburnt colliery spoil may be used as general fill provided it is compacted in compliance with Clause 612 and complies with the requirements of Appendix 6/1.

**17** (05/01) Pulverised-fuel ash shall not be placed within the dimension described in Appendix 6/3, below sub-formation or formation.

**18** (05/01) Where pulverised-fuel ash is used, the Contractor shall for each consignment make available to the Overseeing Organisation a record of the type and source of the material and the name of the power station from which it was obtained and a certificate of results of tests showing that the material complies with the requirements of Table 6/1.

## 607NI Explosives and Blasting for Excavation

**1** Blasting for excavation shall not be employed unless permitted or required in 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, provide written notice to the Overseeing Organisation 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 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 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 Appendix 6/3, on property off the Site, make available the results to the Overseeing Organisation 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 Construction (General Provisions) Northern Ireland Regulations 1963 (Regulation 19) 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.