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Transport Infrastructure Ireland

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Specification for Road Works Series 600 - Earthworks (including Erratum No. 1, dated June 2013)

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CC Construction & Commissioning

Standards

About TII

Transport Infrastructure Ireland (TII) is responsible for managing and improving the country's national road and light rail networks.

About TII Publications

TII maintains an online suite of technical publications, which is managed through the TII Publications website. The contents of TII Publications is clearly split into 'Standards' and 'Technical' documentation. All documentation for implementation on TII schemes is collectively referred to as TII Publications (Standards), and all other documentation within the system is collectively referred to as TII Publications (Technical). This system replaces the NRA Design Manual for Roads and Bridges (NRA DMRB) and the NRA Manual of Contract Documents for Road Works (NRA MCDRW).

Document Attributes

Each document within TII Publications has a range of attributes associated with it, which allows for efficient access and retrieval of the document from the website. These attributes are also contained on the inside cover of each current document, for reference. For migration of documents from the NRA and RPA to the new system, each current document was assigned with new outer front and rear covers. Apart from the covers, and inside cover pages, the documents contain the same information as previously within the NRA or RPA systems, including historical references such as those contained within NRA DMRB and NRA MCDRW.

Document Attributes

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For all documents that existed within the NRA DMRB or the NRA MCDRW prior to the launch of TII Publications, the NRA document reference used previously is listed above under 'historical reference'. The TII Publication Number also shown above now supersedes this historical reference. All historical references within this document are deemed to be replaced by the TII Publication Number. For the equivalent TII Publication Number for all other historical references contained within this document, please refer to the TII Publications website.

National Roads Authority

Manual of Contract Documents for Road Works (NRA MCDRW)

ERRATUM No. 1 (June 2013) to NRA Specification for Road Works Series 600 - Earthworks Dated March 2013

The NRA Specification for Road Works (NRA MCDRW), Series 600 – Earthworks, dated March 2013 is amended as follows:-

1. Page 65, Table 6/2

Replace "15-780" with "15-80" for Class 6F1, 6F2 & 6F3 and size shown of 10mm.

EARTHWORKS

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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 Works;

(ii) unacceptable material Class U1 as defined in sub-Clause 2 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 Works;

(iii) unacceptable material Class U2 as defined in sub-Clause 3 of this Clause: material excavated from within the Site which shall not be used in the Works.

2 Unacceptable material Class U1 shall be:

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

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

(a) peat, materials from swamps, marshes and bogs;

(b) logs, stumps and perishable material;

(c) materials in a frozen condition;

(d) clay having a liquid limit determined in accordance with BS 1377 : Part 2, exceeding 80 or plasticity index determined in accordance with BS 1377 : Part 2, exceeding 55;

(e) material susceptible to spontaneous combustion;

(f) non-hazardous materials other than those permitted in Table 6/1 and Appendix 6/1.

3 Unacceptable material Class U2 shall be:

(i) material having hazardous chemical or physical properties requiring special measures for its excavation, handling, storing, transportation, deposition and disposal.

4 Where required in Appendix 6/1 unacceptable material shall be processed by mechanical, chemical or other means to render the material acceptable for use in the Works. This can be undertaken where the following requirements are met:

(i) all current legislation and guidelines are met and all relevant permits are obtained as required;

(ii) the processed material meets the criteria outlined in Table 6/1 and Appendix 6/1;

(iii) the use of the fill is agreed with the Employer's Representative.

Definitions

5 Argillaceous rock shall mean shales mudstones siltstones slates and micaceous schists composed of particles of clay and silt and mica.

6 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 in the Contract.

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

8 Lime and cement improvement shall mean the spreading of lime or lime and cement on a layer of deposited or intact cohesive material, and the subsequent process of pulverising and mixing followed by appropriate compaction to form a layer of acceptable general fill.

9 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 be classified by hand-sorting the coarse aggregate particles in accordance with IS EN 933-11. The content of materials including wood, plastic and metal shall not exceed 1% by mass. Where 'recycled aggregate except recycled asphalt' is used in this Series, the material shall be aggregate resulting from the processing of material used in a construction process. The aggregate shall be classified by hand-sorting the coarse aggregate particles in accordance with IS EN 933-11. The content of asphalt (mineral aggregate with bituminous binder) shall not exceed 2% by mass and the content of materials including wood, plastic and metal shall not exceed 1% by mass. Organic materials are not permitted. The haulage and processing of this material shall be fully compliant with all current legislation and guidelines and all permits obtained as required.

Use of Fill Materials

10 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. Isolated boulders with an equivalent diameter-less than 250 mm may be incorporated in embankments not of rock fill provided the specified compaction requirements are met. These boulders shall not be placed less than 600 mm below formation level of carriageways or hard-shoulders where there is no capping; or less than 600 mm below sub-formation where there is capping.

11 Material shall not be deposited within 500 mm, or other distances described in Appendix 6/3, of concrete, cement bound materials or other cementitious materials forming part of the Permanent Works if, when tested in accordance with IS EN 1744-1:2009 either:

(i) the water-soluble sulfate (WS) content exceeds 1500 mg of sulfate (as SO4) per litre (Test No.10); or

(ii) the oxidisable sulfides (OS) content exceeds 0.3% of sulfate as SO4 (Test Nos. 11 and 12); or

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

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.

12 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 IS EN 1744-1:2009 either:

(i) the water-soluble sulfate (WS) content exceeds 300 mg of sulfate (as SO4) per litre (Test No.01); or
(ii) the oxidisable sulfides (OS) content exceeds 0.06 % of sulfate as SO4 (Test Nos. 11 and 12).

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. 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.

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 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.

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 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 Works and all unacceptable material Class U2, and Class U1 not required to be processed or used in the Works, 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 U2 the Contractor shall comply with any specific requirements for disposal described in Appendix 6/2.

6 In carrying out the requirements of sub-Clause 5 of this Clause the Contractor shall:

(i) comply with all relevant legislation in respect of all operations including the excavation and disposal off-Site of all contaminated unacceptable materials, including any construction and demolition materials that do not comply with the requirements of Appendix 6/1.

(ii) comply with all relevant legislation in respect of treatment of any areas of contaminated material known to exist or encountered in the execution and completion of the Works.

(iii) produce as part of the Environmental Operating Plan a "Construction and Demolition Waste Management Plan" in accordance with the provisions of current guidance and

(iv) prepare as part of the Quality Assurance System an "Execution Quality Assurance Plan" that shall include all of the following:

(a) all the necessary procedures to ensure relevant testing and classifying of all materials to ensure that all unacceptable contaminated material shall not be designated as acceptable material in accordance with the Specification and to ensure that there shall be documentary control and written evidence of all materials that shall be required to be disposed off-Site to any licensed landfill site in accordance with the provision of current legislation.

(b) all the necessary procedures to ensure that the assessment and management of any unacceptable contaminated materials excavated as part of the execution of the Works shall be supervised by a qualified body independent of the Contractor.

(c) all the necessary procedures to ensure that the relevant authority shall be notified 2 working days in advance of the excavation or disposal of any contaminated unacceptable material as part of the execution of the Works, whose personnel or advisers shall be entitled to witness any such activities and all the necessary procedures to ensure the documentation of the chain of custody for all materials classified as "contaminated unacceptable material" that is disposed off-Site to any licensed landfill site.

7 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 Works without contamination by the unacceptable materials. Unless otherwise described in the Contract Classes of fill material required to be deposited separately shall be excavated separately without contamination by other Classes of material.

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

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

10 Existing topsoil material shall, except where it is to be left in place in the locations described in Appendix 6/8, be stripped 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. Existing topsoil material shall always be removed where it will be covered by fill of less than 3 metres in height unless specifically stated otherwise in the Contract. For the purpose of this clause height shall be

measured from existing ground level to the underside of capping or the underside of roadbase where no capping is used.

11 Topsoil shall wherever practicable be used immediately after its stripping and if not shall be stored in stockpiles of heights not exceeding 2m. 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.

12 All Class 5A topsoil arising from the Site, or any Class 5B material replacing Class 5A material in accordance with sub-Clause 3 of this Clause, in excess of the requirements for topsoiling, shall be subject to the requirements described in Appendix 6/8.

13 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. Sheeting and other excavation supports shall be removed as filling proceeds except where they are required in Appendix 6/3 to be left in position.

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

15 Excavations requiring backfilling in existing paved or other surfaces shall be carried out and reinstated in compliance with Clause 706.

16 The Contractor shall keep earthworks free of water including:

(i) arranging for the rapid removal of water:

(a) shed on to the earthworks;

(b) entering the earthworks from any source;

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

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

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

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

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

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

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

19 Where materials are designated in the Contract as Class U2 hazardous material, the Contractor shall carry out any special requirements for their handling described in Appendix 6/2. Where hazardous materials are encountered during the progress of the Works, the Contractor shall make

all necessary arrangements for their safe handling and disposal as Class U2 material after consultation with the Employer's Representative and the appropriate statutory bodies.

20 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 350mm of the designed final surface of a road or paved central reserve. .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 as described in sub-Clause 801.5.

603 Forming of Cuttings and Cutting Slopes

1 Cuttings shall be excavated to the lines and levels described in Appendix 6/3. The final faces of all cuttings (other than cuttings through rock) shall:

(i) have a maximum gradient of 1 vertical to 2 horizontal

(ii) be protected against erosion at all times

(iii) be rounded to a minimum radius of 2.0m at the toe and crest.

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. The Contractor shall install the permanent drainage before the bulk excavation reaches a level 300mm above formation or sub-formation. The cuttings shall be kept well drained at all times. The Contractor shall ensure that plant utilised in the earthworks operation does not in any way damage or alter the location or levels of drainage works already constructed.

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 Employer's Representative before commencement of drilling operations.

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

(i) 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 or water 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:

(i) Isolated patches of soft, fragmented and insecure material shall each be excavated to a depth of at least 200 mm unless other depths are stated in Appendix 6/3 and replaced as soon as practicable with concrete mix ST2 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 approved permanent formers shall be constructed in the locations described in Appendix 6/;

(iii) 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 concrete mix ST2 to Clause 2602 or with masonry infill complying with the 2400 Series and provided with weep holes all in accordance with requirements in Appendix 6/3 or as required by the Employer's Representative

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

7 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) 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.

(ii) 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.

9 Rock cuttings shall adopt finished rock slope profiles which minimise long term maintenance of the rock slope.

10 The rock slope shall reflect natural profiles by the use of techniques including shaping the top parts of cuttings and varying the heights of intermediate benches.

11 Rock cuttings profiles, where the finished rock slope profiles do not exceed 50 degrees to the horizontal, shall be engineered to exploit the natural fissures and character of the rock to create an irregular but stable profile of a textured and natural appearance. However, any blasting and excavation techniques adopted shall not compromise the stability of the rock slopes, or lead to increased risk to the road infrastructure or to the general public.

12 The angle of the rock slope profile shall avoid, where possible, the need for any means of rock strengthening or support, such as rock slope reinforcements, buttressing, dentition, shotcrete and the like.

13 Where rockhead benches are utilised, all geotechnical and excavation factors shall be taken into account, which could lead to instability in the rock at the edge of the bench or in the overlying material.

14 Intermediate benches shall be included within completed rock slopes to provide access for maintenance and to break up the appearance of extensive rock slopes exceeding 12 metres in height.

15 Rockhead benches:

(i) shall have a transverse profile (crossfall) which shall be horizontal or dip towards the upper rock slope,

(ii) shall incorporate drainage measures to discharge the surface water runoff from the cutting side slope above the bench

604 Excavation for Foundations

1 The bottom of all foundation excavations shall be formed to the lines and levels shown on the drawings in the Contract. Pockets of soft soil or loose rock shall be removed and the resulting voids and any natural voids shall be filled with mix ST1 concrete (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 in the Contract, no trimming of the side faces of the excavation shall be carried out for 24 hours.

2 The Contractor shall make good:

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

(ii) any additional excavation at or below the bottom of foundations, including that resulting from removal of material which the Contractor has allowed to deteriorate, with mix 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 Not Used

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 existing 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 Explosive shall be packed, conveyed and stored in accordance with the relevant statutory orders, instruments and bye-laws. The Contractor shall comply also with all current regulations and requirements of An Garda Siochana for the security and use of explosives. The requirements of the Explosives, Factories, Health and Safety Acts shall be complied with. Explosives shall be handled by experienced and competent shot firers and only with the direct authority of the Contractor. The Contractor shall ensure that there is no unauthorised issue or improper use of explosive brought to the site and shall maintain a strict check on quantities issued and consumed. Where explosives are stored the store or magazine shall be provided with a separate compartment for detonators.

2 Explosives shall be used in the quantities and in the manner recommended by the manufacturers. 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. Such permission shall not in any way relieve the Contractor of his liabilities or obligations under the Contract.

3 Where blasting is carried out the Contractor shall ensure, by adherence to proper safety distances and by the use of heavy blasting mats where necessary to prevent the dispersal of material, that no damage is caused to persons or property on or off the site. Special care shall be taken when blasting in wet ground to ensure that individual explosions are reduced to such a size as to preclude damage to any building, existing embankments or structures or any movement of soil, i.e., slippage, etc. Plaster shooting will not be permitted.

4 The Contractor shall 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.

5 The Contractor shall ensure that noise from blasting operations is controlled in accordance with Clause 109.

6 The Contractor shall 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.

7 For each location where blasting is to be undertaken, the contractor shall give written notice to the Employer's Representative of the programme of blasting, including trial explosions, at least 10 days before it commences and give written notice of each blasting event at least 12 hours beforehand.

8 Trial explosions shall be carried out 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 as set out in Appendix 6/3, to prevent damage to structures and earthworks, existing or under construction, on and off site during blasting operations. The Contractor shall ensure peak particle overpressures, of magnitude such as to endanger windows and glazed areas of structures, do not occur.

9 The Contractor shall 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 on amplitude and velocity respectively, measured as instantaneously as the resolution of the recording instrument permits.

10 The Contractor shall determine danger zones likely to be created by the blasting operations, including trial explosions, within which blasted material may be projected and utilise stable arrangements including temporary works, to retain such projectiles and ensure that no injury or damage is caused to persons or property thereby. Particular attention shall be given to structures within 100m of any blast, and trial blasts shall be required where this occurs, with a detailed report submitted to the Employer's Representative for consent to blast.

11 Where instrumentation and monitoring is required in Appendix 6/12, the Contractor shall:

(i) Rigidly fix to structures and insert in earthworks suitable instruments to measure the vibrational amplitude and resultant vibrational peak particle velocity, and peak overpressures as required in Clause 607-9,, experienced during blasting operations including trial explosions

(ii) Make available details of the proposed instrumentation within the site.

(iii) 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

(iv) Read such instruments and take measurements throughout the period of blasting operations, including trial explosions

(v) 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 Employer's Representative at the end of each days blasting.

12 Blasting shall not be permitted in the execution and completion of the works for foundations of structures.

13 All blasting activities shall meet the requirements of Appendix 1/9 of the specification and the Garda Siochana.

14 The Employer's Representatives' written consent to employ blasting shall be obtained by the Contractor a minimum of 28 days in advance of any blasting activity.

15 Where the side slope profile shall be greater than 50 degrees to the horizontal and the cutting shall be excavated by use of explosives, the design, execution and completion of the works shall

ensure that the finished rock slope of any rock cutting shall be formed using pre-split blasting techniques in accordance with the reports LR1094 (pre split blasting for highway rock excavation, 1983) and SR817 (Device for measuring drill rod and drill hole orientation, 1984), published by the UK Transport Research Laboratory.

16 Pre-split holes shall be drilled using down the hole hammer drills.

17 Blasting, execution and completion of the rock excavation works shall limit the weight of explosive charges in each delay and employ all possible measures or techniques necessary to reduce vibration to a minimum, minimise overbreak, minimise induced instability in the rock mass and minimise fracturing of the rock in the rock slope as a result of the method of excavation.

18 Blasting, and execution and completion of the works shall prevent undercutting of embankment or cutting slopes, structure foundations and buried services and the like.

19 In each rock cutting containing intermediate benches, the drill holes and depth of sub-drill at each blast level shall be completed to minimise damage and instability at the edges of the bench execution and completion works.

20 The Contractor shall liaise with land and property owners adjacent to the execution and completion of the works and take all necessary measures to minimise disturbance or intrusion to the general public and to prevent surprise or alarm being caused to the public and livestock during the execution and completion of the Works.

21 Prior to any rock blasting, the Contractor shall be responsible for notifying the public of any proposed blasting activities in accordance with the following requirements:

(i) The Contractor shall advise the public of all proposed blasting activities forming part of the work items, and to safeguard the public against such blasting activities

(ii) All blasting activities shall be undertaken in accordance with the general works requirements and this specification

(iii) The Contractor shall issue written notification to all households, businesses, public buildings and any other occupied premises within 500 metres of the blast site of any imminent blasting activities no later than 14 days in advance of the commencement of the blasting activities

(iv) The Contractor shall publicise the work with an advisory notice which shall be published in the local press and shall be posted at public buildings and offices and other locations as required by the employers representative no later than 14 days in advance of the commencement of the blasting activities

(v) Where possible blasting shall be carried out at the same time or times on each date

(vi) Written notification and public notices shall as a minimum include all of the following:

(a) Project details, name of the employer and name of the contractor

(b) Location of the proposed blasting activities

(c) Precise dates and times of the blast

(d) The name, address and telephone number of a contact within the contractors organisation who shall deal with the queries from members of the public

(e) The period over which the blasting shall be undertaken or likely undertaken, and

(f) Details of audible and visual warnings that shall be provided prior to all individual blasts.

22 Notwithstanding any other provisions of the contract, the Contractor shall during the execution and completion of the works ensure all of the following;

(i) That carriageways shall be protected from fly rock or other debris, and that there shall be no damage to adjacent property or infrastructure during the execution and completion of the works

(ii) That execution and completion of the works shall comply with the requirements of BS5607:1998 Code of practice for safe use of explosives in the construction industry

(iii) That the Contractor shall employ a suitable system to warn of blasting.

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;

(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.

(v) with a maximum gradient of 1 vertical to 2 horizontal

2 Starter layers of Classes 6B or 6C 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. 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 The use of lighter spreading plant or the reduction of the number of passes of the 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 over-steepening 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 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 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. The surcharge material shall be as described in Appendix 6/3 and shall be deposited and compacted in accordance with the requirements of Appendix 6/3.

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, followed immediately 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 Contractors own resources and the protection layer shall be constructed in a continuous operation.

10 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.

11 All permanent faces of side slopes of embankments and other areas of fill formed in Classes 2 or 7 cohesive materials 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.

12 During construction of embankments and other fills, exposed fill material shall be protected against scour and erosion from any source.

13 The use of light weight fill as a permanent fill material is not acceptable under this specification.

609 Geotextiles Used to Separate Earthworks Materials

1 Geotextiles required as part of the Works to separate 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. All geotextile products incorporated into the works shall be affixed with a CE marking symbol and the accompanying documents in accordance with EN 13249.

2 The Contractor shall provide evidence to the Employer's Representative, before the geotextile is incorporated in the Works, that the geotextile will be sufficiently durable when installed in contact with the materials to be separated. The Contractor shall also provide evidence to the Employer's Representative that the geotextile is capable of maintaining its integrity for at least the life period required in Appendix 6/5. Durability testing in accordance with EN ISO 13249 shall be undertaken to demonstrate this.

3 Geotextiles shall be protected at all times against mechanical or chemical damage and shall not be uncovered between manufacture and incorporation in the Works. Unless demonstrated otherwise by performing resistance to weathering tests in accordance with EN ISO 12224, all geotextiles shall be completely covered within three days of installation.

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 Works in accordance with EN ISO 9862. 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 and any additional criteria described in Appendix 6/5:

(i) The geotextile shall sustain a tensile load of not less than 13kN/m, when tested in any direction, determined in a wide strip tensile test carried out in accordance with EN ISO 10319. The minimum elongation at maximum strength tested in accordance with EN ISO 10319 shall not be less than 25%. 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 have a CBR Puncture Resistance of not less than 2kN, determined in accordance with EN ISO 12236.The characteristic CBR puncture strength shall be taken as the value of the strength of the materials 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.

(iii) 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^2/s under a constant head of water of 50 mm, determined in accordance with EN 11058. The flow rate determined in the test shall be corrected to that applicable to a temperature of 20°C using published data on variation in viscosity of water with temperature.

(iv) The geotextile shall have a characteristic size distribution of pore openings such that the mean 0_{90}, determined in accordance with EN ISO 12956, is between 50 microns and 200 microns.

5 The geotextile shall be laid and lapped as described in this Clause or as described in Appendix 6/5. 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 it's laying and as described in sub-clause 3 of this clause.

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° ± 2°C, and a relative humidity of 65 ± 5%. The dry weight of the geotextile tested shall be quoted in g/^{m2}.

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 6N1, 6N2 or 6P 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 6N1, 6N2 and 6P 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 250mm 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 6N1, 6N2 and 6P material shall be shown, by means of a trial utilising not less than 20 m^3 of the material, deposited and compacted in accordance with this Clause, to be stable when it is trimmed to a slope of 1 vertical to 1 ½ 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 in the Contract:

(i) Class 6N1, 6N2 or 6P selected fill material complying with Clause 610 including compaction requirements;

(ii) 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.

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 the Employer's Representative 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, or when required by the Contractor or the Employer's Representative. If the results of field tests show densities which indicate (when compared with the results of similar tests made on approved work in similar materials carried out in accordance with this Clause and Table 6/4), 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, 2C1, 2C2 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) 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^2 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) 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.

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

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.

(viii) 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.

(ix) 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.

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

(xi) 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.

(xii) 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.

(xiii) 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.

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

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

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

End-product Compaction

11 Where end-product compaction is required it shall comply with sub-Clauses 12 to 15 of this Clause.

12 The Contractor shall at least 14 working days before commencement of end-product compaction submit the following to the Employer's Representative:

(i) 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);

(ii) a graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.

13 Once the information contained in sub-Clause 12 of this Clause has been reviewed without objection by the Employer's Representative 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 reviewed without objection by the Employer's Representative.

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 in Appendix 6/3. Where nuclear methods are used, the gauge shall be calibrated in accordance with BS 1377: Part 9. Use of nuclear gauges shall comply with Clause 123.

613 Sub-formation and Capping

1 Capping shall be provided only in those locations, and to the extent, particularly stated in Appendix 6/7 and shall comply with sub-Clauses 613.2 to 613.13 of this Clause.

2 Capping shall be constructed with Class 6F1 or 6F2 material as required or permitted in Appendix 6/7 and complying with Table 6/1.Class 6F3 complying with Table 6/1 shall be used only when they are specifically included in Appendix 6/7.

3 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.

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

5 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.

6 No unprotected sub-formation which is to receive capping shall remain continuously exposed to rain causing degradation, nor, be left uncovered overnight. Sub-formation which is to receive capping shall be kept free of groundwater, infiltration water and the effects of weather and every means shall be taken to ensure that the formation shall be protected.

7 In cuttings the Contractor shall, as permitted or as required in Appendix 6/7, 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^2 of not less than 1,400 kg, and immediately deposit and compact above it, in one or more layers, the capping material

8 On embankments and other areas of fill the Contractor shall, as permitted or as required in Appendix 6/7, 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^2 of not less than 1,400 kg, and immediately construct above it, in one or more layers, the capping material

9 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 m².

10 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 Employers Representative 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.

11 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.

12 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.

13 The finished capping surface shall be kept free of groundwater, infiltration water and not be left exposed to the effects of weather for a prolonged period of time.

614 Lime and Cement Improvement to Form General Fill

1 Materials to be improved with lime or lime and cement shall be Class U1 materials complying with Clause 601 and the requirements of this Clause, except that peat and materials susceptible to swelling shall be excluded. In addition, the Class U1 material proposed for improvement shall have an organic content less than 2% and a water soluble sulfate content not exceeding 3000 mg/l as SO4 when tested in accordance with Test No. 1 of TRL Report 447.

2 Lime shall, as required in Appendix 6/13, be either quicklime or hydrated lime complying with BS EN 459-1. Quicklime shall, when sieved, have 100% passing an ISO 3310-1:2000 10 mm sieve and at least 95% by mass passing an ISO 3310-1:2000 5 mm sieve.

3 Cement shall be Portland cement complying with Clause 1001.

4 Class U1 material to be improved shall have added to it, at any point, the percentage of its dry weight of lime and cement as determined on a demonstration area, to meet the requirements of acceptable general fill in Appendix 6/1. The requirements of the demonstration area shall be set out in Appendix 6/13. Following completion of the demonstration area, a Demonstration Area Report shall be submitted to the Employer's Representative and shall contain as a minimum, the results of all testing carried out, the percentage binder applied, the compactive effort applied, level of compaction achieved and recommendations for applying the approach as part of the Permanent Works.

5 The Contractor shall not carry out lime and cement improvement works when the shade temperature is below 3°C. Lime and cement improvement works shall not be carried out during periods of rain or when rain is imminent.

6 Where lime binder is used, as required in Appendix 6/13, the Contractor shall carry out all of the following procedures:

(i) Lime shall be uniformly spread by an approved spreading machine on top of the layer to be improved. Using a collecting tray and balance the Contractor shall check the rate of spread by weight, once for every 500 m^2 of lime spread and in accordance with Clause 641.

(ii) The material shall be improved 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.

(iii) The material forming the layer to be improved shall be improved by pulverising and mixing in the lime by means of sufficient number of passes of an approved mobile machine until 95% of the silt and clay fraction of improved material passes an ISO 3310-

1:2000 28 mm sieve after dry sieving. Pulverising and mixing shall be undertaken in accordance with sub-Clause 8 of this Clause.

(iv) During improvement 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. Any added water shall have a sulfate content not exceeding 1400 mg/l as SO4 when tested in accordance with Test No. 1 of TRL Report 447.

(v) The layer shall receive at least two passes of the improvement machinery to pulverise and mix the lime and soil, after which the improvement work shall be interrupted by a mellowing period as determined in accordance with sub-clause 4 of this Clause. 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.

(vi) Each layer of improved material shall be compacted as soon as possible after the final pass of the stabilising machine. Immediately before compaction the improved material shall not have a Moisture Condition Value (MCV) of greater than nor less than the figures stated in Appendix 6/1.

(vii) The compaction of each layer of material shall comply with Clause 612 and Table 6/4, except that the number of passes of the compaction plant shall be determined from the results of a demonstration area to be detailed in Appendix 6/13 and as described in sub-clause 4 of this clause.

7 Where cement binder is used, as required in Appendix 6/13, the Contractor shall carry out all of the following procedures:

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

(ii) the material previously mixed with lime shall be improved 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 8 of this Clause. Pulverising and mixing shall be undertaken in accordance with sub-Clause 8 of this Clause.

(iii) Each layer of improved 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. Immediately before compaction the improved 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 SO4 when tested in accordance with Test No. 1 of TRL Report 447.

(iv) The compaction of each layer of material shall comply with Clause 612 and Table 6/4, except that the number of passes of the compaction plant shall be determined from the results of a demonstration area to be detailed in Appendix 6/13 and as described in sub-clause 4 of this clause.

(v) During periods when the air temperature is forecast to drop below 3°C or when ground frost is forecast these materials 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.

(vi) Materials improved with a cement binder 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.

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

615 Not Used

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 relative to its designed level after completion of the following operations as necessary:

(i) 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 Class U1.

(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. 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, 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^2 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) 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 Series 1000, or mix ST1 concrete to Clause 2602.

5 The Contractor shall limit any areas of completed formation to suit the output of plant in use and the rate of deposition 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 Formation areas shall be kept free of groundwater, infiltration water and the effects of weather, and every means shall be taken to ensure that the formation is protected at all times.

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 submit to the Employer's Representative 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 Topsoiling, Grass Seeding and Turfing

1 Topsoiling and turfing 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.

3 When required in Appendix 6/8 topsoil shall not be excavated from stockpiles:

(i) which have been exposed to a cumulative rainfall exceeding 100mm, or other figure stated in Appendix 6/8, over the preceding 28 days; or

(ii) when heavy rain is falling.

4 The areas to be grassed shall be prepared as described in Appendix 6/8 and receive one of the following treatments as described in Appendix 6/8:

(i) Treatment I: topsoiled, fertilised and seeded. Fertiliser and seed may, unless otherwise stated in Appendix 6/8 be applied by hydraulic mulch;

(ii) Treatment II: topsoiled, fertilised and turfed;

(iii) Treatment III: left untopsoiled but fertilised and seeded by hydraulic mulch;

(iv) Treatment IV: topsoiled and seeded, but not fertilised.

5 Cutting slopes which are to receive Treatments I or II shall:

(i) be benched where required in Appendix 6/3 to retain topsoil;

(ii) unless otherwise stated in Appendix 6/8, 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.

6 Topsoil in Treatments I and II and IV shall:

(i) be deposited and spread to the thicknesses described in Appendix 6/8, which thickness shall be reduced where necessary to allow for any subsequent turfing required in Appendix 6/8 (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 stated otherwise in Appendix 6/8; and

(b) dimensions greater than 50 mm equivalent diameter which lie within 50 mm of the surface;

(iii) not have stones or other debris protruding above the surface by more than 30 mm; and

(iv) immediately prior to sowing of seed, including that applied by hydraulic mulch, and before laying of turf, have:

(a) its upper 50 mm thickness reduced to a fine till by use of a chain harrow or other plant producing a similar fine till; and in the case of Treatments I and II only

(b) unless otherwise required in Appendix 6/8, fertiliser complying with sub-Clause 12 of this Clause evenly distributed and raked in, at a rate not less than 75 g per m^2 or other rate required in Appendix 6/8. If hydraulic mulch seeding is used such fertiliser may be incorporated in the mulch and no raking in is necessary.

7 Seeding in Treatment I and IV shall:

(i) employ a mixture of seed complying with sub-Clause 13 of this Clause; and

(ii) be carried out by evenly distributing such seed at a rate of not less than 20 g/ m^2 for side slopes of both embankments and cuttings and not less than 10 g/ m^2 elsewhere or other rates required in Appendix 6/8; and

(iii) be immediately followed by lightly raking, by use of a chain harrow or other suitable plant, the surface of the topsoil to cover the seeds, except that no raking is required following hydraulic mulch seeding.

8 Turf in Treatment II shall:

(i) be laid in the areas described in Appendix 6/8; and

(ii) consist of Class 5C imported turf complying with Table 6/1 or, when permitted by Appendix 6/8, turf arising on Site and required to be excavated as Class 5A material; and

(iii) be laid well bonded and lightly tamped and, when on slopes, be laid diagonally; and

(iv) where required in Appendix 6/8 be retained in position by methods described therein; and

(v) be regularly watered as necessary during prolonged dry weather.

9 Hydraulic mulch seeding shall:

(i) be applied by a process and consist of a mulch detailed in Appendix 6/8; and

(ii) where required in Appendix 6/8 have, as part of the mulch, glass fibre or other material, to form a retaining agent during establishment of sward growth; and

(iii) for Treatment III, have as part of the mulch, additional additives for promotion of grass growth on the material to be grassed.

10 Except on areas not required to be mown, or to be mown three times, all as described in Appendix 6/8, areas of grass resulting from Treatments I to III and IV shall be mown twice to leave a nominal 75 mm height. The first mowing shall be carried out once the grass has reached a height of between 100 mm and 150 mm, the second when it has regrown to between 150 mm and 200 mm. The plant used for mowing shall comply with any requirements in Appendix 6/8. All areas shall, unless stated otherwise in Appendix 6/8, be left clear of grass cuttings following each mowing, by raking or other suitable method and arisings disposed off Site.

11 A selective herbicide especially formulated for the eradication of docks, thistles, ragwort and other pernicious agricultural weeds shall be applied by spot treatment spray or other efficacious method to such plants individually; the use of a spray boom will not be permitted.

12 Fertiliser, including where permitted in Appendix 6/8 that are incorporated in hydraulic mulch, shall consist of a compound containing not less than 10% Nitrogen, 15% Phosphoric Acid and 10% Potash and samples shall be submitted to the Employer's Representative prior to its use in the Works.

13 Grass seed, including, where permitted in Appendix 6/8, that incorporated in a hydraulic mulch, shall be a tested mixture and certificates of germination and purity shall be provided before sowing, together with the names of the varieties used in the mixture. Unless otherwise required in Appendix 6/8 this shall contain the seeds listed in Table 6/5 to the proportions therein.

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

620 Landscape Areas and Screening Mounds

1 Landscape areas and screening mounds 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 and screening mounds, 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 or screening mounds after any adjoining embankment or other area of fill has been completed. Where permitted in Appendix 6/9 and provided the embankment or other area of fill is always kept at least 1m higher than the landscape area fill, construction of such landscape area may proceed in parallel.

5 Landscape areas and screening mounds shall be topsoiled and seeded or turfed in accordance with Clause 618 to the requirements of Appendix 6/9.

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 Earth and Anchored Earth Structures

1 The construction of earthworks for reinforced earth 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 earth structures shall, except for their associated drainage layers, be of Class 6I or 6J selected material complying with Table 6/1 as permitted in Appendix 6/1 together with any other additional requirements therein.

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 earth 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) 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 earth and anchored earth structures shall be deposited and compacted in compliance with Clauses 608 and 612 and Table 6/1. 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 earth 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 Contractors option, the reinforced earth 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 earth 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 earth or anchored earth fill;

(viii) if the retained material at the rear of the reinforced earth 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 removed progressively as the work proceeds to prevent the formation of voids.

8 The rear of the reinforced earth 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.

4 In addition to the requirements of sub-Clauses 5 to 11 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 150mm 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 6/1.

5 Class 6K lower bedding material shall have its top surface shaped during compaction to match the steel structure profile. 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 250 mm at all times.

8 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 to horizontal as practicable.

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 During all operations of filling, compaction, road pavement construction and of any other traffic movements which affect the shape of the structure, the changes in the horizontal and vertical diameters of the structure shall not exceed ± 5% for circular structures and ± 2% for structures of other cross-sections. The longitudinal straightness over any 10m 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.

12 Only that compaction plant described in sub-Clause 8 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 1m, 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.

13 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.

14 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 and Soil Nails

1 Ground anchorages and soils nails listed in Appendix 1/11, shall be constructed in accordance with the requirements of Appendix 6/10 and shall have a minimum operational life of 120 years, unless otherwise agreed in writing by the Employer's Representative. The ground anchorages and soil nails shall be installed and tested in accordance with the requirements of Appendix 6/10.

2 Ground anchorages and soils nails not forming part of the Permanent Works will only be permitted where such anchorage will not affect the Permanent Works.

625 Crib Walling

1 Crib walling listed in Appendix 1/10 shall be constructed in accordance with the requirements of Appendix 6/10.

2 Infill material shall be Class 6N complying with Table 6/1, having a permeability coefficient greater than 1x10-3 m/sec and a maximum nominal particle size less than 0.1 times the minimum cell dimension. Backfill shall be Class 6N complying with Table 6/1 and any additional requirements of Appendix 6/6.

3 Concrete components shall meet the requirements of the Series 1700 and the concrete shall not be less than Grade C25/30.

4 Metallic components, other than those used for reinforcing concrete, shall consist of:

(i) carbon steel, to IS EN 10025, galvanised in accordance with IS EN ISO 1461, or

(ii) stainless steel designations 1.4401 or 1.4436 to IS EN 10088-2.

5 Metallic components shall have a non-structural sacrificial thickness of 0.75mm for carbon steel and 0.10mm for stainless steel.

6 Metallic dowels or interlocking devices between crib elements shall not be used.

7 Joint fillers and spacers between the crib elements shall be resistant to the effects of air pollution, exposure to sunlight and water. These elements shall be capable of performing throughout the design life of the crib wall.

8 Joint fillers and spacers between the crib elements shall be resistant to the effects of air pollution, exposure to sunlight and water. These elements shall be capable of performing throughout the design life of the crib wall.

9 The wall shall be filled and backfilled as the crib is erected. Construction of the crib skeleton shall not precede the placement of the infill or backfill by more than three courses of elements. Filling of adjacent crib cells shall be carried out at equal rates with the maximum permitted differential not exceeding three courses.

10 The foundation treatment and drainage system for the crib wall shall follow the specific requirements of Appendix 6/10. As a minimum and unless the wall is founded on bedrock, a concrete blinding layer with a minimum thickness of 75mm ST1 Concrete shall be provided beneath the full width of the wall.

626 Gabions

1 Gabions shall be constructed in compliance with this Clause and with any additional requirements in Appendix 6/10. Gabions shall not be incorporated as part of a road structure.

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. Pre-filling gabion baskets is not permitted.

3 The gabion mesh shall be:

(i) A mesh manufactured from wire complying with BS 1052 having a minimum core diameter of 2.7 mm, unless otherwise described in Appendix 6/10.

4 All wire shall be galvanized in compliance with BS EN 10244-2 Class A and be coated with a minimum thickness of 0.50 mm of PVC for extruded coatings and 0.25mm of PVC for bonded coatings. The PVC shall be capable of resisting the effects of immersion in sea water, exposure to ultra violet lights and abrasion, when tested for a period not less than 3000 hours in accordance with BS 2782: Part 5 Method 54OG.

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. Where described in Appendix 6/10, large stones shall be hand placed at the exposed face of the gabion walls to produce a uniform finish.

6 Mechanical equipment may only be used for filling gabion units where the results are equivalent to filling by hand.

7 The foundation treatment and drainage system for the gabion wall shall follow the specific requirements of Appendix 6/10. As a minimum and unless the wall is founded on bedrock, a concrete blinding layer with a minimum thickness of 75mm ST1 Concrete shall be provided beneath the full width of the wall.

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 Employer's Representative.

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 Undertakers 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.

Other Methods

4 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 or required in Appendix 6/1 testing of earthworks materials shall be carried out in accordance with BS 1377: Part 1 to Part 9 inclusive except where noted otherwise in Clauses 632-643

2 The sampling techniques applied shall ensure that each sample is representative of the average properties of the material to be sampled. Sampling of material shall be carried out in accordance with IS EN 932 and BS 5930.

3 When sampling from stockpiles, the location and number of sampling increments shall take into account the way in which the stockpile was built, its shape and the possibility of segregation within the stockpile.

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. For each sample of material, the MCV shall be the average of the values determined for two specimens riffled from the sample.

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 Unless otherwise described in Appendix 6/1, the specimens shall be tested at an operating cell pressure of 200 ± 10 kN/ m^2 and an axial strain rate of 1% per minute. Where Appendix 6/1 requires c' and □' to be determined, the test shall be modified to enable Mohr circles to be plotted and c and □' 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 Slake Durability Index

1 The Slake Durability Index shall be determined in accordance with ASTM D 4644-8. The water content of the sample shall be determined in accordance with BS 1377 : Part 2

635 Los Angeles Coefficient and Other Tests for Particle Soundness

Los Angeles Coefficient (LA)

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

Other Tests for Particle Soundness

2 Where Appendix 6/1 requires magnesium sulphate soundness tests to be carried out, they shall be carried out in accordance with IS EN 1367-2. Where Appendix 6/1 requires point load or other tests for soundness to be carried out, they shall be carried out in accordance with the procedures given therein.

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

1 The effective angle of internal friction □' ' 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-Clause 2 of this Clause.

Shear Box Tests

2 For Classes 6N1, 6N2, 6P, 6I and 6J granular materials, the tests shall be carried out in accordance with BS 1377 : Part 7 and the following:

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

(ii) Three samples shall be tested, each sample occupying the full depth of the shear box and shall be compacted at the optimum moisture content to a dry density of 92% ± 2% of the

maximum dry density determined in accordance with BS 1377 : Part 4 using the vibrating hammer method. The samples shall not be immersed in water.

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

The values of c' and □' reported shall be those corresponding to the maximum strength envelope.

3 For Classes 2A, 2B, 2C1 and 2C2 cohesive materials, the tests shall be carried out in accordance with BS 1377 : Part 7 and the following:

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

(ii) For the initial determination of fill properties three samples shall be tested in each size of shear box. The samples shall occupy the full depth of the shear box and shall be compacted at the optimum moisture content to a dry density of 92% ± 2% of the maximum dry density determined in accordance with BS 1377 : Part 4 using the 2.5 kg rammer method. After compaction the shear box assembly shall be immersed in water for a minimum period of 24 hours to avoid interparticle surface tension forces affecting the test result.

(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 Ø 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.

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 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.

3 Details of the area and volume of material to be tested shall be submitted to the Employer's Representative together with the arrangement of electrodes in each test. The Employer's Representative shall be given notice of the date, time and location of each test so that he can arrange for attendance at 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 submitted to the Employer's Representative.

638 Determination of Redox Potential (Eh) to Assess Corrosivity of Earthworks Materials for Reinforced Earth 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.

3 Details of the area and volume of material to be tested shall be submitted to the Employer's Representative together with the locations of the test pits.

4 The Employer's Representative shall be given notice of the date, time and location of each test so that he can arrange for attendance at 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 Earth 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 Works, of sufficient size to carry out the tests, and within the range of moisture contents permitted in Table 6/1 for such material, shall be sieved to obtain a test sample passing the 20 mm BS sieve, of sufficient quantity after compaction to fill the top half of the shear box. The top and bottom of the shear box shall be fixed together and the test sample of the sieved fill materials immediately placed and compacted in the top half of the box as described in Clause 636.

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

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

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

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

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

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 Improved General Fill

1 The available lime content of lime for lime or lime and cement improvement of unsuitable fill or general fill 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.

2 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

General

1 When required in Appendix 6/1, the constrained soil modulus M* shall be determined from a plate loading test in accordance with BS 1377: Part 9. Three tests for M* shall be carried out 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.

Procedure

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 plaster depending on whether the soil is granular or cohesive.

4 The loading test shall be carried out under a series of maintained loads. The maximum load should be such that the average pressure applied to the plate is in excess of 350 kN/m^2. The elastic modulus Es shall be determined as the secant modulus between average pressures applied to the plate of 150 and 350 kN/m^2 in the first load cycle. A value of Poisson 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 Es using the equation:

$$M^* = \frac{(1 - v)\, Es}{(1 + v)\,(1 - 2v)} \quad (N/mm^2)$$

where v = Poisson ratio to be taken as 0.3

and Es = Elastic modulus of the soil

643 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 IS EN 1744 Part 1 Section 10, 11 and 12.

2 Test results and limiting values for sulfate shall be given as SO4. Further information on sulfur compounds is given in NG 643.

3 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.

4 The Oxidisable sulfide (OS) content shall be determined from the relationship outlined in BRE Special Digest 1 and outlined below:

OS = Total Potential Sulfate – Acid Soluble Sulfate

The total potential sulfate (TPS_ shall be calculated from the relationship:

TPS = 3 x Total Sulfur (as outlined in BRE SD1)

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

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
GENERAL GRANULAR FILL	1	A	-	Well graded granular material	General Fill	Any material or combination of materials.	(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				
	1	B	-	Uniformly graded granular material	General Fill	Any material or combination of materials.	(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				
	1	C	-	Coarse granular material	General Fill	Any material or combination of materials.	(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 (Continued): 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				
GENERAL COHESIVE FILL	2	A	-	Wet cohesive material	General Fill	Any material, or combination of materials.	(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 BS 1377 : Part 2, only tamping or grid rollers shall be used.	2	A	-
							(ii) plastic limit (PL)	BS 1377: Part 2	-	-				
							(iii) mc	BS 1377: Part 2	PL -3%	App 6/1				
							(iv) MCV	Clause 632	App 6/1	App 6/1				
							(v) undrained shear strength of remoulded material	Clause 633	App 6/1	App 6/1				
							(vi) effective angle of internal friction (Ø') and effective cohesion (c')	Clause 636	App 6/1	App 6/1				

Table 6/1 (Continued): 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				
GENERAL COHESIVE FILL	2	B	-	Dry cohesive Material	General Fill	Any material or combination of materials.	(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 -3%				
							(iv) MCV	Clause 632	App 6/1	App 6/1				
							(v) undrained shear strength of remoulded material	Clause 633	App 6/1	App 6/1				
							(vi) effective angle of internal friction (Ø') and effective cohesion (c')	Clause 636	App 6/1	App 6/1				
	2	C	1	Stony cohesive material (High Fines Content)	General Fill	Any material or combination of materials.	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	2	C	1
							(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	-				
							(v) effective angle of internal friction (Ø') and effective cohesion (c')	Clause 636	App 6/1	App 6/1				

Table 6/1 (Continued): 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				
GENERAL COHESIVE FILL	2	C	2	Stony cohesive material (Low Fines Content)	General Fill	Any material or combination of materials.	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	2	C	**2**
							(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	-				
							(v) effective angle of internal friction (Ø') and effective cohesion (c')	Clause 636	App 6/1	App 6/1				

Table 6/1 (Continued): 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				
GENERAL COHESIVE FILL	2	D	-	Silty cohesive material	General Fill	Any material or combination of materials.	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 3 (except that vibration techniques shall not be permitted)	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				
							(v) effective angle of internal friction (Ø') and effective cohesion (c')	Clause 636	App 6/1	App 6/1				
LANDSCAPE FILL	4	-	-	Various	Fill to landscape Areas	See App 6/1	(i) grading	BS 1377: Part 2	App 6/1	App 6/1	See Clause 620 and App 6/1	4	-	-
							(ii) mc	BS 1377: Part 2	-	App 6/1				
							(iii) MCV	Clause 632	App 6/1	App 6/1				

Table 6/1 (Continued): 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				
TOPSOIL	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	Material complying with BS 3882	-	-	-	-	-	5	B	-
	5	C	-	Imported turf	Turfing	Material complying with BS 3969	-	-	-	-	-	5	C	-
SELECTED GRANULAR FILL	6	A	-	Selected well graded granular material	Below water	Natural gravel, crushed gravel, crushed rock other than argillaceous rock [Note 7] or gravel, crushed concrete or any combination thereof. (Properties (v) and (vi) only apply when material is described as argillaceous as defined in Clause 601.5)	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	No compaction	6	A	-
							(ii) uniformity	See Note 5	10	-				
							(iv) plasticity index	BS 1377: Part 2	Non-plastic					
							(v) Los Angeles Coefficient	Clause 635	-	50				
							(vi) Slake Durability	Clause 634	95%	-				

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	6	B	-	Selected coarse granular material	Starter layer	Natural gravel, crushed rock, crushed concrete or any combination thereof.	(i) grading	Visual	Tab 6/2	Tab 6/2	Tab 6/4Method 5	6	B	-
							(ii) plasticity index	BS 1377: Part 2	Non-plastic					
							(iii) Los Angeles coefficient	Clause 635	-	50				
	6	C	-	Selected uniformly graded granular material	Starter layer	Natural gravel, crushed gravel, crushed rock other than argillaceous rock [Note 7] or gravel, crushed concrete, or any combination thereof. (Property (vi) only applies when material is described as argillaceous as defined in Clause 601.5)	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	6	C	-
							(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				
							(vi) Slake Durability	Clause 634	95%	-				

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	6	F	1	Selected granular material	Capping	Natural gravel, crushed gravel or combination of both, excluding argillaceous rock [Note 7]. 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. Property (vii) in the next column shall not apply if the Class Ra (asphalt) content of recycled aggregate is 20% or less. Property (v) as set out in SR21: 2009 (Property (viii) only applies when material is described as argillaceous as defined in Clause 601.5)	(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				
							(iv) Los Angeles coefficient	Clause 635	-	50				
							(v) total sulfur content	IS EN 1744-1: 2009 Test No. 11	-	1%				
							(vi) Class RA (asphalt) content	BS EN 933-11	-	50%				
							(vii) bitumen content	BS EN 12697-1 or BS 12697-39	-	2%				
							(viii) Slake Durability	Clause 634	95%	-				

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	6	F	2	Selected granular material	Capping	Crushed rock (other than argillaceous rock [Note 7]) and crushed concrete. 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. Property (vii) in the next column shall not apply if the Class Ra (asphalt) content of recycled aggregate is 20% or less. Property (v) as set out in SR21: 2009 (Property (viii) only applies when material is described as argillaceous as defined in Clause 601.5)	(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				
							(iv) Los Angeles coefficient	Clause 635	-	50				
							(v) total sulfur content	IS EN 1744-1: 2009 Test No. 11	-	1%				
							(vi) Class RA (asphalt) content	BS EN 933-11	-	50%				
							(vii) bitumen content	BS EN 12697-1 or BS 12697-39	-	2%				
							(viii) Slake Durability	Clause 634	95%	-				

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	6	F	3	Selected granular material	Capping	Natural gravel, crushed gravel or sand, or a combination thereof, excluding argillaceous gravel or sand. . 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. Property (vii) in the next column shall not apply if the Class Ra (asphalt) content of recycled aggregate is 20% or less. Property (v) as set out in SR21: 2009	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 6	6	F	3
							(ii) optimum mc	Clause 613	-	-				
							(iii) mc	Clause 613	Optimum mc - 2%	Optimum mc				
							(iv) Los Angeles coefficient	Clause 635	-	50				
							(v) total sulfur content	IS EN 1744-1: 2009 Test No. 11	-	1%				
							(vi) Class RA (asphalt) content	BS EN 933-11	-	50%				
							(vii) bitumen content	BS EN 12697-1 or BS 12697-39	-	2%				

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	6	G	-	Selected granular material	Gabion filling	Natural gravel, crushed rock, excluding argillaceous gravel or rock [Note 7], crushed concrete or any combination thereof	(i) grading	IS EN 933-1	Clause 626	Clause 626	None	6	G	-
							(ii) Los Angeles coefficient	Clause 635	-	50				

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	6	H	-	Selected granular material	Drainage layer to reinforced earth and anchored earth structures	Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock [Note 7] or gravel, crushed concrete or any combination thereof. (Properties (vi), (vii), (viii), (ix), (x), (xi),(xii) and (xiii) in next column only apply when metallic rein-forcing or anchor elements, facing units or fastenings are used)	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	6	H	-
							(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 812: Part 117	-	Tab 6/3				
							(viii) water soluble sulfate content	IS EN 1744-1:2009 Test 10	-	Tab 6/3				
							(ix) Oxidisable sulfides (OS) content	IS EN 1744-1:2009 Test 11 and Test 12	-	Tab 6/3				
							(x) resistivity	Clause 637	Tab 6/3	-				
							(xi) redox potential	Clause 638	Tab 6/3	-				
							(xii) organic content	BS 1377: Part 3	-	Tab 6/3				
							(xiii) microbial activity index	Table 6/3	-	Table 6/3				
							(xiv) Slake Durability	Clause 634	95%	-				

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	6	I	-	Selected well graded granular material	Fill to reinforced earth and anchored earth	Natural gravel, natural sand, crushed gravel, crushed rock, other than argillaceous rock [Note 7] or gravel, crushed concrete, or any combination thereof. (Properties (viii), (ix), (x), (xi), (xii), (xiii) and (xiv) only apply when metallic reinforcing or anchor elements, facing units or fastening are used). (Properties (xv) and (xvi) only apply when material is described as argillaceous as defined in Clause 601.5)	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	6	I	-
							(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) effective angle of friction ($ø'$) and effective cohesion (c')	Clause 636	App 6/1	-				
							(vi) coefficient of friction and adhesion (fill/ elements)	Clause 639	App 6/1	-				
							(vii) pH value	BS 1377: Part 3	Tab 6/3	Tab 6/3				
							(viii) chloride ion content	BS 812: Part 117	-	Tab 6/3				
							(ix) water soluble sulfate content	IS EN 1744-1:2009 Test 10	-	Tab 6/3				
							(x) Oxidisable sulfides	IS EN 1744-1:2009 Test 11 and Test 12	-	Tab 6/3				
							(xi) resistivity	Clause 637	Tab 6/3	-				
							(xii) redox potential	Clause 638	Tab 6/3	-				
							(xiii) organic content	BS 1377: Part 3	-	Tab 6/3				
							(xiv) microbial activity index	Tab 6/3	-	Tab 6/3				
							(xv) Los Angeles Coefficient	Clause 635	-	50				
							(xvi) Slake Durability	Clause 634	95%	-				

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	6	J	-	Selected uniformly graded granular material	Fill to reinforced earth and anchored earth	Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock [Note 7] or gravel or any combination thereof. (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 (xv) and (xvi) only apply when material is described as argillaceous as defined in Clause 601.5)	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	6	J	-
							(ii) uniformity coefficient	See Note 5	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) effective angle of friction ($ø'$) and effective cohesion (c')	Clause 636	App 6/1	-				
							(vi) coefficient of friction and adhesion (fill/elements)	Clause 639	App 6/1	-				
							(vii) pH value	BS 1377: Part 3	Tab 6/3	Tab 6/3				
							(viii) chloride ion content	BS 812: Part 117	-	Tab 6/3				
							(ix) water soluble sulfate content	IS EN 1744-1:2009 Test 10	-	Tab 6/3				
							(x) Oxidisable sulfides	IS EN 1744-1:2009 Test 11 and Test 12	-	Tab 6/3				
							(xi) resistivity	Clause 637	Tab 6/3	-				
							(xii) redox potential	Clause 638	Tab 6/3	-				
							(xiii) organic content	BS 1377: Part 3	-	Tab 6/3				
							(xiv) microbial activity index	Tab 6/3	-	Tab 6/3				
							(xv) Los Angeles Coefficient	Clause 635	-	50				
							(xvi) Slake Durability	Clause 634	95%	-				

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	6	K	-	Selected granular material	Lower bedding for corrugated steel buried structures	Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock [Note 7] or gravel or any combination thereof.	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	End product 90% of maximum dry density of BS 1377: Part 4 (Vibrating hammer method)	6	K	-
							(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	-	50				
							(viii) resistivity	Clause 637	2000 ohm cm	-				
							(ix) water soluble sulfate content	IS EN 1744-1:2009 Test 10	-	Tab 6/3				
							(x) Oxidisable sulfides	IS EN 1744-1:2009 Test 11 and Test 12	-	Tab 6/3				
							(xi) chloride ion content	BS 812: Part 117	-	0.025 %				
							(xii) pH value	BS 1377: Part 3	6	9				
							(xiii) Slake Durability	Clause 634	95%	-				

Table 6/1 (Continued): 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				
SELECTED GANULAR FILL	6	L	-	Selected uniformly graded granular material	Upper bedding for corrugated steel buried structures	Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock [Note 7] or gravel or any combination thereof.	(i) grading	BS 812: Part 103	Tab 6/2 (BS 882 Tab 5)	Tab 6/2	None	6	L	-
							(ii) resistivity	Clause 637	2000 ohm cm	-				
							(iii) plasticity index	BS 1377: Part 2	-	6				
							(iv) water soluble sulfate content	IS EN 1744-1:2009 Test 10	-	Tab 6/3				
							(v) Oxidisable sulfides	IS EN 1744-1:2009 Test 11 and Test 12	-	Tab 6/3				
							(vi) chloride ion content	BS 812: Part 117	-	0.025 %				
							(vii) pH value	BS 1377: Part 3	6	9				
							(viii) Los Angeles coefficient	Clause 635	-	50				
							(ix)xiv) Slake Durability	Clause 634	95%	-				

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	6	M	-	Selected Granular material	Surround to corrugated steel buried structures	Natural gravel, natural sand, crushed gravel, crushed rock, other than argillaceous rock [Note 7] or gravel, crushed concrete or any combination thereof.	(i) grading	BS 1377: Part 2	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	-
							(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 +1%				
							(vi) MCV	Clause 632	App 6/1	App 6/1				
							(vii) Los Angeles coefficient	Clause 635	-	50				
							(viii) resistivity	Clause 637	2000 ohm cm	-				
							(ix) water soluble sulfate content	IS EN 1744-1:2009 Test 10	-	Tab 6/3				
							(x) Oxidisable sulfides	IS EN 1744-1:2009 Test 11 and Test 12	-	Tab 6/3				
							(xi) chloride ion content	BS 812: Part 117	-	0.025%				
							(xii) pH value	BS 1377: Part 3	6	9				
							(xiv) Slake Durability	Clause 634	95%	-				

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	6	N	1	Selected granular material	Fill to structures	Crushed rock, other than argillaceous rock [Note 7], and crushed concrete (Property (xii) only applies when material is described as argillaceous as defined in Clause 601.5)	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	End product 95% of maximum dry density of BS 1377: Part 4 (vibrating hammer method)	6	**N**	**1**
							(ii) Los Angeles coefficient	Clause 635	-	50				
							(iii) Undrained shear parameters (c and ø)	Clause 633	App 6/1	-				
							(iv) effective angle of internal friction ($ø^{/}$) and effective cohesion ($c^{/}$)	Clause 636	App 6/1	App 6/1				
							(v) permeability	Clause 640	App 6/1	-				
							(vi) mc	BS 1377: Part 2	App 6/1	App 6/1				
							(vii) MCV	Clause 632	App 6/1	App 6/1				
							(viixi) pH value	BS 1377: Part 3	6	9				
							(ix) water soluble sulfate content	IS EN 1744-1:2009 Test 10	-	1.5 gms/litre SO_4				
							(x) Oxidisable sulfides	IS EN 1744-1:2009 Test 11 and Test 12	-	0.3% SO_4				
							(xi) slope stability test (where required in App 6/6)	Clause 610	App 6/6					
							(xii) Slake Durability	Clause 634	95%		-			

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	6	N	2	Selected granular material	Fill below structures	Crushed rock, other than argillaceous rock [Note 7], and crushed concrete (Property (xii) only applies when material is described as argillaceous as defined in Clause 601.5)	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	End product 95% of maximum dry density of BS 1377: Part 4 (vibrating hammer method)	6	N	2
							(ii) Los Angeles coefficient	Clause 635	-	50				
							(iii) Undrained shear parameters (c and ø)	Clause 633	App 6/1	-				
							(iv) effective angle of internal friction ($ø^{/}$) and effective cohesion ($c^{/}$)	Clause 636	App 6/1	-				
							(v) permeability	Clause 640	App 6/1	-				
							(vi) mc	BS 1377: Part 2	App 6/1	App 6/1				
							(vii) MCV	Clause 632	App 6/1	App 6/1				
							(viii) pH value	BS 1377: Part 3	6	9				
							(ix) water soluble sulfate content	IS EN 1744-1:2009 Test 10	-	1.5 gms/litre SO_4				
							(x) Oxidisable sulfides	IS EN 1744-1:2009 Test 11 and Test 12	-	0.3% SO_4				
							(xi) slope stability test (where required in App 6/6)	Clause 610	App 6/6					
							(xii) Slake Durability	Clause 634	95%					

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	6	P	-	Selected granular material	Fill to structures	Natural gravel, crushed gravel or combination of both, excluding argillaceous gravel. (Property (xii) only applies when material is described as argillaceous as defined in Clause 601.5)	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	End product 95% of maximum dry density of BS 1377: Part 4 (vibrating hammer method)	6	P	-
							(ii) Los Angeles coefficient	Clause 635	-	60				
							(iii) Undrained shear parameters (c and ø)	Clause 633	App 6/1	-				
							(iv) effective angle of internal friction ($ø^{/}$) and effective cohesion ($c^{/}$)	Clause 636	App 6/1	-				
							(v) permeability	Clause 640	App 6/1	-				
							(vi) mc	BS 1377: Part 2	App 6/1	App 6/1				
							(vii) MCV	Clause 632	App 6/1	App 6/1				
							(viii) pH value	BS 1377: Part 3	6	9				
							(ix) water soluble sulfate content	IS EN 1744-1:2009 Test 10	-	1.5 gms/litre SO_4				
							(x) Oxidisable sulfides	IS EN 1744-1:2009 Test 11 and Test 12	-	0.3% SO_4				
							(xi) slope stability test (where required in App 6/6)	Clause 610	App 6/6					
							(xii) Slake Durability	Clause 634	95%					

Table 6/1 (Continued): 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				
SELECTED GRANULAR FILL	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, other than argillaceous rock [Note 7] or gravel, or any combination thereof	As for Class 1A, 1B or 1C with the addition of the following:					6	Q	-
							(i) water soluble sulfate content	IS EN 1744-1:2009 Test 10	-	Tab 6/3				
							(ii) Oxidisable sulfides	IS EN 1744-1:2009 Test 11 and Test 12	-	Tab 6/3				
							(iii) Chloride ion content	BS 812: Part 117	-	0.025%				
							(iv) pH value	BS 1377: Part 3	6	9				
	7	H	-	Wet, dry, stony or silty cohesive material	Overlying fill for corrugated steel buried structures	As Class 2A, 2B, 2C, 2D general cohesive fill material, except that argillaceous rock [Note 7] or gravel shall not be used	As for Class 2A, 2B, 2C, 2D with the addition of the following					7	H	
							(i) water soluble sulfate content	IS EN 1744-1:2009 Test 10	-	Tab 6/3				
							(ii) Oxidisable sulfides	IS EN 1744-1:2009 Test 11 and Test 12	-	Tab 6/3				
							(iii) chloride ion content	BS 812: Part 117	-	0.025 %				
							(iv) pH value	BS 1377: Part 3	6	9				

Table 6/1 (Continued): 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				
M I S C F I L L	8	-	-	Class 1 or Class 2 material	Lower trench fill	Any, except there shall not be any stones or lumps of clay >40mm nominal diameter.	(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				

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. Where BS 1377: Part 2 is specified for mc, this shall mean BS 1377: Part 2 or BS 812: Part 3 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. Determination of moisture content shall be made from that part of the material passing the 20 mm BS Sieve.

7. Material defined as argillaceous in accordance with Clause 601.5 may be permitted for incorporation in the permanent works, provided that it is demonstrated by slake durability and LA abrasion testing that the material will be sufficiently durable. Where acceptable limits in this regard are not provided in Table 6/1 they shall be included within Appendix 6/1.

8. Refer to particular requirements in Clauses 601.11, 601.12 and 643. A petrographer's detailed mineralogical description may be required as described under section 3.4.2 of SR 21.

Table 6/2: Grading Requirements for Acceptable Earthworks Materials

Percentage by Mass Passing the Size Shown

Class	Size (mm)		Size (mm) BS Series													Size (microns) BS Series				Size (microns)	Class
	500	300	125	100	75	37.5	28	20	14	10	6.3	5	3.35	2	1.18	600	300	150	63	2	
1A		100	100																0-15		**1A**
1B			100																0-15		**1B**
1C	100		10-95													0-25			0-15		**1C**
2A & 2B			100											80-100					15-100		**2A & 2B**
2C1			100											35-80					35-80		**2C1**
2C2			100											15-80					15-35		**2C2**
2D			100																80-100	0-20	**2D**
6A	100			60-90				0-70						0-20					0-5		**6A**
6B	100		0-10																		**6B**
6C			100							15-85						0-30			0-10		**6C**
6F1, 6F2 & 6F3				100	65-100	45-100				15-80[1]		10-70				0-30			0-10		**6F1, 6F2 & 6F3**
6H								100				60-100			15-45	0-25		0-5			**6H**
6I & 6J			100		85-100				25-100					15-100		9-100			0-15		**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**
6M					100														0-10		**6M**
6N1 & 6N2				100	65-100	45-100				15-75		10-60				0-30			0-15		**6N1 & 6N2**
6P			100		65-100	45-100				15-75		10-60				0-30			0-15		**6P**

[1] *Amended as per Erratum No. 1, item 1*

Footnote to Table 6/2:

For the purposes of classifying materials, the gradings specified in this table, with the exception of 1C, 6A and 6B materials, apply to the portion of the material passing the 125 mm BS Sieve.

Table 6/3 : Limits of Material Properties of Fill for Use With Metal Components

Material	Properties of Fill								
	pH Value		Max Chloride Ion Content %	Max Organic Content %	Max Water Soluble (WS) Sulfate Content grams/litre as SO_4	Max Oxidisable Sulfides (OS) Content % as SO_4	Minimum Resistivity ohm.cm	Minimum Redox Potential volts	Microbial Activity Index
	Min	Max							
Hot Dip Galvanised Steel	6	9	0.025	0.2	0.3	0.06	5000	0.43	) less than 5)
Stainless Steel	5	10	0.025	0.2	0.6	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. The corrosion potential of frictional fill shall be assessed from resistivity, pH, chloride and soluble sulphate tests. For cohesive soil it will be necessary to test additionally for organic content. Should either organic content or sulphate 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. Methods of test (except for Microbial Activity Index) are given in BS 1377: Part 3.

4. The water soluble sulfate content and oxidisable sulfides content shall be determined in accordance with the methods described in IS EN 1744-1:2009 Test Nos. 10, 11 and 12.

5 Refer to particular requirements in Clauses 601.1, 601.12 and Table 6/1. A petrographer"s detailed mineralogical examination may be required as described under section 3.4.2 of SR 21.

Table 6/4 : Method Compaction for Earthworks Materials : Plant and Methods

(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			Ref No.
			D	N#	D	N#	D	N#	D	N	D	N	N for D=110mm	N for D=150mm	N for D=250mm	
Smooth wheeled roller (or vibratory roller operating without vibration)		**Mass per metre width of roll:**														
	1	over 2100 kg up to 2700 kg	125	8	125	10	125	10*	175	4	unsuitable		unsuitable	unsuitable	unsuitable	1
	2	over 2700kg up to 5400 kg	125	6	125	8	125	8*	200	4	unsuitable		16	unsuitable	unsuitable	2
	3	over 5400 kg	125	4	150	8	unsuitable		300	4	unsuitable		8	16	unsuitable	3
Grid roller		**Mass per metre width of roll:**														
	1	Over 2700 kg up to 5400 kg	150	10	unsuitable		150	10	250	4	unsuitable		unsuitable	unsuitable	unsuitable	1
	2	Over 5400 kg up to 8000 kg	150	8	125	12	unsuitable		325	4	unsuitable		20	unsuitable	unsuitable	2
	3	Over 8000 kg	150	4	150	12	unsuitable		400	4	unsuitable		12	20	unsuitable	3
Tamping roller		**Mass per metre width of roll:**														
	1	over 4000 kg	225	4	150	12	250		350	4	unsuitable		12	20	unsuitable	1
Pneumatic-tyred roller		**Mass per wheel:**														
	1	over 1000 kg up to 1500 kg	125	6	unsuitable		150	10*	240	4	unsuitable		unsuitable	unsuitable	unsuitable	1
	2	over 1500 kg up to 2000 kg	150	5	unsuitable		unsuitable		300	4	unsuitable		unsuitable	unsuitable	unsuitable	2
	3	over 2000 kg up to 2500 kg	175	4	125	12	unsuitable		350	4	unsuitable		unsuitable	unsuitable	unsuitable	3
	4	over 2500 kg up to 4000 kg	225	4	125	12	unsuitable		400	4	unsuitable		unsuitable	unsuitable	unsuitable	4
	5	over 4000 kg up to 6000 kg	300	4	125	10	unsuitable		unsuitable		unsuitable		12	unsuitable	unsuitable	5
	6	over 6000 kg up to 8000 kg	350	4	150	8	unsuitable		unsuitable		unsuitable		12	unsuitable	unsuitable	6
	7	over 8000 kg up to 12000 kg	400	4	150	8	unsuitable		unsuitable		unsuitable		10	16	unsuitable	7
	8	over 12000 kg	450	4	175	6	unsuitable		unsuitable		unsuitable		8	12	unsuitable	8

Table 6/4 (contd.): Method Compaction for Earthworks Materials : Plant and Methods

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

Table 6/5: Grass Seed Mixture per 50 kg

	kg	**%**
Perennial Rye Grass	12.5	25
Strong Creeping Red Fescue	10.0	20
Hard Fescue	15.0	30
Smooth-stalked Meadow Grass	5.0	10
Highland Browntop Bent	5.0	10
Huia White Clover	2.5	5

NOTE:
Seed varieties to be from the UK National List where marked 'not for fodder production'/

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