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Earthworks Specification for National Roads

CC-SPW-00600

September 2024

CC Construction & Commissioning

Standards

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TII Publications

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Contents

1. Classification, Definitions and Uses of Earthworks Materials 1
2. General Requirements 5
3. Forming of Cuttings and Cutting Slopes 9
4. Excavation for Foundations 12
5. Not Used. 13
6. Watercourses 14
7. Explosives and Blasting for Excavation 15
8. Construction of Fills 20
9. Geotextiles Used to Separate Earthworks Materials 24
10. Fill to Structures and Fill Below Structures 26
11. Fill Above Structures 28
12. Compaction of Fills 29
13. Sub-Formation and Capping 31
14. Soil Treatment with Lime and/or Hydraulic Binders 36
15. Not Used. 41
16. Preparation and Surface Treatment of Formation 42
17. Use of Sub-Formation or Formation by Construction Plant 44
18. Topsoiling, Seeding and Turfing 45

19. Earthwork Environmental Bunds 48

20. Landscape Areas 49

21. Strengthened Earthworks 50

22. Earthworks for Reinforced Soil Structures 51

23. Earthworks for Corrugated Steel Buried Structures 53

24. Grouted Anchors, Rock Bolts and Soil Nails 55

25. Crib Walling 57

26. Gabions 59

27. Swallow Holes and other Naturally Occurring Cavities 60

28. Disused Mine Workings 61

29. Instrumentation and Monitoring 62

30. Ground Improvement 63

31. Earthworks Materials Tests 66

32. Determination of Moisture Condition Value (MCV) of Earthworks Materials 67

33. Determination of Undrained Shear Strength of Remoulded Cohesive Material 68

34. Slake Durability Index 69

35. Los Angeles Coefficient and other Tests for Particle Soundness 70

36. Determination of Effective Angle of Shearing Resistance (φ') and Effective Cohesion (c') of Earthworks Materials 71

37. Determination of Resistivity (r_s) to Assess Corrosivity of Soil, Rock or Earthworks Materials 73

38. Determination of Redox Potential (E_h) to Assess Corrosivity of Soil, Rock or Earthworks Materials 74

39. Determination of Effective Angle of Shearing Resistance and Adhesion Between Fill and Reinforcing Elements for Reinforced Soil Structures 75

40. Determination of Permeability of Earthworks Materials 77

41. Determination of Available Lime Content 78

42. Determination of the Constrained Soil Modulus (M*) of Earthworks Materials for Corrugated Steel Buried Structures 79

References 108

Updates to TII Publications resulting in changes to

Earthworks Specification for National Roads CC-SPW-00600

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The updates to CC-SPW-00600 cover the whole document and include the following:

- Changes have been made throughout to align with TII's sustainability and circular economy principles.
- The terms 'acceptable', 'unacceptable - U1' and 'unacceptable - U2', in the context of material classification, have been replaced with 'compliant', 'non-compliant' and 'unacceptable'. This is intended to promote the reuse of materials to their highest value, in a sustainable manner, while still ensuring their engineering properties are appropriate for the intended purpose.
- Treatment of soils with lime and/or hydraulic binders to form capping is included in the Specification.
- Requirements for treatment of soils to form general fill have been updated.
- Classes of capping have been separated depending on whether they contain recycled aggregates.
- The Section on ground improvement has been expanded to include dynamic compaction, vibro-compaction, vibro-replacement, rigid inclusions and soil mixing.
- Rock slope assessments are now specified to validate the design assumptions and ensure that finished rock slopes are acceptable.
- Sections on pavement foundations have been updated for consistency with the updates to CC-SPW-00800 and DN-PAV-03021, to facilitate analytic pavement and foundation design.
- References have been updated to the current Irish and European Standards, where applicable, including reference to the Irish Standard for Earthworks - I.S. EN 16907.
- Each Section has been reviewed and updated to provide more clarity, consistency and detail.
- Document numbering has been revised to replace Clauses with Sections.

Contents

1. Classification, Definitions and Uses of Earthworks Materials 1
1.1 General Classifications 1
1.2 Unacceptable Material 1
1.3 Classification 1
1.4 Processing 2
1.5 Organic Material 2
1.6 Definitions 2
1.7 Maximum Particle Size 2
1.8 Aggressivity 3
1.9 Peat 4

2. General Requirements 5
2.1 Circular Economy 5
2.2 Earthworks Standard 5
2.3 Compliant Earthworks Materials 5
2.4 Haulage 5
2.5 Separation of Earthworks Materials 5
2.6 Removal of Earthworks Materials from Site 5
2.7 Unacceptable Materials 6
2.8 In Situ Contaminated Material 6
2.9 Construction and Demolition Waste Management Plan 6
2.10 Stockpiling 6
2.11 Topsoil 6
2.12 Pre-Earthworks Drainage 7
2.13 Groundwater Lowering 8
2.14 Frost Susceptibility 8
2.15 Road Restraint Systems 8

3. Forming of Cuttings and Cutting Slopes 9
3.1 General 9
3.2 Soil Cuttings 9
3.3 Rock Cuttings 9

4. Excavation for Foundations 12
4.1 Lines and Levels, Voids and Trimming 12
4.2 Protection 12
4.3 Lateral Overbreak 12
4.4 Compaction 12
4.5 Support and Battering 12
4.6 Opening Period 12
4.7 Pavement Reinstatement 12

5. Not Used. 13

6. Watercourses 14
6.1 Requirements 14
6.2 Clearance 14
6.3 Maintenance 14
6.4 Redundant Watercourses 14

7. Explosives and Blasting for Excavation 15
7.1 Legislation 15

7.2 Permissions 15
7.3 Notifications 15
7.4 Prevention of Damage 16
7.5 Event Limits 16
7.6 Noise 17
7.7 Electrical Detonators 17
7.8 Trial Explosions 17
7.9 Measurement of Vibrational Amplitude and Peak Particle Velocity 17
7.10 Danger Zones 17
7.11 Instrumentation and Monitoring 17
7.12 Foundations for Structures 18
7.13 Blasting Requirements 18
7.14 Pre-Split Blasting 18
7.15 Limitations on the Weight of Explosive Charges 18
7.16 Prevention of Undercutting 18
7.17 Intermediate Benches 18
7.18 Landowners 18
7.19 Other Requirements 19

8. Construction of Fills 20
8.1 General Requirements 20
8.2 Starter Layers 20
8.3 Plant Movement Across Existing Ground 21
8.4 Class 1C and Class 6B Materials 21
8.5 Uniform Construction and Repair of Damage 21
8.6 Side Slopes 21
8.7 Pipes in Embankments 21
8.8 Sub-Formation, Formation and Weather Protection 22
8.9 Benching 22
8.10 Sealing 22
8.11 Scour and Erosion Protection 22
8.12 Light-Weight Fill 22
8.13 Verges 22
8.14 Staged Construction 22

9. Geotextiles Used to Separate Earthworks Materials 24
9.1 Locations and CE Marking Symbols 24
9.2 Durability 24
9.3 Protection 24
9.4 Minimum Criteria 24
9.5 Laying and Lapping 25
9.6 Surrounding Materials and Installation 25

10. Fill to Structures and Fill Below Structures 26
10.1 Exclusions 26
10.2 Fill to Structures 26
10.3 Fill Below Structures 26
10.4 Compaction 26
10.5 Filling Either Side of a Structural Element 26
10.6 Restrictions on Compaction Plant 26
10.7 Field Dry Density Tests 27
10.8 Stability Trial 27

11. Fill Above Structures 28

11.1 Requirements 28
11.2 Restrictions on Compaction Plant 28

12. Compaction of Fills 29
12.1 General 29
12.2 Method Compaction 29
12.3 End-Product Compaction 30

13. Sub-Formation and Capping 31
13.1 Pavement and Pavement Foundation Components 31
13.2 Capping Requirements 32
13.3 Capping Materials 32
13.4 Compaction 32
13.5 Capping Formed by Soil Treatment 32
13.6 Gradient and Crossfall 32
13.7 Protection of Sub-Formation 32
13.8 Preparation of Sub-Formation in Cuttings 33
13.9 Preparation of Sub-Formation in Areas of Fill 33
13.10 Validation Trials 34
13.11 Optimum Water Content Testing of Class 6F4 Material 34
13.12 Sub-Formation Testing 35

14. Soil Treatment with Lime and/or Hydraulic Binders 36
14.1 Definition 36
14.2 Proposal and Approval 36
14.3 Validation Trials 36
14.4 Soil Treatment Standard 36
14.5 Materials for Treatment to Form General Fill 36
14.6 Materials for Treatment to Form Capping 37
14.7 In Situ Treatment 37
14.8 Layer Thicknesses 37
14.9 Binder Requirements 37
14.10 Temperature and Area Restrictions 38
14.11 Pulverising and Mixing 38
14.12 Water Requirements 38
14.13 Sealing 38
14.14 Depth Control and Overlap 39
14.15 Testing 39
14.16 Lime Treatment 39
14.17 Compaction 39
14.18 Additional Requirements for General Fill Formed by Soil Treatment 39
14.19 Protection of Treated Materials 40
14.20 Deposition and Compaction of Materials Above Treated Materials 40

15. Not Used. 41

16. Preparation and Surface Treatment of Formation 42
16.1 Surface Level Tolerances 42
16.2 Correcting the Formation Level to Meet Tolerances 42
16.3 Formation in Rock 42
16.4 Limitations on Areas of Completed Formation 43
16.5 Formation Protection 43
16.6 Testing 43

17. Use of Sub-Formation or Formation by Construction Plant 44
17.1 Plant Use 44
17.2 Remedial Action 44

18. Topsoiling, Seeding and Turfing 45
18.1 Class 5 Material 45
18.2 Imported Topsoil 45
18.3 Restrictions on Topsoil Stockpiles 45
18.4 Planting Area Preparation 45
18.5 Requirements for Topsoil in Treatments I and II 45
18.6 Requirements for Seeding in Treatment I 46
18.7 Requirements for Turf in Treatment II 46
18.8 Requirements for Hydraulic Mulch Seeding 46
18.9 Mowing Requirements 46
18.10 Seed Testing and Certification 46
18.11 Topsoil Thickness 47

19. Earthwork Environmental Bunds 48
19.1 Locations, Materials and Compaction 48
19.2 Strengthened Earthworks 48
19.3 Reinforced Soil Structures 48
19.4 Topsoiling and Seeding or Turfing 48
19.5 Construction Sequence 48

20. Landscape Areas 49
20.1 Locations and Materials 49
20.2 Compaction 49
20.3 Shaping 49
20.4 Construction Sequence 49
20.5 Topsoiling and Seeding or Turfing 49

21. Strengthened Earthworks 50
21.1 Definition 50
21.2 Locations, Details and Materials 50

22. Earthworks for Reinforced Soil Structures 51
22.1 Definition 51
22.2 Requirements 51
22.3 Fill Materials 51
22.4 Drainage Layers 51
22.5 Deposition and Compaction 51
22.6 Additional Compaction Requirements 52

23. Earthworks for Corrugated Steel Buried Structures 53
23.1 References 53
23.2 Excavation 53
23.3 Fill Materials 53
23.4 Deposition and Compaction 53
23.5 Shaping 53
23.6 Surround Material 54
23.7 Filling Above the Structure 54
23.8 Compaction Under the Structure 54
23.9 Compaction Limitations 54
23.10 Integrity of the Structure 54

23.11 Limits on Tipping 54
23.12 Method Compaction 54

24. Grouted Anchors, Rock Bolts and Soil Nails 55
24.1 Definitions 55
24.2 General 55
24.3 Grouted Anchors 56
24.4 Rock Bolts and Soil Nails 56

25. Crib Walling 57
25.1 Construction Requirements 57
25.2 Infill Material Requirements 57
25.3 Concrete 57
25.4 Metallic Component Materials 57
25.5 Sacrificial Thickness for Metallic Components 57
25.6 Prohibition on Metallic Dowels and Interlocking Devices 57
25.7 Durability Requirements for Joint Fillers and Spacers 57
25.8 Construction Sequence 57
25.9 Foundation Treatment and Drainage System 58

26. Gabions 59
26.1 Restrictions of the Construction and Use of Gabions 59
26.2 Assembly and Materials 59
26.3 Mesh 59
26.4 Size of Mesh Openings and Grading 59
26.5 Foundation Treatment, Backfill and Drainage 59

27. Swallow Holes and other Naturally Occurring Cavities 60
27.1 Excavation, Filling and Capping of Infilled Swallow Holes 60
27.2 Clearing, Filling and Capping of Open Swallow Holes 60
27.3 Areas Prone to Karstification 60

28. Disused Mine Workings 61
28.1 Treatment 61

29. Instrumentation and Monitoring 62
29.1 Requirements and Locations 62
29.2 Monitoring 62
29.3 Decommissioning 62

30. Ground Improvement 63
30.1 General 63
30.2 Dynamic Compaction 64
30.3 Vibro-compaction, Vibro-replacement and/or Rigid Inclusions 64
30.4 Soil Mixing 65

31. Earthworks Materials Tests 66
31.1 Requirements for Source Testing and Compliance Testing 66
31.2 Sampling 66
31.3 Tests for Rapid Evaluation 66

32. Determination of Moisture Condition Value (MCV) of Earthworks Materials 67
32.1 Standard 67
32.2 MCV/Water Content Relation 67

32.3 Rapid Assessment Procedure 67

33. Determination of Undrained Shear Strength of Remoulded Cohesive Material .. 68
33.1 Requirements and Standard 68
33.2 Sample Preparation 68
33.3 Cell Pressure, Strain Rate and Plotting 68
33.4 Other Tests 68

34. Slake Durability Index 69
34.1 Standards 69

35. Los Angeles Coefficient and other Tests for Particle Soundness 70
35.1 Los Angeles (LA) Coefficient 70
35.2 Magnesium Sulfate Soundness 70
35.3 Other Tests for Particle Soundness 70

36. Determination of Effective Angle of Shearing Resistance (φ') and Effective Cohesion (c') of Earthworks Materials 71
36.1 Requirements 71
36.2 Shear Box Tests on Granular Materials 71
36.3 Shear Box Tests on Cohesive Materials 71

37. Determination of Resistivity (r_s) to Assess Corrosivity of Soil, Rock or Earthworks Materials 73
37.1 Requirements 73
37.2 Locations 73
37.3 Information for the Employer's Representative 73
37.4 Right Angle Measurements 73
37.5 Test Depths 73
37.6 Excavation 73

38. Determination of Redox Potential (E_h) to Assess Corrosivity of Soil, Rock or Earthworks Materials 74
38.1 Requirements 74
38.2 Locations 74
38.3 Information for the Employer's Representative 74
38.4 Trial Pit Dimensions 74
38.5 Sampling for pH Value Testing 74

39. Determination of Effective Angle of Shearing Resistance and Adhesion Between Fill and Reinforcing Elements for Reinforced Soil Structures 75
39.1 Test Set-up 75
39.2 Procedure 75
39.3 Plotting and Determination of Results 75
39.4 Records 76

40. Determination of Permeability of Earthworks Materials 77
40.1 Requirements 77

41. Determination of Available Lime Content 78
41.1 Requirements 78
41.2 Reporting and Categorisation 78

42. Determination of the Constrained Soil Modulus (M*) of Earthworks Materials for Corrugated Steel Buried Structures 79
42.1 Standard and Frequency 79
42.2 Surface Preparation 79
42.3 Procedure 79
42.4 Formula 79

References 108

1. Classification, Definitions and Uses of Earthworks Materials

1.1 General Classifications

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

i. Compliant material: Material excavated from within the Site or imported on to the Site which meets the requirements of a particular Class of material in Table 6/1 and meets the requirements of Appendix 6/1 for use in the Works. Imported material shall meet the requirements of all current legislation and may comprise the following:

   a) Products: Earthworks materials resulting from extraction, the primary aim of which was the production of that material;

   b) By-products: Earthworks materials resulting from a production process, the primary aim of which was not the production of that material; or

   c) Recycled aggregates: Earthworks materials resulting from the recovery of mineral waste. The aggregate shall be classified by hand-sorting the coarse aggregate particles in accordance with I.S. EN 933-11. The content of materials including wood, plastic, rubber, plaster and metal shall not exceed 1% by mass. Organic content shall not exceed 1% by mass, or other value stated in Appendix 6/1. The haulage and processing of this material shall be fully compliant with all current legislation and guidelines, and all permits obtained as required.

ii. Non-compliant material: Material excavated from within the Site, other than unacceptable material as defined in Section 1.2, which does not meet the requirements of a particular Class of material in Table 6/1 or does not meet the requirements of Appendix 6/1. If it is processed by physical, mechanical, chemical or other means to meet the requirements of a Class of material in Table 6/1 and the requirements of Appendix 6/1, it may become compliant and may be used; or

iii. Unacceptable material as defined in Section 1.2: Material excavated from within the Site which shall not be used in the Works.

1.2 Unacceptable Material

Unacceptable material shall be ‘hazardous waste’ or ‘bio-waste’ as defined in the European Union (Waste Directive) Regulations 2011-2020.

1.3 Classification

Classification of earthworks materials shall comprise a visual assessment of the material type and testing for compliance with the limits in Table 6/1. The classification of earthworks materials shall be undertaken by the Contractor unless stated otherwise in Appendix 6/1. The classification of the source of earthworks materials shall be undertaken at the source unless otherwise stated in Appendix 6/1. The classification of earthworks materials shall also be confirmed by visual assessment and compliance testing at the point of deposition. Source and compliance testing shall be undertaken at the frequency specified in the Appendices to CC-SPW-00100. Test results shall be used to determine if the material meets the compliance limits stated in Table 6/1, for its given classification.

1.4 Processing

Where required in Appendix 6/1, non-compliant material shall be processed by physical, mechanical, chemical, or other means to render the material compliant for use in the Works, at its highest practical value. This can be undertaken where:

i. The requirements of all current legislation and guidelines are met and all relevant permits are obtained;

ii. The processed material meets the requirements of a particular material in Table 6/1; and

iii. The requirements in the Contract are met, subject to the approval of the Employer's Representative.

1.5 Organic Material

Fill Classes 1, 2, 6, 7, 8 and 9 shall have organic content less than 1%, or other value stated in Appendix 6/1.

1.6 Definitions

1.6.1 Argillaceous Rock

Argillaceous rock shall mean rock comprised significantly of clay mineral particles. Argillaceous rocks include shale and siltstone and may include mudstone, siltstone, or other rock types.

1.6.2 Micaceous Rock

Micaceous rock shall mean rock comprised significantly of mica such as micaceous schist or micaceous sandstone.

1.6.3 Acrotelm

Acrotelm shall mean the upper layer of in situ peat consisting of living mosses and poorly decomposed plant debris.

1.6.4 Catotelm

Catotelm shall mean the layer of in situ peat below the acrotelm which is relatively decomposed and compacted.

1.7 Maximum Particle Size

The following limitations apply, in addition to any grading requirements:

i. The maximum particle size of any fill material shall be less than or equal to two-thirds of the compacted layer thickness; and

ii. Particles with a maximum diameter of more than 125 mm shall not be deposited within 600 mm of formation or within 600 mm of the underside of topsoil within verges or central reserves.

1.8 Aggressivity

1.8.1 Cementitious Materials

Sulfur, sulfate or sulfide containing materials are considered aggressive to cementitious materials (as a result of sulfides) if, when tested in accordance with I.S. EN 1744-1, either:

i. Water-soluble sulfates exceed 0.3%;
ii. Total sulfur content exceeds 0.1%;
iii. Acid soluble sulfates exceed 0.2%; or
iv. Oxidisable sulfides exceed 0.3%.

The determination of total sulfur content shall be by high temperature combustion. The total sulfur content may be between 0.1% and 1% if a petrographic analysis, as described in S.R. 21 Annex E.2.4.5, shows that the material is suitable for the proposed use.

Oxidisable sulfides shall be determined using the following relationship:

(Oxidisable sulfides) = 3 x (Total sulfur content) – (Acid soluble sulfates)

Sulfur, sulfate or sulfide containing materials that are aggressive to cementitious materials, as a result of sulfides or other deleterious compounds, shall not be deposited:

i. Within 500 mm, or greater distances described in Appendix 6/3, of concrete, cement bound materials or other cementitious materials forming part of the Permanent Works;
ii. Above concrete, cement bound materials, or other cementitious materials forming part of the Permanent Works; or
iii. At other locations restricted in Appendix 6/3.

1.8.2 Metal

Material is considered aggressive to metal if it does not meet the requirements of Table 6/3.

The requirements in Table 6/3 shall not apply to metallic items protected by concrete and ancillary metallic items such as the tops of chambers and gullies.

Material that is aggressive to metal, as a result of sulfides, chlorides, or other deleterious compounds, shall not be deposited:

i. Within 500 mm, or greater distances described in Appendix 6/3, of metallic structural elements forming part of the Permanent Works;
ii. Above metallic structural elements forming part of the Permanent Works; or
iii. At other locations restricted in Appendix 6/3.

1.8.3 Testing

At least five samples of each material shall be tested for each property. 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.

1.9 Peat

Peat shall remain undisturbed unless stated otherwise in Appendix 6/3. Where peat is permitted to be excavated as part of the Works, the acrotelm and catotelm shall be kept separate during excavation, handling, storage and transportation unless stated otherwise in Appendix 6/3. Where peat is used for peatland restoration, its excavation, handling, storage, transportation and reinstatement shall be as described in Appendix 6/3.

2. General Requirements

2.1 Circular Economy

The Contractor shall use earthworks materials and methodologies that are consistent with TII's sustainability and circular economy principles.

2.2 Earthworks Standard

The Contractor shall carry out all earthworks in accordance with I.S. EN 16907.

2.3 Compliant Earthworks Materials

The Contractor shall employ only plant and working methods which are suited to the materials to be handled and traversed. They shall be responsible for maintaining the nature of the compliant material so that when it is placed and compacted it remains compliant in accordance with the Contract. Compliance shall be determined in accordance with Table 6/1 and the requirements of Appendix 6/1. The Contractor shall also visually assess earthworks materials at the point of deposition to confirm that they are consistent with the compliance testing.

As part of their quality control measures, the Contractor shall ensure that the relevant testing and classification of all materials is undertaken to such that compliant material shall not be designated as non-compliant or unacceptable material.

2.4 Haulage

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 Section 12.

2.5 Separation of Earthworks Materials

Where the excavation encounters a combination of compliant, non-compliant and/or unacceptable materials the Contractor shall, unless indicated otherwise in Appendix 6/3, carry out the excavation in such a manner that each material is excavated separately from the others. Unless otherwise described in the Appendix 6/3, Classes of material required to be deposited separately shall be excavated separately without mixing with other Classes of material.

2.6 Removal of Earthworks Materials from Site

Excavated compliant material, or non-compliant material which is to be processed, which is necessary for the Contract, shall not be removed from the Site, unless indicated otherwise in Appendix 6/1. Where the Contractor is permitted to remove compliant material or non-compliant material from the Site, they should, where possible, seek to export the material under Regulation 27 or 28 of the European Union (Waste Directive) Regulations 2011-2020, subject to the requirements of these regulations. The Contractor shall make good any consequent deficit of material arising from the export of material.

There shall be documentary control and written evidence of all materials that are exported or disposed off-site in accordance with the provisions of the European Union (Waste Directive) Regulations 2011-2020 and current legislation.

2.7 Unacceptable Materials

The Contractor shall comply with all relevant legislation in respect of all operations including the excavation and removal off-Site of all unacceptable materials. All unacceptable material shall be removed in accordance with the European Union (Waste Directive) Regulations 2011-2020. The Contractor shall comply with any specific requirements for handling and removal described in Appendix 6/2. The Contractor shall also determine what requirements are necessary for their handling, and arrange for their safe handling and disposal. These arrangements shall be agreed with the Employer's Representative and the relevant authorities.

As part of their quality control measures, the Contractor shall ensure that the relevant testing and classification of all materials is undertaken to such that unacceptable material shall not be designated as compliant or non-compliant material. The assessment and management of any unacceptable materials excavated as part of the Works shall be supervised by a qualified body independent of the Contractor. The relevant authorities shall be notified minimum two working days in advance of the excavation or disposal of any unacceptable material. The relevant authorities' personnel or advisers shall be entitled to witness any such activities. The Contractor shall produce documentation of the chain of custody for all materials classified as unacceptable that are removed off-Site.

2.8 In Situ Contaminated Material

The Contractor shall comply with all relevant legislation in respect of treatment of any areas of in situ contaminated material known to exist or encountered in the execution and completion of the Works.

2.9 Construction and Demolition Waste Management Plan

The Contractor shall produce as part of the Environmental Operating Plan a "Construction and Demolition Waste Management Plan" in accordance with the:

i. Guidelines for the Management of Waste from National Road Construction Projects (NRA, November 2014);
ii. EU Construction & Demolition Waste Management Protocol (European Commission, September 2016); and
iii. Best Practice Guidelines for the preparation of resource & waste management plans for construction and demolition projects (EPA, 2021).

2.10 Stockpiling

The Contractor shall ensure that they do not adversely affect the stability of excavations or fills by their methods of stockpiling materials, use of plant or siting of temporary buildings or structures.

2.11 Topsoil

2.11.1 Stripping

Existing topsoil material shall, except where it is to be left in place in the locations 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 fill. Existing topsoil material shall always be removed beneath embankments less than 3 m in height. For the purpose of this Section, height shall be measured from existing ground level to the sub-formation. Existing topsoil material shall always be removed beneath widened embankment sections placed against existing embankments.

Topsoil shall be stripped and stockpiled when relatively dry. Weather restrictions and water content limits are as stated in Appendix 6/8. The Contractor shall undertake topsoil stripping such that the underlying materials are not allowed to degrade from exposure to weather and/or construction plant.

2.11.2 Stockpiling

Topsoil shall wherever practicable be used immediately after its stripping. If this is not practicable, topsoil shall be stored in stockpiles of heights not exceeding 3 m, unless stated otherwise in Appendix 6/8. The design and maintenance of topsoil stockpiles shall be as stated in Appendix 6/8. Topsoil shall not be stockpiled for more than 2 years or other duration stated in Appendix 6/8. Topsoil stockpiled for more than 6 months shall be seeded with a mix specified in Appendix 6/8. 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.

2.11.3 Other Requirements

All Class 5A topsoil arising from the Site, or any Class 5B material replacing Class 5A material in accordance with Section 2.6, in excess of the requirements for topsoiling, shall be subject to the requirements described in Appendix 6/8.

2.12 Pre-Earthworks Drainage

2.12.1 Construction

The Contractor shall keep earthworks free of water to avoid adverse impact on the stability of slopes and integrity of the subgrade. This includes:

i. Arranging for the rapid removal of water shed onto the earthworks or 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; and

iii. Implementing the drainage system in accordance with the CC-SPW-00500, including Appendices.

Pre-earthworks drainage shall be installed prior to the start of earthworks and early enough to appropriately manage groundwater. The Contractor shall plan the sequencing of drainage and earthworks operations as Works progress.

2.12.2 Discharge

In carrying out the requirements of Section 2.12.1 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 other appropriate measures;

iii. Discharge accumulated water and groundwater into the permanent outfalls of the drainage system where practicable; and

iv. Provide adequate means for trapping silt on temporary systems discharging into permanent drainage systems.

2.13 Groundwater Lowering

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

2.14 Frost Susceptibility

Frost-susceptible material shall not be used within 350 mm of the final surface of a road or paved central reserve. Material shall be classified as frost-susceptible if the mean heave is greater than 15 mm, when tested in accordance with BS 1377-2 as described in Section 2.3.1 of CC-SPW-00800.

2.15 Road Restraint Systems

Fill materials and treatment of in situ ground materials into which Road Restraint Systems (vehicle and pedestrian) are to be installed shall be selected to be suitable to support the Road Restraint System, in accordance with the manufacturer's installation instructions/manual. Fill materials shall be Class 1, 2, 6 or 9 and shall be compacted in accordance with Section 12, Table 6/1 and Table 6/4.

Refer to Appendix 6/3 for fill requirements. Refer to the CC-SPW-00400 for installation requirements.

3. Forming of Cuttings and Cutting Slopes

3.1 General

3.1.1 Lines and Levels

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; and
iii. Be rounded at the toe and crest as shown in CC-SCD-00603.

3.1.2 Undercutting Restrictions

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, to avoid adverse impact upon the Permanent Works.

3.1.3 Weather Protection

A weather protection layer at least 300 mm thick, or greater thickness if required in Appendix 6/3, shall be left in place above the sub-formation. The weather protection layer shall only be removed immediately before the final preparation of the sub-formation and the placement of overlying materials.

3.1.4 Drainage

The Contractor shall install the permanent drainage before the bulk excavation reaches a level 300 mm above 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.

3.2 Soil Cuttings

3.2.1 Soft, Fragmented or Insecure Materials

Where required in Appendix 6/3, faces of cuttings 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 filled by placing and compacting a Class of fill with similar characteristics as the surrounding intact material; and/or
ii. Other areas required to be made stable shall be dealt with as stated in Appendix 6/3.

3.3 Rock Cuttings

3.3.1 Pre-Split Blasting

Where pre-split blasting is required or permitted in Appendix 6/3, it shall comply with Section 7 and any other requirements in Appendix 6/3. Full details of the methods and arrangements to be adopted shall be approved by the Employer’s Representative before commencement of drilling operations.

3.3.2 Intermediate Benches

Where intermediate benches are used, they shall be as described in Appendix 6/3.

3.3.3 Excavation

Prior to and during excavation, the Contractor shall consider the particular characteristics of rock cuttings, including rockmass properties, slope geometry, proximity to sensitive receptors, aesthetic requirements and excavation methods, to minimise long term maintenance of the rock slope.

3.3.4 Rock Slope Remediation, Control Measures and Reinforcement

When forming rock cuttings, the Contractor shall, where possible, avoid the requirement for concrete infilling, rockfall control barriers, rockfall protection netting and rock reinforcement. If these are required, they shall be as per Appendix 6/3 and shall have a minimum design life of 120 years, unless stated otherwise in Appendix 6/3. Rock reinforcement shall be as per Section 24 and Appendix 6/10.

3.3.5 Natural Appearance

Rock cuttings shall be excavated to form stable profiles that exploit the natural fissures and character of the rock to create an irregular, textured and natural appearance. Excavation techniques shall not compromise the stability of the rock slopes or increase the risk to the asset or asset users. The following measures shall be carried out as appropriate:

i. Leave final faces without scars or damage from construction plant;

ii. Leave the face irregular within limits given in Appendix 6/3; and/or

iii. Reflect natural profiles by the use of techniques including shaping the top parts of cuttings and varying the heights of intermediate benches, where used.

3.3.6 Scaling

The Contractor shall remove boulders or other rock fragments that can be moved by hand, without tools, from final faces of rock cuttings which are not to receive topsoil. Where required in Appendix 6/3, the Contractor shall remove material that can be blown away by airline or water hose, having pressures no greater than those stated in Appendix 6/3.

3.3.7 Soft, Fragmented or Insecure Materials

Where required in Appendix 6/3, faces of rock cuttings which are not required to receive topsoil shall have one or more of the following measures carried out:

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 CC-SPW-02600 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 installed before application of the concrete or grout. Weep holes using approved permanent formers shall be constructed in the locations described in Appendix 6/3;

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 CC-SPW-02600 or with masonry infill complying with CC-SPW-02400 and provided with weep holes all in accordance with requirements in Appendix 6/3 or as required by the Employer's Representative; and/or

iv. Netting or other sheet covering as described in Appendix 6/3 or rock reinforcement as described in Appendix 6/10. Components shall be sourced from manufacturers with ISO 9001 accredited quality assurance systems. The Contractor shall check all components to identify and rectify any damage prior to installation.

Where concrete is used in such measures, it shall have surface features matching, as nearly as possible, those of the adjacent intact face. Such concrete and grout shall have a consistent colour matching, as nearly as possible, that of the adjacent intact face.

3.3.8 Rockhead Benches

Rockhead benches shall be formed at the interface of overburden soil and competent rock. Rockhead benches shall:

i. Dip away from the soil slope above; and

ii. Be minimum 2 m wide, or greater width stated in Appendix 6/3, and shall be larger if required to contain coarser overburden material. The bench shall not be formed by oversteepening the overburden material.

3.3.9 Rock Slope Assessments

The Contractor shall arrange for the Designer to assess all rock slopes exceeding 2 m, at intervals corresponding to 2 m of vertical excavation. The Designer shall gather the following data from the exposed rock slope:

i. Discontinuities - dip, azimuth, trace length, principal spacing, planarity, roughness, strength, weathering, infill;

ii. Rock material - strength, weathering;

iii. Potential failures - mechanisms, dimensions, height on the slope; and

iv. Slope geometry - profile, berms, height, slope angle and azimuth (local to potential failures and average dip and azimuth for the slope), upper slope angle.

The Designer will then compare the field observations to their design assumptions to validate the design. Where necessary, the Designer shall recommend modification and/or remedial measures to address discrepancies between the design assumptions and the field observations. The Contractor shall undertake the recommended modifications and/or remedial measures.

3.3.10 Rock Traps

Rock traps shall be implemented if required by, and in accordance with, Appendix 6/3. The design and construction of rock traps shall take account of the following slope features:

i. Height, angle and vertical profile;

ii. Degree of instability;

iii. Expected block size, should dislodgement occur; and

iv. Distance to the road, footpath or cycleway.

4. Excavation for Foundations

4.1 Lines and Levels, Voids and Trimming

Foundation excavations shall be formed to the lines and levels shown in the Contract. Soft soil or loose material shall be removed and the resulting voids, and any natural voids, shall be filled with mix ST1 concrete to CC-SPW-02600 (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. The side faces of the excavation shall be trimmed and the resulting debris removed prior to placing the blinding concrete.

4.2 Protection

A protection layer at least 300 mm thick shall be left in place above the base of all foundation excavations, unless a greater distance is required in Appendix 6/3. The protection layer shall only be removed immediately before the final preparation of the surface and the placement of overlying materials.

4.3 Lateral Overbreak

The Contractor shall make good 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 of fill specified above the foundation. For corrugated steel buried structures Class 6K lower bedding material shall be used. Where the excavation is too narrow to allow the compaction of earthworks materials, mix ST1 concrete to CC-SPW-02600 shall be used.

4.4 Compaction

Fill referred to in this Section shall be deposited and compacted in compliance with Sections 8 and 12 and Table 6/1.

4.5 Support and Battering

Excavations for foundations and trenches shall be adequately supported at all times and shall not be battered if prohibited in Appendix 6/3. Where battering is not prohibited, excavations shall be benched as described in Appendix 6/3 prior to backfilling and compaction. 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.

4.6 Opening Period

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

4.7 Pavement Reinstatement

Excavations requiring backfilling in pavements and paved areas shall be carried out and reinstated in compliance with CC-SPW-00700.

5. Not Used.

6. Watercourses

6.1 Requirements

The clearance and modification of existing watercourses, 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.

6.2 Clearance

Clearance of existing watercourses shall include the removal of vegetation, vegetable matter and all other deposits within the watercourse profile.

6.3 Maintenance

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

6.4 Redundant Watercourses

Redundant watercourses shall, where required in Appendix 6/3, be drained and cleared. The excavations shall be to the dimensions stated in CC-SCD-00604, unless otherwise stated in Appendix 6/3, and shall be backfilled as shown in CC-SCD-00604, unless otherwise described in Appendix 6/3. Backfill shall comply with Table 6/1 and be deposited and compacted in compliance with Sections 8 and 12. Where the surface is to remain exposed it shall be topsoiled and seeded, or receive other treatment, all as described in Appendix 6/8.

7. Explosives and Blasting for Excavation

7.1 Legislation

Explosives 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 following non-exhaustive list of legislation shall be complied with, along with all other relevant legislation:

i. Explosives Act, 1875 (as amended by the Criminal Justice Act 2006);
ii. Factories Act 1955 (No. 10 of 1955);
iii. Safety, Health and Welfare at Work Act 2005; and
iv. Safety, Health and Welfare at Work Act (Construction) Regulations 2013.

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 explosives 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.

7.2 Permissions

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.

7.3 Notifications

7.3.1 Written Consent

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

7.3.2 Notification of the Public

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 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;
ii. 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 Employer's Representative no later than 14 days in advance of the commencement of the blasting activities;
iii. 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) The name, address and telephone number of a contact within the Contractor's organisation who shall deal with the queries from members of the public;

d) The period over which the blasting shall be undertaken or likely undertaken; and

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

7.3.3 Written Notice

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. The programme shall include precise dates and times of the blasting activities. The written notice shall be provided to the Employer's Representative at least 10 days before blasting commences.

The Contractor shall provide further written notice to the Employer's Representative 12 hours before each blasting event.

7.3.4 Summary

As stated in the sub-Sections above, the Contractor shall adhere to the following:

Table 7.1 - Notification requirements

Time (no later than)	Requirement
28 days	The Employer's Representative's written consent shall be obtained by the Contractor.
14 days	The Contractor shall notify the public.
10 days	The Contractor shall provide written notification to the Employer's Representative of the programme of blasting.
12 hours	The Contractor shall provide written notification to the Employer's Representative of each blasting event.

7.4 Prevention of Damage

All blasting activities shall be undertaken in accordance with the Contract. 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.

Explosives shall be used in the quantities and in the manner recommended by the manufacturers. Special care shall be taken 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 shall not be undertaken.

7.5 Event Limits

The Contractor shall limit the number of blasting events as specified in Appendix 6/3.

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. Where possible blasting shall be carried out at the same time or times each day.

7.6 Noise

The Contractor shall ensure that noise from blasting operations is controlled in accordance with CC-SPW-00100.

7.7 Electrical Detonators

The Contractor shall comply with the requirements of BS PD CLC/TR 50426 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.

7.8 Trial Explosions

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. Trial explosions shall inform the quantities of explosive used 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. The explosions shall not cause damage to structures and earthworks, existing or under construction, on or 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.

7.9 Measurement of Vibrational Amplitude and Peak Particle Velocity

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.

7.10 Danger Zones

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 100 m 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.

7.11 Instrumentation and Monitoring

Where instrumentation and monitoring are 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 Section 7.9, 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 their 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; and

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 day's blasting.

7.12 Foundations for Structures

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

7.13 Blasting Requirements

All blasting activities shall meet the requirements of Appendix 1/9 to CC-SPW-00100 and the Garda Siochana.

7.14 Pre-Split Blasting

Where the cutting shall be excavated by use of explosives, the design, execution and completion of the Works shall ensure that the finished rock slope shall be formed using pre-split blasting techniques, in accordance with TRL PPR556. Pre-split holes shall be drilled using down-the-hole hammer drills.

7.15 Limitations on the Weight of Explosive Charges

Blasting, execution and completion of the rock excavation 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.

7.16 Prevention of Undercutting

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

7.17 Intermediate Benches

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.

7.18 Landowners

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.

7.19 Other Requirements

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 BS 5607 Code of practice for safe use of explosives in the construction industry; and

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

8. Construction of Fills

8.1 General Requirements

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;

iii. By depositing in layers to meet the compaction requirements of Section 12 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 in water shall be Class 6A or Class 6B material and shall be deposited by end tipping without compaction; and

   c) Material deposited in areas to receive ground improvement shall comply with Section 30 and shall be deposited and compacted to the requirements therein.

iv. With a maximum finished gradient of 1 vertical to 2 horizontal.

8.2 Starter Layers

8.2.1 Definition

A starter layer is a layer of fill immediately above ground level, or above any ground improvement, comprised of Class 6B or 6C material. Starter layers shall be included where required and as described in Appendix 6/3.

8.2.2 Locations

Starter layers shall be deposited at the following locations:

i. Fill areas where the underlying soils are sufficiently soft or loose to reduce the effectiveness of the compaction of overlying fill layers;

ii. Fill areas where the Annual Exceedance Probability (AEP) of the water level exceeding the existing ground level (after topsoil strip) is 1% or greater (areas prone to flooding); or

iii. Fill areas identified as requiring starter layers in Appendix 6/3.

8.2.3 Thickness

The thickness of starter layers shall be as described in Appendix 6/3 but shall be minimum 500 mm. Where starter layers are required as per Section 8.2.2, the top of the starter layer shall also be at least 500 mm above the water level with an AEP of 1%.

8.3 Plant Movement Across Existing Ground

Plant movement across existing ground shall be restricted to:

i. That plant which is necessary for the deposition, spreading and compaction of the first layer or layers of fill, in compliance with this Section and Section 12; or

ii. That plant required to carry out any ground improvement beneath it if required by Section 30.

The Contractor shall take all reasonable measures, and any measures stated in Appendix 6/3, to prevent damage to the underlying strata. These may include the use of lighter spreading plant or the reduction of the number of passes of the compaction plant. Vibratory plant shall not be used on water-bearing silty or sandy ground materials.

8.4 Class 1C and Class 6B Materials

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 Unbound Granular Mixture is constructed.

8.5 Uniform Construction and Repair of Damage

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 construction 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.

8.6 Side Slopes

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.

8.7 Pipes in Embankments

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.

8.8 Sub-Formation, Formation and Weather Protection

The last 600 mm depth of fill up to sub-formation level (refer to Figure 13.1), shall 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:

i. Form the sub-formation followed immediately by the construction of the full thickness of capping, or Unbound Granular Mixture, as appropriate; or

ii. Place an additional 300 mm minimum compacted thickness, or greater thickness if required in Appendix 6/3, of material above sub-formation level for the full width of the filling to form a weather protection. The protection layer shall be constructed in a continuous operation.

8.9 Benching

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 CC-SCD-00605, CC-SCD-00608 and Appendix 6/3 immediately before placing the subsequent fill.

8.10 Sealing

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 suitable methods.

8.11 Scour and Erosion Protection

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

8.12 Light-Weight Fill

The use of light-weight fill or other materials not derived from soil or rock is not permitted as a permanent fill material.

8.13 Verges

Fill within verges shall be Class 1, 2, 6 or 9 material which shall be compacted in accordance with Section 12, Table 6/1 and Table 6/4.

8.14 Staged Construction

8.14.1 Definition

Staged construction shall mean the placement of fill and the allowance of time for fine in situ soil or cohesive fill material to consolidate. The placed fill may form part of the Permanent Works (preloading) or may be additional to the Permanent Works and subsequently removed (surcharging). Staged construction may be used with or without vertical drainage. Vertical drainage shall mean a column of material that is significantly more permeable than the surrounding ground or fill.

8.14.2 Methods and Locations

Staged construction shall be as specified in Appendix 6/3, including locations for its use. Staged construction of fills and any controlled rates of filling shall be carried out in accordance with any requirements described in Appendix 6/3. Installation of instrumentation and its monitoring shall be as per Appendix 6/12. The Contractor shall monitor the settlement of the ground surface, the pore pressure of the underlying ground being treated and the lateral displacement of foundation soil, in accordance with Appendix 6/12.

Vertical drainage shall be in accordance with I.S. EN 15237.

8.14.3 Experience and Supervision

Staged construction shall be carried out by experienced personnel under engineering supervision.

8.14.4 Feedback to Designer

The Contractor shall inform the Designer immediately if the behaviour of the embankment, during or after filling, differs from what is expected.

8.14.5 Records

The Contractor shall record the following, as a minimum:

i. Locations, if any, of vertical drains and their type, size, depth, spacing and any issues encountered during installation;
ii. Location, Class, thickness, rate of filling and unit weight of all placed fills;
iii. Time and date of fill placement and the cause and duration of any delays;
iv. Details of instrumentation, monitoring and testing;
v. Settlement, pore pressure and lateral displacement measurements; and
vi. Results of in situ testing.

9. Geotextiles Used to Separate Earthworks Materials

9.1 Locations and CE Marking Symbols

Geotextiles required as part of the Permanent 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 Permanent Works shall be affixed with a CE marking symbol and the accompanying documents in accordance with I.S. EN 13249.

9.2 Durability

The Contractor shall provide evidence to the Employer's Representative 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 can maintain its integrity for at least the design life required in Appendix 6/5. Evidence of durability testing in accordance with I.S. EN 13249 shall be provided to demonstrate this. Geotextiles shall not be incorporated into the Permanent Works until the evidence in this Section is approved by the Employer's Representative.

9.3 Protection

Geotextiles shall be protected at all times against mechanical or chemical damage. Unless demonstrated otherwise by performing resistance to weathering tests in accordance with I.S. EN 12224, all geotextiles shall be completely covered within three days of installation.

9.4 Minimum Criteria

Geotextiles shall meet the following minimum criteria and shall meet any additional criteria described in Appendix 6/5:

i. The geotextile shall sustain a tensile load of not less than 13 kN/m, when tested in either direction, determined in a wide strip tensile test carried out in accordance with EN ISO 10319. A minimum tensile strength of 11 kN/m is acceptable if the maximum particle diameter of the materials in contact with the geotextile is less than 40 mm. The minimum elongation at maximum strength, tested in accordance with EN ISO 10319, shall not be less than 32%. 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 2.25 kN, determined in accordance with EN ISO 12236. A minimum CBR puncture resistance of 1.80 kN is acceptable if the maximum particle diameter of the materials in contact with the geotextile is less than 40 mm. The characteristic CBR puncture resistance 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 27 litres/m^2/s under a constant head of water of 50 mm, determined in accordance with EN ISO 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; and

iv. The geotextile shall have a characteristic size distribution of pore openings such that the mean O90, determined in accordance with EN ISO 12956, is between 50 microns and 150 microns.

These criteria shall be demonstrated by evidence of testing supplied by the manufacturer, subject to approval by the Employer's Representative. Additional testing shall be carried out by the Contractor if specified in Appendix 6/5, to the requirements therein.

9.5 Laying and Lapping

The geotextile shall be laid and lapped as described in this Section, the manufacturer's recommendations and 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. Geotextiles placed on soft ground shall be overlapped by minimum 500 mm.

9.6 Surrounding Materials and Installation

The materials surrounding geotextiles shall not have protrusions or sharp projections which may 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 placed, and the geotextile shall not be stretched or bridged over hollows or humps greater than 100 mm. Operation of construction plant directly on the installed geotextile shall not be permitted and its covering with fill material shall take place immediately after its laying and as described in Section 9.3. The fill material shall be placed gently on the geotextile and graded with an excavator bucket to the required uncompacted thickness. The minimum compacted thickness of the first layer shall be 150 mm. The minimum compacted thickness of the first layer shall be 300 mm where the geotextile is placed on soft ground.

10. Fill to Structures and Fill Below Structures

10.1 Exclusions

This Section shall apply to fill to structures and fill below structures other than:

i. Fill for reinforced soil, including associated drainage layers;
ii. Material for gabion filling;
iii. Fill for surround, bedding and overlying, corrugated steel buried structures; and
iv. Fill above structures.

10.2 Fill to Structures

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

10.3 Fill Below Structures

Material, as required or permitted in Appendix 6/6, of Class 6N and complying with Table 6/1, shall be used as fill below structures, in the locations described in Appendix 6/6.

10.4 Compaction

The Contractor shall compact Class 6N and 6P material in accordance with the end-product compaction requirements in Table 6/1 and Section 12.

10.5 Filling Either Side of a Structural Element

Where fill to structures is required to the same level on more than one side of a structural element or buried structure (except where Section 23 applies) it shall be maintained at heights not differing by more than 250 mm after compaction on opposing sides of the structural element as filling proceeds.

10.6 Restrictions on Compaction Plant

The Contractor shall restrict compaction plant used on fill to structures, within 2 m of a structure, to the following items as described in Table 6/4:

i. Vibratory roller having a mass per metre width of roll, as determined in accordance with the footnotes to Table 6/4, 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; or
iii. Vibro-tamper having a mass not exceeding 75 kg.

Compaction methodology for the fill and drainage layers within 2 m of a structure, including layer thickness and number of passes, shall be appropriate to the type of plant used, the mass of the plant and material type.

10.7 Field Dry Density Tests

The Contractor shall test carry out field dry density tests within 1 m of structures. The tests shall be undertaken at a rate of 1 test per 1 m thickness of fill per 5 m length of structure. Tests shall be in accordance with BS 1377-9.

10.8 Stability Trial

Where required in Appendix 6/6, Class 6N 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 Section, to be stable when it is trimmed to a slope of 1 vertical to 1.5 horizontal, or other slope described in Appendix 6/6. The minimum height of the trial embankment shall be 1.5m. As part of the trial, a minimum of three direct shear tests using the shearbox apparatus shall be undertaken on 6N or 6P trial material in accordance with I.S. EN ISO 17892-10.

11. Fill Above Structures

11.1 Requirements

Fill deposited above structures shall comply with Section 10.5, Section 1.8 and any other requirements in Appendix 6/6.

11.2 Restrictions on Compaction Plant

Fill above structures within 0.5 m of the structure shall be subject to the limitations on compaction plant stated in Section 10.6.

12. Compaction of Fills

12.1 General

12.1.1 Compaction Requirements

Except for dynamic compaction, which shall comply with Section 30, the Contractor shall carry out compaction in compliance with this Section, as soon as practicable after deposition, on all those Classes of fill in Table 6/1 which require to be compacted.

12.1.2 Type of Compaction

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.

12.1.3 Backfill to Ducting and other Services

Backfill to ducting and other services shall be compacted to ensure no adverse effects on the stability of the verge, particularly its ability to support road restraint systems.

12.2 Method Compaction

12.2.1 Plant and Methods

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.

12.2.2 Restrictions on Compaction Equipment

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 considered when assessing the amount of compaction required for any layer.

12.2.3 Multiple Material Classes

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.

12.2.4 Field Dry Density Tests

The Contractor shall carry out field dry density tests as described in Section 12.3.3 on material compacted to method requirements at a frequency defined in Appendix 1/5, as well as any additional testing requested by the Designer or the Employer’s Representative. The results of field tests shall be compared with the results of suitable dry density/water content relationship laboratory tests carried out in accordance with Section 12.3.1 and the requirements of Appendix 6/3.

If the comparison suggests the state of compaction to be inadequate, then, the Contractor shall remove the inadequately compacted material and replace it with suitably compacted material.

12.3 End-Product Compaction

12.3.1 Maximum Dry Density and Optimum Water Content

For each Class of fill requiring end-product compaction, the Contractor shall submit the following to the Employer's Representative at least 14 working days before commencement of end-product compaction:

i. The values of maximum dry density and the optimum water content obtained in accordance with BS 1377-2 using the 2.5 kg rammer, 4.5 kg rammer method or vibrating hammer method as appropriate for each of the fills they intend to use. The fills shall 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 water contents the Class shall be further sub-divided, by extending the identification system, to monitor the compacted density;

ii. A graph of density plotted against water content from which each of the values above of maximum dry density and optimum water content were determined;

iii. The allowable range of water content values required to meet the end-product compaction compliance limits stated in Table 6/1;

iv. Their methodology for ensuring that fill materials are within the allowable range of water content values; and

v. Their methodology for compacting the fill materials to meet the end-product compaction compliance limits stated in Table 6/1.

Once this information has been agreed with the Employer's Representative it shall form the basis for the compaction compliance limits.

12.3.2 Field Dry Density

Fill compacted to end-product requirements shall have a field dry density, measured in accordance with Section 12.3.3, 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.

12.3.3 Field Dry Density Tests

Field dry density shall be measured in accordance with BS 1377-9, except that nuclear methods shall only be used where permitted in Appendix 6/3. Where nuclear methods are used, the gauge shall be calibrated in accordance with BS 1377-9. Use of nuclear gauges shall comply with CC-SPW-00100. The Contractor shall carry out the testing at a frequency defined in Appendix 1/5, or when required by the Designer or the Employer's Representative.

13. Sub-Formation and Capping

13.1 Pavement and Pavement Foundation Components

The components of the pavement and pavement foundation are shown in in Figure 13.1 and summarised in Table 13.1.

Where capping is not used:

i. The underside of the subbase shall still be the formation;
ii. All sub-formation references and requirements shall apply to the formation; and
iii. All formation references and requirements shall apply to the formation.

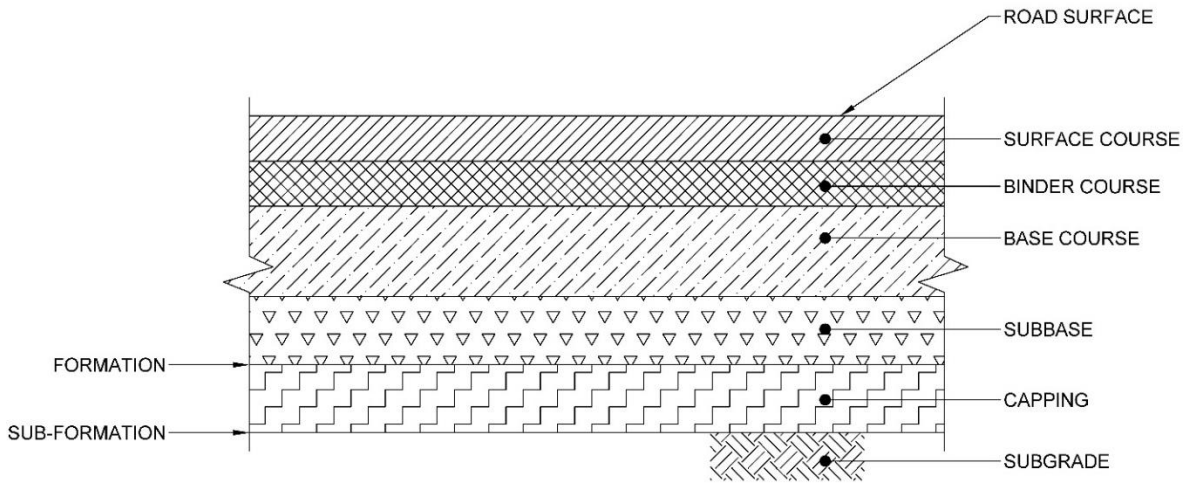

Figure 13.1 - Components of the pavement and pavement foundation

Table 13.1 - Components of the pavement and pavement foundation

Layer	Material	Specification for Works
Surface course and binder course	Bituminous	CC-SPW-00900
Base course	Bituminous, Unbound Granular Mixtures or hydraulically bound mixtures	CC-SPW-00900 CC-SPW-00800
Subbase	Unbound Granular Mixtures	CC-SPW-00800
Capping	Class 6F or Class 9 Fill	CC-SPW-00600
Subgrade	Fill or in situ natural ground materials	

13.2 Capping Requirements

Capping shall be provided in those locations, and to the extent, stated in Appendix 6/7 and shall comply with this Section and Appendix 6/7.

Soil treated to form capping shall comply with Section 14, Appendix 6/7 and Appendix 6/13.

13.3 Capping Materials

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, 6F4 material complying with Table 6/1 shall be used only when specifically permitted in Appendix 6/7 and agreed with the Employer's Representative.

Class 9A, 9B, 9C, 9D and 9E material complying with Table 6/1 shall be used only when specified in Appendix 6/7 and agreed with the Employer's Representative.

13.4 Compaction

Capping shall consist of no more than two Classes or sub-Classes of capping material at each location. Capping shall be laid in one or more layers of compacted thickness complying with Section 12.

13.5 Capping Formed by Soil Treatment

Class 9D or 9E capping material shall not be placed or constructed above Class 6F granular capping material.

13.6 Gradient and Crossfall

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

13.7 Protection of Sub-Formation

The Contractor shall limit any unprotected area of sub-formation to suit the output of the plant in use and the rate of deposition of capping or Unbound Granular Mixture (UGM). No unprotected sub-formation shall remain continuously exposed to rain causing degradation nor be left uncovered overnight. Sub-formation shall be kept free of groundwater, infiltration water and the effects of weather. Weather protection layers shall be used in accordance with Section 3.1.3 or Section 8.8.

13.8 Preparation of Sub-Formation in Cuttings

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

i. For Class 6F granular capping material or Unbound Granular Mixture (UGM):

   a) Excavate to a suitable depth, trim the surface to form the sub-formation and immediately compact with one pass of a smooth-wheeled roller having a mass per m width of roll not less than 2,100 kg or a vibratory roller having a mass per m width of roll not less than 700 kg or a vibrating plate compactor having a mass per m2 of not less than 1,400 kg, and immediately deposit and compact above it, in one or more layers, the capping material or UGM.

ii. For Class 9A, 9B, 9C, 9D or 9E capping material:

   a) Construct the capping by treating the in situ material, providing it complies with Class 6D, 6E, 7C, 7D or 7E material requirements, immediately below formation to form Class 9A, 9B, 9C, 9D or 9E material respectively;

   b) Excavate below formation to sufficient depth to enable treatment of in situ Class 6D, 6E, 7C, 7D or 7E material to be carried out, to produce Class 9A, 9B, 9C, 9D or 9E material forming the lower layer of the capping. After treatment of this layer, the capping shall be completed by depositing a further layer or layers of Class 6D, 6E, 7C, 7D or 7E material and treating it to form Class 9A, 9B, 9C, 9D or 9E capping or depositing and compacting Class 6F granular capping material to form the upper layer of the capping; or

   c) Excavate to sub-formation level and deposit Class 6D, 6E, 7C, 7D or 7E material to be treated to form a capping of Class 9A, 9B, 9C, 9D or 9E layers.

13.9 Preparation of Sub-Formation in Areas of Fill

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

i. For Class 6F granular capping material or Unbound Granular Mixture (UGM):

   a) 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.

ii. For Class 9A, 9B, 9C, 9D or 9E capping material:

   a) Construct the embankment to sufficient height and carry out stabilisation to form capping in one or more layers utilising, where appropriate, any protection layer previously constructed.

iii. For capping with two Classes or sub-Classes including Class 9A, 9B, 9C, 9D or 9E capping material:

   a) Construct the embankment to sufficient height to carry out the work described above and immediately construct above it one or more layers of Class 6F granular capping material.

13.10 Validation Trials

13.10.1 Purpose

The Contractor shall undertake validation trials to demonstrate that the subgrade and capping are compliant with the Contract, unless stated otherwise in Appendix 6/7. The Contractor shall use the validation trials to demonstrate the suitability of the methods, equipment, materials and material thicknesses they propose to use in the Permanent Works. Validation trials shall be in accordance with Appendix 6/7.

13.10.2 Methodology

Validation trials shall be undertaken before commencing the Permanent Works. Validation trials shall be at least 100 m long and 6 m wide. They shall be in the same locations as the validation trials for Unbound Granular Mixtures (UGMs) and shall be in accordance with CC-SPW-00800.

Proposals for validation trials shall be submitted to the Employer's Representative at least five days in advance of commencing construction of the validation trial.

Validation trials shall include:

i. Preparation and testing of the subgrade at the sub-formation level;
ii. Placement and compaction of capping to the same thickness as the Permanent Works; and
iii. Preparation and testing of the formation level.

The Contractor shall prepare a report on the verification trial. The report shall demonstrate compliance with the Contract. The report shall be submitted to the Employer's Representative for approval within five days after completion of each validation trial and before commencing the main construction of the pavement foundation in the Permanent Works.

The materials placed during validation trials may form part of the Permanent Works, provided they meet the design requirements. The Contractor shall provide weather protection to the validation trial sections which will form part of the Permanent Works.

The validation trial sections shall, if they do not meet the requirements of the Contract, be repeated with different earthworks methodologies, materials and/or levels until it meets the requirements of the Permanent Works.

The methods and materials used in approved validation trials shall not be changed during the Works without the construction of a further validation trial section.

Validation trial sections which do not form part of the Permanent Works shall be reinstated in accordance with Appendix 6/7.

13.11 Optimum Water Content Testing of Class 6F4 Material

For Class 6F4 material, Optimum Water Content shall be determined according to BS 1377-2 clause 11.7 (vibrating hammer).

Measurements of water content both for control purposes and for optimum water content determination shall be according to I.S. EN ISO 17892-1 (oven dry method) but using an oven on a reduced temperature setting of 45°C to 50°C.

13.12 Sub-Formation Testing

13.12.1 Falling Weight Deflectometer

The sub-formation shall be tested using a Falling Weight Deflectometer (FWD) to determine the surface modulus. FWD testing shall be in accordance with CC-GSW-04008, CC-GSW-04009 and Appendix B of AM-PAV-06050. Sub-formation testing shall also be in accordance with Appendix 6/7.

13.12.2 Additional DCP Testing

If groundwater is within 1 m of the sub-formation, the FWD testing shall be supplemented with Dynamic Cone Penetrometer (DCP) tests, if the subgrade materials are suitable, or plate loading tests, as required in Appendix 6/7. DCP tests shall be in accordance with DN-PAV-03021 and Appendix D of AM-PAV-06050. Plate loading tests shall be in accordance with BS 1377-9 and the modulus shall be determined in accordance with Appendix K of I.S. EN 1997-2.

13.12.3 Additional Surface Modulus Testing

The Contractor shall carry out additional surface modulus testing when required by the Employer's Representative.

14. Soil Treatment with Lime and/or Hydraulic Binders

14.1 Definition

Soil treatment with lime and/or hydraulic binders shall mean mixing soil with a binder, and optionally water, to enhance the engineering properties of the soil. The binder may be lime or a hydraulic binder such as cement, or both. The soil may be treated to form general fill or capping.

14.2 Proposal and Approval

Prior to using soil treatment with lime and/or hydraulic binders, the Contractor shall outline their proposal and seek the approval of the Employer's Representative. Soil treatment with lime and/or hydraulic binders shall not be undertaken without the written approval of the Employer's Representative.

14.3 Validation Trials

Validation trials shall be undertaken for treated soil. The requirements of the validation trial shall be set out in Appendix 6/13. Following completion of the validation trial, a report shall be submitted to the Employer's Representative and shall contain as a minimum:

i. Results of all testing carried out;
ii. Percentage binder applied;
iii. Compactive effort applied;
iv. Level of compaction achieved; and
v. Recommendations for applying the approach as part of the Permanent Works.

14.4 Soil Treatment Standard

Soil treatment with lime and/or hydraulic binders shall be in accordance with I.S. EN 16907-4 and Appendix 6/13.

14.5 Materials for Treatment to Form General Fill

14.5.1 Materials

Soils to be treated with lime and/or hydraulic binders to form general fill shall comply with Section 1 and the requirements of this Section. Peat and materials susceptible to swelling shall be excluded.

14.5.2 Tests

The Contractor shall test soils to be treated to form general fill to assess their water content, plasticity index and chemical content to determine their suitability for treatment. Water content testing shall be in accordance with I.S. EN ISO 17892-1. Plasticity index testing shall be in accordance with I.S. EN ISO 17892-12. In addition, the material to be treated shall have the following, when tested in accordance with I.S. EN 1744-1:

i. Organic content less than 2%; and
ii. Water-soluble sulfates not exceeding 0.6%.

14.6 Materials for Treatment to Form Capping

Soils to be treated with lime and/or hydraulic binders to form capping shall be Class 6D, 6E, 7C, 7D or 7E materials all complying with Section 1 and Table 6/1.

14.7 In Situ Treatment

In situ natural soils, which have not been removed and replaced, may be treated with lime and/or hydraulic binders up to a depth of up to 250 mm, in accordance with this Section. These soils may be treated to form general fill or capping if they meet the corresponding requirements of Sections 14.5 and 14.6. In situ natural soils shall be subject to the same testing and compaction requirements as the corresponding Class of material (Class 6D, 6E, 7C, 7D or 7E). The in situ natural soils below 250 mm shall be demonstrated to be at least as stiff as the overlying material. The sub-formation level at the underside of the treated in situ natural material shall be subject to the requirements of Section 13.

14.8 Layer Thicknesses

Unless otherwise stated in Appendix 6/13, the soil shall be treated in a single layer if its compacted thickness is 250 mm or less. If its compacted thickness is greater, the material shall be treated in layers not less than 130 mm and not more than 250 mm thick, including any cutting-in required by Section 0. If soil is treated with lime and hydraulic binder then the thickness of treated layers shall be the same for the lime and for the hydraulic binder.

14.9 Binder Requirements

14.9.1 General

Soil to be treated shall have added to it, at any point, the quantity of lime and/or hydraulic binder measured as a percentage of its dry weight as determined in a validation trial. Soils treated to form general fill shall meet the requirements of general fill in Appendix 6/1 and Table 6/1.

Soils treated to form capping shall meet the requirements of Appendix 6/7 and Table 6/1 and shall have the following minimums for each treatment type:

i. Lime only: 2.5% by weight of ‘available lime’;
ii. Hydraulic binder only: 2% by weight of hydraulic binder; or
iii. Lime and hydraulic binder: 1% by weight of ‘available lime’ and 2% by weight of hydraulic binder.

14.9.2 Lime

Lime shall, as required in Appendix 6/13, be either quicklime, hydrated lime or lime slurry complying with I.S. EN 16907-4. Quicklime shall, when sieved, have 100% passing an ISO 3310-1 10 mm sieve and at least 95% by mass passing an ISO 3310-1 5 mm sieve. Lime shall meet the performance requirements in Appendix 6/13.

14.9.3 Cement

Cement shall comply with I.S. EN 197-1, unless otherwise described in Appendix 6/13.

14.9.4 Spreading

The Contractor shall spread the appropriate quantity of lime and/or hydraulic binders using an approved spreading machine on top of the layer to be treated.

Using a collecting tray and balance, the Contractor shall check the rate of spread by weight once for every 500 m^2 of spread, unless stated otherwise in Appendix 1/5, and in accordance with Section 41. If lime is being spread, the Contractor shall collect samples deposited on the collecting tray for testing for available lime content in accordance with Appendix 1/5.

14.10 Temperature and Area Restrictions

The Contractor shall not carry out soil treatment with lime and/or hydraulic binders to form capping when the shade temperature is below 5°C. The Contractor shall not treat soil to form general fill when the soil is frozen. Upper temperature limits for soil treatment shall be in accordance with Appendix 6/13. Soil treatment with lime and/or hydraulic binders shall not be carried out during periods of rain or when rain is imminent. Spreading shall be limited to areas with maximum size in accordance with Appendix 6/13. The spreading of lime shall not be carried out in a manner or under conditions that will result in lime being blown from the Site onto adjacent land or property. When hydraulic binders are spread on material likely to cause premature hydration, processing in accordance with Section 14.11 shall follow immediately.

14.11 Pulverising and Mixing

Unless stated otherwise in Appendix 6/13, the material forming the layer to be treated shall be treated by pulverising and mixing in the lime and/or hydraulic binder by means of sufficient number of passes of an approved mobile machine until 95% of the silt and clay fraction of treated material passes an ISO 3310-1 28 mm sieve after dry sieving and the pulverisation complies with Table 6/1.

14.12 Water Requirements

During treatment, sufficient water shall be available in the material to slake the quicklime (if used) and/or hydrate the hydraulic binder 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 SO_4.

14.13 Sealing

Layers being treated with lime shall receive at least two passes of the treatment machine to pulverise and mix the lime and soil, after which the treatment work shall be interrupted by a mellowing period, with duration between 24 hours and 72 hours. Before this period commences the surface of the layer shall be sealed with one pass of a smooth wheeled roller having a mass per metre width of roll of not less than 2700 kg or a pneumatic tyred roller of not less than 1000 kg per wheel. At the end of this period the layer shall receive one further pass of the treatment machine or more if required to enable the material to comply with Sections 14.11 and 14.15, adding water uniformly if necessary. Any added water shall have sulfate content not exceeding 1400 mg/l as SO_4.

14.14 Depth Control and Overlap

The treatment machine shall be equipped with a device for controlling the depth of treatment 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 treated, the tines or blades of the machine shall be set so that they cut into the previously treated layer below by at least 20 mm.

14.15 Testing

Each layer of treated material shall be compacted as soon as possible after the final pass of the treatment machine. For treatment with a hydraulic binder, compaction shall be completed within 2 hours following the mixing of the binder into the material. Immediately before compaction, the treated material shall not have a Moisture Condition Value (MCV) of greater than nor less than the figures stated in Appendix 6/13. For treatment with a hydraulic binder, the maximum MCV shall be 12. MCV shall be determined in accordance with Section 32. Water shall be added, if necessary, in a uniform manner, to enable the MCV requirements to be met. Any added water shall have a sulfate content not exceeding 1400 mg/l as SO_4.

14.16 Lime Treatment

For treatment with lime, if there is a delay following the final pass, and before commencement of compaction, the surface shall be sealed by at least 2 passes of a smooth-wheeled roller having a mass per metre width of not less than 2,700 kg or of a pneumatic tyred roller of not less than 1,000 kg mass per wheel. On recommencement, and before compaction, the layer shall be reprocessed without the addition of lime, by a sufficient number of passes of the stabilising machine to meet the MCV requirements of Section 14.15, adding water uniformly, if necessary.

14.17 Compaction

The compaction of each layer of material shall comply with Section 12 and Table 6/4, except that the number of passes of the compaction plant shall be determined from the results of a validation trial to be detailed in Appendix 6/13 and as described in Section 14.9.

14.18 Additional Requirements for General Fill Formed by Soil Treatment

General fill formed by treatment with lime and/or hydraulic binders shall be assessed for all of the properties of the resultant Class of material as well as the following, in accordance with I.S. EN 16907-4 and the requirements of Appendix 6/13:

i. Pulverisation;
ii. Characteristics for execution;
iii. Workability period; and
iv. Water content.

14.19 Protection of Treated Materials

During periods when the air temperature is forecast to drop below 3°C, or when ground frost is forecast, materials treated with a hydraulic binder shall be protected to prevent freezing. Protection shall be for a period of seven days from the time of completion of compaction. Such protection shall be sealed to prevent the ingress of moisture. Unprotected treated material that is left exposed to air temperatures less than 3°C shall be excavated and replaced.

14.20 Deposition and Compaction of Materials Above Treated Materials

Treated materials shall not have other material deposited or compacted above them until such time as they meet the requirements of Table 6/1 and Appendix 6/1 (for general fill) or of Table 6/1 and Appendix 6/7 (for capping). Restrictions on compaction plant and other vehicular traffic in Section 17 shall also apply until these requirements are met.

15. Not Used.

16. Preparation and Surface Treatment of Formation

16.1 Surface Level Tolerances

The formation shall, after completion of any subgrade drainage, and immediately before laying Unbound Granular Mixtures in accordance with CC-SPW-00800, have a surface level tolerance within +20 mm and –30 mm relative to its designed level after completion of the following operations:

i. Any protection layer shall be removed. The surface of the formation shall be trimmed and immediately cleaned free from debris and soft material. Any soft or damaged areas shall be rectified by excavating them and replacing with compliant material having the same characteristics and strength as the surrounding material;

ii. The formation shall immediately be compacted as for a layer of 250 mm finished thickness compacted in compliance with Section 12 and Table 6/4 Method 6. Where the formation is on fill, the compaction shall be in addition to the compaction required for the fill. Immediately after the compaction the formation shall be trimmed to achieve the tolerances of this Section; and

iii. 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.

16.2 Correcting the Formation Level to Meet Tolerances

Where the tolerances in Section 16.1 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 Section 12 and Section 16.1; or

ii. If the surface is too low it shall be corrected by the addition of material complying with Table 6/1 having characteristics and strength matching the underlying material, deposited and compacted in compliance with Sections 8 and 12 and Section 16.1. 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. Refer to limits on particle size in Section 1.7.

16.3 Formation in Rock

Where required in Appendix 6/7 or where the tolerances in Section 16.1 cannot be achieved in the preparation of formation in rock then one of the following shall be carried out 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 replaced with capping compacted in compliance with Sections 8 and 12 and 13 or Unbound Granular Mixtures in accordance with CC-SPW-00800; 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 CC-SPW-00800, or mix ST1 concrete to CC-SPW-02600.

16.4 Limitations on Areas of Completed Formation

The Contractor shall limit any areas of completed formation to suit the output of plant in use and the rate of deposition of Unbound Granular Mixtures. No formation of cohesive material shall remain continuously exposed to rain causing degradation or be left uncovered overnight.

16.5 Formation Protection

Formation areas shall be kept free of groundwater and the effects of weather, and the Contractor shall ensure that the formation is protected at all times.

16.6 Testing

16.6.1 Falling Weight Deflectometer

The formation shall be tested using a Falling Weight Deflectometer (FWD) to determine the surface modulus. Formation testing shall be in accordance with Appendix 6/7.

16.6.2 Additional DCP Testing

If groundwater is within 1m of the formation the FWD testing shall be supplemented with Dynamic Cone Penetrometer (DCP) tests, if the subgrade materials are suitable, or plate loading tests, as required in Appendix 6/7. DCP tests shall be in accordance with DN-PAV-03021 and Appendix D of AM-PAV-06050. Plate loading tests shall be in accordance with BS 1377-9 and the modulus shall be determined in accordance with Appendix K of I.S. EN 1997-2.

16.6.3 Additional Surface Modulus Testing

The Contractor shall carry out additional surface modulus testing on the formation where required by the Employer’s Representative.

17. Use of Sub-Formation or Formation by Construction Plant

17.1 Plant Use

Construction plant and other vehicular traffic (except that required for the construction of capping, or the preparation of formation, or the supply and deposition of subbase) shall not be operated on the sub-formation or formation, unless adequate protection, if necessary in addition to 300 mm weather protection, is provided.

The Contractor shall submit to the Employer's Representative their proposals for the protection of the sub-formation and formation in areas where they are within 300 mm of the underside of the existing topsoil level, before using construction plant or other vehicular traffic at or above sub-formation or formation.

17.2 Remedial Action

The Contractor shall undertake any remedial action required, including any specific requirements in Appendix 6/3, to reinstate the sub-formation or formation following damage by construction plant.

18. Topsoiling, Seeding and Turfing

18.1 Class 5 Material

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

18.2 Imported Topsoil

Imported topsoil, Class 5B material, shall only be imported when permitted in Appendix 6/8.

18.3 Restrictions on Topsoil Stockpiles

Topsoil shall not be excavated from stockpiles:

i. Which are saturated;
ii. Which are frozen; or
iii. When heavy rain is falling.

18.4 Planting Area Preparation

The areas to be planted 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 and seeded. Seed may, unless otherwise stated in Appendix 6/8, be applied by hydraulic mulch;
ii. Treatment II: topsoiled and turfed; or
iii. Treatment III: left untopsoiled but seeded by hydraulic mulch.

18.5 Requirements for Topsoil in Treatments I and II

Topsoil in Treatments I and II 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. Be deposited and spread in layers, if required in Appendix 6/8; and
iii. Have stones and other debris removed 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.
iv. Not have stones or other debris protruding above the surface by more than 30 mm; and
v. Include soil enhancement to promote vegetation growth, if required in Appendix 6/8.

18.6 Requirements for Seeding in Treatment I

Seeding in Treatment I shall:

i. Employ a mixture of seed complying with Section 18.10;

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. If required in Appendix 6/8, 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.

18.7 Requirements for Turf in Treatment II

Turf in Treatment II shall:

i. Be laid in the areas described in Appendix 6/8;

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;

iii. Be laid well bonded and lightly tamped and, when on slopes, be laid diagonally;

iv. Where required in Appendix 6/8 be retained in position by methods described therein;

v. Be regularly watered as necessary during prolonged dry weather.

18.8 Requirements for Hydraulic Mulch Seeding

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, fibre or other material, to form a retaining agent during establishment of sward growth.

18.9 Mowing Requirements

For areas 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 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.

18.10 Seed Testing and Certification

Seed, including 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.

18.11 Topsoil Thickness

Topsoil shall not be spread to thicknesses greater than 150 mm except at the locations shown in Appendix 6/8.

19. Earthwork Environmental Bunds

19.1 Locations, Materials and Compaction

Earthwork environmental bunds shall be constructed in the locations described in Appendix 6/9 with fill materials complying with the requirements therein and Section 1 and Table 6/1. Deposition shall be in accordance with Section 8 and compaction with the requirements of Table 6/1 and Table 6/4 unless otherwise described in Appendix 6/9 or the requirements of Sections 19.2 or 19.3 apply.

19.2 Strengthened Earthworks

Earthwork environmental bunds formed of strengthened earthworks shall be constructed in accordance with Section 21.

19.3 Reinforced Soil Structures

Earthwork environmental bunds formed of reinforced soil structures shall be constructed in accordance with CC-SPW-02500 and Section 22.

19.4 Topsoiling and Seeding or Turfing

Where required in Appendix 6/9 earthwork environmental bunds shall be topsoiled and seeded, or topsoiled and turfed, all in accordance with Section 18.

19.5 Construction Sequence

Earthwork environmental bunds shall be constructed as per the sequence stated in Appendix 6/9.

20. Landscape Areas

20.1 Locations and Materials

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

20.2 Compaction

Unless method compaction to Section 12 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.

20.3 Shaping

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

20.4 Construction Sequence

Class 4 material shall be deposited in landscape areas after any adjoining embankment or other area of fill has been completed. Where permitted in Appendix 6/9 and provided the 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.

20.5 Topsoiling and Seeding or Turfing

Landscape areas shall be topsoiled and seeded or turfed in accordance with Section 18 to the requirements of Appendix 6/9.

21. Strengthened Earthworks

21.1 Definition

Strengthened earthworks shall mean placed or in situ soil or other material, the stability of which has been improved by, without limitation, inclusions in the form of tensile reinforcement acting through interface friction, bearing or other means, e.g. reinforced soil, soil nailing, or by external support or other proprietary means.

21.2 Locations, Details and Materials

Strengthened earthworks shall be constructed in the locations and to the details described in Appendix 6/9 with materials and strengthening elements described therein.

22. Earthworks for Reinforced Soil Structures

22.1 Definition

Reinforced soil structures are a type of strengthened earthworks comprising engineered fills that are reinforced by the inclusion of horizontal or sub-horizontal reinforcement placed between layers of fill during construction.

22.2 Requirements

Reinforced soil structures shall be constructed in the locations and to the details described in Appendix 6/9 with fill materials and reinforcement described therein. Reinforced soil structures shall be in accordance with I.S. EN 14475 and CC-SPW-002500. Excavation shall be carried out in accordance with Section 4.

22.3 Fill Materials

Fill for reinforced soil 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. Tests for interaction between fill and reinforcing elements shall be undertaken in accordance with Section 39, unless stated otherwise in Appendix 6/1.

22.4 Drainage Layers

Drainage layers to reinforced soil 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 CC-SPW-00500 for use only in horizontal drainage layers; or
iii. Vertical layers of drainage layer material shall be brought up at the same rate as the adjoining fill material without mixing or contamination.

22.5 Deposition and Compaction

In addition to the requirements of Sections 22.6, fill for reinforced soil structures shall be deposited and compacted in compliance with Sections 8 and 12 and Table 6/1. Drainage layer material shall be deposited in accordance with Section 8 and compacted as described in Appendix 6/3.

22.6 Additional Compaction Requirements

Reinforced soil structures shall have:

i. The deposition and compaction carried out so that all layers of reinforcing 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 elements and the facing elements;

iii. The reinforcing elements shall be kept free 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); and

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. Within 2 m of the back of the facing, the plant used for compacting the fill restricted to the following items as described 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; and/or

   c) Vibro tamper having a mass not exceeding 75 kg.

v. Compaction requirements for the fill and drainage layers within 2 m of a structure, including layer thickness and number of passes, shall be appropriate to the type of plant used, the mass of the plant and material type;

vi. At the Contractor’s option, the reinforced soil beyond the 2 m zone referred to above, may be raised in thicker layers than within the 2 m zone, providing this is compatible with the arrangement of the reinforcing elements and the difference in compacted level does not exceed 300 mm;

vii. During construction of the reinforced soil structure the retained fill behind the structure shall be maintained at the same level as the adjoining reinforced soil; and

viii. If the retained material at the rear of the reinforced soil structure is an existing earthwork or natural slope which requires supporting by temporary shoring, the shoring system and methodology for installation and removal shall be such as to prevent the formation of voids.

23. Earthworks for Corrugated Steel Buried Structures

23.1 References

The construction of earthworks for corrugated steel buried structures together with assembly and erection of their components shall be in compliance with this Section, CC-SPW-02500 and Appendix 6/10.

23.2 Excavation

Excavation shall be carried out in compliance with Section 4 and any additional requirements given in Appendix 6/3.

23.3 Fill Materials

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
iv. Overlying material shall be one of the following:
    a) Well graded, uniformly graded or coarse granular material Class 6Q; or
    b) Wet, dry, stony or silty cohesive material Class 7H.

23.4 Deposition and Compaction

In addition to the requirements of Sections 23.5 to 23.12, Class 6K, 6L and 6M materials shall be deposited in compliance with Section 8 and shall (except for Class 6L upper bedding material which shall be uncompacted) be end-product compacted in compliance with Section 12 and Table 6/1, except that the compacted layers shall not exceed 150 mm thickness. The compaction and testing requirements for Class 6K lower bedding and Class 6M surround materials shall also comply with any additional requirements given in Appendix 6/1.

23.5 Shaping

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.

23.6 Surround Material

Class 6M surround material shall be used for filling all excavations above the bedding, except those in rock for which Class 6K lower bedding material shall be used throughout. 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.

23.7 Filling Above the Structure

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 structure 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. Overlying fill above the structure shall not be thicker than the thickness of fill required in the design and the depth of any protection layer.

23.8 Compaction Under the Structure

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.

23.9 Compaction Limitations

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 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; and/or
iii. Vibro-tampers.

23.10 Integrity of the Structure

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

23.11 Limits on Tipping

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.

23.12 Method Compaction

Method compaction shall be used for the overlying fill (Classes 6Q and 7H) according to Section 12. The methods for Class 1 material shall be used for Class 6Q and the methods for Class 2 material shall be used for Class 7H.

24. Grouted Anchors, Rock Bolts and Soil Nails

24.1 Definitions

24.1.1 Grouted Anchors

Grouted anchors shall mean structural elements that are capable of transmitting a tensile load from an anchor head, through a tendon free length, to a bond with the ground. They may be in soil or rock and may be prestressed or non-prestressed.

24.1.2 Rock Anchors

Rock anchors shall mean prestressed grouted anchors installed in rock.

24.1.3 Rock Bolts

Rock bolts shall mean rigid bars inserted into holes drilled into rock and grouted along their full length. These may be for tensile resistance or for shear resistance.

24.1.4 Soil Nails

Soil nails shall mean reinforcing elements installed into the ground, usually at a sub-horizontal angle, that mobilise resistance with the soil along their entire length.

24.1.5 Facings

Facings shall mean covering to the exposed face of reinforced ground that may provide a stabilising function to retain the ground, provide erosion protection and/or have an aesthetic function.

24.2 General

24.2.1 Testing and Design Life

Grouted anchors, rock bolts and soil nails shall be constructed and tested in accordance with the requirements of Appendix 6/10 and shall have a minimum design life of 120 years.

24.2.2 Corrosion and Deterioration

The protection against corrosion of steel elements, and deterioration of synthetic reinforcement, shall take into account the aggressiveness of the environment, the anchor, bolt or nail type, the type of load and the design life required.

24.2.3 Facings

The suitability of the facings shall be proven by comparable experience or by tests, demonstrating the serviceability of the system and the durability of the materials used, for the design life.

24.2.4 Elements Not Forming Part of the Permanent Works

Grouted anchors, rock bolts and soils nails not forming part of the Permanent Works shall only be used where they will not affect the Permanent Works.

24.2.5 Grout Leaching

The Contractor shall adopt methodologies which prevent the leaching of grout into groundwater or surface water bodies.

24.3 Grouted Anchors

24.3.1 Standard

Grouted anchors, and associated components and materials, shall be in accordance with I.S. EN 1537.

24.3.2 Corrosion Protection

Grouted anchors shall have two independent layers of corrosion protection (double corrosion protection).

24.3.3 Testing for Grouted Anchors

All tests shall be in accordance with I.S. EN 1537, I.S. EN 22477-5 and any additional requirements in Appendix 6/10.

Investigation tests shall be undertaken unless the Contractor can demonstrate the behaviour of the ground using results from previous grouted anchor investigation tests in similar ground conditions, to the same or higher working load.

At least three suitability tests shall be performed for each distinct condition of ground and structure to determine the characteristic resistance.

Acceptability tests shall be carried out on every grouted anchor.

24.4 Rock Bolts and Soil Nails

24.4.1 Standard

Rock bolts and soil nails shall be in accordance with I.S. EN 14490.

24.4.2 Corrosion Protection

The corrosion protection of steel used in rock bolts and soil nails shall be in accordance with I.S. EN 1537.

24.4.3 Testing for Rock Bolts and Soil Nails

Investigation tests shall be undertaken unless the Contractor can demonstrate the behaviour of the ground using results from previous investigation tests in similar ground conditions, to the same or higher working load.

Sacrificial tests and production tests shall be performed at the frequency in Table 2 of I.S. EN 14490. Tests shall be in accordance with I.S. EN 14490 and any additional requirements in Appendix 6/10.

25. Crib Walling

25.1 Construction Requirements

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

25.2 Infill Material Requirements

Infill material shall have 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.

25.3 Concrete

Concrete components shall meet the requirements of CC-SPW-01700 and the concrete shall not be less than Grade C25/30.

25.4 Metallic Component Materials

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

i. Carbon steel, to I.S. EN 10025, galvanised in accordance with I.S. EN ISO 1461; or
ii. Stainless steel designations 1.4401 or 1.4436 to I.S. EN 10088-2.

25.5 Sacrificial Thickness for Metallic Components

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

25.6 Prohibition on Metallic Dowels and Interlocking Devices

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

25.7 Durability Requirements for Joint Fillers and Spacers

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.

25.8 Construction Sequence

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.

25.9 Foundation Treatment and Drainage System

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

26. Gabions

26.1 Restrictions of the Construction and Use of Gabions

Gabions shall be constructed in compliance with this Section and with any additional requirements in Appendix 6/10. Gabions shall not be incorporated where their failure would significantly impact the road network and associated assets. Gabions shall not be used to resist vehicle impacts or to support Road Restraint Systems.

26.2 Assembly and Materials

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, to reduce distortion. Gabion units shall 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 to maintain tightness of mesh and shall be laced securely with wire. Pre-filling gabion baskets is not permitted. Gabions shall be filled by hand unless otherwise stated in Appendix 6/10. Unless otherwise stated in Appendix 6/10, large stones shall be hand placed at the exposed face of the gabion walls to produce a uniform finish.

26.3 Mesh

The gabion mesh shall be woven steel wire conforming to I.S. EN 10223-3 or welded steel mesh conforming to I.S. EN 10223-8, having a minimum core diameter of 2.7 mm and a minimum tensile strength of 540 N/mm^2, unless otherwise described in Appendix 6/10. All wire shall be coated in accordance with I.S. EN 10244-1 and I.S. EN 10244-2 Class A. Coating shall be for a minimum design life of 120 years unless stated otherwise in Appendix 6/10. Gabions with plastic mesh or plastic corrosion protection shall not be used.

26.4 Size of Mesh Openings and Grading

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.

26.5 Foundation Treatment, Backfill and Drainage

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

27. Swallow Holes and other Naturally Occurring Cavities

27.1 Excavation, Filling and Capping of Infilled Swallow Holes

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.

27.2 Clearing, Filling and Capping of Open Swallow Holes

Open swallow holes and other shallow cavities shall, where required in Appendix 6/11, be flushed, cleared of rubbish to the extent that it is practicable, and filled and capped as described in Appendix 6/11.

27.3 Areas Prone to Karstification

Areas prone to karstification, or where swallow holes or other naturally occurring cavities may occur over the design life of the asset, shall be treated as per Appendix 6/11.

28. Disused Mine Workings

28.1 Treatment

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.

29. Instrumentation and Monitoring

29.1 Requirements and Locations

Instrumentation shall be as described in Appendix 6/12 and shall be installed in the locations shown therein.

Inclinometers shall be in accordance with I.S. EN ISO 18674-3.

Piezometers shall be in accordance with I.S. EN ISO 18674-4.

29.2 Monitoring

As a minimum, three baseline measurements shall be taken at each monitoring point, over a period of at least one week. The baseline results shall be submitted to the Employer's Representative and approved before the start of the Works to be monitored.

Monitoring of instrumentation shall be carried out as required in Appendix 6/12. All monitoring results shall be submitted to the Employer's Representative in an approved format on a weekly basis.

29.3 Decommissioning

Instrumentation shall be decommissioned as described in Appendix 6/12. Where instrumentation is to be left in place beyond the Contract, all measures necessary for its future security, access, maintenance, and monitoring shall be undertaken in accordance with Appendix 6/12.

30. Ground Improvement

30.1 General

30.1.1 Types, Methods and Locations

Ground improvement may include one or a combination of the types listed below, or other methods. Ground improvement shall be as specified in Appendix 6/13, including locations for its use.

30.1.2 Proposed Methodologies

Prior to commencing ground improvement, the Contractor shall submit their proposed methodologies to the Employer's Representative for approval.

30.1.3 Safety of Personnel and Property

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 ground improvement.

30.1.4 Noise and Vibration

The Contractor shall monitor the noise and vibration caused by ground improvement and ensure that they are within the limits in Appendix 6/13.

30.1.5 Experience and Supervision

Ground improvement shall be carried out by experienced personnel under engineering supervision.

30.1.6 Testing

After ground improvement, the Contractor shall undertake in situ testing of the affected areas, in accordance with Appendix 6/13, to confirm that the performance requirements set out in Appendix 6/13 have been achieved. The tests shall be those listed below, or suitable alternatives permitted in Appendix 6/13:

i. Plate loading tests in accordance with BS 1377-9 and I.S. EN 1997-2;
ii. Zone tests in accordance with BS 1377-9;
iii. Cone penetrometer testing (CPT) in accordance with I.S. EN ISO 22476-1; and/or
iv. Dynamic probing in accordance with I.S. EN ISO 22476-2.

30.1.7 Trials

The Contractor shall use trial areas, in accordance with Appendix 6/13, to demonstrate the suitability of ground improvement techniques. The equipment, materials and methodologies used in the trial areas shall be the same as for the Permanent Works. The trial areas may form part of the Permanent Works if they meet the design requirements. The Contractor shall prepare a report detailing all aspects of the trial area, including test results.

30.1.8 Feedback to Designer

The Contractor shall inform the Designer immediately if the behaviour of the ground during improvement, monitoring or testing differs from what is expected.

30.2 Dynamic Compaction

30.2.1 Definition

Dynamic compaction shall be achieved by impacting a heavy weight repeatedly on the ground at regularly spaced intervals.

30.2.2 Construction Sequence

Dynamic compaction shall be completed before the commencement of construction of any Permanent Works, or work on the placement or diversion of services, within that part of the Site defined in Appendix 6/13 which contains, or could be affected by, the dynamic compaction.

30.2.3 Tolerance

For dynamic compaction by dropping, the centre of the weight shall be at the positions and within the tolerances stated in Appendix 6/13.

30.2.4 Records

The Contractor shall record the following, as well as any information required in Appendix 6/13:

i. Special drainage measures implemented;
ii. Method of compaction and plant type;
iii. Date of compaction and the cause and duration of any delays;
iv. Mass, shape and contact area of the weight;
v. Height dropped and spacing of compaction points, where applicable;
vi. Number of drops, where applicable;
vii. Arrangements and number of passes;
viii. Depths of resulting compaction points;
ix. Water ingress to compaction points;
x. Any unforeseen conditions encountered;
xi. Class of material and volume used to fill compaction points; and
xii. Details of instrumentation, monitoring and testing.

30.3 Vibro-compaction, Vibro-replacement and/or Rigid Inclusions

30.3.1 Definition

Vibro-compaction, vibro-replacement and rigid inclusions create zones of stiffer material within the ground to improve the performance of the area as a whole. The materials may include the in situ ground materials, compacted granular fill, concrete, or a combination thereof. They may be installed using replacement or displacement techniques, with or without vibration.

30.3.2 Testing

Post-improvement in situ testing shall include zone tests, in accordance with Appendix 6/13.

30.3.3 Records

The Contractor shall record the following, as a minimum:

i. Locations, depths, dates and times of installation;
ii. Consumption of materials;
iii. Speed of penetration and withdrawal, where applicable;
iv. Records of power consumption during installation; and
v. Type, energy rating and movement of vibratory equipment, where applicable.

30.4 Soil Mixing

30.4.1 Definition

Soil mixing shall mean mixing zones of soil with a hydraulic binder to increase their strength. Dry soil mixing uses a dry binder and wet soil mixing uses a binder slurry. The soil zones may be columns, blocks or trenches. The maximum depth of mixing is greater than 250 mm.

30.4.2 Standard

Soil mixing shall be carried out in accordance with I.S. EN 14679.

30.4.3 Testing

Post-improvement in situ testing shall include zone tests and cone penetrometer tests, and in accordance with Appendix 6/13.

30.4.4 Records

The Contractor shall record the following, as a minimum:

i. Types, storage, handling and mixing of component materials;
ii. Drilling rates;
iii. Injection pressures, rates and volumes; and
iv. Penetration, rotation and withdrawal rates of mixing blades.

31. Earthworks Materials Tests

31.1 Requirements for Source Testing and Compliance Testing

The Contractor shall undertake testing of earthworks materials in accordance with Appendix 1/5 to ensure it meets the compliance limits in Table 6/1. Source testing results for earthworks materials shall be produced by the Contractor and provided to the Employer's Representative for approval, prior to commencement of excavation. Source testing results shall be provided to the Employer's Representative two weeks prior to conveying the material to the site of deposition, unless stated otherwise in Appendix 6/1. Compliance testing shall be undertaken on samples obtained immediately prior to placement of the material in the Works. Compliance testing results shall be provided to the Employer's Representative within two weeks of incorporation of the material in the Works, unless stated otherwise in Appendix 6/1. The Contractor shall undertake tests additional to those stated in Appendix 1/5 when required by the Employer's Representative.

31.2 Sampling

Sampling of material shall be carried out in accordance with I.S. EN 932-1, and I.S. EN ISO 22475-1. Sample locations and sampling techniques shall be such that they are representative of the relevant properties of the material, having regard to the potential variation in these properties throughout the material. When sampling from a stockpile, the potential variation of the material, and for segregation or other changes to have occurred, shall be considered.

31.3 Tests for Rapid Evaluation

Alternative tests for rapid evaluation of earthworks materials shall only be used where permitted and as described in Appendix 6/1.

32. Determination of Moisture Condition Value (MCV) of Earthworks Materials

32.1 Standard

Where the Moisture Condition Value (MCV) is to be determined, the determination shall be carried out in accordance with BS 1377-2. For each sample of material, the MCV shall be the average of the values determined for two specimens taken from the sample.

32.2 MCV/Water Content Relation

The determination of the MCV/water content relation, in accordance with BS 1377-2, shall be carried out when required in Appendix 6/1.

32.3 Rapid Assessment Procedure

Where permitted and as described in Appendix 6/1, the rapid assessment procedure for material acceptability also given in BS 1377-2 may be used.

33. Determination of Undrained Shear Strength of Remoulded Cohesive Material

33.1 Requirements and Standard

Where required in Appendix 6/1, the undrained shear strength of cohesive material 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 I.S. EN ISO 17892-8 and the additional requirements of Sections 33.2 to 33.4.

33.2 Sample Preparation

The specimens shall be prepared in accordance with I.S. EN ISO 17892-8 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 water content and compacted in accordance with BS 1377-1 using the 2.5 kg or 4.5 kg rammer method described in BS 1377-2.

33.3 Cell Pressure, Strain Rate and Plotting

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 ϕ to be determined, the test shall be modified to enable Mohr circles to be plotted and c and ϕ reported.

33.4 Other Tests

Where stated and described in Appendix 6/1, other tests may be used during construction, in addition to the test described above, provided the results have been correlated to ensure accuracy.

34. Slake Durability Index

34.1 Standards

The Slake Durability Index shall be determined in accordance with ASTM D 4644-16. The water content of the sample shall be determined in accordance with I.S. EN ISO 17892-1.

35. Los Angeles Coefficient and other Tests for Particle Soundness

35.1 Los Angeles (LA) Coefficient

The value of Los Angeles coefficient shall be determined in accordance with I.S. EN 1097-2. The tests shall be carried out on multiple range classifications in accordance with Annex B.1 of I.S. EN 1097-2 and Appendix 6/1.

35.2 Magnesium Sulfate Soundness

Magnesium sulfate soundness tests shall be carried out in accordance with I.S. EN 1367-2. The tests shall be carried out on multiple range classifications in accordance with Annex B.1 of I.S. EN 1367-2 and Appendix 6/1.

35.3 Other Tests for Particle Soundness

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.

36. Determination of Effective Angle of Shearing Resistance (φ') and Effective Cohesion (c') of Earthworks Materials

36.1 Requirements

The effective angle of shearing resistance ϕ' 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 Section 36.2.

36.2 Shear Box Tests on Granular Materials

For Classes 6N, 6P, 6I and 6J granular materials, the tests shall be carried out in accordance with I.S. EN ISO 17892-10 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 water content to a dry density of 92% ± 2% of the maximum dry density determined in accordance with BS 1377-2 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; and

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

The consistency of supply should be checked by comparing samples with the grading, particle shape, plasticity and other characteristics of the material used for the shear box test.

36.3 Shear Box Tests on Cohesive Materials

For Classes 2A, 2B, 2C1, 2C2 and 2D cohesive materials, the tests shall be carried out in accordance with I.S. EN ISO 17892-10 and the following:

i. For source testing, three samples shall be tested in each size of shear box (nominally 300 mm square and 60 mm square). The source testing results obtained using the 300 mm square box shall be used to determine the compliance of the source with the acceptable limits in Table 6/1. The source testing results obtained using the 60 mm square box shall be used for the subsequent quality control of the fill (i.e. to set the compliance limits for compliance testing);

ii. The samples shall occupy the full depth of the shear box and shall be compacted at the optimum water content to a dry density of 92% ± 2% of the maximum dry density determined in accordance with BS 1377-2 using the 4.5 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 immersed 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 excess pore water pressure is generated; and

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

37. Determination of Resistivity (r_s) to Assess Corrosivity of Soil, Rock or Earthworks Materials

37.1 Requirements

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 or, when required in Appendix 6/1, by laboratory tests on samples in accordance with BS 1377-3.

37.2 Locations

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 1377-9 and Appendix 6/1.

37.3 Information for the Employer's Representative

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 they can arrange for attendance at each test.

37.4 Right Angle Measurements

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.

37.5 Test Depths

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.

37.6 Excavation

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 their arrangements shall be submitted to the Employer's Representative.

38. Determination of Redox Potential (E_h) to Assess Corrosivity of Soil, Rock or Earthworks Materials

38.1 Requirements

Where the redox potential of earthworks materials is required to be determined, this shall be obtained by in situ tests as described in Sections 38.2 to 38.5 or, when required in Appendix 6/1, by laboratory tests on samples in accordance with BS 1377-3.

38.2 Locations

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 1377-9 and Appendix 6/1.

38.3 Information for the Employer's Representative

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 trial pits. 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.

38.4 Trial Pit Dimensions

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

38.5 Sampling for pH Value Testing

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 1377-3.

39. Determination of Effective Angle of Shearing Resistance and Adhesion Between Fill and Reinforcing Elements for Reinforced Soil Structures

39.1 Test Set-up

The effective angle of shearing resistance and the adhesion shall be determined by tests carried out in a 300 mm 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.

39.2 Procedure

The test shall be carried out following the procedure given in Section 36 for the determination of the effective angle of shearing resistance 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; and

ii. The preparation of test specimens shall be as follows:

   a) 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; and

   b) A sample of the fill material, of sufficient size to carry out the tests, and within the range of water 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 Section 36.

39.3 Plotting and Determination of Results

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.

39.4 Records

The following additional information shall be recorded for each test:

i. Normal stress applied (kN/m^2);
ii. Peak shear stress (kN/m^2); and
iii. Strain at peak shear stress (%).

40. Determination of Permeability of Earthworks Materials

40.1 Requirements

Where required in Table 6/1 or Appendix 6/1, the permeability of earthworks materials shall be determined as described in I.S. EN 17892-11 and Appendix 6/1.

41. Determination of Available Lime Content

41.1 Requirements

The Contractor shall determine the available lime content of lime for:

i. Soil treatment with lime; and

ii. Soil treatment with lime and a hydraulic binder.

The determination shall be in accordance with I.S. EN 459-2 except that the sample increments shall be taken from the collecting tray used to check the rate of spread at intervals of one increment per 500 m^2.

41.2 Reporting and Categorisation

The available lime content shall be reported and categorised in accordance with I.S. EN 459-1.

42. Determination of the Constrained Soil Modulus (M*) of Earthworks Materials for Corrugated Steel Buried Structures

42.1 Standard and Frequency

When required in Appendix 6/1, the constrained soil modulus M* of Class 6M Fill shall be determined from plate loading tests in accordance with BS 1377-9. Three tests for M* shall be carried out on each side of each structure, one of which is to be at the level of the maximum span.

42.2 Surface Preparation

When testing compacted granular fill materials, the test surface shall be prepared by either to:

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

ii. Compact 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 water content shall be determined at the position of each plate loading test in accordance with Section 12 and I.S. EN ISO 17892-1.

42.3 Procedure

The plate 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 greater than 350 kN/m^2. The plate settlement modulus E_{PLT} shall be determined as the secant modulus between average pressures applied to the plate of 150 kN/m^2 and 350 kN/m^2 in the first load cycle. 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.

42.4 Formula

The constrained soil modulus M* shall be determined from the plate settlement modulus, E_{PLT}, and Poisson's ratio, v, using the equation:

$$M^* = \frac{(1 - v)\, E_{PLT}}{(1 + v)(1 - 2\, v)}$$

E_{PLT} and v shall be determined in accordance with I.S. EN 1997-2 Annex K.

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

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
General Granular Fill	1	A	-	Well graded granular material	General Fill	Sand, gravel, crushed rock or crushed concrete with clay, silt or any combination thereof excluding peat, topsoil and other organic material	i. Grading	Sourced on Site - I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	1	A	-
							ii. Uniformity coefficient	See Note 5	10	-				
							iii. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
	1	B	-	Uniformly graded granular material	General Fill	Sand, gravel, crushed rock or crushed concrete with clay, silt or any combination thereof excluding peat, topsoil and other organic material	iv. Grading	Sourced on Site - I.S. EN ISO 17892- 4	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	1	B	-
							v. Uniformity coefficient	See Note 5	-	10				
							vi. Water content	I.S. EN ISO 17892- 1	App 6/1	App 6/1				
	1	C	-	Coarse granular material	General Fill	Sand, gravel, crushed rock or crushed concrete with clay, silt or any combination thereof excluding peat, topsoil and other organic material	i. Grading	Sourced on Site – I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 5	1	C	-
							ii. Uniformity coefficient	See Note 5	5	-				
							iii. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
							iv. Los Angeles coefficient	Section 35	-	60				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
General Cohesive Fill	2	A	-	Wet cohesive material	General Fill	Clay or silt with sand, gravel, crushed rock, crushed concrete, or any combination thereof, excluding peat, topsoil and other organic material	i. Grading	I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 1 except; for materials with liquid limit greater than 50, determined by I.S. EN ISO 17892- 12, only tamping or grid rollers shall be used.	2	A	-
							ii. Plastic limit (PL)	I.S. EN ISO 17892-12	-	-				
							iii. Water content	I.S. EN ISO 17892- 1	PL -3%	App 6/1				
							iv. MCV	Section 32	App 6/1	App 6/1				
							v. Undrained shear strength of remoulded material	Section 33	App 6/1	App 6/1				
							vi. Effective angle of shearing resistance (ϕ') and effective cohesion (c')	Section 36	App 6/1	App 6/1				
	2	B	-	Dry cohesive material	General Fill	Clay or silt with sand, gravel, crushed rock, crushed concrete, or any combination thereof, excluding peat, topsoil and other organic material	i. Grading	I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	2	B	-
							ii. Plastic limit (PL)	I.S. EN ISO 17892-12	-	-				
							iii. Water content	I.S. EN ISO 17892-1	App 6/1	PL -3%				
							iv. MCV	Section 32	App 6/1	App 6/1				
							v. Undrained shear strength of remoulded material	Section 33	App 6/1	App 6/1				
							vi. Effective angle of shearing resistance (ϕ') and effective cohesion (c')	Section 36	App 6/1	App 6/1				
	2	C	1	Stony cohesive material (high fines content)	General Fill	Clay or silt with sand, gravel, crushed rock, crushed concrete, or any combination thereof, excluding peat, topsoil and other organic material.	i. Grading	I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	2	C	1
							ii. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
							iii. MCV	Section 32	App 6/1	App 6/1				
							iv. Undrained shear strength of remoulded material	Section 33	App 6/1	-				
							v. Effective angle of shearing resistance (ϕ') and effective cohesion (c')	Section 36	App 6/1	App 6/1				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
General Cohesive Fill	2	C	2	Stony cohesive material (low fines content)	General Fill	Clay or silt with sand, gravel, crushed rock, crushed concrete, or any combination thereof, excluding peat, topsoil and other organic material	i. Grading	I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	2	C	2
							ii. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
							iii. MCV	Section 32	App 6/1	App 6/1				
							iv. Undrained shear strength of remoulded material	Section 33	App 6/1	-				
							v. Effective angle of shearing resistance (ϕ') and effective cohesion (c')	Section 36	App 6/1	App 6/1				
	2	D	-	Silty cohesive material	General Fill	Clay or silt with sand, gravel, crushed rock, crushed concrete, or any combination thereof, excluding peat, topsoil and other organic material	i. Grading	I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 3 (except that vibration techniques shall not be permitted)	2	D	-
							ii. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
							iii. MCV	Section 32	App 6/1	App 6/1				
							iv. Undrained shear strength of remoulded material	Section 33	App 6/1	App 6/1				
							v. Effective angle of shearing resistance (ϕ') and effective cohesion (c')	Section 36	App 6/1	App 6/1				
Landscape Fill	4	-	-	Various	Fill to landscape areas	See App 6/1	i. Grading	I.S. EN ISO 17892-4	App 6/1	App 6/1	See Section 20 and App 6/1	4	-	-
							ii. Water content	I.S. EN ISO 17892-1	-	App 6/1				
							iii. MCV	Section 32	App 6/1	App 6/1				
Topsoil	5	A	-	Topsoil, or turf, existing on Site	Topsoiling	Topsoil or turf designated as Class 5A in the Contract	i. Grading	Section 18	-	Section 18	-	5	A	-
							ii. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
	5	B	-	Imported topsoil	Topsoiling	Material complying with BS 3882	-	-	-	-	-	5	B	-
	5	C	-	Imported turf	Turfing	Material complying with BS 3969	-	-	-	-	-	5	C	-

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Selected Granular Fill	6	A		Selected well graded granular material	Placement in water	Natural gravel, crushed gravel, crushed rock or gravel, crushed concrete or any combination thereof, excluding argillaceous and/or micaceous rock (see Note 7)	i. Grading	Sourced on Site – I.S. EN ISO 17892- 4	Tab 6/2	Tab 6/2	No compaction	6	A	
								Imported – I.S. EN 933-1	Tab 6/5	Tab 6/5				
							ii. Uniformity	See Note 5	10	-				
							iii. Plasticity index	I.S. EN ISO 17892-12	Non-plastic					
							iv. Los Angeles Coefficient	Section 35	-	50				
							v. Slake durability	Section 34	95%	-				
	6	B	-	Selected coarse granular material	Starter layer or placement in water	Natural gravel, crushed rock, crushed concrete or any combination thereof, excluding argillaceous and/or micaceous rock (see Note 7)	i. Grading	Sourced on Site – I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 5	6	B	-
								Imported – I.S. EN 933-1	Tab 6/5	Tab 6/5				
							ii. Plasticity index	I.S. EN ISO 17892-12	Non-plastic					
							iii. Los Angeles coefficient	Section 35	-	50				
	6	C	-	Selected uniformly graded granular material	Starter layer	Natural gravel, crushed gravel, crushed rock or gravel, crushed concrete, or any combination thereof, excluding argillaceous and/or micaceous rock (see Note 7)	i. Grading	Sourced on Site - I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	6	C	-
								Imported – I.S. EN 933-1	Tab 6/5	Tab 6/5				
							ii. Uniformity coefficient	See Note 5	10	-				
							iii. Plasticity index	I.S. EN ISO 17892-12	Non-plastic					
							iv. Los Angeles Coefficient.	Section 35	-	50				
							v. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
							vi. Slake durability	Section 34	95%	-				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Selected Granular Fill	6	D	-	Selected granular material	For treatment with hydraulic binder to form capping (Class 9A)	Natural gravel, crushed gravel, crushed rock, crushed concrete, or any combination thereof, excluding argillaceous and/or micaceous rock (see Note 7)	i. Grading	Sourced on Site - I.S. EN 17892- 4	Tab 6/2	Tab 6/2	Not applicable	6	D	-
								Imported – I.S. EN 933-1	Tab 6/5	Tab 6/5				
							ii. Water content	I.S. EN 17892-1	App 6/1	App 6/1				
							iii. Organic content	BS 1377-3	-	App 6/1				
							iv. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	App 6/1				
							v. Total sulfur content	I.S. EN 1744-1 clause 11.2	-	App 6/1				
							vi. Acid soluble sulfates	I.S. EN 1744-1 clause 12	-	App 6/1				
							vii. Oxidisable sulfides	Section 1.8	-	App 6/1				
	6	E	-	Selected granular material	For treatment with lime and hydraulic binder to form capping (Class 9B)	Natural gravel, crushed gravel, crushed rock, crushed concrete, or any combination thereof, excluding argillaceous and/or micaceous rock (see Note 7)	i. Grading	Sourced on Site - I.S. EN 17892-4	Tab 6/2	Tab 6/2	Not applicable	6	E	-
								Imported – I.S. EN 933-1	Tab 6/5	Tab 6/5				
							ii. Water content	I.S. EN 17892- 1	App 6/1	App 6/1				
							iii. Organic content	BS 1377-3	-	App 6/1				
							iv. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	App 6/1				
							v. Total sulfur content	I.S. EN 1744-1 clause 11.2	-	App 6/1				
							vi. Acid soluble sulfates	I.S. EN 1744-1 clause 12	-	App 6/1				
							vii. Oxidisable sulfides	Section 1.8	-	App 6/1				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Selected Granular Fill	6	F	1	Selected granular material	Capping	Natural gravel or sand or a combination of both	i. Grading	Sourced on Site – I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 6	6	F	1
								Imported – I.S. EN 933-1	Tab 6/5 - (0/31.5 or 0/80, GE, UF 9 and OC 75)					
							ii. Optimum water content	BS 1377-2 (vibrating hammer method)	-	-				
							iii. Water content	I.S. EN ISO 17892-1	-	Optimum water content				
							iv. Los Angeles coefficient	Section 35	-	50				
							v. Slake durability	Section 34	95%	-				
							vi. Total sulfur content	I.S. EN 1744-1 clause 11.2	-	1%				
							vii. Permeability	Section 40	App 6/1					
	6	F	2	Selected granular material	Capping	Crushed rock or crushed gravel or a combination of both, excluding argillaceous and/or micaceous rock (see Note 7)	i. Grading	Sourced on Site – I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 6	6	F	2
								Imported – I.S. EN 933-1	Tab 6/5 (0/31.5 or 0/80, GE, UF 9 and OC 75)					
							ii. Optimum water content	BS 1377-2 (vibrating hammer method)	-	-				
							iii. Water content	I.S. EN ISO 17892-1	-	Optimum water content				
							iv. Los Angeles coefficient	Section 35	-	50				
							v. Slake durability	Section 34	95%	-				
							vi. Total sulfur content	I.S. EN 1744-1 clause 11.2	-	1%				
							vii. Permeability	Section 40	App 6/1	-				

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

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Selected Granular Fill	6	F	3	Selected granular material	Capping	Recycled aggregates (including crushed concrete and/or bituminous materials), natural (uncrushed) gravel, sand, crushed rock, crushed gravel or a combination thereof, excluding argillaceous and/or micaceous rock (see Note 7) Bituminous materials shall make up less than 50% of the total and shall exclude materials that contain tar and tar-bitumen binders.	i. Grading	Sourced on Site – I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 6	6	F	3
								Imported – I.S. EN 933-1	Tab 6/5 (0/31.5 or 0/80, GE, UF 9 and OC 75)					
							ii. Optimum water content	BS 1377-2 (vibrating hammer method)	-	-				
							iii. Water content	I.S. EN ISO 17892-1	Optimum water content minus 2%	Optimum water content				
							iv. Los Angeles coefficient	Section 35	-	50				
							v. Slake durability	Section 34	95%	-				
							vi. Total sulfur content	I.S. EN 1744-1 clause 11.2	-	1%				
							vii. Permeability	Section 40	App 6/1	-				
							viii. Bituminous materials (Ra) content	I.S. EN 933-11	-	50%				
							ix. Soluble binder content	I.S. EN 12697-1 or I.S. EN 12697-39	-	2%				
							x. Organic content	BS 1377-3	-	1%				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Selected Granular Fill	6	F	4	Selected granular material	Capping	Recycled aggregates (including crushed concrete and/or bituminous materials), natural (uncrushed) gravel, sand, crushed rock, crushed gravel or a combination thereof, excluding argillaceous and/or micaceous rock (see Note 7) Bituminous materials shall make up more than 50% of the total and shall exclude materials that contain tar and tar-bitumen binders.	i. Grading	Sourced on Site – I.S. EN 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 6 Maximum compacted layer thickness shall be 200 mm	6	F	4
								Imported – I.S. EN 933-1	Tab 6/5 (0/31.5 or 0/80, GE, UF 9 and OC 75)					
							ii. Optimum water content	Section 13	-	-				
							iii. Water content	Section 13	Optimum water content minus 2%	Optimum water content				
							iv. Los Angeles coefficient	Section 35	-	50				
							v. Slake durability	Section 34	95%	-				
							vi. Total sulfur content	I.S. EN 1744-1 clause 11.2	-	1%				
							vii. Permeability	Section 40	App 6/1	-				
							viii. Bituminous materials (Ra) content	I.S. EN 933-11	50%	-				
							ix. Soluble binder content	I.S. EN 12697-1 or I.S. EN 12697-39	-	10%				
							x. Organic content	BS 1377-3	-	1%				
	6	G	-	Selected granular material	Gabion filling	Natural gravel, crushed rock, crushed concrete or any combination thereof, excluding argillaceous and/or micaceous rock (see Note 7)	i. Grading	I.S. EN 933-1	Section 26	Section 26	None	6	G	-
							ii. Los Angeles coefficient	Section 35	-	50				
							iii. pH value	I.S. EN 1744-1	Tab 6/3	Tab 6/3				
							iv. Chloride ion content	I.S. EN 1744-1 clause 7, 8 or 9	-	Tab 6/3				
							v. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	Tab 6/3				
							vi. Oxidisable sulfides	Section 1.8	-	Tab 6/3				
							vii. Resistivity	Section 37	Tab 6/3	-				
							viii. Organic content	BS 1377-3	-	Tab 6/3				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Selected Granular Fill	6	H	-	Selected granular material	Drainage layer to reinforced soil structures	Natural gravel, natural sand, crushed gravel, crushed rock 7 or gravel, crushed concrete or any combination thereof, excluding argillaceous and/or micaceous rock (see Note 7) Properties (v), (vi), (vii), (viii), (ix) and (x) in next column only apply to material placed above or within 500 mm of metallic reinforcing elements, facing units or fastenings.	i. Grading	Sourced on Site - I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	6	H	-
								Imported – I.S. EN 933-1	Tab 6/5	Tab 6/5				
							ii. Plasticity index	I.S. EN ISO 17892-12	Non-plastic					
							iii. Los Angeles coefficient	Section 35	-	50				
							iv. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
							v. pH value	I.S. EN 1744-1	Tab 6/3	Tab 6/3				
							vi. Chloride ion content	I.S. EN 1744-1 clause 7, 8 or 9	-	Tab 6/3				
							vii. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	Tab 6/3				
							viii. Oxidisable sulfides	Section 1.8	-	Tab 6/3				
							ix. Resistivity	Section 37	Tab 6/3	-				
							x. Organic content	BS 1377-3	-	Tab 6/3				
							xi. Slake durability	Section 34	95%	-				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Selected Granular Fill	6	I	-	Selected well graded granular material	Fill to reinforced soil structures	Natural gravel, natural sand, crushed gravel, crushed rock, or gravel, crushed concrete, or any combination thereof, excluding argillaceous and/or micaceous rock (see Note 7) Properties (vi), (vii), (viii), (ix), (x) and (xi) only apply to material placed above or within 500 mm of metallic reinforcing elements, facing units or fastenings.	i. Grading	Sourced on Site - I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	6	I	-
								Imported – I.S. EN 933-1	Tab 6/5	Tab 6/5				
							ii. Uniformity coefficient	See Note 5	10	-				
							iii. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
							iv. Effective angle of shearing resistance (ϕ') and effective cohesion (c')	Section 36	App 6/1	-				
							v. Effective angle of shearing resistance and adhesion (fill/elements)	Section 39	App 6/1	-				
							vi. pH value	I.S. EN 1744-1	Tab 6/3	Tab 6/3				
							vii. Chloride ion content	I.S. EN 1744-1 clause 7, 8 or 9	-	Tab 6/3				
							viii. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	Tab 6/3				
							ix. Oxisiable sulfides	Section 1.8	-	Tab 6/3				
							x. Resistivity	Section 37	Tab 6/3	-				
							xi. Organic content	BS 1377-3	-	Tab 6/3				
							xii. Los Angeles coefficient	Section 35	-	50				
							xiii. Slake durability	Section 34	95%	-				
							xiv. Permeability	Section 40	App 6/1	-				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Selected Granular Fill	6	J	-	Selected uniformly graded granular material	Fill to reinforced soil structures	Natural gravel, natural sand, crushed gravel, crushed rock, or gravel, crushed concrete, or any combination thereof, excluding argillaceous and/or micaceous rock (see Note 7) Properties (vi), (vii), (viii), (ix), (x) and (xi) in next column only apply to material placed above or within 500 mm of metallic reinforcing elements, facing units or fastenings.	i. Grading	Sourced on Site – I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	6	J	-
								Imported – I.S. EN 933-1	Tab 6/5	Tab 6/5				
							ii. Uniformity coefficient	See Note 5	5	10				
							iii. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
							iv. Effective angle of shearing resistance (ϕ') and effective cohesion (c')	Section 36	App 6/1	-				
							v. Effective angle of shearing resistance and adhesion (fill/elements)	Section 39	App 6/1	-				
							vi. pH value	I.S. EN 1744-1	Tab 6/3	Tab 6/3				
							vii. Chloride ion content	I.S. EN 1744-1 clause 7, 8 or 9	-	Tab 6/3				
							viii. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	Tab 6/3				
							ix. Oxidisable sulfides	Section 1.8	-	Tab 6/3				
							x. Resistivity	Section 37	Tab 6/3	-				
							xi. Organic content	BS 1377-3	-	Tab 6/3				
							xii. Los Angeles coefficient	Section 35	-	50				
							xiii. Slake durability	Section 34	95%	-				
							xiv. Permeability	Section 40	App 6/1	-				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance 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 or gravel or any combination thereof, excluding argillaceous and/or micaceous rock (see Note 7)	i. Grading	Sourced on Site – I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	End product 90% of maximum dry density of BS 1377-2 (vibrating hammer method)	6	K	-
								Imported – I.S. EN 933-1	Tab 6/5	Tab 6/5				
							ii. Uniformity coefficient	See Note 5	5	-				
							iii. Plasticity index	I.S. EN ISO 17892-12	-	6				
							iv. Optimum water content	BS 1377-2 (vibrating hammer method)	-	-				
							v. Water content	I.S. EN ISO 17892-1	Optimum water content minus 2%	Optimum water content plus 1%				
							vi. Resistivity	Section 37	2000 ohm cm	-				
							vii. Water-soluble sulfates	I.S. EN 1744-1 clause10	-	Tab 6/3				
							viii. Oxidisable sulfides	Section 1.8	-	Tab 6/3				
							ix. Chloride ion content	I.S. EN 1744-1 clause 7, 8 or 9	-	Tab 6/3				
							x. pH value	I.S. EN 1744-1	Tab 6/3	Tab 6/3				
							xi. Los Angeles coefficient	Section 35	-	50				
							xii. Slake durability	Section 34	95%	-				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Selected Granular Fill	6	L	-	Selected uniformly graded granular material	Upper bedding for corrugated steel buried structures	Natural gravel, natural sand, crushed gravel, crushed rock or gravel or any combination thereof, excluding argillaceous and/or micaceous rock (see Note 7)	i. Grading	Sourced on Site – I.S. EN ISO 17892-4	Tab 6/2 (BS 882 Tab 5)	Tab 6/2	None	6	L	-
								Imported – I.S. EN 933-1	Tab 6/5	Tab 6/5				
							ii. Resistivity	Section 37	2000 ohm cm	-				
							iii. Plasticity index	I.S. EN ISO 17892-12	-	6				
							iv. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	Tab 6/3				
							v. Oxidisable sulfides	Section 1.8	-	Tab 6/3				
							vi. Chloride ion content	I.S. EN 1744-1 clause 7, 8 or 9	-	Tab 6/3				
							vii. pH value	I.S. EN 1744-1	Tab 6/3	Tab 6/3				
							viii. Los Angeles coefficient	Section 35	-	50				
							ix. Slake durability	Section 34	95%	-				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance 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, or gravel, crushed concrete or any combination thereof, excluding argillaceous and/or micaceous rock (see Note 7)	i. Grading	Sourced on Site – I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	End product 90% of maximum dry density of BS 1377-2 (vibrating hammer method)	6	M	-
								Imported – I.S. EN 933-1	Tab 6/5	Tab 6/5				
							ii. Uniformity coefficient	See Note 5	5	-				
							iii. Plasticity index	I.S. EN ISO 17892-12	-	6				
							iv. Optimum water content	BS 1377-2 (Vibrating hammer method)	-	-				
							v. Water content	I.S. EN ISO 17892-1		Optimum water content plus 1%				
							vi. Resistivity	Section 37	2000 ohm cm	-				
							vii. Water-soluble sulfates	I.S. EN 1744-1 clause10	-	Tab 6/3				
							viii. Oxidisable sulfides	Section 1.8	-	Tab 6/3				
							ix. Chloride ion content	I.S. EN 1744-1 clause 7, 8 or 9	-	Tab 6/3				
							xi. pH value	I.S. EN 1744-1	Tab 6/3	Tab 6/3				
							xii. Los Angeles coefficient	Section 35	-	50				
							xiii. Slake durability	Section 34	95%	-				
							xiv. Constrained soil modulus (M*)	Section 42	App 6/1	App 6/1				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Selected Granular Fill	6	N	-	Selected granular material	Fill to structures and below structures	Crushed rock and crushed concrete, excluding argillaceous and/or micaceous rock (see Note 7)	i. Grading	Sourced on Site – I.S. EN ISO 178924	Tab 6/2	Tab 6/2	End product 95% of maximum dry density of BS 1377-2 (vibrating hammer method)	6	N	-
								Imported – I.S. EN 933-1	Tab 6/5	Tab 6/5				
							ii. Los Angeles coefficient	Section 35	-	50				
							iii. Effective angle of shearing resistance (ϕ') and effective cohesion (c')	Section 36	App 6/1	App 6/1 (see Note 10)				
							iv. Permeability	Section 40	App 6/1	-				
							v. Water content	I.S. EN 17892-1	App 6/1	App 6/1				
							vi. pH value	I.S. EN 1744-1	6	9				
							vii. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	0.3%				
							viii. Total sulfur content	I.S. EN 1744-1 clause 11.2	-	0.1%				
							ix. Acid soluble sulfates	I.S. EN 1744-1 clause 12	-	0.2%				
							x. Oxidisable sulfides	Section 1.8	-	0.3%				
							xi. Slope stability test (where required in App 6/6)	Section 10	App 6/6					
							xii. Slake durability	Section 34	95%	-				
							xiii. Magnesium sulfate soundness	Section 35	App 6/1	App 6/1				
							xiv. Water absorption	I.S. EN 1097-6	App 6/1	App 6/1				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance 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 and/or micaceous rock (see Note 7)	i. Grading	Sourced on Site – I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	End product 95% of maximum dry density of BS 1377-2 (vibrating hammer method)	6	P	-
								Imported – I.S. EN 933-1	Tab 6/5	Tab 6/5				
							ii. Los Angeles coefficient	Section 35	-	60				
							iii. Effective angle of shearing resistance (ϕ') and effective cohesion (c')	Section 36	App 6/1	-				
							iv. Permeability	Section 40	App 6/1	-				
							v. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
							vi. pH value	I.S. EN 1744-1	6	9				
							vii. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	0.3%				
							viii. Total sulfur content	I.S. EN 1744-1 clause 11.2	-	0.1%				
							ix. Acid soluble sulfates	I.S. EN 1744-1 clause 12	-	0.2%				
							x. Oxidisable sulfides	Section 1.8	-	0.3%				
							xi. Slope stability test (where required in App 6/6)	Section 10	App 6/6					
							xii. Slake durability	Section 34	95%					

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance 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, or gravel, or any combination thereof	As for Class 1A, 1B or 1C with the addition of the following:				As for Class 1A, 1B or 1C, corresponding to the grading	6	Q	-
							i. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	Tab 6/3				
							ii. Oxidisable sulfides	Section 1.8	-	Tab 6/3				
							iii. Chloride ion content	I.S. EN 1744-1 clause 7, 8 or 9	-	Tab 6/3				
							iv. pH value	I.S. EN 1744-1	Tab 6/3	Tab 6/3				
Selected Cohesive Fill	7	C	-	Selected silty cohesive material	For treatment with hydraulic binder to form capping (Class 9C)	Clay or silt with sand, gravel, crushed rock, crushed concrete or any combination thereof, excluding peat, topsoil and other organic material	i. Grading	I.S. EN ISO 17892-4	Tab 6/2	Tab 6/2	Not applicable	7	C	-
							ii. Uniformity coefficient	I.S. EN ISO 17892-4	5	-				
							iii. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
							iv. MCV	Section 32	App 6/1	App 6/1				
							v. Liquid limit	I.S. EN ISO 17892- 12	-	45				
							vi. Plasticity index	I.S. EN ISO 17892- 12	-	20				
							vii. Organic content	BS 1377- 3	-	App 6/1				
							viii. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	App 6/1				
							ix. Total sulfur content	I.S. EN 1744-1 clause 11.2	-	App 6/1				
							x. Acid soluble sulfates	I.S. EN 1744-1 clause 12	-	App 6/1				
							xi. Oxidisable sulfides	Section 1.8	-	App 6/1				
	7	D	-	Selected cohesive material	For treatment with lime to form capping (Class 9D)	Clay or silt with sand, gravel, crushed rock, crushed concrete or any combination thereof, excluding peat, topsoil and other organic material	i. Grading	I.S. EN ISO 17892-4	Table 6/2	Table 6/2	Not applicable	7	D	-
							ii. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
							iii. MCV	Section 32	App 6/1	App 6/1				
							iv. Plasticity index	I.S. EN ISO 17892-12	10	App 6/1				
							v. Organic content	BS 1377- 3	-	App 6/1				
							vi. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	App 6/1				
							vii. Total sulfur content	I.S. EN 1744-1 clause 11.2	-	App 6/1				
							viii. Acid soluble sulfates	I.S. EN 1744-1 clause 12	-	App 6/1				
							ix. Oxidisable sulfides	Section 1.8	-	App 6/1				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Selected Cohesive Fill	7	E	-	Selected cohesive material	For treatment with lime and a hydraulic binder to form capping (Class 9E)	Clay or silt with sand, gravel, crushed rock, crushed concrete or any combination thereof, excluding peat, topsoil and other organic material	i. Grading	I.S. EN ISO 17892-4	Table 6/2	Table 6/2	Not applicable	7	E	-
							ii. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
							iii. MCV	Section 32	App 6/1	App 6/1				
							iv. Plasticity index	I.S. EN ISO 17892-12	10	App 6/1				
							v. Organic content	BS 1377- 3	-	App 6/1				
							vi. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	App 6/1				
							vii. Total sulfur content	I.S. EN 1744-1 clause 11.2	-	App 6/1				
							viii. Acid soluble sulfates	I.S. EN 1744-1 clause 12	-	App 6/1				
							ix. Oxidisable sulfides	Section 1.8	-	App 6/1				
	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	As for Class 2A, 2B, 2C, 2D with the addition of the following				As for Class 2A, 2B, 2C or 2D, corresponding to the grading	7	H	-
							i. Water-soluble sulfates	I.S. EN 1744-1 clause 10	-	Tab 6/3				
							ii. Chloride ion content	I.S. EN 1744-1 clause 7, 8 or 9	-	Tab 6/3				
							iii. pH value	I.S. EN 1744-1	Tab 6/3	Tab 6/3				
Misc Fill	8	-	-	Class 1 or Class 2 material	Lower trench fill	Any, except there shall not be any stones or lumps of clay >40 mm nominal diameter	i. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1	Tab 6/4	8	-	-
							ii. MCV	Section 32	App 6/1	App 6/1				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Treated Materials	9	A	-	Well graded granular material treated with hydraulic binder	Capping	Class 6D with addition of hydraulic binder according to Section 14	i. Pulverisation	BS EN 13286-48	60%	-	Tab 6/4 Method 6	9	A	-
							ii. Characteristics for execution	I.S. EN 16907-4	App 6/1	App 6/1				
							iii. Workability period	BS EN 13286-45	App 6/1	App 6/1				
							iv. Resistance to frost	S.R. CEN/TS 13286-54	App 6/1	App 6/1				
							v. Laboratory mechanical performance	I.S. EN 16907-4	App 6/1	App 6/1				
							vi. Water content	BS EN 13286-2, BS EN 13286-3, BS EN 13286-4 and BS EN 13286-5	App 6/1	App 6/1				
							vii. Resistance to water	I.S. EN 16907-4	App 6/1	App 6/1				
	9	B	-	Well graded granular material treated with lime and hydraulic binder	Capping	Class 6E with addition of lime and hydraulic binder according to Section 14	i. Pulverisation	BS EN 13286-48	60%	-	Tab 6/4 Method 6	9	B	-
							ii. Characteristics for execution	I.S. EN 16907-4	App 6/1	App 6/1				
							iii. Workability period	BS EN 13286-45	App 6/1	App 6/1				
							iv. Resistance to frost	S.R. CEN/TS 13286-54	App 6/1	App 6/1				
							v. Laboratory mechanical performance	I.S. EN 16907-4	App 6/1	App 6/1				
							vi. Water content	BS EN 13286-2, BS EN 13286-3, BS EN 13286-4 and BS EN 13286-5	App 6/1	App 6/1				
							vii. Resistance to water	I.S. EN 16907-4	App 6/1	App 6/1				
	9	C	-	Silty cohesive material treated with hydraulic binder	Capping	Class 7C with addition of hydraulic binder according to Section 14	i. Pulverisation	BS EN 13286-48	App 6/1	-	Table 6/4 Method 7	9	B	-
							ii. Characteristics for execution	I.S. EN 16907-4	App 6/1	App 6/1				
							iii. Workability period	EN 13286-45	App 6/1	App 6/1				
							iv. Resistance to frost	S.R. CEN/TS 13286-54	App 6/1	App 6/1				
							v. Laboratory mechanical performance	I.S. EN 16907-4	App 6/1	App 6/1				
							vi. Water content	BS EN 13286-2, BS EN 13286-3, EN 13286-4 and BS EN 13286-5	App 6/1	App 6/1				
							vii. Resistance to water	I.S. EN 16907-4	App 6/1	App 6/1				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Treated Materials	9	D	-	Cohesive material treated with lime	Capping	Class 7D with addition of lime according to Section 14	i. Pulverisation	BS EN 13286-48	30%	-	Tab 6/4 Method 7	9	D	-
							ii. Characteristics for execution	I.S. EN 16907-4	App 6/1	App 6/1				
							iii. Workability period	EN 13286-45	App 6/1	App 6/1				
							iv. Resistance to frost	S.R. CEN/TS 13286-54	App 6/1	App 6/1				
							v. Laboratory mechanical performance	I.S. EN 16907-4	App 6/1	App 6/1				
							vi. Water content	BS EN 13286-2, BS EN 13286-3, BS EN 13286-4 and BS EN 13286-5	App 6/1	App 6/1				
							vii. Resistance to water	I.S. EN 16907-4	App 6/1	App 6/1				
	9	E	-	Cohesive material treated with lime and hydraulic binder	Capping	Class 7E with addition of lime and hydraulic binder according to Section 14	i. Pulverisation	BS EN 13286-48	30%	-	Tab 6/4 Method 7	9	E	-
							ii. Characteristics for execution	I.S. EN 16907-4	App 6/1	App 6/1				
							iii. Workability period	EN 13286-45	App 6/1	App 6/1				
							iv. Resistance to frost	S.R. CEN/TS 13286-54	App 6/1	App 6/1				
							v. Laboratory mechanical performance	I.S. EN 16907-4	App 6/1	App 6/1				
							vi. Water content	BS EN 13286-2, BS EN 13286-3, BS EN 13286-4 and BS EN 13286-5	App 6/1	App 6/1				
							vii. Resistance to water	I.S. EN 16907-4	App 6/1	App 6/1				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Section 1 and Appendix 6/1)	Material Properties Required for Compliance (In Addition to Requirements on Use of Fill Materials in Section 1 and Testing in Section 31)				Compaction Requirements in Section 12	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Compliance Limits Within:					
									Lower	Upper				
Organic Fill	10	-	-	Peat	Peatland regeneration	Semi-decomposed plant biomass	i. Grading	I.S. EN ISO 17892-4	App 6/1	App 6/1	-	10	-	-
							ii. Water content	I.S. EN ISO 17892-1	App 6/1	App 6/1				
							iii. Organic content	I.S. EN 13039	App 6/1	App 6/1				
							iv. Dry bulk density	I.S. EN 13041	App 6/1	App 6/1				

Footnotes to Table 6/1

1. App = Appendix
2. Tab = Table
3. Where in the 'Compliance Limits Within' 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 I.S. EN ISO 17892-1 is specified for water content, this shall mean I.S. EN ISO 17892-1 (for Site-won materials) or I.S. EN 1097-5 (for imported materials), 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 water content shall be made from that part of the material passing the 20 mm BS Sieve.
7. Argillaceous or micaceous rock may be used in the Permanent Works if it is demonstrated by Los Angeles coefficient and slake durability testing that the argillaceous or micaceous material meets the compliance limits for durability.
8. Where materials are required to be aggregates conforming to I.S. EN 13242, materials certificated as being in accordance with I.S. EN 13285 are compliant for use if they meet all the Contract requirements and the Declaration of Performance for constituent parts to I.S. EN 13242 are provided to the Employer's Representative.
9. Materials shall comply with the current environmental regulations at the time of use.
10. An upper limit is required for the angle of shearing resistance (ϕ') for Class 6N Fill when it is used behind integral bridge abutments or when otherwise required.
11. For Class 6N and 6P fill, the total sulfur content may be between 0.1% and 1% if a petrographic analysis, as described in S.R. 21 Annex E.2.4.5, shows that the material is suitable for the proposed use.

Table 6/2 - Grading Requirements for Compliant 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																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**
6D & 6E			100	85-100						25-100						10-100				0-15	**6D & 6E**
6F1, 6F2, 6F3 & 6F4				100	65-100	45-100				15-80		10-70				0-30			0-10		**6F1, 6F2,6F3 & 6F4**
6H								100				60-100			15-45	0-25		0-5			**6H**
6I & 6J			100		85-100					15-85						0-30			0-10		**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**
6N				100	65-100	45-100				15-75		10-60				0-30			0-15		**6N**

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**	
6P			100		65-100	45-100				15-75		10-60				0-30			0-15		6P
7C			100																15-100		7C
7D					100		95-100												15-100		7D
7E					100		95-100												15-100		7E

Footnote to Table 6/2

1. 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		**Maximum chloride ion content (%)**	**Max organic content (%)**	**Maximum water-soluble sulfates (%)**	**Maximum oxidisable sulfides (%)**	**Minimum resistivity (ohm.cm)**
	Min	**Max**					
Hot Dip Galvanised Steel	6	9	0.025	0.2	0.06	0.06	5000
Stainless Steel	5	10	0.025	0.2	0.12	0.12	3000

Footnotes to Table 6/3

1. Methods of test are given in Table 6/1.
2. Oxidisable sulfides shall be determined in accordance with Section 1.8.1.
3. If resistivity is less than the minimum value stated in Table 6/3 then the material may only be used with metal components if the requirements of I.S. EN 14475 Table B.1 are met.

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

(This Table is to be read in conjunction with Section 12)

Type of Compaction Plant	Ref No.	Category	Method 1		Method 2		Method 3		Method 4		Method 5		Method 6			Method 7		Ref No.
			D	N#	D	N#	D	N#	D	N	D	N	N for D=110mm	N for D=150mm	N for D=250mm	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	unsuitable	unsuitable	1
	2	over 2700kg up to 5400 kg	125	6	125	8	125	8*	200	4	unsuitable		16	unsuitable	unsuitable	unsuitable	unsuitable	2
	3	over 5400 kg	125	4	150	8	unsuitable		300	4	unsuitable		8	16	unsuitable	12	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	unsuitable	unsuitable	1
	2	Over 5400 kg up to 8000 kg	150	8	125	12	unsuitable		325	4	unsuitable		20	unsuitable	unsuitable	16	unsuitable	2
	3	Over 8000 kg	150	4	150	12	unsuitable		400	4	unsuitable		12	20	unsuitable	8	unsuitable	3
Tamping roller		**Mass per metre width of roll:**																
	1	over 4000 kg	225	4	150	12	250	4 4	350	4	unsuitable		12	20	unsuitable	4 3	8 6	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	unsuitable	unsuitable	1
	2	over 1500 kg up to 2000 kg	150	5	unsuitable		unsuitable		300	4	unsuitable		unsuitable	unsuitable	unsuitable	12	unsuitable	2
	3	over 2000 kg up to 2500 kg	175	4	125	12	unsuitable		350	4	unsuitable		unsuitable	unsuitable	unsuitable	6	unsuitable	3
	4	over 2500 kg up to 4000 kg	225	4	125	12	unsuitable		400	4	unsuitable		unsuitable	unsuitable	unsuitable	5	unsuitable	4
	5	over 4000 kg up to 6000 kg	300	4	125	10	unsuitable		unsuitable		unsuitable		12	unsuitable	unsuitable	4	16	5
	6	over 6000 kg up to 8000 kg	350	4	150	8	unsuitable		unsuitable		unsuitable		12	unsuitable	unsuitable	unsuitable	8	6
	7	over 8000 kg up to 12000 kg	400	4	150	8	unsuitable		unsuitable		unsuitable		10	16	unsuitable	unsuitable	4	7
	8	over 12000 kg	450	4	175	6	unsuitable		unsuitable		unsuitable		8	12	unsuitable	unsuitable	4	8

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

(This Table is to be read in conjunction with Section 12)

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

Footnotes to Table 6/4

1. 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.
2. 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. 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.
3. 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.
4. A grid roller is a machine with a compacting roll or rolls constructed of heavy steel mesh of square pattern.
5. A tamping roller is a machine with a roll or rolls from which 'feet' project and where the projected end area of each "foot" exceeds 0.01 m2 and the sum of the areas of the feet exceeds 15% of the area of the cylinder swept by the ends of the feet. The requirements for tamping rollers apply to machines that have 2 rolls in tandem. If only one tamping roll traverses each point on the surface of the layer on any one pass of the machine, the minimum number of passes shall be twice the number given in Table 6/4 plus any further doubling required to satisfy (ii) above.
6. 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.
7. 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.
8. 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.
9. 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.
10. Vibratory rollers operating without vibration will be classified as smooth-wheeled rollers.
11. 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.
12. 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 remotely by the Employer's Representative.
13. 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. 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. 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.
14. 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.
15. Power rammers are machines which are actuated by explosions in an internal combustion cylinder, each explosion being controlled manually by the operator.
16. 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.
17. 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.
18. 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.
19. Where combinations of different types or categories of plant are used, the following shall apply:
    - The depth of layer shall be that for the type of plant requiring the least depth of layer; and
    - The number of passes shall be that for the type of plant requiring the greatest number of passes.

Table 6/5 - Grading Requirements for Earthworks Materials Imported onto Site

Class	**Size (mm)**		**Size (mm) EN 933-2 Series**													**Size (microns) EN 933-2 Series**				**Class**
	500	**300**	**125**	**80**	**63**	**40**	**31.5**	**20**	**16**	**10**	**8**	**6.3**	**4**	**2**	**1**	**500**	**250**	**125**	**63**	
6A	100			60-90				0-70						0-20					0-5	6A
6B	100		0-10																	6B
6C			100							15-85						0-30			0-10	6C
6D & 6E			100	85-100						25-100						10-100			0-15	6D & 6E
6F1, 6F2, 6F3 & 6F4[1]			100	75-100		50-90		30-90		15-75			0-60		0-35				0-9	6F1, 6F2, 6F3 & 6F4[1]
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			90-100	60-100	30-100	15-100	5-70	0-15		6L
6M				100															0-10	6M
6N				100		45-100				15-75			10-60			0-30			0-15	6N
6P			100	65-100		45-100				15-75			10-60			0-30			0-15	6P

Footnote to Table 6/5

1. Equivalent to the following properties in I.S. EN 13285:

   Mixture designation – 0/31.5 or 0/80

   Maximum fines content – UF 9

   Oversize – OC 75

   Grading range - G_E

References

AM-PAV-06050 Pavement Assessment, Repair and Renewal Principles

ASTM D 4644-16 Standard Test Method for Slake Durability of Shales and Other Similar Weak Rocks

BS 1377-2 Methods of test for soils for civil engineering purposes Part 2: Classification tests and determination of geotechnical properties

BS 1377-3 Methods of test for soils for civil engineering purposes Part 3: Chemical and electro-chemical testing

BS 1377-9 Methods of test for soils for civil engineering purposes Part 9: In-situ tests

BS 5607 Code of practice for safe use of explosives in the construction industry

BS EN 13286-2 Unbound and hydraulically bound mixtures Part 2: Test methods for the determination of the laboratory reference density and water content. Proctor compaction

BS EN 13286-3 Unbound and hydraulically bound mixtures Part 3: Test methods for the determination of the laboratory reference density and water content. Vibrocompression with controlled parameters

BS EN 13286-4 Unbound and hydraulically bound mixtures Part 4: Test methods for the determination of the laboratory reference density and water content. Vibrating Hammer

BS EN 13286-5 Unbound and hydraulically bound mixtures Part 5: Test methods for the determination of the laboratory reference density and water content. Vibrating Table

BS EN 13286-45 Unbound and hydraulically bound mixtures Part 45: Test method for the determination of the workability period of hydraulically bound mixtures

BS EN 13286-48 Unbound and hydraulically bound mixtures Part 48: Test method fort he determination of degree of pulverisation

BS PD CLC/TR 50426 Assessment of inadvertent initiation of bridge wire electro-explosive devices by radio-frequency radiation. Guide

CC-GSW-04008 Guidelines for the Use of the Falling Weight Deflectometer in Ireland

CC-GSW-04009 Falling Weight Deflectometer Setup and Quality Assurance for Works Performance Assessment of Unbound Granular Mixtures

CC-SCD-00603 Earthworks - Rounding of Earthworks Slopes

CC-SCD-00604 Earthworks - Treatment of Abandoned Watercourse and/or Ditch

CC-SCD-00605 Earthworks - Benching for Embankment of Sloping Ground

CC-SCD-00608 Earthworks - Fill Against Existing Embankment

CC-SPW-00100 Preliminaries

CC-SPW-00400 Specification for Road Restraints Systems (Vehicle and Pedestrian)

CC-SPW-00500 Drainage and Service Ducts

CC-SPW-00700 Road Pavements - General

CC-SPW-00800 Road Pavements - Unbound and Hydraulically Bound Mixtures

CC-SPW-00900 Road Pavements - Bituminous Materials

CC-SPW-01700 Structural Concrete

CC-SPW-02400 Brickwork, Blockwork and Stonework

CC-SPW-02500 Special Structures

CC-SPW-02600 Miscellaneous

DN-PAV-03021 Analytic Pavement & Foundation Design

EN ISO 10319 Geosynthetics - Wide-width tensile test

EN ISO 11058 Geotextiles and geotextile-related products - Determination of water permeability characteristics normal to the plan, without load

EN ISO 12236 Geosynthetics - Static puncture test (CBR test)

EN ISO 12956 Geotextiles and geotextile-related products - Determination of the characteristic opening size

European Union (Waste Directive) Regulations 2011-2020

S.I. No. 126 of 2011 European Communities (Waste Directive) Regulations

S.I. No. 323 of 2020 European Union (Waste Directive) Regulations

I.S. EN 197-1 Cement - Part 1: Composition, specifications and conformity criteria for common cements

I.S. EN 459-1 Building lime - Part 1: Definitions, specifications and conformity criteria

I.S. EN 459-2 Building lime - Part 2: Test methods

I.S. EN 932-1 Tests for general properties of aggregates - Part 1: Methods for sampling

I.S. EN 933-1 Tests for geometrical properties of aggregates - Part 1: Determination of particle size distribution- Sieving method

I.S. EN 933-11 Tests for geometrical properties of aggregates - Part 11: Classification test for the constituents of coarse recycled aggregate

I.S. EN 1097-2 Tests for mechanical and physical properties of aggregates - Part 2: methods for the determination of resistance to fragmentation

I.S. EN 1097-5 Tests for mechanical and physical properties of aggregates - Part 5: Determination of the water content by drying in a ventilated oven

I.S. EN 1097-6 Tests for mechanical and physical properties of aggregates – Part 6: Determination of particle density and water absorption

I.S. EN 1367-2 Tests for Thermal and weathering properties of aggregates - Part 2: Magnesium sulphate test

I.S. EN ISO 1461 Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods

I.S. EN 1537 Execution of special geotechnical works- Ground anchors

I.S. EN 1744-1 Tests for chemical properties of aggregates - Part 1: Chemical analysis

I.S. EN 10025 Hot rolled products of structural steels

I.S. EN 10088-2 Stainless steels - Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes

I.S. EN 10223-3 Steel wire and wire products for fencing and netting Part 3: Hexagonal steel wire mesh products for civil engineering purposes

I.S. EN 10223-8 Steel wire and wire products for fencing and netting - Part 8: Welded mesh gabion products

I.S. EN 10244-1 Steel wire and wire products - Non-ferrous metallic coatings on steel wire - Part 1: General principles

I.S. EN 10244-2 Steel wire and wire products - Non-ferrous metallic coatings on steel wire - Part 2: Zinc or Zinc alloy coatings

I.S. EN 12224 Geotextiles and geotextile-related products - Determination of the resistance to weathering

I.S. EN 12697-1 Bituminous mixtures - Test methods for hot mix asphalt - Part 1: Soluble binder content

I.S. EN 12697-39 Bituminous mixtures - Test methods for hot mix asphalt - Part 39: binder content by ignition

I.S. EN 13039 Soil improvers and growing media - Determination of organic matter content and ash

I.S. EN 13242 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction

I.S. EN 13249 Geotextiles and geotextile-related products - Characteristics required for use in the construction of roads and other trafficked areas (excluding railways and asphalt inclusion)

I.S. EN 13285 Unbound mixtures - Specifications

I.S. EN 14475 Execution of special geotechnical works - Reinforced fill

I.S. EN 14490 Execution of special geotechnical works - Soil nailing

I.S. EN 14679 Execution of special geotechnical works - Deep mixing

I.S. EN 15237 Execution of special geotechnical works - vertical drainage

I.S. EN 16907 Earthworks

I.S. EN 16907-4 Earthworks - Part 4: Soil treatment with lime and/or hydraulic binders

I.S. EN 17892-1 Geotechnical investigation and testing- Laboratory testing of soil - Part 1: Determination of water content - Amendment 1

I.S. EN 17892-11 Geotechnical investigation and testing - Laboratory testing of soil - Part 11: Permeability tests

I.S. EN 1997-2 Eurocode 7- Geotechnical design - Part 2: Ground investigation and testing

I.S. EN 22477-5 Geotechnical investigation and testing - Testing of geotechnical structures - Part 5: Testing of grouted anchors

I.S. EN ISO 17892-1 Geotechnical investigation and testing - Laboratory testing of soil - Part 1: Determination of water content - Amendment 1

I.S. EN ISO 17892-4 Geotechnical investigation and testing - Laboratory testing of soil Part 4: Determination of particle size distribution

I.S. EN ISO 17892-8 Geotechnical investigation and testing - Laboratory testing of soil Part 8: Unconsolidated undrained triaxial test

I.S. EN ISO 17892-10 Geotechnical investigation and testing - Laboratory testing of soil - Part 10: Direct shear tests

I.S. EN ISO 17892-12 Geotechnical investigation and testing - Laboratory testing of soil - Part 12: Determination of liquid and plastic limits

I.S. EN ISO 18674-3 Geotechnical investigation and testing - Geotechnical monitoring by field instrumentation Part 3: Measurement of displacements across a line: Inclinometers

I.S. EN ISO 18674-4 Geotechnical investigation and testing - Geotechnical monitoring by field instrumentation Part 4 - Measurement of pore water pressure: Piezometers

I.S. EN ISO 22475-1 Geotechnical investigation and testing - Sampling methods and groundwater measurements - Part 1: Technical principles for the sampling of soil, rock and groundwater

I.S. EN ISO 22476-1 Geotechnical investigation and testing - Field testing - Part 1: Electrical cone and piezocone penetration test

I.S. EN ISO 22476-2 Geotechnical investigation and testing - Field testing - Part 2: Dynamic probing

ISO 3310-1 Test sieves technical requirements and testing Part 1: Test sieves of metal wire cloth

ISO 9001 Quality management systems - Requirements

S.R. 21 Annex E.2.4.5 Guidance on the use of I.S. EN 13242:2002+A1:2007 - Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction

S.R. CEN/TS 13286-54 Unbound and hydraulically bound mixtures - Part 54: Test method for the determination of frost susceptibility - Resistance to freezing and thawing of hydraulically bound mixtures

TRL PPR556 Rock engineering guides to good practice: road rock slope excavation

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