GENERAL SPECIFICATION
FOR
CIVIL ENGINEERING WORKS

SECTION 6
EARTHWORKS
SECTION 6

EARTHWORKS

GENERAL

Reclamation 6.01 Reclamation shall comply with Section 21 except as stated in this Section.

Trip-ticket System 6.02 The disposal of construction and demolition materials generated from the Contract shall comply with the Trip-ticket System promulgated by the Environment, Transport and Works Bureau.

GLOSSARY OF TERMS

Areas of fill 6.03 Areas of fill are areas within the Site, including areas in embankments, platforms and slopes and in excavations for structures, pits and trenches, in which fill material is deposited and compacted as part of the permanent work.

Earthworks final surface 6.04 Earthworks final surface is the surface to which the work included in Section 6 is finished.

Inert construction and demolition material 6.05 Inert construction and demolition material shall mean rock, rubble, earth, soil, concrete, asphalt, brick, tile and masonry generated from construction and demolition works.

Earthworks material 6.06 Earthworks material may consist of soil, rock, or inert construction and demolition material on or below the Site at the commencement of the Contract, or which is imported to the Site to carry out the Works.

Formation 6.07 Formation is that part of the earthworks final surface on which a pavement, structure or utility, is constructed, or on which the blinding or bedding for a pavement, structure or utility is placed.

Intermediate areas of fill 6.08 Intermediate areas of fill are areas of fill which are stated in the Contract as such, and in which fill material is deposited and compacted directly into shallow water or onto naturally occurring soft ground.

MATERIALS

Fill material 6.09 (1) Fill material shall consist of naturally occurring or processed material, or inert construction and demolition material, which at the time of deposition is capable of being compacted in accordance with the specified requirements to form stable areas of fill.

(2) Fill material shall not contain any of the following:

(a) Material susceptible to volume change, including marine mud, soil with a liquid limit exceeding 65% or a plasticity index exceeding 35%, swelling clays and collapsible soils,
(b) Peat, vegetation, timber, organic, soluble or perishable material,

(c) Dangerous or toxic material or material susceptible to combustion, and

(d) Metal, rubber, plastic or synthetic material.

(3) The different types of fill material shall have the particle size distributions within the ranges stated in Table 6.1.

(4) Special fill material shall consist of material which has a liquid limit not exceeding 45%, a plasticity index not exceeding 20% and a coefficient of uniformity exceeding 50.

(5) Granular fill material shall consist of clean, hard and durable material including recycled aggregates, rock and concrete.

(6) Rock fill material shall consist of pieces of concrete or hard and durable rock of which the maximum size shall not be greater than three times the minimum dimension of individual pieces and in the opinion of the Engineer not more than 30% by mass is discoloured or shows evidence of decomposition.

(7) The soluble sulphate content of fill material placed within 500 mm of concrete, cement bound material or cementitious material shall not exceed 1.9 grams of sulphate, expressed as SO_3, per litre.

(8) The total sulphate content, expressed as SO_3, of fill material placed within 500 mm of metalwork shall not exceed 0.5% by mass.

(9) Well-graded material shall consist of material that has a coefficient of uniformity exceeding 10.

(10) Uniform-graded material shall consist of material that has a coefficient of uniformity of 10 or less.
Table 6.1: Particle size distributions of fill material

<table>
<thead>
<tr>
<th>Type of fill material</th>
<th>Percentage by mass passing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Size</td>
</tr>
<tr>
<td></td>
<td>400 mm</td>
</tr>
<tr>
<td>Fine fill material</td>
<td>-</td>
</tr>
<tr>
<td>General fill material</td>
<td>-</td>
</tr>
<tr>
<td>Special fill material</td>
<td>-</td>
</tr>
<tr>
<td>Granular fill material</td>
<td>-</td>
</tr>
<tr>
<td>Rock fill material (Grade 200)</td>
<td>100</td>
</tr>
<tr>
<td>Rock fill material (Grade 400)</td>
<td>100</td>
</tr>
</tbody>
</table>

SUBMISSIONS

**Particulars of earthworks**

6.10  (1) The following particulars of the proposed materials and methods of construction for earthworks shall be submitted to the Engineer:

(a) Details of construction plant and haulage vehicles,

(b) Methods of excavation and of deposition and compaction of fill material,

(c) Use of different types of excavated material and sources of imported fill material,

(d) Arrangements for stockpiling, sorting and separating excavated material, earthworks material and fill material, and for reusing and disposing of such materials,

(e) Methods of controlling the moisture content of fill material,

(f) Methods of controlling surface water and groundwater and of protecting earthworks and earthworks material from damage due to water and from weather conditions which may affect the earthworks or earthworks material,

(g) Methods of monitoring groundwater levels, and

(h) Methods of monitoring the ground and structures for movements.

(2) The particulars shall be submitted to the Engineer at least 14 days before the relevant work starts.
Particulars of blasting 6.11

(1) The following particulars of the proposed blasting procedures shall be submitted to the Engineer:

(a) Any conditions or restrictions imposed by the Commissioner of Mines, including copies of applications, licences, permits and correspondence,

(b) Names, qualifications and experience of the persons responsible for the design and supervision of blasting operations,

(c) Location, diameter, inclination and depth of holes to be charged with explosive,

(d) Type and total mass of explosive to be used and its mass and distribution in each hole,

(e) Dimensions of stemming and decking,

(f) Initiation sequence, delay periods and mass of explosive per delay,

(g) Burden and bench height,

(h) Ratio of diameter of explosive to diameter of hole,

(i) Arrangements for and methods of instrumentation and monitoring the effects of blasting,

(j) Details of velocity seismographs, including manufacturer's literature,

(k) Method of controlled blasting,

(l) Details of blasting trials, and

(m) Protective measures.

(2) The particulars, other than particulars relating to blasting trials, shall be submitted to the Engineer at least 48 hours before the relevant blasting starts. Particulars relating to blasting trials shall be submitted to the Engineer at least 14 days before the blasting trials are carried out.

Ownership of earthworks material 6.12

(1) Earthworks material within the Site at the commencement of the Contract shall remain the property of the Employer except as stated in Clause 6.12(2).

(2) Earthworks material that needs to be disposed of by the Contractor shall become the property of the Contractor when it is removed from the Site and shall be disposed of in tips provided by the Contractor, unless otherwise stated in the Contract.
Temporary Works for earthworks 6.13

(1) The design of Temporary Works associated with earthworks, including temporary slopes, stockpiles and drainage, shall be such that the risk of failure is not more than that which would be adopted if the Temporary Works were to be permanent. Allowance may be made in the design of the Temporary Works for the shorter design life and for the risk to persons and property and the surface water and groundwater conditions that are likely to occur during construction.

(2) The Contractor shall provide details to the Engineer to demonstrate that the design of Temporary Works has been considered and incorporated measures, which minimise excavation of materials.

Handling and storage of earthworks material 6.14

(1) Earthworks material shall not be handled or stored in a manner which will result in segregation, deterioration, erosion or instability of the material.

(2) Different types of earthworks material shall be kept separate from each other. Earthworks material that is suitable for use as fill material shall be maintained in a suitable condition and shall not be contaminated.

(3) Material handling and storage areas shall be levelled and well drained. Stockpiles of material shall be sprayed with water or a dust suppression chemical to minimize dust generation.

Protection from water and weather 6.15

(1) Earthworks after site clearance, excavation or filling and earthworks material after excavation shall be kept free of water and shall be protected from damage due to water and from exposure to weather conditions which may affect the earthworks or earthworks material. The measures to be taken shall include the following:

(a) As stated in Clauses 1.19 and 1.20.

(b) Surfaces shall be maintained in a stable condition and shall be formed to falls to shed water and to prevent ponding.

(c) The area of exposed surfaces shall be kept to a minimum.

(2) Excavations for structures, pits and trenches shall not be carried out on or adjacent to slopes unless measures are taken to drain the excavation and to prevent water from the excavation entering the slope.

Earthworks material allowed to become unsuitable or to deteriorate 6.16

(1) Earthworks material which has been used, or is required for use, in the permanent work and which is allowed to become unsuitable such that in the opinion of the Engineer it no longer complies with the specified requirements for that type of material shall be replaced or dealt with by methods agreed by the Engineer.

(2) Earthworks material which is not stated in the Contract to be excavated and which the Contractor causes or allows to deteriorate such that in the opinion of the Engineer the permanent work will be affected shall be replaced or dealt with by methods agreed by the Engineer.

(3) Material provided to replace earthworks material, which has been allowed to become unsuitable, or which the Contractor causes or allows to deteriorate, shall be an equivalent material approved by the Engineer. The replacement material shall have the same volume after compaction as the material replaced.

(4) The material that is to be replaced shall be disposed of by the Contractor.
### Additional excavation and stabilisation 6.17

1. Earthworks material which is not stated in the Contract to be excavated but which in the opinion of the Engineer has inadequate strength, durability or stability shall be dealt with by additional excavation or filling as stated in Clause 6.17(2) or by stabilisation as stated in Clause 6.17(3) or by other methods instructed by the Engineer.

2. Additional excavation shall be carried out and the resulting voids shall be dealt with as follows:

   a. General fill material, fine fill material or special fill material shall be deposited and compacted below areas of fill and below formations other than in rock.

   b. Grade 10 concrete shall be placed and compacted below formations in rock.

   c. Granular fill material shall be deposited below standing water.

3. Stabilisation shall be carried out using rock fill material (Grade 400) deposited directly into the original unstable material and compacted to form a stable foundation on which to construct the subsequent work.

### Removal of earthworks material 6.18

1. Earthworks material that is required for use in the permanent work as fill material shall not be removed from the Site unless permitted by the Engineer. The Contractor shall notify the Engineer before any earthworks material is removed from the Site.

### EXCAVATION

### Disposal of excavated material 6.19

1. The Contractor shall take measures to sort and separate excavated material on site for use in the permanent works as required in the environmental protection measures unless otherwise stated in the Contract. Excavated material, which in the opinion of the Engineer cannot be selected, processed or mixed in a practical manner to make it suitable for use in the permanent works, as fill material shall be disposed of by the Contractor unless otherwise stated in the Contract.

2. Excavated material that is surplus to the requirements of the permanent work shall be disposed of by the Contractor unless otherwise stated in the Contract. The Contractor shall, unless otherwise stated in the Contract, take all practical measures to sort and separate the surplus material according to its nature before disposal as required in the environmental protection measures and dispose of the material off-site using the Trip-ticket System.

### Use of excavated material 6.20

1. Excavated material required for use in the permanent work which is capable of being selected, processed and mixed to make it suitable for use as fill material shall not be used for any other purposes unless permitted by the Engineer.

2. Excavated material that is required for use in the permanent work as fill material and which the Engineer permits to be removed from the Site or used for other purposes shall be replaced by an equivalent material approved by the Engineer. The replacement material shall have the same volume after compaction as the material replaced.
**Obstructions in excavations** 6.21

(1) The Contractor shall inform the Engineer without delay of the nature and location of any unforeseen obstruction encountered during excavation.

(2) Boulders that intersect the earthworks final surface or formation shall be dealt with as excavation proceeds by methods agreed by the Engineer. Boulders shall not be left protruding unless permitted by the Engineer.

**Excavation** 6.22

(1) Temporary supports or other methods shall be used to maintain excavations in a stable condition and to prevent settlement of structures or utilities due to excavation or dewatering.

(2) Construction plant or other vehicles shall not be operated or parked adjacent to excavations and earthworks material or other materials shall not be placed adjacent to excavations unless this has been allowed for in the design of the Temporary Works for the support of the excavation.

**Excavations adjacent to structures and utilities** 6.23

(1) Excavations shall be carried out by hand adjacent to utilities that are known, proven or suspected to exist.

(2) Unless otherwise permitted by the Engineer excavations next to structures shall be carried out by hand.

**Excavations for structures, pits and trenches** 6.24

(1) Excavations for structures, pits and trenches shall be the minimum size necessary to construct the permanent work. The sides of excavations shall be vertical unless otherwise permitted by the Engineer.

(2) The length of trench excavation left open at any one time shall not exceed that agreed by the Engineer.

(3) Unless permitted by the Engineer, trenches for utilities in fill areas shall not be excavated until the fill material has been deposited and compacted up to the earthworks final surface or formation or up to 1 m above the top of the utility, whichever is lower.

**BLASTING TRIALS**

**Blasting trials** 6.25

(1) Blasting trials shall be carried out for each proposed blasting procedure to demonstrate that:

(a) The procedure is safe,

(b) The resulting ground vibrations at locations stated in the Contract or instructed by the Engineer can be satisfactorily predicted, recorded and are within acceptable limits, and shall not adversely affect the safety and stability of adjoining structures, installations, slopes and land, and

(c) The specified tolerances for earthworks final surfaces and formations can be achieved.

(2) Blasting trials shall be completed at least 7 days before the related blasting starts.
(3) Blasting trials shall be carried out in accordance with the trial procedure submitted to and agreed by the Engineer. The location and size of blasting trials shall be as agreed by the Engineer.

**Controlled blasting trials**

6.26 Blasting trials for pre-splitting and other methods of controlled blasting shall be carried out to form a face at least 6 m wide by 6 m high. The blasting trials shall be carried out on rock which has similar properties to that of the earthworks final surface and which is at least 6 m away from the earthworks final surface.

**Results of blasting trials**

6.27 If in the opinion of the Engineer any aspect of the proposed blasting procedure as demonstrated by blasting trials is unsatisfactory, particulars of proposed changes to the procedure shall be submitted to the Engineer. Further blasting trials shall be carried out until the procedure is satisfactory.

**Commencement of blasting**

6.28 Blasting shall not proceed until in the opinion of the Engineer the procedure as demonstrated by the relevant blasting trials is satisfactory.

**Changes in blasting procedure**

6.29 Unless permitted by the Engineer, the satisfactory blasting procedure shall not be changed. Further blasting trials shall be carried out to demonstrate proposed changes to the procedure unless otherwise permitted by the Engineer.

**BLASTING**

**Statutory requirements for blasting**

6.30 Blasting operations and the supply, transportation, storage, use and disposal of explosives shall be in accordance with conditions and restrictions imposed by the Commissioner of Mines. The Contractor shall make all arrangements with and obtain all licences and permits from the Commissioner of Mines in connection with blasting operations.

**Recording vibrations due to blasting**

6.31 (1) Measurements of vibrations due to blasting shall be taken at locations stated in the Contract or instructed by the Engineer at all times when blasting is carried out. Records of the vibrations shall be kept by the Contractor on the Site and a copy provided for the Engineer. Arrangements for installing instruments and taking measurements both inside and outside the Site shall be made by the Contractor.

(2) Vibrations due to blasting shall be measured in terms of peak particle velocity, peak particle acceleration and vibrational amplitude. The peak values shall be taken as the maximum resultant calculated by vector summation of the three components of velocity and amplitude respectively, measured as instantaneously as the resolution of the recording instrument permits.

(3) Measurements shall be made with velocity seismographs of a type agreed by the Engineer. Seismographs shall be capable of:

(a) Recording vibrations in terms of peak particle velocity and vibrational amplitude over a frequency of 0 – 200 Hz in three mutually perpendicular directions, and

(b) Producing a permanent record of vibrations by tracing an ultra-violet light beam on sensitised paper, or by other methods agreed by the Engineer.
6.11

(4) The accuracy of seismographs shall be checked before blasting trials are carried out and at regular intervals agreed by the Engineer.

Preparatory work for blasting  6.32
Before assessments of blasting safety precautions are made, all vegetation, overburden and soft or loose material shall be removed to expose the rock that is to be blasted.

Notification of blasting  6.33
The Contractor shall notify the Engineer by not later than noon of the previous day of his intention to bring any explosives to the Site or to carry out any blasting.

Storage of explosives  6.34
Explosives and detonators shall not be stored on the Site overnight unless permitted by the Commissioner of Mines. Explosives and detonators which are not used by the end of each day shall be disposed of as stipulated by the Commissioner of Mines.

Restrictions on blasting times  6.35
Blasting shall not be carried out at the following times:

(a) On General Holidays,
(b) Before 8:30 a.m. or after 5:30 p.m. on any day,
(c) Unless permitted by the Commissioner of Mines, when a Hong Kong Observatory thunderstorm warning is in force, and
(d) Unless permitted by the Commissioner of Mines, when strong wind signal or storm signal No. 3 or higher is hoisted.

Blasting  6.36
(1) Unless otherwise permitted by the Commissioner of Mines, screens and other protective covers shall be erected to prevent the projection of flying fragments of material resulting from blasting. The screens shall be constructed using wire mesh securely supported on steel frames. The nominal diameter of the wire shall be at least 3.5 mm and the wire mesh size shall not exceed 25 mm.

(2) Unless permitted by the Commissioner of Mines, plaster blasting shall not be used.

(3) Unless otherwise permitted by the Commissioner of Mines blast holes shall be stemmed and decked using free-flowing granular material. Charges shall be covered with thick gunny sacking and 2 m by 2 m squares of steel fabric reinforcement weighed down with filled sandbags. Surface detonating cords, knots, detonating relay conductors and initiating detonators shall be covered with a 300 mm thickness of sand or soil.

(4) Unless permitted by the Commissioner of Mines electrical detonators shall not be used within 60 m of overhead power lines. The use of electrical detonators in the vicinity of static or mobile radio transmitters shall comply with BS 6657.

(5) Unless otherwise permitted by the Commissioner of Mines delay blasting with millisecond delays shall be used for all blasting, except as stated in Clause 6.37(5).

(6) Unless permitted by the Engineer blasting shall not be carried out within a distance of:
(a) 60 m from water retaining structures or water tunnels, and
(b) 6 m from water mains or other water supply structures or installations.

(7) Unless permitted by the Engineer the vibrations at structures and installations due to blasting measured in terms of peak particle velocity and vibrational amplitude shall not exceed the values stated in Table 6.2.

(8) Unless otherwise permitted by the Engineer, the vibration at adjoining slopes and land due to blasting measured in terms of peak particle acceleration and peak particle velocity shall not exceed the values stated in the Contract.

Table 6.2: Restrictions on peak particle velocity and vibrational amplitude

<table>
<thead>
<tr>
<th>Type of structure or Installation</th>
<th>Peak particle velocity (mm/s)</th>
<th>Vibrational amplitude (mm)</th>
</tr>
</thead>
</table>
| Water retaining structures
  Water tunnels                    | 13                           | 0.1                       |
| Water mains
  Other structures and pipes     | 25                           | 0.2                       |

**Controlled blasting** 6.37

(1) Earthworks final surfaces which are to be formed by blasting and which slope at a gradient exceeding 2 vertical to 1 horizontal and exceed 3 m in height shall be formed by pre-splitting. Other methods of controlled blasting shall not be used unless permitted by the Engineer.

(2) Pre-splitting and other methods of controlled blasting shall be carried out in such a manner that the rock mass is cleanly split on the required plane to within the specified tolerances and such that rock outside the earthworks final surface is not shattered or loosened.

(3) Faces formed by pre-splitting or other methods of controlled blasting shall not exceed 15 m in height in any one blasting operation unless permitted by the Engineer.

(4) If an earthworks final surface is to be formed by pre-splitting or other methods of controlled blasting:

(a) Other blast holes shall be located at a sufficient distance from the earthworks final surface to avoid damaging the surface, and

(b) The row of blast holes nearest to that surface shall be parallel to the row of pre-splitting holes.

(5) Pre-splitting shall consist of a single row of holes drilled at the appropriate inclination along the line of the earthworks final surface. The holes shall be loaded with explosives not exceeding half the diameter of the hole. The explosives shall be detonated simultaneously or with the minimum amount of delay necessary to reduce ground vibrations.
(6) Holes for pre-splitting shall be at least 50 mm diameter and the ratio of the distance between the centre of the holes and the diameter of the hole shall not exceed 10. The holes shall be within a distance of 0.015 times the length of the hole from their designed position.

(7) Holes for pre-splitting shall not be drilled into the sub-grade below berm levels. Rock that remains in position on berms after blasting shall be removed by methods other than blasting.

---

DEPOSITION OF FILL MATERIAL

**Types of fill material** 6.38

Unless otherwise stated in the Contract, areas of fill shall be formed of general fill material.

**Sources of fill material** 6.39

Except in public filling area as stated in Clause 6.58, fill material shall be obtained from excavation within the Site. If there is insufficient fill material of the required types within the Site, imported fill material shall be provided by the Contractor from sources outside the Site.

**Surface preparation for fill material** 6.40

Except as stated in Clause 6.56, surfaces on which fill material is to be deposited shall be prepared after site clearance in accordance with the following requirements:

(a) Topsoil, grass, and other organic matter shall be removed.

(b) Soft spots, boulders and other materials, which in the opinion of the Engineer are unsuitable or unstable, shall be removed.

(c) Watercourses shall be diverted as stated in the Contract.

(d) Benches shall be cut and sub-soil drainage systems installed as stated in the Contract.

(e) Voids shall be dealt with as stated in the Contract or instructed by the Engineer.

(f) Surfaces other than rock shall be scarified to a depth of 200 mm and compacted to the same standard as the fill material that is to be deposited.

**Commencement of deposition of fill material** 6.41

The permission of the Engineer shall be obtained before deposition of fill material starts in any area of fill.

**Haulage of fill material** 6.42

Haulage of fill material to an area of fill shall proceed only when the compaction plant operating at the area to be filled is sufficient to achieve the specified requirements for relative compaction of the fill material.

**Deposition of fill material** 6.43

(1) Fill material obtained from excavations within the Site shall be deposited in its final location as soon as practicable after it has been excavated.

(2) Fill material shall be deposited in layers of a thickness appropriate to the compaction method to be used. In deposition of fill material, the Contractor shall ensure that a good bond is achieved between layers of fill, and unless otherwise directed by the Engineer, no material shall be placed
on previously compacted layers unless the surface has been scarified or otherwise broken up and, if necessary, watered.

(3) Unless otherwise permitted by the Engineer, layers of fill material shall be horizontal, except for any gradient required for drainage, and the thickness of each layer shall be uniform over the area to be filled. The fill material shall be brought up from the bottom in uniform horizontal layers, with the top of each layer graded to enable surface water to drain readily.

(4) Except in excavations for structures, pits and trenches, if the difference in level between adjacent areas to be filled exceeds 1 m, the edge of the higher area shall be benched before fill material is placed against it.

(5) Execution of the Works shall be controlled in such a manner that any compaction of the fill material resulting from the passage of construction plant or haulage vehicles is uniform.

(6) Except as stated in Clause 6.56, fill material shall not be deposited by end-tipping, by pushing loose material down slope faces or by other methods which may result in segregation or inadequate compaction of the fill material.

**Overfilling**

6.44

In areas of fill formed of material other than rock fill material, earthworks final surfaces sloping at a gradient exceeding 1 vertical to 3 horizontal shall be formed by overfilling and cutting back after compaction. Over-filling shall extend beyond the earthworks final surface by a horizontal distance of 0.5 m or three times the thickness of the compacted layer, whichever is greater.

**Deposition of fill material adjacent to structures and utilities**

6.45

(1) Except as stated in Clause 6.45(4), fill material deposited within 0.5m of a structure or utility shall be fine fill material unless otherwise stated in the Contract. In addition, the material may contain up to 5% by weight of fresh, slightly decomposed or moderately decomposed rock fragments of up to 200 mm provided that these do not cause any damage to structures, nor do they interfere with the compaction requirements.

(2) Fill material shall not be deposited adjacent to or above structures or utilities until the construction of the structure or utility is sufficiently advanced to accept the imposed forces without disturbance or damage.

(3) Fill material shall be deposited evenly on all sides of structures and utilities and in such a manner that the structure or utility is not disturbed or damaged.

(4) Unless otherwise stated in the Contract, fill material around water, sewage and drainage pipes which are laid as part of the permanent work shall be special fill material. They shall be deposited in layers not exceeding 100 mm thick to a level of 300 mm above the top of the pipe. The fill material shall be deposited in such a manner that the layer on one side of the pipe is not more than 100 mm higher than the layer on the other side.
Deposition of rock fill material 6.46

(1) The final compacted thickness of each layer of rock fill material shall exceed 1.5 times and shall not exceed twice the nominal Grade size of the rock fill material.

(2) The surface voids of each layer of rock fill material shall be filled with fragments of rock before the next layer is deposited. The final surface of rock fill material shall also be blinded with fine fill material.

Deposition of fill material in excavations for structures, pits and trenches 6.47

If sheet piling, timbering or other temporary supports to excavations for structures, pits and trenches are not to be left in place, the sheet piling, timbering or supports shall be removed as deposition of fill material proceeds. The supports shall be removed in such a manner that the stability of the adjacent ground is maintained and the compacted fill material is not disturbed.

COMPACATION OF FILL MATERIAL

Compaction of fill material 6.48

(1) Fill material in areas of fill shall be compacted in layers to a stable condition as soon as practicable after deposition and in a manner appropriate to the location and to the material to be compacted.

(2) The permission of the Engineer shall be obtained before the next layer is deposited on each layer of compacted fill material.

(3) Except as stated in Clauses 6.50(2), 6.52(1), 6.54(2), 6.57 and 6.66, fill material shall be compacted to obtain a relative compaction of at least 95% throughout unless otherwise stated in the Contract.

Moisture content of fill material 6.49

Fill material other than rock fill material and material as stated in Clause 6.52(1) shall be at optimum moisture content during compaction. The tolerance on the optimum moisture content percentage shall be ±3%, provided that the fill material is still capable of being compacted in accordance with the specified requirements to form stable areas of fill. All necessary measures shall be taken to achieve and maintain the specified moisture content.

Compaction of fill material adjacent to structures and utilities 6.50

(1) Fill material shall be compacted in such a manner that structures or utilities are not disturbed or damaged.

(2) Fill material around water, sewage and drainage pipes, which are constructed as part of the permanent work, shall be compacted by hand-rammers or manually operated power equipment. Fill material within 300 mm above the top of sewage and drainage pipes shall be compacted to obtain a relative compaction of at least 85% throughout.

Compaction of rock fill material 6.51

(1) Every layer of rock fill material shall be compacted by at least eight passes of a vibrating roller or by other equivalent compaction method approved by the Engineer. The final surface of rock fill material shall be compacted by at least two additional passes of a vibrating roller or by other equivalent compaction method approved by the Engineer.

(2) Vibratory rollers used for the compaction of rock fill material shall have a static load per 100 mm width of roll of at least 2 kN for layers with a compacted thickness not exceeding 500 mm and at least 4 kN for layers with a compacted thickness exceeding 500 mm.
6.16 Compaction of general fill material with a large portion of coarse material

6.52 (1) For general fill material of which less than 90% passes a 20 mm BS test sieve, it is difficult to determine of the moisture content and maximum dry density according to Clauses 6.75(2), 6.75(3), 6.78(2), 6.81(5) and 6.81(6). This type of material shall be compacted to the requirements of Clauses 6.52(2), 6.52(3) and 6.52(4).

(2) Each horizontal layer of general fill material shall be spread and levelled with a thickness not less than 1.5 times the maximum size of the general fill material and not exceeding the maximum depth of compacted layer in accordance with Table 6.2A. If there is a presence of over-sized coarse material in the general fill, the over-sized coarse material shall be removed or broken down to sizes acceptable to the Engineer. Each layer shall be systematically compacted by a vibratory roller with the stipulated minimum number of passes corresponding to the minimum static load per 100 mm width of the roller.

(3) The number of passes of the roller shall only be counted when the roller is travelled on the material to be compacted at a speed of not more than 2 km per hour with full vibration. Plant other than a vibratory roller carrying out material spreading or providing some preliminary compaction, to assist the use of heavier plant, shall be disregarded in counting the number of passes.

(4) Variation from the method or the use of plant different from that specified in Clause 6.52(2) will be permitted only if the Contractor demonstrates at site trials that equivalent compaction is achieved by the alternative method or plant. The procedure to be adopted for these site trials shall be agreed with and approved by the Engineer.

(5) Without prejudice to the provision of the Conditions of Contract and in order that the Engineer may take proper provision for the supervision of compaction in the permanent work, the Contractor shall, not less than 24 hours before he proposes to carry out compaction processes, apply in writing to the Engineer for permission to do so.

(6) When materials of widely divergent grading are used in embankments and fill areas, they shall be spread and compacted in separate clearly defined areas.

(7) If more than one class of material is being used in such a way that in the opinion of the Engineer, it is not practicable to define the areas in which each class occurs, compaction plant shall be operated as if only the material that requires the greatest compaction effort is being compacted.
Table 6.2A: Compaction requirement for general fill material with a large portion of coarse material

<table>
<thead>
<tr>
<th>Force per 100 mm width</th>
</tr>
</thead>
<tbody>
<tr>
<td>(kN)</td>
</tr>
<tr>
<td>0.25 – 0.45</td>
</tr>
<tr>
<td>0.46 – 0.70</td>
</tr>
<tr>
<td>0.71 – 1.25</td>
</tr>
<tr>
<td>1.26 – 1.75</td>
</tr>
<tr>
<td>1.76 – 2.30</td>
</tr>
<tr>
<td>2.31 – 2.80</td>
</tr>
<tr>
<td>2.81 – 3.50</td>
</tr>
<tr>
<td>3.51 – 4.20</td>
</tr>
<tr>
<td>4.21 – 4.90</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Well-graded material</th>
<th>Uniform-graded material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum depth of compacted layer (mm)</td>
<td>Maximum depth of compacted layer (mm)</td>
</tr>
<tr>
<td>Minimum no. of passes</td>
<td>Minimum no. of passes</td>
</tr>
<tr>
<td>125</td>
<td>150</td>
</tr>
<tr>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

COMPLETION OF EARTHWORK SURFACES

Completion of earthwork final surfaces

Completion of formations

6.53

(1) Earthwork final surfaces shall be completed to a stable condition as soon as practicable after excavation or after deposition and compaction of fill material has been completed. The subsequent permanent work or surface protection shall be carried out as soon as practicable after the earthworks final surface has been completed.

(2) Earthworks final surfaces shall be completed to smooth alignments without abrupt irregularities unless otherwise stated in the Contract.

6.54

(1) Formations above structures or utilities shall be completed after construction of the structure or utility.

(2) Except in excavations in rock and in areas of fill formed of rock fill material or fill material as stated in Clause 6.52(1), formations shall be compacted to obtain a relative compaction of at least 98% to a depth of 200 mm below the formation.

(3) Unless otherwise permitted by the Engineer, proof rolling shall be carried out on formations. The formation shall be rolled in the presence of the Engineer by at least two passes of a non-vibrating rubber tyred roller. The roller shall have a static load per 100 mm width of roll of at least 4 kN and shall travel at a speed not exceeding 2 km/h. Any defect in the formation which is revealed during proof rolling by deformation of the formation which in the opinion of the Engineer is excessive shall be made good as instructed by the Engineer.

(4) After all other formation work and testing have been completed and damage caused by testing reinstated, formations for pavements shall be rolled with one pass of a smooth steel-wheeled non-vibrating roller. The roller shall have a load per 100 mm width of roll of at least 2 kN.

(5) Unless otherwise permitted by the Engineer, formation surfaces that will not be immediately covered by the subsequent permanent works shall be protected by methods agreed by the Engineer.
Protection of earthwork final surfaces and formations 6.55

(1) Earthwork final surfaces and formations shall be maintained in a stable condition and shall be protected from damage due to water or other causes and from exposure to conditions which may adversely affect the surface.

(2) Formation shall not be used by construction plant or vehicles other than those which, in the opinion of the Engineer, are essential to construct the subsequent work.

INTERMEDIATE AREAS OF FILL

Deposition of fill material in intermediate areas of fill 6.56

Fill material may be deposited in intermediate areas of fill by end-tipping or by pushing into position until, in the opinion of the Engineer, it is sufficient to form a stable foundation on which to construct the subsequent work.

Compaction of fill material in intermediate areas of fill 6.57

Fill material in intermediate areas of fill up to the level stated in Clause 6.56 shall be compacted to a degree, which in the opinion of the Engineer is practicable. Except as stated in Clause 6.52(1), fill material above the level stated in Clause 6.56 shall be compacted to obtain a relative compaction of at least:

(a) 90% throughout,

(b) 95% within 1.5 m of earthworks final surfaces and formations, and

(c) 98% within 200 mm of formations.

EARTHWORKS IN PUBLIC FILLING AREA

Public filling area 6.58

Public filling area shall mean any area or portion of earthworks/reclamation works to receive inert construction and demolition material, and other materials disposed of by the public as stated in the Contract.

Public fill 6.59

Public fill shall mean inert construction and demolition material that is disposed of at a public filling area.

Combined reception and exit offices 6.60

(1) Combined reception and exit offices for the operation of a public filling area shall be provided at the location shown on the Drawings.

(2) The Contractor shall design and provide the combined reception and exit office in accordance with the schematic layout shown on the Drawings. The combined reception and exit office shall comply with the following requirements:

(a) Each shall consist of two floors and shall be constructed on a 1300mm high raised hollow platform. The upper floor is an inspection cabin, which shall be designed to withstand at least 5kPa live load and equipped with staircases and guard railings.
(b) Windows of sliding type with locks and security bars shall be provided at the sides to enable a clear view of the approaching traffic. All windows shall be provided with venetian blinds.

(c) Collision barriers, collision bollards, separation barriers, red/green light type automatic signaling system and drop-bars shall be provided as shown on the Drawings.

(d) An overhead water-spraying system shall be installed at each of the reception hallways. It shall consist of groups of nozzles and shall be supported firmly with posts standing on the ground. Each overhead water-spraying system shall be capable of emitting 100 litres of water in 30 seconds.

(e) The roof and all walls shall be fully lined, well insulated, waterproof and painted.

(f) All doors shall have secure and efficient locks.

(g) A surveillance system shall be installed in each combined reception and exit office at locations agreed by the Engineer. The surveillance system shall consist of closed circuit digital colour video camera, closed circuit video duplex multiplexer and the accessories with schedule as stated in the Contract. The surveillance system shall be operated in accordance with Clause 6.60(3).

(h) Weighbridge system shall be installed at each combined reception and exit office at locations as agreed with the Engineer to measure and record the weight of each and every dump truck using the public filling area. The weighbridge system shall be calibrated by a suitable method and at frequency as agreed with the Engineer.

(3) The surveillance system shall be operated as follows:

(a) The camera of the surveillance system shall allow continuous recording and close surveillance of activities within the public filling area during the operation hours.

(b) Images captured by the cameras shall be continuously recorded by DVD recorders. Each recorded DVD shall be kept for at least 6 months. The Contractor shall insert and replace the DVD for the surveillance system so as to ensure the continuous recording of the operation activities.

(c) The position and angle of each camera of the surveillance system shall be as instructed by the Engineer. The Contractor shall be responsible for any relocation and/or adjustment required.

(4) Detailed proposals for the combined reception and exit offices shall be submitted by the Contractor to the Engineer for approval within 14 days of the date for commencement of the Works. The proposal shall include locations, layouts, associated facilities and construction details.
(5) Within 28 days of the date of approval by the Engineer, the Contractor shall complete the construction of the combined reception and exit offices that shall be ready for occupation and operation.

(6) The combined reception and exit offices shall be maintained in a clean, stable and secure condition daily.

(7) Equipment provided for the use of the Engineer shall be maintained in a clean and serviceable condition and all consumables shall be replenished as instructed by the Engineer.

(8) The permission of the Engineer shall be obtained before the combined reception and exit office or equipment is removed. The combined reception and exit office or equipment which are to be left in position or become the property of the Employer after completion of the Works shall be repaired, repainted and serviced as instructed by the Engineer.

**Reception areas, queuing areas and access roads**

6.61 (1) Reception areas, queuing areas and access roads shall be provided in accordance with the Drawings.

(2) The Contractor shall operate and maintain reception areas, queuing areas and access roads complying with the following requirements:

   (a) The riding surfaces shall be kept in good condition without excessive bumps and depressions,

   (b) The surfaces shall be kept in wet condition so as to minimize dust generation,

   (c) The surfaces shall be kept free of grease, debris and the like, and

   (d) Measures shall be taken to prevent ponding and flooding.

**Management of dump truck movements**

6.62 (1) The Contractor shall manage entry to and exit from the public filling area to:

   (a) Maintain orderly traffic conditions at the reception areas, queuing areas and access roads,

   (b) Ensure all dump trucks are inspected and weighed at the combined reception and exit offices before and after deposition. In the event that the materials carried by a dump truck are inspected as not acceptable, the Contractor shall direct the dump truck to leave the Site as instructed by the Engineer, and

   (c) Direct dump trucks to the designated deposition point for deposition.

(2) The maximum speed of dump trucks within the public filling area shall be restricted to 10km per hour.

Upon instruction by the Engineer, the Contractor shall within three hours tow away any broken down dump truck from an operation area to a safe area within the Site as agreed with the Engineer so as not to disrupt the operation of the public filling area.
(3) The Contractor shall supply and erect temporary traffic signs, including speed limit signs, for directing dump trucks and traffic diversion within the public filling area.

Temporary haul roads and drains 6.63

(1) The Contractor shall provide and maintain temporary haul roads and drains to suit the programme of deposition and shall remove all temporary drainage systems after the Works. Lighting facilities shall be provided along the temporary haul roads and at each deposition point to ensure safe operation.

(2) The Contractor shall design the temporary haul roads and drains to ensure good riding condition and safety. All temporary haul roads shall be paved with granular material. The Contractor shall submit the details of the proposed temporary haul roads and drains to the Engineer for agreement 14 days before implementation or commencement of associated work whichever is earlier.

(3) The Contractor shall grade, regulate and compact all temporary haul roads as instructed by the Engineer to prevent undulation.

Handling and storage of wet soil 6.64

(1) Public fill may consist of wet soil. Wet soil may be any naturally occurring or processed material, which at the time of deposition is unable to be compacted in accordance with the specified requirements to form a stable area of fill.

(2) The Contractor shall plan the Works by allowing stockpiling space as agreed with the Engineer for handling wet soil. The Contractor shall process the wet soil received including mixing it with public fill to make it suitable for compaction and use in the Works. The processed material shall be handled and stored in accordance with Clause 6.14. The proposed method of processing and mixing shall be agreed with the Engineer at least 7 days before any processing and mixing starts.

Deposition of public fill 6.65


Compaction of public fill 6.66

(1) In addition to Clauses 6.48(1), 6.48(2) and 6.50(1), public fill shall be compacted to the requirements of Clauses 6.66(2), 6.66(3) and 6.66(4). The Contractor shall submit the proposed method of compaction including the proposed compaction plant, thickness of compacted layer and minimum number of passes to the Engineer for approval at least 7 days before any compaction starts.

(2) Each horizontal layer of public fill shall be spread and levelled with a thickness not exceeding the maximum depth of a compacted layer in accordance with Table 6.2B. Each layer shall be systematically compacted by the compaction plant with the minimum number of passes approved by the Engineer.

(3) Definitions and requirements associated with Table 6.2B are as follows:

(a) Where combinations of different types or categories of plant are used, the compaction requirements shall be:

- The depth of layer shall be that for the type of plant requiring the least depth of layer; and

6.21
- The number of passes shall be that for the type of plant requiring the greatest number of passes.

(b) The number of passes of the roller shall only be counted when the roller is travelled on the materials to be compacted at a speed of not more than 2 km per hour with full vibration where appropriate.

(c) The plant other than the approved compaction plant by the Engineer as stated in Clause 6.66(1) to carry out material spreading or to provide some preliminary compaction only to assist the use of heavier plant shall be disregarded in counting the number of passes.

(d) The force per 100 mm width is the total weight on the roll divided by the total roll width. Where a smooth-wheeled roller has more than one axle the machine will be assessed on the basis of the axle giving the highest value of force per 100 mm width.

(e) Wheel load is the total weight of the roller divided by the number of wheels.

(f) Vibratory rollers are machines having means of applying mechanical vibration to one or more rolls.

- The requirements for vibratory rollers are based on the use of the lowest gear on a self-propelled machine and a towing speed of 1800 - 2400 m/hour for a towed machine. If higher gears or speed are used, an increased number of passes shall be provided in proportion to the increase in speed of travel.

- Vibratory rollers operating without their vibration mechanism in use will be classified as smooth-wheeled rollers.

- Vibratory rollers shall only be operated with their vibration mechanism operating at the frequency of vibration recommended by the manufacturers. All such rollers shall be equipped with a device automatically indicating the frequency at which the mechanism is operating.

(g) Vibrating-plate compactors are machines having a base-plate to which a source of vibration consisting of one or two eccentrically weighted shafts is attached.

- The static pressure under the plate of a vibrating-plate compactor is calculated by dividing the total weight of the machine in working order by the area in contact with compacted material.

- Vibrating-plate compactors shall be operated at the frequency of vibration recommended by the manufacturer. They shall normally be operated at travelling speeds of
less than 900 m/hour but, if higher speeds are necessary, the number of passes shall be increased in proportion to the increase in speed of travel.

(h) 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.

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

(4) Variation from the methods or the use of plant different from that specified in Clause 6.66(2) will be permitted only if the Contractor demonstrates by site trials that equivalent compaction effect is achieved by the alternative method or plant. The procedure to be adopted for these site trials shall be agreed with and approved by the Engineer.

(5) Without prejudice to the provision of the Conditions of Contract and in order for the Engineer to make proper provision for the supervision of compaction in the permanent work, the Contractor shall, not less than 24 hours before he proposes to carry out compaction processes, apply in writing to the Engineer for permission to do so.
## Table 6.2B: Compaction requirement

<table>
<thead>
<tr>
<th>Type of compaction plant</th>
<th>Category</th>
<th>Maximum depth of compacted layer (mm)</th>
<th>Minimum no. of passes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smooth-wheel roller</td>
<td>Force per 100 mm width</td>
<td>2.1 – 2.6 kN</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.61 – 5.2 kN</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More than 5.2 kN</td>
<td>150</td>
</tr>
<tr>
<td>Grid-roller</td>
<td>Force per 100 mm width</td>
<td>5.3 – 7.8 kN</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More than 7.8 kN</td>
<td>150</td>
</tr>
<tr>
<td>Pneumatic-tyre roller</td>
<td>Wheel load</td>
<td>2 - 2.5 tonnes</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.6 - 4 tonnes</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 - 6 tonnes</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 - 8 tonnes</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 - 12 tonnes</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More than 12 tonnes</td>
<td>175</td>
</tr>
<tr>
<td>Vibratory roller</td>
<td>Force per 100 mm width</td>
<td>0.71 – 1.25 kN</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.26 – 1.75 kN</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.76 – 2.3 kN</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.31 – 2.8 kN</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.81 – 3.5 kN</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.51 – 4.2 kN</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.21 – 4.9 kN</td>
<td>250</td>
</tr>
<tr>
<td>Vibratory-plate compactor</td>
<td>Static pressure under base plate (kN/m²)</td>
<td>13.8 - 17.2</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17.3 - 20.7</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More than 20.7</td>
<td>200</td>
</tr>
<tr>
<td>Vibro-tamper</td>
<td>Mass (kg)</td>
<td>50 – 65</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>66 – 75</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More than 75</td>
<td>150</td>
</tr>
<tr>
<td>Power rammer</td>
<td>Mass (Kg)</td>
<td>More than 500</td>
<td>275</td>
</tr>
</tbody>
</table>

**Use of fill material adjacent to structures and utilities in public filling area**

6.67 Fill material shall be used adjacent to structures and utilities in public filling areas as stated in the Contract. Fill material shall comply with Clause 6.09. The use of fill material shall comply with Clauses 6.45, 6.47 and 6.50.
TOLERANCES

6.68 Earthworks final surfaces and formations shall be within the tolerances of the specified lines and levels stated in Table 6.3. The tolerances for formations do not apply to pipes or preformed structures that require to be supported over their complete length or area.

(2) In excavation, a positive tolerance refers to insufficient excavation and a negative tolerance refers to excess excavation. In areas of fill, a positive tolerance refers to excess fill material and a negative tolerance refers to insufficient fill material.

Table 6.3: Tolerances for earthworks final surfaces and formations

<table>
<thead>
<tr>
<th>Type of surface</th>
<th>Method of forming surface</th>
<th>Tolerance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Formations for structures and utilities</td>
<td>Excavation except in rock</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Excavation in rock</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Deposition and compaction of fill material</td>
<td>0</td>
</tr>
<tr>
<td>Formations for pavements, including carriageways, footways, cycletracks, paved areas, aircraft pavements and railway trackbeds.</td>
<td>Excavation except in rock</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Excavation in rock</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Deposition and compaction of fill material</td>
<td>0</td>
</tr>
<tr>
<td>Earthworks final surfaces other than formations, with a gradient not exceeding 1 vertical to 10 horizontal</td>
<td>Excavation except in rock</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Excavation in rock</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Deposition and compaction of fill material</td>
<td>0</td>
</tr>
<tr>
<td>Other earthworks final Surfaces</td>
<td>Excavation except in rock</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Excavation in rock</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Deposition and compaction of fill material</td>
<td>100</td>
</tr>
</tbody>
</table>
A batch of fill material is any quantity of fill material of the same type and which in the opinion of the Engineer has similar properties throughout. For the purpose of testing for moisture content and relative compaction a batch shall, in addition to the above, be fill material which is deposited in a single layer in any area of fill presented by the Contractor for testing on one occasion.

(1) Each sample of fill material shall consist of at least four increments taken from different parts of the batch. The increments shall be combined and thoroughly mixed and shall then be divided by quartering or by using a riffle box to obtain specimens of an appropriate size to carry out the individual tests.

(2) The size of samples of fill material other than rock fill material shall be in accordance with Geospec 3, Clauses 2.5.1, 4.2 and Table 2.1. Each sample of rock fill material of Grade size not exceeding 200 shall have a mass of at least 250 kg and each sample of rock fill material of Grade size exceeding 200 shall have a mass of at least 1000 kg.

Samples of fill material to be tested for particle size distribution, liquid limit, plasticity index, coefficient of uniformity and sulphate content shall be delivered at least 14 days, or such shorter period agreed by the Engineer, before deposition of the fill material starts. The number of samples to be provided from each batch shall be as stated in Table 6.4.

Table 6.4: Number of samples to be tested for particle size distribution, liquid limit, plasticity index, coefficient of uniformity, sulphate content, optimum moisture content and maximum dry density

<table>
<thead>
<tr>
<th>Description</th>
<th>Size of batch</th>
<th>No. of samples per batch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special fill material</td>
<td>0 - 3,000 m³</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Exceeding 3,000 m³</td>
<td>1 for each 1,000 m³ or part thereof</td>
</tr>
<tr>
<td>Fill material other than special fill material</td>
<td>0 - 15,000 m³</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Exceeding 15,000 m³</td>
<td>1 for each 5,000 m³ or part thereof</td>
</tr>
</tbody>
</table>
6.27

Testing: particle size distribution, liquid limit, plasticity index, coefficient of uniformity, sulphate content

(1) Each sample of fill material taken as stated in Clause 6.71 shall be tested to determine the particle size distribution. In the case of special fill material, testing shall include calculation of the coefficient of uniformity as stated in Clause 6.72(4). Unless otherwise agreed by the Engineer, each sample of fill material other than rock fill material shall be tested to determine the liquid limit and the plasticity index of that portion of the fill material passing a 425µm BS test sieve. Each sample of fill material, which will be deposited within 500 mm of concrete, cement, bound material, cementitious material or metalwork shall be tested to determine the soluble sulphate content.

(2) The method of testing shall be in accordance with the following:

- Particle size distribution: Clause 6.72(3)
- Liquid limit: Test Method 6.1 of Geospec 3
- Plasticity index: Test Method 6.1 of Geospec 3
- Soluble sulphate content: Test Method 9.3 of Geospec 3
- Total sulphate content: Test Method 9.3 of Geospec 3

(3) The particle size distribution of fill material passing a 75 mm BS test sieve shall be determined in accordance with Geospec 3, Test Method 8.1 or 8.2, whichever as instructed by the Engineer. The size of particles of fill material, which do not pass a 75 mm BS test sieve, shall be taken as the largest dimension measured in any plane.

(4) The coefficient of uniformity (Cu) shall be calculated from the equation:

\[ Cu = \frac{D_{60}}{D_{10}} \]

where:

- \(D_{60}\) and \(D_{10}\) are the equivalent sieve sizes in millimetres, interpolated from the particle size distribution curve, through which 60% and 10% of the fill material would pass respectively.

6.73

Non-compliance: particle size distribution, liquid limit, plasticity index, coefficient of uniformity, sulphate content

(1) If the result of any test for soluble sulphate content of fill material does not comply with the specified requirements for soluble sulphate content, each sample shall be tested to determine the total sulphate content.

(2) If the result of any test for particle size distribution, liquid limit, plasticity index, coefficient of uniformity or total sulphate content of fill material does not comply with the specified requirements for the property, additional samples shall be provided from the same batch and additional tests for the property shall be carried out. The number of additional samples shall be as stated in Table 6.4.
TESTING: FILL MATERIAL - OPTIMUM MOISTURE CONTENT AND MAXIMUM DRY DENSITY

Samples: optimum moisture content, maximum dry density

6.74 (1) Samples of fill material to be tested for optimum moisture content and maximum dry density shall be delivered at least 72 hours, or such shorter period agreed by the Engineer, before deposition of the fill material starts. The number of samples to be provided from each batch shall be as stated in Table 6.4.

(2) The Contractor shall inform the Engineer of the exact location in which the fill material from which each sample is taken is to be deposited.

(3) Samples to be tested for optimum moisture content and maximum dry density shall also be taken after the fill material has been deposited in its final position, at intervals of not more than 28 days.

(4) Samples shall not be provided from:

(a) Fill material including rock fill material which contains an insufficient proportion of particles passing a 20 mm BS test sieve to permit determination of the moisture content and maximum dry density, and

(b) Fill material that is to be deposited as stated in Clause 6.56.

Testing: optimum moisture content, maximum dry density

6.75 (1) Each sample of fill material taken as stated in Clause 6.74 shall be tested to determine the optimum moisture content and the maximum dry density.

(2) The method of testing shall be in accordance with Geospec 3, Test Method 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7 or 10.8, whichever is instructed by the Engineer.

(3) If agreed by the Engineer, the Hilf method stated in Appendix 6.3 may be used instead of the methods stipulated in Clause 6.75(2) to determine the optimum moisture content and maximum dry density.

(4) If in the opinion of the Engineer there is any undue discrepancy between the results of tests for optimum moisture content of fill material using methods stipulated in Clause 6.75(2) and the results of tests using the Hilf method, the results of tests using methods stipulated in Clause 6.75(2) shall prevail.

Consistency: optimum moisture content, maximum dry density

6.76 If the result of any test for optimum moisture content or maximum dry density of fill material indicates that the batch contains material which in the opinion of the Engineer, differs to such an extent that subsequent tests for relative compaction may be affected, the batch shall be divided into smaller batches. Each of the smaller batches shall comprise material with similar properties throughout. Additional samples shall be provided from each of the smaller batches and additional tests for optimum moisture content and maximum dry density shall be carried out. The number of additional samples shall be as stated in Table 6.4.
TESTING: FILL MATERIAL - MOISTURE CONTENT:

Samples: moisture content

6.77 (1) Samples of fill material to be tested for moisture content shall be taken during deposition and compaction of fill material and shall be delivered not more than 1 hour after the fill material has been deposited in its final position.

(2) The number of samples to be provided from each batch shall be as stated in Table 6.5. Samples shall not be provided if, in accordance with Clause 6.74(4)(a) or (b), the optimum moisture content has not been determined.

Testing: moisture content

6.78 (1) Each sample of fill material taken as stated in Clause 6.77 shall be tested to determine the moisture content.

(2) The method of testing shall be in accordance with one of the following methods:

(a) Method 1: Geospec 3, Test Method 5.1 or 5.2, whichever is instructed by the Engineer

(b) Method 2: Microwave oven drying method as stated in Appendix 6.2.

Method 1 shall be used unless otherwise agreed by the Engineer.

Compliance criteria: moisture content

6.79 If in the opinion of the Engineer there is any undue discrepancy between the results of tests for moisture content of fill material using Method 1 and the results of tests using Method 2 in Clause 6.78, the results of tests using Method 1 shall prevail.

Non-compliance: moisture content

6.80 If the result of any test for moisture content of fill material differs from the optimum moisture content by more than the specified amount and if instructed by the Engineer, the moisture content of the whole of the batch of fill material shall be adjusted. Additional samples shall be provided from the same batch and additional tests for moisture content shall be carried out. The number of additional samples shall be as stated in Table 6.5.

Table 6.5: Number of samples to be tested for moisture content and number of tests for relative compaction

<table>
<thead>
<tr>
<th>Description</th>
<th>Size of area of fill in batch</th>
<th>No. of samples/No. of tests per batch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Areas of fill in excavations for structures, pits and trenches and on formations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 100 m²</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>100 - 500 m²</td>
<td>2 for each 100 m² or part thereof</td>
<td></td>
</tr>
<tr>
<td>exceeding 500 m²</td>
<td>1 for each 100 m² or part thereof</td>
<td></td>
</tr>
<tr>
<td>Other areas of fill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 1 ha</td>
<td>4 for each 1000 m² or part thereof</td>
<td></td>
</tr>
<tr>
<td>1 - 10 ha</td>
<td>3 for each 1000 m² or part thereof</td>
<td></td>
</tr>
<tr>
<td>exceeding 10 ha</td>
<td>2 for each 1000 m² or part thereof</td>
<td></td>
</tr>
</tbody>
</table>
6.30

TESTING: FILL MATERIAL - RELATIVE COMPACTION

(1) Unless otherwise agreed by the Engineer, each batch of fill material shall be tested to determine the relative compaction. Tests shall be carried out after the fill material has been deposited and compacted in its final position. The number of tests on each batch shall be as stated in Table 6.5. Tests shall not be carried out on:

(a) Fill material including rock fill material which contains an insufficient proportion of particles passing a 20 mm BS test sieve to permit determination of the relative compaction, and

(b) Fill material that has been deposited as stated in Clause 6.56.

(2) Tests shall be carried out at positions, which in the opinion of the Engineer are representative of the batch of compacted fill material as a whole.

(3) Testing will be carried out by the Engineer.

(4) The relative compaction of fill material shall be determined in accordance with one of the following methods:

(a) Method 1: Geospec 3, Test Method 11.4

\[ RC = \frac{IDD}{MDD} \times 100\% \]

where:

- IDD is the in-situ dry density determined as stated in Clause 6.81(5)
- MDD is the maximum dry density determined as stated in Clause 6.75(2)

(b) Method 2: The relative compaction (RC) shall be calculated from the equation:

\[ RC = \frac{IBD}{MCBD} \times 100\% \]

where:

- IBD is the in-situ bulk density determined as stated in Clause 6.81(5)
- MCBD is the maximum converted bulk density determined by the Hilf method as stated in Appendix 6.3

Method 1 shall be used unless otherwise permitted by the Engineer.

(5) The in-situ bulk density and the in-situ dry density of fill material shall be determined in accordance with one of the following methods:
(a) Method 1: Geospec 3, Test Method 11.1 or 11.2

(b) Method 2: Nuclear densometer method as stated in Geospec 3, Test Method 11.3

Method 1 shall be used unless otherwise permitted by the Engineer.

(6) The maximum converted bulk density of fill material of which more than 5% is retained on a BS 20 mm test sieve, shall be adjusted as stated in Appendix 6.4.

| Compliance criterion: relative compaction | 6.82 | If in the opinion of the Engineer there is any undue discrepancy between the results of tests for relative compaction of fill material using Method 1 and the results of tests using Method 2 in Clause 6.81, the results of tests using Method 1 shall prevail. |
| Non-compliance: relative compaction | 6.83 | If the result of any test for relative compaction of fill material does not comply with the specified requirements for relative compaction, additional tests for relative compaction shall be carried out on the same batch. The number of additional tests shall be as stated in Table 6.5. |
APPENDIX 6.1

TEST METHODS FOR FILL MATERIAL

**General** 6.1.1 The definitions, terms, abbreviations symbols, and grouping of materials stated in BS 1377 shall apply except as stated in Clauses 6.1.2 and 6.1.3.

**Terms and symbols** 6.1.2 Terms used in the GS, and in BS 1377 are identified in the GS by the abbreviations and symbols stated in Table 6.1.1.

Table 6.1.1: Abbreviations and Symbols

<table>
<thead>
<tr>
<th>Abbreviation/ Symbol</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD</td>
<td>Bulk density</td>
</tr>
<tr>
<td>CBD</td>
<td>Converted bulk density</td>
</tr>
<tr>
<td>DD</td>
<td>Dry density</td>
</tr>
<tr>
<td>IBD</td>
<td>In-situ bulk density</td>
</tr>
<tr>
<td>IDD</td>
<td>In-situ dry density</td>
</tr>
<tr>
<td>MDD</td>
<td>Maximum dry density</td>
</tr>
<tr>
<td>MCBBD</td>
<td>Maximum converted bulk density</td>
</tr>
<tr>
<td>RC</td>
<td>Relative compaction</td>
</tr>
<tr>
<td>W</td>
<td>Moisture content</td>
</tr>
<tr>
<td>w&lt;sub&gt;i&lt;/sub&gt;</td>
<td>In-situ moisture content</td>
</tr>
<tr>
<td>w&lt;sub&gt;o&lt;/sub&gt;</td>
<td>Optimum moisture content</td>
</tr>
</tbody>
</table>

**Grouping of material** 6.1.3 (1) Fine-grained material is material of which at least 90% passes a 2 mm BS test sieve.

(2) Medium-grained material is material of which at least 90% passes a 20 mm BS test sieve and more than 10% is retained on a 2 mm BS test sieve.
APPENDIX 6.2

DETERMINATION OF THE MOISTURE CONTENT OF FINE GRAINED AND MEDIUM GRAINED MATERIAL BY THE MICROWAVE OVEN DRYING METHOD

Scope

6.2.1 This method covers the determination of the moisture content of fine-grained and medium-grained material as a percentage of the mass of the dry material.

Apparatus

6.2.2 The following apparatus is required:

(a) A microwave oven with a timer and an adjustable power setting.
(b) An airtight container of microwave safe and non-reflective material.
(c) A balance readable and accurate to 0.01g.
(d) A desiccator containing anhydrous silica gel.

Procedure

6.2.3 The procedure shall be as follows:

(a) The container shall be cleaned, dried and weighed to the nearest 0.01g (m1).

(b) A specimen shall be crumbled and placed loosely in the container and the lid shall be replaced. Each specimen of fine-grained material shall be at least 30 g and each specimen of medium-grained material shall be at least 300 g. Specimens of medium-grained material may be tested in several parts each less than 300 g and the results aggregated.

(c) The container and contents shall be weighed to the nearest 0.01g (m2).

(d) The lid of the specimen container shall be removed and the container with its lid and contents shall be placed in the microwave oven and dried. The specimen shall be considered to be dry when, after an initial drying period, successive weighings at intervals of 1 minute produce results that are the same to the nearest 0.01g. Alternatively, the oven may be set to an appropriate time and power setting to dry the specimen as determined by calibration of the oven on soil of a similar type.

(e) After drying, the container and contents shall be removed from the microwave oven and placed in the desiccator to cool.

(f) The lid shall be replaced and the container and contents shall be weighed to the nearest 0.01g (m3).
Calculation 6.2.4 The moisture content of the material (w) shall be calculated as a percentage of the dry mass of the material from the equation:

\[ w = \frac{(m_2 - m_3)}{(m_3 - m_1)} \times 100\% \]

where:

- \( m_1 \) is the mass of the container (g)
- \( m_2 \) is the mass of the container and contents before drying (g)
- \( m_3 \) is the mass of the container and contents after drying (g)

Reporting of results 6.2.5 The following shall be reported:

(a) Source and identification of the soil.

(b) The moisture content of the material to the nearest 0.1%.

(c) That the test method used was in accordance with this Specification.
APPENDIX 6.3

DETERMINATION OF THE MAXIMUM CONVERTED BULK DENSITY BY THE HILF METHOD

Scope 6.3.1 This method covers the determination of the maximum converted bulk density and the difference between the optimum moisture content and the in-situ moisture content of a material by relating the converted bulk density and the moisture added.

Apparatus 6.3.2 The following apparatus is required:

(a) Apparatus in accordance with Geospec 3, Test Method 10.1 or 10.2, whichever as instructed by the Engineer.

(b) Apparatus for determination of the moisture content in accordance with either Geospec 3, Test Method 5.1 or 5.2 or Appendix 6.2, whichever as instructed by the Engineer.

(c) Apparatus to extract specimens from the mould.

(d) Apparatus, such as a warm air blower, for rapid drying of the material.

Procedure 6.3.3 The procedure shall be as follows:

(a) A sample of material shall be taken immediately after completing the in-situ bulk density test at the same location as the test. The sample shall be obtained by digging to the same depth as that of the in-situ bulk density test, keeping the sides of the excavation vertical and the bottom flat and level. The size of the sample shall be sufficient to yield a minimum of 10 kg after screening over a 20 mm BS test sieve.

(b) The sample shall be weighed to the nearest 0.01 g.

(c) The sample shall be screened over a 20 mm BS test sieve, ensuring that moisture loss is kept to a minimum and that any free moisture appearing in the containers is worked back into the sample.

(d) The amount retained on the sieve shall be weighed to the nearest 0.01 g and expressed as a percentage of the mass of the sample. If the percentage exceeds 5%, an adjustment for coarse material shall be made in accordance with Appendix 6.4. If the percentage does not exceed 5%, no adjustment is required.

(e) The material to be tested shall be thoroughly mixed and divided by quartering or by using a riffle box to obtain a minimum of four specimens of at least 2500 g each, ensuring that moisture loss is kept to a minimum. Alternatively, if it has previously been ascertained that the material is not susceptible to crushing, a single specimen of at least 2500 g may be used for repeat testing.
(f) Each specimen shall be weighed to the nearest 0.01 g and the result shall be taken as the mass of the specimen at the in-situ moisture content.

(g) Each specimen and any remaining material shall be placed in separate moisture-tight containers and the containers sealed.

(h) The converted bulk density of at least three specimens shall be plotted against the amount of water added or removed as a percentage of the mass of the specimen at the in-situ moisture content \((z)\) on a graph as shown in Civil Engineering and Development Department Standard Drawing No. C2006, in accordance with the procedure stated in Clause 6.3.3(i) to (o).

(i) The first point on the graph shall be obtained as follows:

- A specimen shall be compacted at its in-situ moisture content in accordance with Geospec 3, Test Method 10.1, Clause 10.1.5 or Test Method 10.2, Clause 10.2.5, whichever is instructed by the Engineer.

- A diametrical slice of approximately 400 g to 500 g shall be cut from the specimen along its entire length. The in-situ moisture content of the slice \((w_i)\) shall be determined in accordance with either Geospec 3, Test Method 5.1 or 5.2 or Appendix 6.2, whichever as instructed by the Engineer.

- The bulk density \((BD_1)\) shall be calculated as stated in Clause 6.3.4(1) and plotted on the 0% ordinate of the graph as the converted bulk density \((CBD_1)\).

(j) The second point on the graph shall be obtained as follows:

- A second specimen shall be examined and, if the in-situ moisture content obviously exceeds the optimum moisture content, the procedure stated in Clause 6.3.3(k) shall be followed.

- The moisture content of the specimen shall be increased by adding an amount of water equal to 2% of the mass of the specimen. The specimen shall be thoroughly mixed and compacted in accordance with the method stipulated in Clause 6.3.3(i).

- The bulk density \((BD_2)\) shall be calculated as stated in Clause 6.3.4(1), adjusted to converted bulk density \((CBD_2)\) as stated in Clause 6.3.4(2) and plotted on the +2% ordinate of the graph.
(k) If the in-situ moisture content of the second specimen obviously exceeds the optimum moisture content, the specimen shall be dried until the amount of water removed is approximately 2% of the mass of the specimen and cooled. The specimen shall be thoroughly mixed and compacted in accordance with the method stipulated in Clause 6.3.3(i). The amount of water removed shall be determined. The bulk density (BD$_2$) shall be calculated as stated in Clause 6.3.4(1), adjusted to converted bulk density (CBD$_2$) as stated in Clause 6.3.4(2) and plotted on the negative ordinate of the graph at a point which corresponds to the amount of water removed.

(l) The third point on the graph shall be obtained as follows:

- If the plotted value of CBD$_2$ is equal to or greater than the plotted-value of CBD$_1$, the moisture content of a third specimen shall be increased by adding an amount of water equal to 4% of the mass of the specimen. Alternatively, if the procedure stated in Clause 6.3.3(k) has been followed, the specimen shall be dried until the amount of water removed is approximately 4% of the mass of the specimen after cooling.

- If the plotted value of CBD$_2$ is less than the plotted value of CBD$_1$, the third specimen shall be dried until the amount of water removed is approximately 2% of the mass of the specimen after cooling. Alternatively, if the procedure stated in Clause 6.3.3(k) has been followed, the moisture content shall be increased by adding an amount of water equal to 2% of the mass of the specimen.

- The specimen shall be thoroughly mixed and compacted in accordance with the method stipulated in Clause 6.3.3(i). The amount of water removed shall be determined.

- The bulk density (BD$_3$) shall be calculated as stated in Clause 6.3.4(1), adjusted to converted bulk density (CBD$_3$) as stated in Clause 6.3.4(2) and plotted on the graph at a point which corresponds to the amount of water added or removed.

(m) If the centre point of the three points plotted is lower than one of the other two points, or is higher than one point and equal to the other, an additional point or points shall be obtained by proceeding in 2% increments or decrements as appropriate.

(n) If it is apparent that the moisture condition of the material is such that a total of five points will not result in the determination of the optimum moisture content, increments and decrements of 3% moisture content may be adopted for the entire procedure.

(o) A smooth approximately parabolic curve shall be drawn to the plotted points. The peak value of the curve shall be determined as the maximum converted bulk density (MCBD).
The amount of water added or removed as a percentage of the mass of the specimen at the in-situ moisture content corresponding to the maximum converted bulk density shall be determined ($z_m$).

The value of the moisture correction curve passing through the peak value of the plotted parabolic curve shall be determined ($z_c$). If there is no moisture correction curve passing through the peak value of the curve, a moisture correction curve shall be drawn through the peak by interpolating to the nearest 0.1%.

**Calculation**

6.3.4

1. The bulk density (BD) shall be calculated from the equation:

$$BD = \frac{(m_2 - m_1)}{V} \text{ Mg/m}^3$$

where:

- $m_1$ is the mass of the mould and base (g)
- $m_2$ is the mass of the mould, base and wet material (g)
- $V$ is the volume of the mould (mL)

2. The converted bulk density (CBD) shall be calculated from the equation:

$$CBD = \frac{BD}{(1+z/100)} \text{ Mg/m}^3$$

where:

- $z$ is the amount of water added or removed as a percentage of the mass of the specimen at the in-situ moisture content
- $z$ is negative for values below the in-situ moisture content

3. The difference between the optimum moisture content ($w_o$) and the in-situ moisture content ($w_i$) of the material shall be calculated from the equation:

$$w_o - w_i = z_m + z_c \ %$$

where:

- $z_m$ is the amount of water added or removed as a percentage of the mass of the specimen at the in-situ moisture content corresponding to the maximum converted bulk density (%)
- $z_c$ is the value of the moisture correction curve passing through the peak value of the plotted parabolic curve (%)

4. The optimum moisture content ($w_o$) shall be calculated from the equation:

$$w_o = w_i + (1 + w_i/100) z_m \ %$$

where:

- $w_i$ is the in-situ moisture content of the material (%)
(5) The maximum dry density (MDD) shall be calculated from the equation:

\[ MDD = \frac{MCBD}{1 + \frac{w_i}{100}} \text{ Mg/m}^3 \]

where:
- \( MCBD \) is the maximum converted bulk density of the material (Mg/m³)

(6) The relative compaction (RC), if required, shall be calculated from the equation:

\[ RC = \frac{IBD}{MCBD} \times 100\% \]

where:
- \( IBD \) is the in-situ bulk density of the material determined in accordance with Geospec 3, Test Method 11.1 or 11.2 as appropriate to the grain size of the material

**Reporting of results** 6.3.5 The following shall be reported:

(a) Source and identification of the soil.

(b) The graph showing the plotted points and the parabolic curve passing through them.

(c) The maximum converted bulk density to the nearest 0.01 Mg/m³.

(d) The optimum moisture content to the nearest 0.1%.

(e) The maximum dry density to the nearest 0.01 Mg/m³.

(f) The relative compaction to the nearest 0.1%, if determined.

(g) The percentage retained on the 20 mm BS test sieve and the percentage retained on the 37.5 mm BS test sieve to the nearest 1%, if applicable.

(h) Whether the test was carried out using individual specimens or repeat testing of a single specimen.

(i) Whether a manual or an automatic compaction rammer was used.

(j) That the test method used was in accordance with this Specification.
APPENDIX 6.4

ADJUSTMENT OF THE MAXIMUM CONVERTED BULK DENSITY FOR THE DETERMINATION OF THE RELATIVE COMPACTION

Scope 6.4.1 This method covers the adjustment of the maximum converted bulk density determined in accordance with Appendix 6.3 for the determination of the relative compaction of a material containing more than 5% of the mass of the material at the in-situ moisture content retained on a 20 mm BS test sieve.

Apparatus 6.4.2 The following apparatus is required:

(a) Apparatus in accordance with Appendix 6.3.

(b) A 20 mm and a 37.5 mm BS test sieve.

(c) A mould with collar as used for determination of the California Bearing Ratio (CBR mould).

(d) An extrusion device as used for determination of the California Bearing Ratio.

Procedure 6.4.3 The procedure shall be as follows:

(a) If the amount of material retained on the 20 mm BS test sieve exceeds 5% and does not exceed 20%, the material passing the sieve shall be compacted in accordance with Appendix 6.3. The maximum converted bulk density (MCBD$_{20}$) shall be determined and adjusted as stated in Clause 6.4.4.

(b) If the amount of material retained on the 20 mm BS test sieve exceeds 20%, the retained material shall be screened over the 37.5 mm BS test sieve. The procedure stated in either Clause 6.4.3(c) or Clause 6.4.3(d) as appropriate shall be followed.

(c) If the amount of material retained on the 37.5 mm BS test sieve does not exceed 5%, the procedure stated in Clause 6.4.3(e) shall be followed.

(d) If the amount of material retained on the 37.5 mm BS test sieve exceeds 5% and does not exceed 20%, the retained material shall be replaced with an equal mass of material which is of a similar nature and which is retained on a 20 mm BS test sieve but passes a 37.5 mm BS test sieve. The procedure stated in Clause 6.4.3(e) shall be followed.

(e) The procedure stated in Appendix 6.3 shall be followed except that the material shall be compacted into the CBR mould and each layer shall be subjected to 62 blows of the rammer.
Calculation 6.4.4  The maximum converted bulk density (MCBD) shall be calculated from the equation:

where:

- MCBD\(_{20}\) is the maximum converted bulk density of the material passing the 20 mm BS test sieve (Mg/m\(^3\))
- \(z\) is the amount of water added as a percentage of the mass of the specimen at the in-situ moisture content corresponding to the maximum converted bulk density (%)  

Reporting of results 6.4.5  The following shall be reported:

(a)  The source and identification of the soil.

(b)  The results in accordance with Appendix 6.3.

(c)  The mass of the original material not passing the 20 mm and 37.5 mm BS test sieve as a percentage of the mass of the material at the in-situ moisture content to the nearest 0.1%.

(d)  The type of mould used.

(e)  The number of blows per layer.

(f)  Whether the specific gravity was measured or assumed and, if measured, the method used.

(g)  That the test method used was in accordance with this Specification, and the results have been adjusted in accordance with this Appendix.