

## SPECIFICATION FOR ENGINEERED FILLS

This specification is intended to be used for the engineered fill. The specification is suitable for most purposes but there may be special conditions existing at some sites which are not treated in this document and which should be taken into account in arriving at a properly engineered fill. It is emphasized that clay fills can be at least as susceptible to settlement or heave due to climatic, vegetation or other effects, as naturally occurring cohesive soils.

This specification is for contracts, which are designed and supervised by a consulting engineer. However, the appropriate wording may readily be adapted for other forms of contract, such as design-and-build. It is assumed that a site investigation will have been performed prior to the works and that the geotechnical properties of relevance to enforcing the specification will have been measured. Guidance on construction of earthworks may be obtained from BS 6031.

### 1.0 ENGINEERED FILL

1.1 Engineered fill is defined as fill, which is selected, placed and compacted to an appropriate specification so that it will exhibit the required engineering behaviour.

1.2 Fill shall be classified as follows:

- (a) unsuitable fill
- (b) general fill
- (c) restricted fill
- (d) special fill
- (e) hazardous fill

1.3 Unsuitable fill shall comprise any material so designated by the Engineer and shall include

- (a) cohesive soils having a liquid limit in excess of 90% or plasticity index in excess of 65%
- (b) any material containing topsoil, wood, peat or waterlogged substances
- (c) any material containing biodegradables or organic material (more than 5%)
- (d) any material containing scrap metal
- (e) material from contaminated sites
- (f) material which by virtue of its particle size or shape cannot be properly and effectively compacted (e.g. some slate wastes, boulders larger than 150mm, etc).
- (g) materials containing substances which can be dissolved or leached or which may undergo expansive reactions in the presence of moisture.

Unsuitable fill and hazardous fill shall not be used at any location or part of the site, including landscaped areas. If hazardous emission such as methane gas is expected, necessary measures shall be taken to contain and discharge such emission.

1.4 General fill shall comprise all fill except unsuitable fill, restricted fill and special fill.

1.5 Restricted fill shall comprise material which would otherwise be classified as general fill but which contains minerals hostile to the built environment and shall include

- (a) pyritic shales
- (b) gypsiferous clays
- (c) burnt colliery discard
- (d) pulverized fuel ash
- (e) steel slag

- (f) spent oil shale
- (g) incinerator waste
- (h) some demolition and construction industry waste.

Such fill shall be precluded from use in designated zones, including locations where groundwater may rise to the level of the underside of the deepest foundation and where its use will be condemned by the appropriate authorities on pollution grounds. Such fill shall not be placed to a depth less than one metre from the underside of the deepest foundation.

- 1.6 Special fill shall comprise material, which would otherwise be classified as general fill but which contains durable well-graded natural sand and natural gravel or crushed rock, other than argillaceous rock, or durable clean crushed demolition rubble of similar particle size and free from any contaminants. Such fill may be employed as capping layers beneath structure foundations, beneath roads or as backfill to retaining walls.

## **2.0 SELECTION OF END PRODUCT REQUIREMENTS**

- 2.1 The Contractor shall, at the time of tender, provide the Engineer the following tests results for the approval of the materials proposed to be used as general fill. The approval from the Engineer shall not relieve the Contractor the responsibility to comply to the specification.

- (a) The results of the tests shall include:

- (i) natural moisture content (BS 1377: Part 2: 1990, Section 3)
- (ii) liquid and plastic limits for cohesive soils (BS 1377: Part 2: 1990, Sections 4 and 5)
- (iii) compaction tests to determine maximum dry density and optimum moisture content at the appropriate compactive effort (2.5 and 4.5 kg rammer) (BS 1377: Part 4: 1990, Section 3)
- (iv) particle density (specific gravity) to assist in evaluating the compaction test (BS 1377: Part 2: 1990, Section 8).
- (v) soil classification tests including sieve analysis and hydrometer tests.
- (vi) linear shrinkage and swelling tests to determine on the potential of expansive soil, if necessary.
- (vii) clay mineralogical tests (or X-ray diffraction tests) to identify the basis of crystal structures of clay materials that shall exhibit different swelling potentials, if necessary.

- (b) A compaction curve showing the relation between dry density versus moisture content.

- 2.2 The graph will show the dry density plotted against moisture content for the 2.5 kg and 4.5 kg rammer method compaction tests; the corresponding optimum moisture contents and maximum dry densities; and the 5% air voids line.

- 2.3 By reference to zone between zero air voids and 5% air voids for 2.5 kg and 4.5 kg rammer in the compaction curve, the required level of compaction will be indicated by selecting appropriate moisture content and dry density values. This level of compaction shall form the basis of the compaction specification.

- 2.4 At least one set of laboratory compaction test (Standard Proctor) shall be carried out for the same type of fill material.

## **3.0 PREPARATION OF SITE**

- 3.1 On side-long ground, drainage grips or trenches shall be excavated uphill of the area to be filled and compacted. Drainage shall be effected without causing siltation or erosion and water shall be disposed of in a manner to be agreed by the Engineer.

- 3.2 The area to be filled, whether an existing excavation or otherwise undisturbed ground, shall be graded to falls, and sump pumping or other suitable dewatering facilities shall be provided by the Contractor to keep the base of the excavation dry at all times.
- 3.3 Where the area to be filled comprises an existing excavation, the excavation shall be inspected and subsequently monitored by the Contractor, to ensure that there is no danger of its collapse during the works with consequences for safety, for existing buildings or for other construction adjoining.
- 3.4 All topsoil shall be stripped and, where required for further use, stockpiled in an area provided by the Contractor and agreed by the Engineer.
- 3.5 Unless otherwise noted, all soft and compressible soils or existing fill shall be removed and run to spoil in dumps provided by the Contractor and agreed by the Engineer (including licensed tips in the case of certain contaminated materials). The work shall be accomplished in such a way that there is no undercutting of the sides of existing excavations.
- 3.6 Existing foundations or ledges of hard rock, roots of trees or former pipelines or services at the base of the area to be filled shall be excavated and replaced with compacted general fill which shall be compacted to the same specification as adopted for subsequent compaction works.
- 3.7 Where unsuitable material has been excavated, the underlying natural ground shall be compacted to the same specification as adopted for subsequent compaction works.

#### **4.0 DISPOSITION OF FILL**

- 4.1 Prior to the disposition of fill, a series of trial compaction (trial run of 6, 8 and 10 passes) shall be carried out to determine the compaction thickness and numbers of passing required to achieve the specified compaction requirement.
- 4.2 Where construction is required upon fill placed over sloping natural ground, and where fill thickness is less than 5 m, the natural ground shall be benched, with the maximum vertical height of each bench not exceeding 500 mm.
- 4.3 Where a development contains landscaped areas on which no structures will be built, the underlying fill shall be selected, placed and compacted in the same way as the engineered fill, unless otherwise directed by the Engineer. Where some relaxation of the specification for fill compaction underlying landscaped areas is permitted, there shall be a transition zone between the fill underlying the landscaped area and the fill underlying the structure. The dimensions of the transition zone will depend on the degree to which fill compaction was relaxed for the fill in the landscaped area. The location and extent of fill placed to a reduced standard of compaction shall be recorded and approved by the Engineer.

#### **5.0 PLACING AND COMPACTING FILL**

- 5.1 Fill materials shall generally be placed in loose layers not exceeding 300m thickness per layer unless otherwise specified by the Engineer. The fill materials shall be uniformly compacted to the specified degree of compaction before the next layer of fill is carried out.
- 5.2 The compaction plant selected, the number of passes made and the fill layer thickness and moisture content used shall have regard to the specified end product and the means and manner of control testing.
- 5.3 Where several different types of fill material (all meeting the requirements of Clause [1] of this

specification) are to be employed, they shall be deposited in such a way that all parts of the site receive roughly equal amounts of a given material, in roughly the same sequence, thus ensuring a uniform distribution of fill types over the whole fill thickness.

- 5.4 The Contractor shall take all necessary steps to ensure that the fill is placed at the moisture content necessary to achieve the specified level of compaction and shall, where necessary, add water to or dry the fill, in order to obtain the required value. Where it is necessary to add water, this shall be done as a fine spray and in such a way that there is time for the water to be absorbed into the fill before being rolled by the plant.
- 5.5 Cobbles, boulders, rock or waste fragments whose largest dimension is greater than two-thirds of the loose layer thickness shall not be incorporated into the fill.
- 5.6 No fill shall be placed and left uncompacted at the end of a working day. Compacted fill shall be graded to falls to ensure free runoff of rainwater to prevent ponding.
- 5.7 Compaction plant and compaction method shall be selected having regard to the proximity of existing trenches, excavations, retaining walls or other structures and all works shall be performed in such a way as to ensure that their existing stability is not impaired.
- 5.8 If weather conditions are such that the specified moisture content and density values cannot be achieved, the Contractor shall cease work until such time that the fill can be placed and compacted to meet specification requirements.
- 5.9 If the results of control tests (Clause [6.0]) indicate that the fill is being placed and compacted in such a way that the desired level of compaction is not being achieved, the Contractor shall further compact or, if necessary, shall excavate the affected work and replace with new fill, compacted to meet the specification requirements.
- 5.10 If the results of control tests (Clause [6.0]) indicate that antecedent weather conditions (such as heavy rain) have caused deterioration of finished work such that the work no longer meets the specification, the Contractor shall bear the cost and time to take such steps as are necessary to bring the fill to specification requirements.
- 5.11 For minimising infiltration of surface runoff into the fill material, the last 1.5m fill before reaching the finished level shall be compacted to at least 90% of maximum dry density for standard proctor test or to the requirement as specified in the drawings or by the Engineer.

## **6.0 CONTROL TESTING**

- 6.1 The end product requirements selected in Clause [2.1] shall be controlled by in situ and laboratory testing as follows
  - (a) in situ dry density (BS 1377: Part 9: 1990, Section 2) and moisture content determinations (BS 1377: Part 2: 1990, Section 3)
  - (b) where required these tests shall be augmented by moisture content–dry density relationships (BS 1377: Part 4: 1990, Section 3) and particle density (BS 1377: Part 2: 1990, Section 8).
- 6.2 At least fourteen working days before the start of site work, the Contractor shall provide the Engineer, for his or her approval, with a list of the equipment the Contractor proposes to use to undertake these tests.
- 6.3 Control tests shall be performed throughout the fill at minimum frequency of one test per 500m<sup>3</sup> for same type of material, and the locations shall be directed by the Engineer.
- 6.4 When requested by the Engineer, the Contractor shall make available a plot of in situ dry

densities against in situ moisture content results on a graph showing that the results lie within or above the area as mentioned in Clause [2.3] or such area as has been selected by the Engineer. Should any results lie outside the selected area, the Contractor shall provide the Engineer with proposals for rectifying the existing situation and for improving future performance.

- 6.5 The Engineer will, from time to time and with reasonable notice, request the Contractor to make available equipment to enable the Engineer to perform his or her own control tests. The results of these tests shall be used by the Engineer in assessing the Contractor's performance.

## **7.0 MONITORING OF FILL PERFORMANCE**

- 7.1 The Contractor shall make arrangements for the performance of the fill, once placed, to be monitored. Monitoring may take one or more of the following forms

- (a) optical levelling of surface markers
- (b) standpipes or piezometers
- (c) load tests
- (d) other methods as directed by the Engineer.

- 7.2 The Contractor shall, arrange for the procurement and supply of the equipment to the Engineer's written specification and shall inform the Engineer of the date on which the equipment installation shall commence. The specification shall include:

- (a) a full description of the nature and type of instrument and the purpose it fulfils
- (b) the number required and the locations and or depths at which it is to be installed
- (c) the frequency, accuracy and duration for which any readings are to be taken.

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