

CITY OF DURBAN

STANDARD ENGINEERING SPECIFICATION

PART "DA"

EARTHWORKS : BULK

CONTENTS OF PART DA : EARTHWORKS : BULK

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PART "DA" : EARTHWORKS : BULK

DA.1 SCOPE

This specification covers bulk earthworks and deals with classification of material, removal of topsoil, excavation, filling, forming of embankments, compacting and finishing.

DA.2 INTERPRETATIONS

Definitions for this specification are included in Part AB : General Specifications.

DA.3 MATERIALS

DA.3.1 Classification

For the purpose of measurement and payment excavated material will be classified under four headings -

DA.3.1.1 Soft

This shall be material which has a seismic velocity of less than or equal to 1 500 m/sec.

DA.3.1.2 Intermediate

This shall be material which has a seismic velocity greater than 1 500 m/sec.

DA.3.1.3 Hard

This shall be rock which may only be removed by the use of explosives.

DA.3.1.4 Boulders greater than 0,15 m³ in Size

Boulder excavation may either be excavation of rock boulders of size in excess of 0,15 m³ from within excavation of soft material, or on-site boulders not removed as part of the site clearance operation.

DA.4 PLANT

In general, the Contractor may use whatever plant he considers appropriate to construct the work to the required specification. In certain circumstances, however, restrictions will be placed on the type of compaction equipment which can be used and in such cases the limitations will be specified in Part "AA" : Project Specification.

DA.5 CONSTRUCTION

DA.5.1 Removal of Topsoil

Where the ground carries a layer of topsoil, the Engineer will define the extent of the layer to be removed.

Where surface growth does not warrant special clearing or stripping instructions, such growth shall be included with the topsoil.

Topsoil shall be placed in stockpiles located so as to easily accessible for subsequent re-handling. Replacement of topsoil is covered in Part "F" : Protection Works.

DA.5.2 Excavation

DA.5.2.1 General

DA.5.2.1.1 Method

The method of excavation shall be at the discretion of the Contractor provided that the work complies with the specification and the following requirements :

- (a) excavations shall be confined within the limits defined by the drawings or as instructed by the Engineer;
- (b) surfaces in excavations shall at all times be formed to shed stormwater and ground-water without ponding;
- (c) where excavation is accomplished by blasting and the material is required for fill, sufficient fragmentation shall be attained to allow the material to be used as fill; and
- (d) excavated faces in abandoned borrow pits shall be formed to stable slopes.

Since borrow sites are usually required for future development, the Contractor shall not excavate haphazardly and strict level control shall be maintained at all times. Site design levels will be supplied to Contractor and he shall ensure that these levels are strictly adhered to. Where top soil is to be removed prior to excavation this will be considered a separate operation and will be measured as such.

DA.5.2.1.2 Selection

In general the materials excavated shall be placed directly in fill. However, when it is necessary to improve the quality of construction by placing different types of materials in either successive layers or mixed in the same layer, the Contractor shall arrange for a concurrent supply of each material.

DA.5 **CONSTRUCTION (CONT'D)**

DA.5.2 Excavation (Cont'd)

DA.5.2.1 General (Cont'd)

DA.5.2.1.2 Selection (Cont'd)

(a) Stockpiles

- (i) Where provided for in the Schedule of Quantities or as instructed by the Engineer excavated material shall be stockpiled at sites as directed by the Engineer. Payment for the rehandling of this stockpiled material is covered in clause DA.8.7.
- (ii) Where the Contractor's construction programme is such that stockpiling of certain materials is unavoidable this shall take place at sites approved by the Engineer. The Contractor shall make allowance for rehandling of such stockpiles in his excavation and imported fill rates, whichever is applicable.

Stockpile sites shall be prepared by clearing and light grading. The Contractor shall ensure that wind blown sand will be kept to a minimum so as not to constitute a public nuisance.

(b) Spoil

No material shall be regarded as spoil without the written consent of the Engineer.

Material from excavations or from under embankments which is found to be unsuitable for use in any portion of the works, or which is surplus to requirements, shall be spoiled at points selected by the Engineer.

Spoil dumps shall be classified as 'uncompacted fills' and may be used for landscaping. Spoil material shall be tipped and spread in layers of 250 mm maximum thickness.

Spoil dumps shall be trimmed by roughly grading surface areas to form smooth, free-draining slopes and by back-blading the batter slopes to a neat and tidy appearance to the satisfaction of the Engineer.

DA.5.2.2 Excavation below Embankments and Below Level in Cutting

Any material below natural ground level under embankments or below formation level in cuttings which is found to be unsuitable, shall be removed to such depth and extent and disposed of as the Engineer shall direct. The resultant excavation shall be backfilled with suitable material and compacted as specified for the forming of embankments. Where such backfill has to be deposited in standing water the Contractor shall use only an approved rock material of maximum size not greater than 375 mm complying with the requirements of Table 1. Such material may be deposited below water without the associated use of compaction plant.

DA.5 CONSTRUCTION (CONT'D)

DA.5.2 Excavation (Cont'd)

DA.5.2.2 Excavation below Embankments and Below Level in Cutting (Cont'd)

If, after the removal of the unsuitable material the Contractor allows the material so exposed to deteriorate such that compaction of backfilling is impracticable, he shall make good at his own expense either by additional excavation and filling in the manner specified in this clause or by waiting until the condition of the exposed material has improved sufficiently to support the approved backfill.

Table 1 : Free-draining Material	
Sieve Size (mm)	Percentage by Weight Passing
9,5	0 - 100
4,75	0 - 70
0,6	0 - 20
0,075	0 - 5

DA.5.3 Fill Embankments

DA.5.3.1 (a) Preparation

Before any placing of fill commences, preparatory work such as site clearing, fencing (where required), and the removal of topsoil and unsuitable ground shall be completed. All drainage structures and culverts shall also be installed unless agreed otherwise by the Engineer. Where the height of fill is 1,0 m or less, the natural ground shall be compacted to 95% Mod. A.A.S.H.T.O., before filling commences and where the fill height is greater than 1 m compaction shall be to 93% Mod. A.A.S.H.T.O. to a depth of at least 150 mm in both cases.

(b) Bonding

If the natural ground crossfall is less than 16,67% the entire interface between the embankment and the natural ground shall be bonded by scarifying to a depth of 150 mm.

(c) Benching

Where the crossfall of the natural ground is greater than 16,67% the Contractor shall side cut in the horizontal plane and form benches with maximum widths of 3,0 m at maximum vertical intervals of 2,0 m. The benches shall be self-draining with a minimum slope of 2% towards the toe of the embankment.

Fills over 15 m in heights shall incorporate a graded rock-toe filter as specified in clause DA.5.4.

DA.5 CONSTRUCTION (CONT'D)

DA.5.3 Fill Embankments (Cont'd)

DA.5.3.2 Placing, Mixing and Compacting

The Contractor may use his own placing, mixing and compacting techniques provided the completed work complies with the specification with regard to density and tolerances and also conforms to the following requirements:

- (a) Embankments shall be built up evenly over the full width with layers of constant thickness and shall be maintained at all times with sufficient camber and surface grading to enable surface water to drain readily. During the construction of embankments the Contractor shall control and direct construction traffic uniformly over the full width of the embankment.
- (b) Compaction shall be carried out in a series of continuous operations over the full width of the layer concerned.

The thickness of any one layer of fill up to 1 m below formation level shall not exceed 150 mm after compaction using static rollers, or 300 mm using vibrating rollers.

The top 1 m layer of fill below formation shall be carried out in layers not exceeding 150 mm thickness.

The standard of compaction required shall be -

- (i) up to 1 m below formation level, 93% Mod. A.A.S.H.T.O. density;
- (ii) the top 1 m layer below formation, 95% Mod. A.A.S.H.T.O. density.

The moisture content during compaction of the top 1 m layer below formation as determined by the Modified A.A.S.H.T.O. compaction test shall be optimum $\pm 2\%$.

After compaction, the layer shall be proof-rolled with a vehicle having a minimum wheel load of 20 kN in order to determine any soft spots.

Any layer which becomes soft after being compacted and tested, shall be recompacted to the specified density at the Contractor's expense.

- (c) All stones, lumps, etc., shall be broken down to conform to a maximum dimension not exceeding two-thirds of the specified compacted thickness of the layer.
- (d) Placing of Fill on Swampy Ground - On swampy ground and at other problem areas but not around structures, the Engineer may permit the pioneering of the embankment by end dumping or bulldozing, but only to the minimum extent necessary to develop adequate facilities for normal placing.

DA.5 CONSTRUCTION (CONT'D)

DA.5.3 Fill Embankments (Cont'd)

DA.5.3.2 Placing, Mixing and Compacting (Cont'd)

- (e) Restricted Placing - Where fill is required to be placed against structures, the Engineer will define a zone of restricted placing, generally within 2,5 m of any concrete face. In any such zone no heavy earthmoving compaction equipment will be permitted and the fill shall consist of selected fine material placed in layers not exceeding the limits of thickness detailed in (b) above and compacted to not less than 95% Mod. A.A.S.H.T.O. density.
- (f) Embankments for culverts and bridges shall be brought up equally on both sides of the structure.

DA.5.4 Rock Toe Filter

The rock toe filter shall be constructed of rock with a minimum size of 75 mm and a maximum size of 300 mm. This material shall be so placed that the larger material is lodged in the outside face of the embankment to form a stable interlocking rip-rap surface and the smaller material is spread to form a dense but porous toe to the embankment. Before constructing the filter the natural ground shall be compacted to 95% Mod. A.A.S.H.T.O. to a depth of 150 mm.

DA.5.5 Formation

In areas of cut or where the fill layer thickness is less than 150 mm the formation shall be scarified to a minimum depth of 150 mm. Any particle size greater than 100 mm within this layer shall be removed and replaced with suitable material.

The whole of the formation, except where stabilised shall then be proof-rolled with a vehicle having a minimum wheel load of 20 kN in order to determine any soft spots.

The whole of the formation shall then be trimmed to grade and level to conform to the required tolerance as specified under Clause DA.6 and compacted to 95% Mod. A.A.S.H.T.O. as specified under Clause DA.7.

The Contractor is responsible for protecting the formation at all times. No construction traffic that is likely to cause damage shall be allowed on the formation.

Preparation of the formation shall only be carried out after all services and ducts have been laid. Soft spots shall be removed and replaced with suitable material and compacted in accordance with the specification.

DA.5 **CONSTRUCTION (CONT'D)**

DA.5.6 Surface Finish

DA.5.6.1 Cuttings

Cut slope surfaces in soft materials shall be finished with small ledges, approximately 75 mm wide at vertical intervals of 300 mm, notched into the face of a line parallel with the finished grade to retain a topsoil cover. Forming of the ledges may be done either by hand or by mechanical means.

When excavating in hard materials which require ripping or blasting, the cut slope surface shall be scalped of all loose material and trimmed to a rough but stable surface of naturally bedded materials within the specified slope line tolerance.

DA.5.6.2 Embankments

The side slopes shall be trimmed to a plane surface free from loose material and stones larger than 100 mm maximum dimension and having no local humps or depressions greater than 150 mm. Where the embankment slope is not to receive topsoil, it shall be compacted to provide a stable slope. Where the surface is to receive topsoil it shall be left with a semi-rough finish free from loose material.

DA.6 **TOLERANCES**

The allowable tolerances shall be -

- (a) the design angle ± 2 degrees for the angle of the cut or fill slope;
- (b) not less than the design width, nor more than 300 mm greater than the design width for the transverse horizontal embankment width at any level; and
- (c) the layer thickness ± 20 mm for topsoil;

For the formation, the Contractor will be required to place level pegs longitudinally at 5 m intervals on a road construction contract and elevation tolerances shall be taken on a section of the works. (When a portion of the works is less than 500 m² one tolerance reading per 10 m² shall be taken).

In any section the average of the elevations taken shall be such that the average thickness of the succeeding layer or layers above the formation shall be not less than that specified/nor greater than that specified plus 20 mm.

The standard deviation of the differences between the actual and design levels shall not be greater than 10 mm.

DA.7

TESTING

The acceptance control testing to be carried out either by the Engineer or by an approved independent materials testing company employed by the Engineer, shall be as indicated below -

(a) Density and Moisture Content

7 No. per "Section" (as defined in Part "AB" : General Specifications) taken at random over the section. The layer is acceptable should the acceptance control testing fulfil the following requirement :

$\bar{x} \geq 93\% + 0,5S$ (up to 1,0 m below formation).

$\bar{x} \geq 95\% + 0,5S$ (top 1,0 m below formation).

Where \bar{x} = Arithmetic mean of 7 density readings.

S = Standard deviation.

(b) Classification of Material

1 No. per section.

DA.8

MEASUREMENT AND PAYMENT

DA.8.1

General

The unit of measurement is specified in each separate clause.

- (a) When measurement is specified by volume it shall be in cubic metres calculated by the average end-area method. Measurements will be based on levelled cross-sections taken at intervals not exceeding 20 m along the centre line after site clearance has been completed. All measurements for cross-sections shall be taken vertically for depth and thickness. All lengths and distances shown on the plans are horizontal distances.

Measurement of boulders shall be the nett volume of boulders excavated.

No allowance will be made for bulking or shrinkage and excavation will be paid as being the volume in place before excavation commenced.

- (b) When measurement is specified by mass it shall be in tons which will be determined by weighing each truckload on an assized weighbridge.

No account shall be taken of the tolerances specified.

Freehaul for all earthwork material, unless stated otherwise, will be 1 kilometre.

DA.8 MEASUREMENT AND PAYMENT (CONT'D)

DA.8.2 Topsoil

The removal of topsoil will be measured in cubic metres (m³) as the product of the area in plan and depth ordered and removed.

Item coverage shall include for -

- (1) clearance, excavation, haulage, deposition and spreading of surface soil in stockpile or at a tip off site;
- (2) allowance for bulking and wastage of excavated material;
- (3) keeping the working site free of water; and
- (4) restricted working at sites of structures.

DA.8.3 Excavation of Material from Site

The unit of measurement in cut areas on site shall be either :

- (a) volume in cubic metres (m³) and/or
- (b) mass in tons.

Item coverage shall include for -

- (1) excavating, loading, hauling, depositing and spreading of suitable material as fill or in stockpiles or, if surplus to requirements, in approved spoil tip off site;
- (2) excavating below foundation surface for embankment and below formation in areas of cut;
- (3) excavating, separating from suitable material, hauling, depositing and spreading of unsuitable material to spoil in tip off site, or on site as permitted by the Engineer;
- (4) constructing and maintaining haul routes;
- (5) selecting suitable material of stated types and layering or depositing in locations indicated by the Engineer or in stockpiles;
- (6) bonding and benching;
- (7) complying with any requirements regarding the rate of deposition of material in areas of fill;
- (8) loosening or breaking up unexcavated material before or during excavation;

DA.8 MEASUREMENT AND PAYMENT (CONT'D)

DA.8.3 Excavation of Material from Site (Cont'd)

- (9) allowing for bulking or shrinkage of material after excavation and for wastage;
- (10) blasting where required;
- (11) keeping the earthworks free of water;
- (12) depositing fill to slope away from vertical drainage layers and providing temporary drainage to prevent surface water from entering such drainage layers;
- (13) working in water courses as may be necessary and dealing with existing flows of water;
- (14) unless otherwise specified in Part "AA" : Project Specification, the provision of tips off-site;
- (15) forming and trimming the slopes;
- (16) restrictions on working at sites of structures;
- (17) taking precautions to avoid damage to structures, existing sewers, drains and services, including providing temporary supports; and
- (18) the drying of material which cannot be placed immediately in the fill embankments as its in-situ moisture content exceeds the limits specified in Clause DA.5.3.2.

DA.8.4 Imported Fill

The units of measurement shall be the cubic metre (m³) or ton as specified in the Schedule of Quantities.

The measured volume of imported fill shall be the difference between the net volume of compacted fill and the net volume of suitable material excavated from the site and actually used as compacted fill. For this purpose it shall be assumed that one cubic metre of suitable material excavated from within the site forms one cubic metre of compacted fill.

Where imported rock-fill is deposited into soft areas, such fill shall be measured by volume in the transport vehicles at the place of deposition and due allowance shall be made for the bulking of the material.

Where imported free draining material is deposited below water and the volume cannot be calculated satisfactorily by any other means, the measurement shall be by volume in the transport vehicles at the place of deposition, suitably adjusted to allow for bulking in the truck which, unless otherwise specified, shall be 70% of the truck volume.

DA.8 MEASUREMENT AND PAYMENT (CONT'D)

DA.8.4 Imported Fill (Cont'd)

Item coverage shall include for -

- (1) excavating, loading, hauling, depositing and spreading in areas of fill, suitable material or rock fill provided by the Contractor from borrow or off-site sources;
- (2) excavating, separating from suitable material, hauling, depositing and spreading of unsuitable material to spoil in tip off site, or on site as permitted by the Engineer;
- (3) constructing and maintaining haul routes;
- (4) selecting suitable material of stated types and layering or depositing in locations indicated by the Engineer or in stockpiles;
- (5) bonding and benching;
- (6) loosening or breaking up unexcavated material before or during excavation;
- (7) allowing for bulking or shrinkage of material after excavation and for wastage;
- (8) blasting where required;
- (9) keeping the earthworks free of water;
- (10) depositing fill to slope away from vertical drainage layers and providing temporary drainage to prevent surface water from entering such drainage layers;
- (11) working in watercourses as may be necessary and dealing with existing flows of water;
- (12) restrictions on working at sites of structures;
- (13) taking precautions to avoid damage to structures, existing sewers, drains and services, including providing temporary supports; and
- (14) the drying of material which cannot be placed immediately in the fill embankment as its in-situ moisture content exceeds the limits specified in Clause DA.5.3.2.

DA.8 MEASUREMENT AND PAYMENT (CONT'D)

DA.8.5 Compaction of Fill

Measurement shall be in cubic metres (m³) as specified in Clause DA.8.1 (a).

The measurement of compacted fill other than that adjacent to structures shall be the net content of the embankments formed or voids filled, measured up to formation level from existing ground level or the level of the sub-soil following the removal of any surface soil or unsuitable material below the site of the embankment or from below formation level in cuttings as appropriate.

For the measurement of settlement the Contractor may provide "tell-tales" at locations agreed to by the Engineer at sites where the presence of peat or materials of comparable compressibility is indicated. For the purpose of calculating the volume of additional fill and compaction due to settlement, the width of the embankment shall be taken as the net width at original ground level or in the case of fill adjacent to structures the area at formation level.

Compaction of rock fill shall be measured separately only where rock fill is specifically shown on the drawings or otherwise expressly required by the Contract.

Item coverage shall include for -

- (1) levelling and compacting of all materials;
- (2) forming embankments;
- (3) compacting of natural ground before forming embankments to 93% Mod. A.A.S.H.T.O. or 95% Mod. A.A.S.H.T.O., whichever is applicable, to a depth of at least 150 mm;
- (4) allowing for shrinkage and wastage of material;
- (5) pulverising material to comply with the requirements of Clause DA.5.3.2.(c);
- (6) spreading levelling and compacting suitable material for protecting the formation level of embankments where the Contractor elects to use the surface of earthworks for construction traffic;
- (7) proof-rolling;
- (8) keeping the earthworks free of water;
- (9) all operations necessary to produce an acceptable ground surface where the method of depositing and compacting rock fill into soft areas is adopted;
- (10) suspending work on embankments in the areas required for the construction of bridges or other structures;

DA.8 MEASUREMENT AND PAYMENT (CONT'D)

DA.8.5 Compaction of Fill (Cont'd)

- (11) taking precautions to avoid damage to structures, existing sewers, drains and other services;
- (12) complying with any requirements for the equalisation of earth pressures; and
- (13) restricted working at site of structures.

DA.8.6 Trimming of Embankments

Measurements shall be in square metres (m²) measured along the shape of the embankment.

The rate shall cover all those operations specified in Clause DA.5.6.2.

DA.8.7 Stockpile Handling

The re-handling of material as specified in Clause DA.5.2.1.2.(a)(i) will be measured in cubic metres (m³), the volume being measured net in place after final compaction.

The rate for stockpile handling shall cover all handling, loading, transporting, dumping and spreading, and maintaining of haul routes.

DA.8.8 Rock Toe Filter

- (a) (i) If available from the site of the works, the supply of rock shall be measured and paid for under Clause DA.8.3.
- (ii) If rock is imported, the unit shall be cubic metres (m³) measured on the site after placing and the rate shall include the supply, transport and deposition of the rock.
- (b) The construction of the rock toe filter shall be measured in cubic metres (m³) in place and payment shall be extra over that in (a) above to provide for the additional effort required to achieve the specified structure and the construction of a filter as specified in Clause DA.5.4.

DA.8.9 Formation

The unit of measurement shall be the square metres (m²) calculated from dimensions shown on the drawings of all surfaces below carriageways.

An extra over rate shall be included in the Schedule of Quantities for areas of cut or where the fill layer thickness is less than 150 mm.

The rates shall include for all those operations specified in Clause DA.5.5 excluding removal and reinstatement of soft spots in original material where these have occurred beyond the control of the Contractor.

DA.8 **MEASUREMENT AND PAYMENT (CONT'D)**

DA.8.10 Overhaul

Haulage of earthwork material up to and including the freehaul distance of 1 km will not be measured.

The overhaul distance shall be the distance between the centre of the overhaul volume of material in its original position in cut, borrow or stockpile and the centre of its volume when placed in its authorised position less the free haul distance.

The unit of measurement for overhaul shall be either cubic metre - kilometre (m³/km), or ton - kilometre (t/km) as specified in the Schedule of Quantities.

The unit of measurement of the material to be moved shall be either the cubic metre (m³) or mass in tons.

If the material is specified by volume the method of measurement shall be -

- (a) for excavated material from site: the volume will be measured in place before excavating and the measurements taken as specified in Clause DA.8.1;
- (b) for imported fill : as specified in Clause DA.8.4.;
- (c) for material from stockpile : the volume will be measured in place after compaction.

If the material is specified by mass the measurement shall be made in ton at a weighbridge situated on site.