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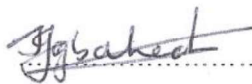
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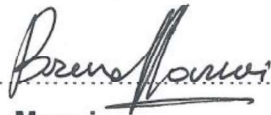
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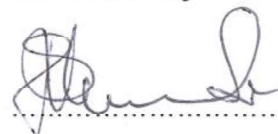
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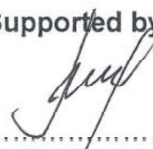
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1. INTRODUCTION

The minimum technical requirements as laid down in this manual shall be applied to the design, materials selected, planning and execution of site preparation, earthworks and scour protection works.

Supplementary to these requirements, work shall be carried out in accordance with recognized and accepted theories, methods, codes of practice, standards and good engineering practice.

As a rule the requirements of this manual shall be adhered to.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this document, the contractor shall determine; by careful scrutiny; which of the requirements and/or combination thereof will be acceptable with regard to safety, economic and legal aspects. In all cases the contractor shall inform the principal of any deviation from the requirements of this document which is considered to be necessary in order to comply with national and/or local regulations. The principal may then negotiate with the authorities concerned with the object of obtaining agreement to follow this document as closely as possible.

2. SUPPORTING CLAUSES

2.1 SCOPE

This manual contains minimum requirements and guidance on the design, planning, materials and construction for:

- site preparation
- earthworks

It shall be used in conjunction with other specifications relevant to site preparation and earthworks.

2.1.1 Purpose

This document serves as a guideline for geotechnical design of civil works.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

The distribution of this document is confined to companies undertaking designs on behalf of Eskom Technology division – capital expansion department or managed by them and to contractors nominated by them.

This document is intended for use in power generating facilities and, where applicable, supply/marketing installations.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

- [1] ISO 9001 Quality Management Systems. ISO 9001 Quality Management Systems.
- [2] All work carried out must adhere to the Occupational Health and Safety Act (Act 85 of 1993)

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2.2.2 Informative

[3] Soil profiling by Jennings, J.E, Brink, A.B.A, & Williams, A.A.B, (1973) "Revised Guide to Soil Profiling for Civil Engineering purposes in Southern Africa" Trans. S.A.I.C.E, Vol 15, No. 1, pp 3 -12.

[4] SAICE, (2010). "Site Investigation code of practice". The Geotechnical Division of SAICE

[5] SANS 1200 C Standardized specification for civil engineering construction Section C: Site clearance

[6] SANS 1200 D Standardized specification for civil engineering construction Section D: Earthworks

[7] SANS 1200 DA Standardized specification for civil engineering construction Section DA: Earthworks (small works)

[8] SANS 1200 DM Standardized specification for civil engineering construction Section DM: Earthworks (roads, subgrade)

[9] SANS 1200 DB Standardized specification for civil engineering construction Section DB: Earthworks (pipe trenches)

[10] SANS 1200 DN Standardized specification for civil engineering construction Section DN: Earthworks (railway sidings)

[11] SANS 2001-BE1 Construction works Part BE1: Earthworks (general)

[12] SANS 2001-BS1 Construction works Part BS1: Site clearance

[13] SANS 2001-BE3 Construction works Part BE3: Repair of sinkholes and subsidence in dolomite land

[14] SANS 2001-DP1 Construction works Part DP1: Earthworks for buried pipelines and prefabricated culverts

2.3 DEFINITIONS

General Definitions:

Definition	Description
Shall and Should	The word 'shall' is to be understood as mandatory and the word 'should' as strongly recommended to comply with the requirements of this manual.
Principal	The party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorized to act for the Principal.
Contractor	The party which carries out all or part of the design, engineering, procurement, construction and commissioning for the project. The Principal may sometimes undertake all or part of the duties of the Contractor.

Definitions of material:

Definition	Description
Suitable materials	Shall comprise all that which is acceptable in a natural or processed state in terms of its intended use and shall be specified for each application.
Unsuitable material	Other than suitable material and shall amongst others include: a. material from swamps and marshes b. peat, logs, stumps and perishable materials c. material susceptible to spontaneous combustion

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Definition	Description
	d. materials with undefined properties e. materials having a moisture content greater than the maximum permitted for such materials f. building rubble and domestic and industrial wastes (unless otherwise approved by the principal) g. soils and rock susceptible to deterioration/change of their properties (unless otherwise approved by the principal).
Rock	Those geological strata or deposits and any hard material requiring the use of blasting or approved pneumatic tools for its removal.
Rockfill	Those geological strata or deposits and any hard material requiring the use of blasting or approved pneumatic tools for its removal.
Soils	All suitable non-cemented granular and cohesive soils.
Silt	Non-clayey soils with individual particle size less than 0.06 mm.
Cemented soils	Soils in which the grains or aggregates adhere firmly, bound together by a material which acts as a cementing agent, e.g. lime, silica, aluminium hydrates, etc.

2.3.2 Disclosure Classification

Controlled Disclosure: Controlled Disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
AASHTO	American Association of State Highways & Transportation Officials
KPa	Kilopascal
MPa	Megapascal
m	metre

2.5 ROLES AND RESPONSIBILITIES

2.5.1 The role of the Engineering Centres of Excellence is provided below:

- Apply its expertise, skill and processes to produce a high quality output of exceptional standards in line with the organizational requirement.
- Assist in providing project activities and man hours for project preplanning
- Provide engineering resources to perform the engineering effort

2.5.2 The Engineering Design Work Lead

- The EDWL has the following reporting lines:
- Accountable for the strategy and all design related activities to the Plant Engineering General Manager. The Centre of Excellence Engineering Manager will prepare, review, assess and score the performance contract of the EDWL.

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- The EDWL is appointed by the Engineering Work Delivery Unit Manager in conjunction with the relevant Centres of Engineering Excellence (CoE's) and Authorised by the Plant Engineering General Manager (GM).
- Reports to the Project Engineering Practitioner for technical delivery achieved to baseline scope, schedule and cost.

2.5.3 Principal

- The party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorized to act for the Principal.

2.5.4 Contractor

- The party which carries out all or part of the design, engineering, procurement, construction and commissioning for the project. The Principal may sometimes undertake all or part of the duties of the Contractor.

2.6 PROCESS FOR MONITORING

This document will follow the SCOT review process. The published record will be stored on Hyperwave.

All SCOT documents undergo a review every three years.

2.7 RELATED/SUPPORTING DOCUMENTS

None

3. EXECUTION OF SITE PREPARATION AND EARTHWORKS STANDARD

3.1 GENERAL

3.1.1 Existing Services and Facilities

The nature and location of all existing aboveground and underground services, and facilities shall be ascertained on site and adjacent areas; by hand excavation where necessary; before commencing site investigations, site preparation works and earthworks.

Every precaution shall be taken including the provision of all necessary temporary supporting, bridging shoring and safety barriers to protect these services and facilities from damage or interference during the execution of the works. The stability of existing above and underground services and the measures considered to be necessary should be ensured and demonstrated by calculations based on realistic assumptions and/or available data.

The principal shall be notified in writing should any previously unrecorded services or other objects be discovered during investigations. A description, dimensions, levels related to reference datum and other relevant details of such services shall be accurately recorded and supplied to the principal.

A certificate or permit shall be obtained from the principal or the responsible body, confirming that services have been cut off and made safe and specifying any services or other facilities adjacent to the work including related safety aspects and measures which must be maintained during the execution of the work.

In the event that services such as drains or natural drainage of a certain area require to be cut during the execution of the works these shall be made good to the satisfaction of the principal, and where applicable a temporary or permanent rerouting shall be provided.

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In the event that services or facilities are accidentally cut or damaged, these shall be made good as directed by the principal.

3.1.2 Site Levels

When selecting site levels (e.g. high point of paving), the following considerations shall be taken into account:

- Surface water run off should be able to take place under gravity via the plant drainage systems to public water.
- Site lay-out/plot plan and related safety aspects should be adhered to.
- Cut and fill should be economically planned such that cut and fill balancing is optimized including allowances for earthen structures and general fill, bulking, wastage and unsuitable materials.
- Danger of flooding should not exist (highest sea level, river level, etc.) or alternatively the area should be adequately protected.

Prior to the commencement of work a limited number of permanent survey beacons shall be strategically placed on site and accurately related to the plant and/or national grid system for time and level.

Prior to the commencement of work the original site surface levels shall be surveyed and recorded on an appropriate drawing.

3.1.3 Site Investigations

Prior to the commencement of site preparation and earthworks a site investigation shall be carried out. This investigation should include but not be limited to soils, topographical, hydrological and geohydrological surveys (and under certain conditions engineering geological surveys).

The design, materials, planning and execution of site preparation and earthworks shall be based on the results of a recently completed full scale or confirmatory site investigation.

Note: Based on the existing geotechnical information and Scope of Works the Project Geotechnical Engineer may decide not to conduct a Geotechnical Investigation.

3.1.4 Classification of Soils and Rocks

3.1.4.1 Soil classification

The soil shall be classified according to the relevant latest applicable standard. Soil Classification shall be done in accordance to the intended use of the soil i.e. backfill, foundations etc. Rock classification

The rock shall be classified according to the relevant latest applicable standard. Rock Classification shall be done in accordance to the intended use of the rock i.e. tunnelling, foundations etc.

Aspects such as the degree of weathering, chemical stability, fracture spacing, bedding plane spacing, strength, structure/texture durability, origin and hardness determine the engineering character of rocks.

3.1.5 Seismic Aspects

Design and execution of site preparation and earthworks shall be based on the seismic conditions and relevant consequences prevalent in the area under consideration.

Liquefaction potential shall be thoroughly investigated by means of laboratory and field tests. In-situ checks should be carried out upon completion of the earthworks.

3.2 SITE PREPARATION

3.2.1 General

Site preparation may consist of one or more of the following activities:

- demolition and site clearance (3.2.2)
- clearing of vegetation and stripping of top soil (3.2.3)
- treatment of existing ditches and water courses (3.2.4)
- treatment of underground cavities (3.2.5)
- treatment of subsoils (3.2.6)
- provision of site drainage (surface and subsurface) (0)
- earthworks (3.2.9)
- provision of temporary access and laydown areas (3.2.10) and (3.2.11)
- shore protection works (3.2.12).

3.2.2 Demolition and Site Clearance

And excavation permit should be applied for before any excavation work is carried out. In addition, scanning and making of underground areas should precede the works.

Demolition works shall include but may not be limited to the demolition and removal of buildings, structures, culverts, roads, pavements, above and underground services and associated foundations.

Site clearance shall include but may not be limited to the taking down or grubbing up and immediate removal from site of surface obstructions and unsuitable materials, such as debris, rubble, gates, fences, shrubs, hedges, trees, stumps and roots.

In areas of known shallow water table or perched seasonal water table conditions, caution shall be exercised with regard to the removal of trees and/or shrubs which may contribute to the overall water balance of the site.

The principal may direct to leave in place certain items such as fences, shrubs, trees, or other features required for incorporation in landscaping. The contractor shall, under such conditions, be responsible for the care and protection of such items during the course of the works.

Demolition and site clearance works shall be planned and executed in a manner such that the safety of personnel, the work and adjacent property is guaranteed and such that a minimum of inconvenience is caused.

Demolition and site clearance works shall be conducted such that minimal disruption and/or inconvenience is placed on local surrounding communities.

All necessary temporary works such as safety barriers, fences, safety nets, coverings and screens shall be provided to protect personnel and adjacent property from injury or damage caused by demolition operations.

All necessary dead or raking shores to support existing work shall be provided during demolition and associated operations.

All materials arising from demolition and site clearance work except materials specified for re-use or as otherwise specified by the principal shall be removed from site as the work progresses, and shall be disposed of and/or stockpiled for re-use.

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Materials required for re-use shall be stored in a safe location and protected from damage or deterioration as agreed with the principal.

Materials removed from site shall be disposed of in accordance with governing local and national laws and regulations.

3.2.3 Clearing of Vegetation and Stripping of Top Soil

All areas to be excavated, filled or constructed upon, should be stripped entirely of vegetation and top soil to a suitable depth below natural ground level, as indicated by the site investigation and agreed upon by the principal.

Vegetation e.g. endangered trees and/or plant species intended for re-use, as agreed with the principal, shall be handled in an approved manner.

Vegetation intended for re-use shall be removed to a location approved by the principal where it shall be neatly stacked and regularly watered and tended until required for replanting.

Top soil intended for re-use as agreed with the principal shall be stock-piled and/or spread at approved locations.

The remaining top soil and vegetation shall be disposed of at locations agreed by the principal. Disposal shall be carried out in accordance with national and local laws and regulations.

3.2.4 Treatment of Existing Ditches and Water Courses

Existing drainage ditches and water courses shall be temporarily or permanently rerouted, where necessary, in order to prevent

- unacceptable rise or fall in ground water level in, and flooding of, the site
- unacceptable changes to the hydrological and geohydrological regimes of the adjacent areas.

The invert and sides of abandoned ditches and water courses shall be cleared of unsuitable deposits which shall be disposed of in a manner approved by the principal.

Filling and compaction of cleared ditches and water courses shall be carried out in accordance with (3.3.3) and (3.3.4).

Erosion protection where required for rerouted water courses shall be designed and constructed in accordance with applicable standards.

3.2.5 Treatment of Underground Cavities

Where naturally occurring cavities; e.g. caverns, underground water courses or man-made cavities, e.g. mineworkings, wells, basements; are detected under or adjacent to the construction area, these shall be suitably treated in consultation with the principal.

The selected treatment shall take into account not only the effect on the geohydrology of the surrounding areas but also the requirements of the structures to be founded within the influence zone of the cavities.

3.2.6 Treatment of Subsoils

In cases where a change in the permeability, an increase in strength/friction properties/density or a decrease in the liquefaction susceptibility/compressibility of the subsoil (i.e. reduction in subsequent settlements) is required, consideration shall be taken as to the correct method of soil remediation/improvement which shall be applied, e.g.:

- shallow or surface compaction
- deep compaction (e.g. vibroflotation, dynamic compaction, stone columns)

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- vertical and/or horizontal drainage
- injection of grouts or chemicals
- addition of chemical stabilising agents
- soils replacement
- preloading.

The design of such improvement shall be based on a thorough soils investigation and shall take into account the soil type (e.g. whether cohesive, granular, cemented) particle strength, particle size and shape analysis, silt content, in-situ density, mineralogical and chemical composition and primary as well as secondary permeability of the soil to be treated.

In general it should be noted that:

- Clay, clayey and silty layers cannot be effectively compacted by means of mechanical compaction. Preloading is the only effective method, although it may take a significant period of time to obtain the required degree of compaction/consolidation (i.e. a number of months or years).
- The secondary permeability (i.e. water flow through cracks and subsurface channels and cavities) is generally more critical and complicated than primary permeability (i.e. water flow through pores). Secondary permeability may exist/develop in cemented soils, dried out clays and especially in rocks.

3.2.7 Faults and Other Geological Disturbances

If faults and/or other geological features exist at the site the long-term behaviour hereof and the behaviour during ground movement either natural or induced, if applicable, shall be investigated by an expert in the field.

3.2.8 Provision of Site Drainage

Adequate drainage systems shall be provided to deal with ground water and surface water run-off.

Permanent surface water run off drainage systems shall be designed in accordance with acceptable procedures, codes and guidelines.

These drainage systems must not only deliberate the geotechnical considerations and the design codes and guidelines, but must also take into consideration the corrosively component of the run-off water and the associated aggression of the run-off water/s on the concrete.

Temporary surface water run off drains (e.g. ditches) and subsoil water drains (e.g. horizontal buried drains, vertical drains) shall be provided in order to prevent flooding and maintain access on site during construction until the permanent drainage systems are brought into operation.

The requirements of construction plant, work progress, building pits and meteorological conditions shall be taken into consideration.

Disturbance of the natural water drainage systems, both surface and subsurface, by construction activities in the area shall be taken into account and where necessary measures shall be taken to eliminate any detrimental effects.

Examples of disturbances:

- Excavation may lead to a lowering of ground water levels in the adjacent area which may cause foundation settlements and consequently damage to foundations and supported structures. Drying out of vegetation can also occur.

- General fill and embankments may lead to a general raising of the ground water level in the fill and surrounding areas with unacceptable consequences such as uplift of foundations and buried structures, corrosion and drainage problems. Drainage problems may become critical during extreme conditions.

3.2.9 Earthworks

Earthworks forming part of site preparation works shall be designed and executed in accordance with (3.3).

3.2.10 Provision of Temporary Access

Suitable temporary roads should be laid to provide all-weather access for construction activities including site preparation.

The temporary access routes should preferably coincide with the planned permanent routes.

Temporary access shall be designed to suit climatic, traffic and subsoil conditions.

The effects of heavy traffic along temporary roads (e.g. propagation of dust clouds, damage to existing structures by vibrations, noise pollution, disturbance of surface and subsurface drainage) shall be taken into consideration and where necessary suitable precautions shall be taken.

Traffic routing schemes should be established, especially for large-scale works.

3.2.11 Laydown and Stockpile Areas

Permanent laydown areas normally located inside battery or module limits for the laying down of bundles, trays, columns, and other structures during shutdown or maintenance of plants shall be designed and constructed in accordance with the procedure for roads, paving, surfacing slope protection and fencing.

Temporary laydown areas (included in the contractors areas) required for construction activities should be suitably levelled and provided with suitable access, temporary paving and surface drainage where required.

The area shall be drained such that stored materials remain dry and the area remains accessible (surface and possibly subsurface drainage may be required).

For stockpiling see (3.3.3.4).

3.2.12 Shore Protection, Coastal Defence and River Works

Shore, river embankment and scour protection works forming part of site preparation works shall be designed and executed in accordance with applicable standards.

3.3 EARTHWORKS

3.3.1 General

Site preparation for earthworks shall be designed, planned and executed in accordance with (3.2).

The effect of earthworks on neighbouring structures, services, etc., shall be analysed (for both short- and long-term effects) and detrimental effects shall be avoided or appropriate measures taken to safeguard the integrity of the item in question.

Similarly the effects of dewatering or disturbance of the existing geohydrological conditions as a result of earthworks on neighbouring structures, services, etc., shall be taken into account.

Examples are:

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- change in horizontal earth pressure on foundations (especially piled foundations) may turn out to be unacceptable
- damage to foundations and structures as a result of differential settlements caused by lowering and raising of ground water level, placement of fill or other surcharge excavation and horizontal soil movement
- damage to foundations and structures by vibrations caused by earth moving equipment and heavy traffic.
- Care shall be taken in removing/planting trees and shrubs which could affect the water table, which in turn may affect adjacent structures.

The possible effect of ground movement on earthworks with respect to:

- liquefaction/excess pore water pressure build-up
- change in soil/rock properties
- change in loading situation

Which shall be investigated and where necessary suitable measures taken.

The magnitude of the earthquake, earthquake coefficient shall be made in accordance with the latest applicable national/international standards. . The structures important factor shall be in agreement with the principal.

3.3.2 Design of Cuttings, Excavations, Embankments and General Fill

The macro and micro stability of cuttings, excavation and embankment slopes and the related soil/rock deformations shall be analysed in accordance with the SAICE Code (2010).

Design of cuttings, excavation and embankment slopes shall include erosion protection of slopes, Soil deformation with respect to settlements due to consolidation, compression of soil structure, movements required to develop shear resistance, the consequence of sliding and squeezing, etc., shall all be analysed in accordance with the procedure for geotechnical and foundation engineering.

The impact of earthworks on ground water levels and the influence on drainage shall be analysed and where appropriate designed for.

The temporary stability of the excavations is the responsibility of the Contractor, however; the Contractor cannot excavate before a method statement is submitted and approved by the principal. The contractor shall be provided with the full geotechnical investigation. For large and deep excavations, the principal may decide to carry out the design of the temporary works.

For Dam design and construction, possible change in soil and ground water properties due to earthworks, such as change in pH value and sulphate content, shall be investigated/studied.

3.3.3 Excavation and Filling

3.3.3.1 General

Site preparation for earthworks shall be planned and executed in accordance with (3.2).

Excavation and filling activities shall take into account the results of the stability and soil deformation analyses carried out in accordance with (3.3.2).

The planning of excavation and filling activities shall take into account the climatic conditions prevalent during the construction period. Drawings shall be prepared prior to commencing work showing locations of excavation, tipping and filling including quantities of each type or class of material to be moved to or from sections defined on the drawings.

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Soil behaviour and soil properties (and possible changing hereof) during and after the execution of earthworks should be monitored if required and agreed with the principal.

Aspects such as settlements, horizontal movements, sliding, ground water levels, piezometric pore pressure and excess pore water pressure development, ground water composition, excavation slope and cutting sidewall stability should be monitored if required and upon with the principal.

3.3.3.2 Excavation

Foundations shall be excavated to the suitable level as indicated in the Geotechnical investigation. In the event that at that level unsuitable material is found, this shall be removed to the level indicated by the geotechnical engineer and replaced by 10MPa mass concrete. Excavations in materials susceptible to deterioration on exposure shall be protected either by coverage with plastic sheeting, blinding or shotcrete.

3.3.3.3 Excavation in rock

Where excavation in rock by mechanical or hand methods prove to be impractical or uneconomic, drilling and blasting should be considered.

Drilling and blasting shall be carried out only with the explicit written permission of the principal.

The contractors blasting method statement shall include storage, transportation, licensing for blasting and handling of explosives which shall comply in all respects with the latest applicable local and national laws. The principal shall approve the contractors blasting method statement before commencement of blasting works.

Blasting operations shall be carried out and supervised only by personnel in possession of a blasting license.

The contractor shall be responsible for determining the blast impact zone likely to be created during blasting operations and he shall be responsible for timeously evacuating this area of personnel before blasting and placing the necessary safety barriers and warning signage. Where blasting could cause damage to nearby structures, the contractor shall take the necessary precautions to avoid damaging the structures. This shall be clearly specified in the method statement. Structures can also be damaged by vibration caused during the explosions, this shall be limited in accordance to the relevant applicable standards and type of structure/s shall be taken into account.

3.3.3.4 Disposal of materials accruing

Suitable materials intended for re-use shall be stock-piled at a feasible location approved by the principal.

Material suitability shall be determined by the intended re-use of the material. Where temporary stockpiles hold materials intended for rehabilitation of ground, stockpiles that can deteriorate if exposed shall be protected against erosion and weathering.

Unsuitable materials not intended for re-use shall be removed from the work site and disposed of at a location approved by the principal. Materials shall be disposed of in accordance with local and national laws and regulations.

3.3.3.5 Filling

Suitable fill materials shall be placed, spread and compacted in horizontal layers of equal thickness appropriate to the compaction specification; this shall include the method of compaction as specified by the geotechnical investigation, the layer thicknesses, the minimum compaction density, the required KPa yield. For Ash facilities and embankments, fill materials shall be built up evenly over the full width of the area with a slope sufficient to allow efficient surface drainage of rain water to prevent ponding. Where

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there is a high risk of ponding; the toe of the slope may run a risk of being submerged thereby inducing slope slip; diversion channels for run-off water shall be implemented.

Monitoring for settlements and stability shall be conducted where necessary and shall be prescribed by the principal engineer. Monitoring instrumentation and reading during and after construction shall be prescribed by the principal engineer. In certain cases subsurface drainage may be required in which case attention shall be paid to the long-term behaviour hereof (e.g. danger of clogging).

The suitability of fill material shall be prescribed by the geotechnical investigation and where applicable, shall be regularly checked by (field) laboratory tests.

Rockfill should be placed in layer thicknesses compatible with the compaction specification.

The best possible grading of the rockfill to be placed should be obtained in order to prevent subsequent 'collapse settlements'.

Rockfill obtained from a strong or moderately strong parent rock should be watered, after placing and prior to compaction, in order to reduce frictional resistance between rock fragments and thus enhance compaction thereby avoiding subsequent 'collapse settlements'.

The gradation of the rockfill in its upper layer, under roads and under other areas where finer fill material is placed, shall be such that loss of finer material due to wash-out, etc., cannot occur.

The gradation of the rockfill in its lower layers where it is placed on softer (or fine grained) materials shall be such that loss of rock into the soft material is prevented.

Unsuitable materials, including weathered rock and rock susceptible to deterioration, should be removed prior to commencing rockfill operation.

Rockfill obtained from a weak or poor parent rock (e.g. mud stones, shales, limestone and chalk) should not be watered prior to compaction in view of the danger of rock fragment disintegration.

Field trials should be carried out in order to determine the optimum layer thickness of rockfill, the method of compaction, the numbers of passes, the amount of watering, variability of grading and the type of compaction plant required to obtain optimum compaction results.

3.3.4 Compaction

Compaction trials shall be conducted, where necessary, as determined by the geotechnical investigation report and should be specified within the works information. The principal shall agree on the compaction method and layer thicknesses prior to commencement of works.

The degree of compaction required is dependent on the load that the ground slab and/or road must carry. The compacted dry density of the soil shall be given either by Mod AASHTO density or by the Mod Proctor density. Where possible, in-situ densities should be obtained during the geotechnical investigation. The compacted in-situ density shall be verified during the course of the works to ensure a uniform density both in elevation and area.

The number of in-situ tests is dependent on the area and thickness to be compacted and shall be given within the works information.

3.3.5 Trenches and Pits

3.3.5.1 General

Trenches and pits deeper than 1.2 m are either provided with temporary support or battered. Drainage should be provided where possible, otherwise water needs to be removed by pumping. Temporary support can either be incorporated with a permanent structure or removed during construction of the permanent structure.

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3.3.5.2 Design

The design of the trenches and pits will be based on the results from the geotechnical investigation.

For trenches and pits in rock deeper than 1.5m with vertical sides, temporary support can be in the form of rockbolts and shotcrete. For trenches and pits in highly weathered rock or soil deeper than 1.5m with vertical sides, temporary support can be one of the following:

1. Timber shoring
2. Sheet piling propped or unpropped
3. Mini piles with or without soil nails
4. Soil nails with shotcrete
5. Post tension cables with soldiers
6. Others.

For trenches and pits with vertical sides, the design of the support must take into account all the vertical permanent or temporary loads applied to the side of the trench / pit.

For trenches and pits in highly weathered rock or soil deeper than 1.5m with batters, the batters slope must be designed in accordance to the angle of repose given by the geotechnical investigation. Battered trenches and pits can have a 1.5m vertical wall at the bottom.

For deep trenches and pits excavated with high water table, caution shall be exercised when dewatering since this can destabilise adjacent structures.

3.3.5.3 Construction

Trenches and pits have different uses and therefore shall be treated differently dependent on the use.

Trenches can be excavated to construct cut and cover tunnels or deep channels, in this case the bottom of the foundation should be capable of supporting the concrete structure. The walls should be designed to resist the side soil load and any other horizontal load coming from either vertical permanent or temporary loads applied to the side of the trench. Trenches excavated for housing pipes at the bottom shall be filled with compacted materials in accordance to the latest applicable standards.

4. AUTHORISATION

This document has been seen and accepted by:

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5. REVISIONS

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November 2012	0.2	M. Were	Draft Document for review
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August 2014	1.1	B.W. Thomas	Content was revised, based on newer information and best practice
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6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- Kobus Vilonel
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- None

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