

# **SPECIFICATION OF EARTHWORKS FOR RETAINING STRUCTURES AND EXCAVATION**

## **1.0 GENERAL REQUIREMENTS**

This specification is to be read in conjunction with the conditions of contract, and all other related specifications and drawings.

Where works are directed to be performed by the Contractor but are not specified in the specification, the Contractor shall carry them out with full diligence and expedience as are expected for works of this nature under the obligations of the Contractor.

## **2.0 STANDARDS AND CODE OF PRACTICE**

Unless otherwise specified herein, the following contemporary Codes and Standards available at the date of the tender shall lay down the minimum standards required for the earthworks. Where these Codes and Standards are in conflict, or are less severe than the equivalent provisions of the Malaysian Standards, the latter standards shall take precedence:

BS 6031 Code of Practice for Earthworks  
BS 8004 Code of Practice for Foundations

Unless otherwise permitted in the local regulations, the latest Malaysian Standards follow by British Codes and Standards pertaining to the particular type of material being used shall determine the quality of material and the method of work in the Contractor's design and construction of temporary structures.

Where the Codes or Standards do not provide adequate guidelines on any aspect of the construction operations or of temporary structures on the Contractor's design, the Contractor shall be responsible for the observance of proper safety measures and good engineering practices, including prototype testing to verify the design. If inexperienced in erecting the type of temporary structures being provided or in doubt as to the adequacy of its design, the Contractor shall engage suitably qualified competent Professional Engineers (In this Specification, Professional Engineer shall be referred to Professional Engineer registered with the Board of Engineers Malaysia) with the requisite expertise in these areas to supervise the erection or perform the design of the temporary structures. All works by Contractor shall comply to Health & Safety Act.

## **3.0 CONTRACTOR'S RESPONSIBILITIES**

The Contractor shall allow in his contract price for his compliance with the requirements of this section and for all other things necessary to complete the required earthworks. He shall allow and be responsible for making all necessary temporary works complete and safe for the purpose of supporting the excavation. In this respect, he shall conduct site investigations, prepare adequate designs, make statutory submissions, construct, test, monitor and subsequently remove all necessary temporary works to the satisfaction of both the Engineer and the local Authority.

The Contractor's method of construction shall comply with the more severe of either the statutory limits imposed on lateral and vertical ground movements, construction noise, vibration and air pollution levels, or such limits necessary for the adequate protection and proper functioning of neighbouring roadways, buildings and their facilities as agreed with the Engineer. The Contractor's compliance with these limits shall not relieve him of his sole responsibility for

all consequential damages to adjoining structures, roads and other properties caused by excavation work.

The Contractor shall excavate to the required lines, levels and grades to meet the requirements of the Works and remove surplus excavated material off the Site. He shall protect the exposed faces of the excavation with approved materials and lay all slope protection in proper and timely sequence to suit his method of construction.

The Contractor shall take all necessary steps before the commencement of earthworks to verify and supplement the soil report and any other information provided at tender, to the extent that is required in his method of construction.

The Contractor should also check for uplift, piping due to different water head/ water pressure that may be caused to excavation, natural artesian or other construction works; and construct drainage and pumping systems (surface pumping and deep well pumping) to prevent uplift or piping in the subsoil. The method statement shall also be submitted to the Engineer prior to excavation work at site.

The Contractor shall conduct pre-commencement site visits where necessary to establish and verify the locations and levels of all existing underground utilities within and surrounding the Site that are affected by the earthworks, and take all necessary steps either of a temporary or a permanent nature to protect, divert or shut off the affected services to the satisfaction of the local Authority.

The Contractor's Professional Engineer shall, jointly with the Contractor, prepare complete and adequate designs, shop drawings, specifications, method statements, sequence and schedule of placement of all necessary temporary works such as temporary earth retaining structures (if any), drainage and dewatering or groundwater control systems, ground movement monitoring systems, protective hoardings, barricades and signages, etc. to enable the excavation to be safely carried out and maintained with minimal disturbance to neighbouring structures, roads and other properties, all to the acceptance and satisfaction of both the Engineer and the local Authority. The Contractor's Professional Engineer shall be responsible for supervising all temporary construction works to the requirements of his designs and specifications.

All designs, shop drawings, specifications, sequences and schedules of placement of temporary works shall be certified by the Contractor's Professional Engineer. Certified copies of the same shall be extended to the Engineer prior to any site installation. The Contractor shall submit the part or the whole of such certified design, drawings and specifications that is necessary to secure from the local Authority the required clearances and the statutory permit to commence earthworks. In this respect, he shall comply with any other statutory requirements pertaining to temporary works which may be imposed from time to time in the course of the Works.

Where temporary works will cause alterations to the permanent structure, such as changes in the design loadings to accommodate construction loads, provision of temporary construction openings, incorporation of the temporary works or part thereof into the permanent structure etc, the Contractor shall be responsible for providing complete revised designs and details of the affected permanent work which shall be certified by his Professional Engineer. Revised designs of the permanent structure shall comply with the requirements of these specifications and shall be in general conformance with the design concept of the permanent structure, all to the satisfaction of the Engineer.

The Contractor and his Professional Engineer shall supervise the performance of all temporary works and monitor lateral and vertical ground movements, including related parameters such as groundwater table level etc. All performance measurements shall be recorded and made available to the Engineer for his record. The Contractor shall be responsible for and execute in a timely manner all corrective measures made necessary due to either his failure to comply with the specified and/or statutory limits imposed on permissible lateral and vertical ground movements or any other inadequacy in his design and/or construction of the temporary works.

The Contractor shall not deviate from his submitted designs, method statements and

construction sequences for the temporary works unless such deviation are approved by his Professional Engineer and agreed with the Engineer. He shall adhere strictly to the use of good workmanship, proven construction techniques and timely implementation of submitted construction sequence to restrict ground loss and movement next to the excavation. The Contractor shall be responsible for all consequent damages caused by his failure to construct in accordance with his submitted designs and method statements or by his failure to adopt adequate safety precautions and to observe good engineering practices in his construction operations.

Upon completion of construction operations, the Contractor shall remove all temporary works to the satisfaction of the Engineer and to the requirement of the local Authority. He shall obtain approved fill material, transport, deposit in voids between the face of the excavation and the permanent structure, and compact to the required lines, levels and grades required for the satisfactory completion of the earthworks. The Contractor may, with the consent of the Engineer, use surplus excavated materials as fill provided the material meets the requirements of these specifications.

#### **4.0 LOCAL REGULATIONS**

The Contractor shall be responsible for executing the earthworks strictly in accordance with the relevant local regulations, Acts and by-laws that are current at the date of the tender together with all amendments and addenda which are imposed as statutory requirements in the course of the Works.

#### **5.0 SITE CONDITIONS AND CONSTRAINTS**

Prior to the submission of the tender, the Contractor is required and deemed to have visited the Site to fully acquaint himself as to the nature, extent and practicality of the excavation, underpinning works, earthworks or associated temporary works. The Contractor shall satisfy himself that the existing ground and formation levels as shown on the drawings are correct.

The award of the Contract shall be based on the understanding that the Contractor is familiar with the geotechnical and geological aspects of the Site. He shall include in his tender for all costs arising from the nature of the ground (ground levels, water table level, rock formations, subsoil conditions etc), climatic conditions, the availability or lack of access, working space, storage, accommodation, the proximity of adjoining structures and roads, the local Regulations regarding the obstruction of public highways and any other limitations imposed by the Site and its surroundings, for the satisfactory completion of the earthworks. He shall make due allowance for the effect of these constraints on his construction operations to ensure on-time completion of the Works. No claim by the Contractor on the grounds of lack of fore sight or knowledge of the site conditions or for under- provision in connection with the Works will be considered.

The Contractor shall ensure that his method of excavation is suitable and safe for use at the Site. The Contractor shall indemnify the Employer against any expense, liability, loss, claim or proceedings which the Employer may incur or sustain by reason of damage to any property, real or personal other than works, injury or accident to workmen or public, caused by collapse, subsidence, vibration, weakening or removal of support or lowering of ground water, arising out of or in the course of or by reason of the execution of the Works.

#### **6.0 SITE ACCESS**

The Contractor shall be responsible for obtaining all necessary statutory approvals on temporary access into the Site for the tenure of the contract period. He shall comply strictly and diligently with all conditions attached to these approvals. The access as well as the portion of public road and walkway connected with it shall be kept clean and safe at all times. Continuous and adequate security arrangements at access points into the site shall be provided for the full duration of the contract.

## **7.0 SUBSOIL DATA**

A soil investigation report for the Site is available to the Contractor for his information. The report is intended solely as a preliminary and approximate guide to the nature of ground stratification as it is known to the Engineer. The completeness and the accuracy of the information provided is neither guaranteed nor implied. No responsibility is assumed by the Employer or the Engineer for any opinion or conclusion given in the soil investigation report.

The soil investigation report limits itself to and identifies subsurface conditions only at selected points where soil samples were taken, when they were taken. The actual conditions in areas not sampled may differ from the reported findings. Continuing adequacy of the report may be affected by time, construction operations at or adjacent to the site and by natural events such as floods and groundwater fluctuations.

Given the limitations attached to the soil investigation report, the Contractor shall be obliged to place his own interpretation on the information provided and include in his tender for the cost of providing all things necessary to ensure the satisfactory completion and the safety of the earthworks, such as supplemental soil investigation and adding, upgrading, strengthening, adapting, modifying, taking down and refixing of temporary works, etc. He shall assess the limitations of the soil report and make due allowance in his construction operations to ensure the on-time completion of the Works. No extra time or payment will be considered at a later date on the grounds of under-provision in the excavation, earthworks or associated temporary works, incomplete or incorrect information contained in the soil report, or want of knowledge or foresight.

The Contractor shall make his own verification of water level/pressure at the Site. No claims will be considered for any special pumping or bailing required related to the work below the water table level. The Contractor shall allow in the tender for the cost of any extra supports to stabilise the earth required to excavate below the water table level.

Details and results of all supplemental soil investigation which the Contractor undertakes in the course of the Works shall be made available to the Engineer for his record.

## **8.0 PROTECTION OF PUBLIC AND PRIVATE SERVICES**

The Contractor shall be responsible for detecting, protecting, upholding, upkeeping and maintaining all existing services such as roadside drains, mains, ducts, water supply pipes, sewers, gas conduits, electrical and telephone cables and the like over and adjacent to the Site during the tenure of the contract, regardless whether or not these services are known to exist at the time of tender. He shall take extra precautions to prevent undermining of foundations to service lines, thereby resulting in damage and interruption of supply, and make good any damage due to any cause within his control at his own expense and time, and pay all consequential costs and charges in connection therewith.

In the event that damage has been done to services due to the Contractor's work or any cause within his control, and should these repairs be carried out by the local Authority, the Contractor shall make a direct reimbursement to the local Authority for the cost and charges for carrying out the repairs, failing which the Employer reserves the right to pay the local Authority direct and deduct the same from any monies due or becoming due to the Contractor.

Any information made available to the Contractor at the time of the tender is indicative and is intended only as an approximate guide for the Contractor's own verification on Site. Immediately after taking possession of the Site and BEFORE commencing work, the Contractor shall establish test holes to confirm the locations and levels of all existing underground utilities within and surrounding the Site that are affected by his excavation works. If the Engineer is of the opinion that the site verification survey of underground services is incomplete or inadequate in any way, he shall order additional confirmatory test holes to be carried out at the Contractor's

expense. The Contractor shall immediately notify the Engineer and the local Authority if he should encounter services not known to have been existing at the time of tender.

If it becomes essential in the opinion of the Engineer and the local Authority to temporarily or permanently divert any cable, pipe or other service, the Contractor shall give the necessary notices to the local Authority and arrange for the diversion work to be carried out, regardless whether or not the service to be diverted is known to exist at the time of tender. The cost of the diversion will be paid for by the Employer but it shall be the Contractor's responsibility to coordinate all service diversion works that are carried out during the tenure of the contract period and ensure that such works do not adversely affect the on-time completion of the Works, failing which the Contractor shall bear all consequences for any delay in completion of the Works due to any cause within his control.

## **8.1 Preservation of Existing Trees**

The Contractor shall take precaution to protect from damage all existing trees and shrubs which are designated to be preserved by the local authorities or the Engineer. When necessary adequate temporary fencing shall be erected for each tree or a group of trees. When required, the tree shall be protected by wrapping with suitable paling materials up to 1.5m high.

## **9.0 ADJACENT PROPERTIES**

### **9.1 Stability and Settlement of Adjacent Properties**

The Contractor shall be solely responsible for the stability of all adjoining structures and facilities. The method of construction adopted by the Contractor for the execution of the excavation, earthworks and associated temporary works shall be such that public roadways, railways, private access roads, underground utilities, principal buildings and permanent facilities in adjoining properties are adequately protected from the detrimental effects of instability and ground subsidence.

The Contractor shall be required to assess the settlements and ground movements that he anticipates will occur around the site boundaries due to the excavation work. His calculations and assumptions on which these assessments will be made shall form a part of his submission to the local Authority for the purpose of obtaining statutory clearance and securing the permit to commence work. A copy of such calculations and assumptions shall be made available to the Engineer for his record.

### **9.2 Limits On Ground Movement**

The Contractor shall be responsible for restricting the maximum settlement and lateral movement of the ground adjacent to the Site to the lesser of either the statutory limit imposed by the local Authority, measured from the initial pre-construction reference level or line. The Contractor's compliance to this limit shall not relieve him of his sole responsibility to make good at his own cost and in the manner prescribed by the Engineer and the local Authority, all consequential damages to adjoining structures, roads and other properties arising from ground movements caused by excavation work.

### **9.3 Dilapidation Survey**

Immediately after taking possession of the Site and BEFORE commencing any work on Site, the Contractor shall conduct an adequate dilapidation survey with measurements of all principal buildings and permanent facilities around the site boundaries to establish their general pre-construction condition. The survey report shall be lodged with the Employer, the Engineer, the

local Authority, the adjacent Owners, and with any other party that the Employer may direct.

For each adjacent building or facility, the Contractor shall prepare a set of photographic records together with proper documentations and a schedule listing the size of the superstructure, extent of underground structure, visible defects with measurement and any other relevant details pertaining to the general condition of that building or facility.

#### **9.4 Ground Movement Instrumentation and Monitoring**

The Contractor shall allow in his tender for the cost of implementing an adequate ground movement monitoring system complying to the minimum requirements set out in this section. He shall be responsible for installing, measuring, recording and maintaining all necessary surface settlement points, piezometers and inclinometers, including securing the required permits and written consents from the local Authority and the adjacent Owners to have the instrumentation installed. If blasting of rock/hard material is to be carried out, accelerometers of sufficient quantity are to be installed on the ground and adjacent buildings and included in the instrumentation monitoring programs. All instrumentation and monitoring methodology or logistics must be submitted to the Engineer for approval prior to installation.

The Contractor shall undertake an initial level survey along and perpendicular to the side boundaries and maintain level checks of surface settlement points at daily intervals, or such intervals as the Engineer may decide, for the duration the excavations are kept open. Surface settlement points shall be laid out at not more than 5m apart, or at such distances as the Engineer may decide. The minimum distance perpendicular to the Site boundaries shall not be less than 10 times the depth of excavation, or such distances as the Engineer may decide.

The Contractor shall make careful and regular checks on the rate and magnitude of any ground movements or movements of adjoining buildings, permanent facilities and roadways for the tenure of the contract. Records of all movements shall be maintained by the Contractor and submitted to the Engineer not later than two(2) days after measurement, and immediately should movements be such as to endanger the stability of adjoining properties.

#### **10.0 TEMPORARY WORKS**

The Contractor shall allow in the tender for the cost of providing the necessary design, statutory submission, construction, testing and monitoring of all temporary works, including the subsequent removal of all recoverable temporary structures, for the satisfactory completion of the earthworks. He shall be responsible for the overall adequacy and safety of all temporary works.

The scope of temporary construction shall include but not limited to:

- (a) Life safety measures such as hoardings, barricades, nettings, signboards, etc.
- (b) Ground improvement and/or ground water cutoff systems using jet grout piling, etc.
- (c) Ground water recharging systems, surface and groundwater drainage system using surface or subsoil drains, sumps, chemical grouting, etc.
- (d) Recoverable earth retaining system, surface and groundwater drainage system using surface or subsoil drains, sumps, chemical grouting, etc.
- (e) Non-recoverable earth retaining structures using contiguous bored piling, diaphragm wall, etc.
- (f) Slope protection systems using concrete lining, soil nail, ground anchors, etc.
- (g) Instrumentation to detect ground and building movement using inclinometers,

piezometers, surface settlement survey, etc.

- (h) Preventive control measures such as daily filling of ground surface cracks behind temporary retaining structures, conducting regular and systematic visual checks for signs of yielding or disturbance of temporary construction, etc.
- (i) All other measures necessary for the safe performance of the temporary works, such as maintaining, adding, upgrading, strengthening, adapting, modifying, re-positioning, taking down and refixing from time to time, etc.

The Contractor shall employ a Professional Engineer to design and supervise the construction of the temporary works. A certified copy of the design calculations and construction drawings for the temporary works shall be made available to the Engineer for the purpose of record. If the Engineer is of the opinion that the provision of temporary support for the excavation is inadequate in any way, the Engineer will order additional supports or remedial works to be provided entirely at the Contractor's own expense with no additional performance time. Such instruction will not relieve the Contractor of his sole responsibility for the sufficient support of the excavation.

The Contractor shall make all necessary statutory submissions in connection with his temporary works, and secure from the local Authority the required clearances and the statutory permit to commence work. He shall comply with the requirements of the local Regulations governing his design and construction of the temporary works, including any statutory requirements that may be imposed from time to time during the tenure of the contract.

#### **10.1 Types of Temporary Construction**

The Contractor shall be fully responsible for the type of temporary construction that he adopts to ensure the adequate support of the excavation. He shall bear all consequences in time, costs and damages arising from his failure to adhere to adequate safety procedures, sequences of work and standards of workmanship in connection therewith.

The method of construction of temporary works shall take into account the following considerations :

- (a) The geotechnical and geological condition along the length and depth of the cutting.
- (b) The water levels, hydrogeology, strata permeabilities and natural artesian (if any) along the length and depth.
- (c) The settlements that will be expected and the anticipated effect on neighbouring structures.
- (d) The depth of construction required.
- (e) Any particular difficulties that special plant might meet with respect to access, clearances and working space.
- (f) Control of heave and instability of the base of excavation.
- (g) The adequate support of existing utilities affected by the excavation.
- (h) The operation of heavy equipment, the storage of bulk materials and any other form of surcharge next to excavation.
- (i) Control of lateral load increase and ground loss induced by water seepage through ground surface cracks behind temporary retaining structures.

Due regard shall be given to the ground settlements associated with the type or method of

temporary construction adopted by the Contractor :

- (a) Where ground water lowering by pumping will cause soil consolidation and ground loss, the Contractor shall design and install a groundwater recharging system; the Contractor shall ensure the sediment deposits and precipitation of solutionized minerals are controlled to maintain continued efficiency of the recharge system.
- (b) Timber ground supports which are non-recoverable shall be treated with approved wood preservative before use.

The minimum precautions to be taken by the Contractor for the particular temporary construction that he has adopted include but are not limited to:

**Dewatering :** Particular attention shall be given to avoid soil consolidation and ground loss next to the excavation caused by fluctuations in the water table level.

**Steel Sheet Piling :** The Contractor shall ensure that sheet piles are providing proper support to the sides of excavation under the worst combination of lateral earth pressure and groundwater pressure, including the possibility of the water level rising temporarily to the ground surface due to heavy rainfall. Particular attention shall be given to ensuring compliance with permitted noise and vibration levels during the installation and removal of sheet piles.

**Timbered Excavation :** The Contractor shall ensure that the timber is providing proper support to the sides of excavation. In water-bearing granular soil conditions where water leakage into the excavation will cause significant groundwater drawdown leading to ground loss and/or soil consolidation, particular attention shall be given to the use of a suitable ground water cutoff system such as jet grout piling behind the timbering. Particular attention shall be given to ensure maximum removal of timber on completion of work, but where timber is likely to be left in place, treated timber to prevent rotting is required.

**Trench Cutting :** Particular attention shall be given when using trench excavation method to control ground movement during the installation of temporary works for braced excavations in close proximity to principal adjacent structures of facilities. Trench cutting requires the sides of excavation to be cut and braced in a preselected sequence of alternate panels.

**Open Cutting :** Particular attention shall be given to the stability of side slopes and the prevention of deterioration of the sides of excavation by prolong weathering. Abrupt changes in soil conditions, such as when a compacted soil layer is underlain by loose soil strata below, will undermine slope stability. Particular attention shall be given to safe work methods and to providing adequate support to the excavation under such conditions.

**Ground Anchors :** If temporary ground anchors are to be used in this contract, they shall be of recoverable type and ALL these anchors shall be properly removed after use and the Contractor shall be responsible for all consequential costs, time and damages arising from his failure to do so. The Contractor shall also submit a full detailed method statement for the ground anchors to the Engineer for approval prior to work on site. The method statement shall include details of ground anchors systems, materials, construction (including drilling, grouting, stressing,

locking off and testing) and removal. Approval of the method statement by the Engineer does not relieve the Contractor of his sole responsibility for the proper construction and removal of the ground anchors. Refer to specification for ground anchors where relevant. If specification for ground anchors is not made available, the British Standard Code of Practice for Ground Anchorages (BS 8081: 1989) shall be adhered to. If the ground anchors extend beyond the site boundaries, the Contractor shall be required to secure all required permits and written consents from the local Authority and/or the adjacent Owners to have the anchors installed and pay all costs in connection therewith.

## 11.0 EXCAVATION

All excavation shall be carried out to the required lengths, breadths, depths, inclinations and curvatures as required for the construction of the permanent works, in whatever material that may be found.

The Contractor shall be required and is deemed to have visited and examined the Site to ascertain the nature thereof and the kinds of materials to be excavated prior to his submission of the tender. He shall allow in his tender for the cost of excavating all types of soil that he will encounter at the Site, and include a separate provision for excavation in rock as defined hereafter in this specification.

The Contractor shall be solely responsible for :

- (a) Implementing an adequate method of excavation, and adhering to safe work sequences and proper standards of workmanship in connection therewith.
- (b) Providing adequate protection of all excavations from collapse and subsidence of adjacent ground and properties.
- (c) The safety and integrity of the adjacent properties of the permanent works.

If in the opinion of the Engineer the method and sequence of excavation is inadequate in any way, he will reject the excavation proposals. Any such rejection shall not relieve the Contractor of his sole responsibility as defined above, and in such event, the Contractor shall bear the additional cost and time of providing a satisfactory alternative method of excavation to comply with the requirements of these specifications.

The Engineer shall have the right to order excavation and construction work to be carried out in such lengths and in such sections of the works as in his opinion, will minimise the danger of the excavation affecting the stability of any nearby ground. The Contractor shall have no claim for any extra payment or time on this account.

Wherever necessary for the safety of the workmen and other authorised persons on site, adequate barricades and protective covers shall be provided around all excavations.

Before commencement of earthwork, levels of existing ground as specified by the Engineer are to be verified by the Contractor's licensed surveyor. The survey shall be witnessed by the Engineer's representative. The Contractor shall produce a survey drawing showing existing ground levels for the Engineer's pre-commencement approval.

The Contractor shall suspend all works in respect of excavations when unsatisfactory work would arise as the result of inclement weather, saturation of materials, seepage flows or any other such conditions. He shall recommence work thereon only when materials and performance are no longer adversely affected.

The Contractor shall inform the Engineer if he should encounter any obstructions such as

boulders, concrete foundations or blocks, etc next to the boundary lines of adjacent buildings or properties. Where there is any likelihood of the adjacent property being affected by the removal of such obstructions, the Contractor shall submit his proposal for removing the obstructions to the satisfaction of the Engineer. Compliance with any instructions from the Engineer in this regard will not relieve the Contractor of his sole responsibility for the safety and integrity of the adjacent property. The Contractor is to use a suitable means of hydraulic or pneumatic tools, blasting or other approved method. No claim for any extra payment or time will be considered on this account. All excavation shall be carried out by machine except as otherwise approved by the Engineer.

The Contractor shall give at least 24 hours notice to the Engineer prior to blinding the surface of the excavation so that an inspection may be made. No blinding or concreting shall be carried out without the approval of the Engineer. The level of all blinded surfaces prior to concreting shall be to the correct levels with a permissible deviation of  $\pm 15$  mm. The thickness of the blinding concrete shall be at least 150mm unless otherwise directed by the Engineer.

No excavation in which construction has been completed is to be filled or back-filled before the finished work has been inspected and approved by the Engineer, failing which the Engineer will order the excavation of the fill to expose the permanent work for inspection. The Contractor shall be entirely responsible for the cost and extra time of such additional work and inspection.

## 12.0 EXCAVATION IN ROCK

For the purpose of this contract, rock shall be material found in ledges or masses in its original position and has a large coherent mass of such size and strength which can be loosened or fractured only by blasting or the employment of heavy pneumatic tools or by chemical expansion methods or, if excavated by hand, will require breaking up by steel wedges and sledge hammers.

Notwithstanding the above, rock shall not include material which in the judgement of the Engineer can be loosened with a dozer mounted drawn ripper of the following description:

**Dozer Unit :** Plant with a minimum weight of 236 kN and net horsepower rating of 300 h.p. or 225 kw. The tractor unit is to be in good conditions and operated by experienced personnel skilled in the operation of ripping equipment.

**Ripper Unit :** The ripper to be attached to the dozer shall be the most efficient parallelogram type recommended by the dozer or ripper manufacturer. The ripper shall have shanks in good condition with sharpened cutting point.

Boulders or detached pieces shall only be regarded as rock if they individually exceed one cubic meter. Artificial hard material shall mean hard artificial material which would require the use of blasting or approved pneumatic tools for its removal but shall exclude individual masses less than one cubic meter. Removal of loose boulders of up to and including one cubic meter in volume from the excavation, and breaking of road surface, road bases, concrete foundations or blocks regardless of volumetric quantity, will not be treated as rock excavation but will be paid for at normal excavation rates. Shale and clay boulders will not be considered as rock. The Engineer's decision as to whether or not the material of the excavation is classified as rock shall be final.

The Contractor shall be entitled to extra payment for rock excavation only if reasonable notice is given to the Engineer to examine such material prior to breaking up and measure the extent and depth before further excavation.

The use of explosives in blasting operations will require prior approval by the local Authority and the Contractor shall make due allowance in the tender for his compliance thereof. Rock excavation will be measured and paid for as "extra over" ordinary excavations by the Contractor shall have no claim for extra time in connection therewith.

## 12.1 Explosives

### 12.1.1 General

Should blasting be allowed, it must be control-blasting and must be carried out with the written permission of the Engineer and with the approval of the appropriate authority. All permits and licenses required in connection with the blasting works are to be obtained by the Contractor prior to execution of the works. The Contractor must inform the Engineer of the steps taken to safeguard the surrounding property and lives. The Contractor must take all responsibility for any damage or annoyance caused by reason of blasting.

### 12.1.2 Storage and Handling

The Contractor shall provide proper buildings or magazines in suitable positions for the storage of explosives in manner and quantities to be approved; he shall also be responsible for the prevention of any unauthorised issue or improper use of any explosives brought on the Works, and shall employ only experienced and qualified men to handle explosives for the purpose of the Works.

### 12.1.3 Security

The Contractor shall comply with the relevant security regulations dealing with the storage, handling and transport of explosives.

### 12.1.4 Blasting

The shots shall be properly loaded and tamped and, where necessary, the Contractor shall use heavy mesh blasting nets. Strictly, no fly-rock is allowed. The blasting vibration limit and velocity measured at the structures during blasting must not exceed 50 mm/sec. Maximum particle velocity-distance criteria for blasting near uncured structural concrete shall be as per table below :

Time from Batching (hours)	Particle Velocity (mm/sec)
0 – 4	5 df
4 – 24	6 df
24 – 72	25 df
72 – 168	50 df
168 – 240	125 df
Over 240	140 df

Source : Oriard, L..L. and Coulson, J.H. (1980) "TVA Blast Vibration Criteria for Mass Concrete, Minimizing Detrimental Construction Vibrations ASCE.

Where        df        =        distance factor to account for frequency attenuation  
                              =        1.0 (0m-15m)  
                              =        0.8 (15m-50m)  
                              =        0.7 (50m-80m)  
                              =        0.6 (Over 80m)

The maximum permissible air overpressure must not exceed 110 dB. Blasting shall be restricted to such periods as the Engineer may prescribe. If, in the opinion of the Engineer, blasting would be dangerous to persons or property or to any finished work or is being carried

on in a reckless manner, he may prohibit it, and order the rock to be excavated by other means. The use of explosives by the Contractor in large blasts, as in seams, drifts, shafts, pits or large holes, is prohibited unless authorised in writing by the Engineer.

All drilling and blasting shall be done in such manner as to bring the excavation as close as possible to the required cross-section or profile and to disturb as little as possible the material to be left in place. Blasting by means of drill holes, tunnels or any other similar method shall be performed at the entire risk and responsibility of the Contractor, who shall have no claim to payment for any extra work occasioned by breakage outside the required cross-section or profile.

Prior to the start of blasting operations, the Contractor, in the presence of the Engineer shall conduct a survey (dilapidation and topographic) of all structures and services within 120 metres of the site where blasting is proposed and any other structures which the Engineer considers may be affected, in order to determine the existing or pre-blast condition of these structure. Prior to commencing blasting operations, a written report, supported by photographs where necessary, listing any existing defects in the structures and services, is to be submitted to the Engineer.

All blasting works shall be carried out within the hours as approved by local authority.

### **13.0 STABILITY OF EXCAVATION AND MAINTENANCE OF EARTHWORKS**

All slopes shall be designed and certified by Contractor's Professional Engineer. Stability analysis shall be carried out to check the stability of the proposed slope using soil parameters agreed by the Engineer. The stability analysis carried out by the Contractor does not relieve his of his sole responsibility for all slopes erosion or failure.

#### **13.1 Surface and Percolating Water**

Surface and percolating water will undermine the stability of the excavation and nearby ground through the process of ground loss, consolidation and/or increase in lateral earth loading. The Contractor shall allow in his tender for the cost of providing adequate measures to maintain the stability of the excavation, including but not limited to:

- (a) Carry out design for the proposed slope using the soil parameters agreed by the Engineer.
- (b) Carry out adequate slope protection.
- (c) Divert surface and percolating water clear of all excavations by means of temporary drains and sumps, and provide a groundwater recharging system and etc if necessary.
- (d) Fill up and seal on a daily basis all movement cracks that appear on the surface of adjacent ground and continue until ground movement has ceased.

The Contractor shall be responsible for making good and rectifying any bank slips, erosion of slopes and other forms of ground loss, and any consequential damage to drains, culverts, pipes, utilities etc, occurring in the course of excavation and during the period when the excavation stays open, all at his own expense.

#### **13.2 Surcharge**

The Contractor shall ensure that surcharge loads due to construction or other vehicles and equipment, excavated material, or other stockpiled material are not placed alongside the banks of the excavation without first making adequate provisions to underpin such loads. Any failure of the excavation caused by the indiscriminate placement of surcharge loads shall be the sole responsibility of the Contractor and he shall bear all consequences and damages arising

therefrom.

### **13.3 Protection of Slopes and Banks**

All exposed earth slopes shall be protected with approved temporary protection not later than one day after they are cut, and IMMEDIATELY if high water table, poor soil or adverse weather conditions are encountered, prior to the application of permanent protection, ie closed turving or hydroseeding. The Contractor shall submit the proposed temporary protection system for the Engineer to review and comment prior to any earthworks at site.

Temporary protection shall not be removed until proper and adequate slope drainage ( berm drains, cascade drains and toe drains ) and permanent protection ( closed turving or hydroseeding ) has been constructed as approved by Engineer.

As earthworks progress, it shall be the responsibility of the Contractor to provide slope protection in a diligent and expeditious manner on completion of each stage of excavation. The Contractor shall on no account deviate from his submitted method or sequence of slope protection unless such deviation has been approved in advance by his Professional Engineer.

### **13.4 Site Drainage and Dry Conditions**

The excavation is at all times to be kept well drained and dry by means of temporary slopes, drains, sumps, etc and by pumping.

As earthworks progress, the Contractor shall provide and maintain temporary concrete drainage channels with cascades for the efficient drainage of the area. These drains shall be cut to a gradient not exceeding 1 in 100. The Contractor shall break up and remove temporary drains after use and make good as directed by the Engineer.

The Contractor shall install a drainage and sump system at the final excavation level. He shall maintain the drainage and sump system for the duration the excavation is kept open or until such time when the permanent construction has adequate weight to resist flotation, whichever is later.

All temporary drains shall be directed to the nearest water course or to sumps which are pumped out to the roadside drain. The roadside drain shall have an adequately large section so that no mud or water will spill onto the roads or pavements. Only self priming submersible pumps of sufficient capacity such as 'Flygt' pumps or similar equipment are to be used. The pumps shall be of sufficient number and capacity to provide adequate pumping capability in the event of breakdown.

The effluent discharge system shall comply with the requirements of the Jabatan Kerja Raya, the Health Department and other appropriate Authorities. The Contractor shall keep the roadside drains in the vicinity of the site are free of silt due to site effluent. He shall provide a desilting basin of adequate size for this purpose and remove silt from the effluent before discharging it into the roadside drain. The Contractor shall obtain all necessary approvals and pay all costs and expenses in connection therewith.

### **13.5 Anti Malarial and Dengue Measures**

The Contractor shall take all necessary precautions to prevent the breeding of mosquitoes and pay all charges made by the local Authority for anti-malarial measures.

### **14.0 VOLUME OF EXCAVATION**

All measurement of excavation shall be based on the net dimensions based on the nett

dimensions between the external faces of the permanent construction. The Contractor shall allow for all additional excavation that he may require for working space, storage, formwork, temporary structures, and/or for his convenience, and for any increase in bulk of the excavated materials in relation to disposal.

The Contractor shall carefully maintain all boundary markers, benchmarks and other such reference points which shall be offset before commencement of the Works. All offsets shall be carried out by a licensed surveyor.

Should any such markers be disturbed or destroyed, these references shall be replaced immediately and the Engineer informed of such replacement.

## **15.0 FORMATION SURFACES**

The last 1000mm of excavation directly above the formation surface shall not be completed until immediately before the laying of blinding materials, concrete etc. Bottoming-up to formation shall be performed by suitable machineries and shall be such that the blinding operations to be carried out immediately and completed in one go. The Contractor should plan his work properly, preventing opening up the final formation surface too large an area and can not complete the blinding in one go. If rains, the Contractor must provide temporary cover/protection and drainage to the exposed final formation surface that blinding has not been carried out.

The base of all excavations, after being trimmed and levelled, shall be well rammed and compacted to form a solid formation to the approval of the Engineer. It shall be the responsibility of the Contractor to prevent damage to the prepared formation from weathering, trampling by workmen and other construction activities.

For the purpose of this section, sound material shall mean soil with the minimum bearing capacity and coefficient of subgrade modulus that is adequate for supporting the superimposed loading.

The Contractor shall satisfy the Engineer by means of tests that sound materials are founded at the base of excavations. Where tests show otherwise or where the original soils encountered at or below formation level are soft, loose or unstable, the excavation shall be carried down to such depths and over such dimensions as the Engineer will direct until sound materials complying with the requirements of these specifications is reached. The excess excavation shall be made good with approved granular fill and compacted to the satisfaction of the Engineer.

Should the Contractor excavate into original sound material beyond or below the designated lines or levels, or should the Contractor cause the prepared formation to deteriorate and become soft or unstable due to his lack of diligence or expedition or any other cause within his control, he shall at his own expense and as directed by the Engineer, replace such excess excavation and softened formation with approved granular fill or concrete depending on the Engineer's design. The Contractor shall have no claim for extra cost and time in connection therewith.

Should the Contractor commence to place concrete without first having satisfied the Engineer, by testing or otherwise, that the base of any excavation is at least of the required bearing capacity and/or having the minimum modulus of subgrade reaction, the Engineer will order the removal of the said concrete and require excavation to continue. The Contractor shall be entirely responsible for the cost and time of such extra work.

## **16.0 HANDLING AND DISPOSAL OF EXCAVATED MATERIALS**

The rates for excavation and disposal of excavated materials are to include for any wheeling or career handling or additional handling, and for the temporary formation of spoil heaps and re-excavating therefrom within the Site and raising to higher levels, as often as may be required.

Surplus or rejected excavated material not required for filling is to be transported off the Site to an approved dump site provided by the Contractor. The Contractor is to take all precautions to prevent any spillage or soiling of the public roads during the earth removal operation, and is to pay all dues in connection therewith.

## **17.0 FILLING**

Filling shall be carried out to the lines, levels and grades required to complete the permanent construction. Should the Contractor fill above the designated levels, the Contractor shall remove such excess filling entirely at his own expense.

### **17.1 Material for Filling**

In general, fill material shall be graded granular soil unless otherwise approved by the Engineer. The Contractor shall allow in the tender for the cost of laboratory tests to determine the optimum moisture content and dry density of the fill material prior to the commencement of filling operations. The compacted fill shall have dry density of not less than 95% (for cohesive material if allowed to be used by the Engineer) and 100% (for cohesionless material) of its maximum dry density determined in the B.S. 1377 Compaction Test (4.5kg rammer method)

The safety of workmen, ease of placement and compaction are primary considerations when carrying out filling operations in narrow, confined spaces. Under these conditions, only well graded granular soil will be permitted for use as fill material. The Contractor shall take this requirement into account and make due allowance in the tender for the cost of importing granular fill from an approved borrow source, including paying all dues in connection therewith.

The use of excavated materials as fill is subject always to the written approval of the Engineer. Notwithstanding any prior approval given in this regard, the Engineer shall bear the right to reject and order the removal of any excavated material that he considers unsuitable for use as fill. The Contractor shall have no claim for extra time or costs in connection therewith.

### **17.2 Compaction of Filling**

Fill materials shall generally be placed in layers not exceeding 300mm thick per layer, and uniformly compacted to the satisfaction of the Engineer by approved type rollers before the next layer is applied. In confined work spaces, the use of approved type mechanical rammers or compressed air compactors will be permitted.

Where the fill materials are transported by tippers, each load shall be subsequently bulldozed, spread and leveled in layers, and compacted as described above in this section. The Contractor may be permitted to use sheepsfoot rollers for compaction on condition that the final layer of fill shall be compacted by smooth-wheeled rollers of not less than 10 tonne capacity.

Compaction of fill shall be controlled and carried out with sufficient passes of the mechanical rammers to obtain at least 90% of the maximum dry density at optimum moisture content compared with standard Proctor laboratory test results. The Contractor shall when directed by the Engineer carry out compliance field tests to check the degree of compaction attained on Site. Only tests that meet the minimum compaction requirements of this specification will be paid. The Contractor shall have no claim for extra time in connection therewith.

Compaction shall not be carried out when the fill is too dry to achieve the satisfactory degree of compaction. In the case of dry fill, the moisture content shall be increased by spraying with water from travelling water tanks or by other approved means as the compaction proceeds.

Where the Contractor has failed to obtain sufficient compaction in each layer to the satisfaction of the Engineer, he shall not be allowed to proceed with the next layer without the Engineer's

approval, and no claim for time lost or extra time required will be allowed in connection therewith.

Where undue movement occurs in the course of compaction due to soft, unstable foundation conditions under the fill, the area affected shall be excavated to such depths and over such dimensions as the Engineer will direct and be run to spoil. The resultant excavation shall be backfilled with suitable and approved materials deposited in layers, each not exceeding 300mm thick in loose form, and compacted as hereinbefore specified, or with suitable compressed air compactors or mechanical rammers where the excavation work is limited. The Contractor shall have no claim on time or cost in connection therewith.

## **18.0   HARDCORE**

Hardcore shall be clean, hard, dry, broken brick, stone or concrete, free from dust or debris, and to the approval of the Engineer. Hardcore shall be spread, levelled, watered and compacted in layers of such numbers and thickness as shown on the drawings.

## **19.0   PROTECTIVE VEGETATION FOR EROSION CONTROL**

If specified in the drawings, directed by the Engineer or required to be used by the Contractor to protect the slope via vegetation, the following sections shall be adhered to unless otherwise directed by the Engineer.

### **19.1   Topsoil**

Topsoil stockpiled for the Works shall be spread and lightly compacted to an even thickness of 50mm as directed by the Engineer in areas to be turfed and/or seeded.

### **19.2   Turfing**

Turfing shall be carried out as soon as practical on all earth slope and other areas as shown on the Drawings and/or where directed by the Engineer. The type of turf shall be as indicated on the Drawings or other alternative type as approved by the Engineer and shall be free of lalang and essentially free of weeds.

Turf shall be obtained in unbroken sods with a substantial amount of topsoil and shall be approximately 250mmx250mm in size and 100mm thick, from an approved source, and shall be placed in position as soon as practical after cutting.

Turf sods shall be stacked and watered when they cannot be laid immediately after cutting. The surfaces to be turfed shall be trimmed and thoroughly wetted. The turf shall then be carefully laid to form a complete and uniform cover as shown on the Drawings. Turf laid on slopes steeper than 1(vertical) : 3 (horizontal) shall be pegged down with bamboo stakes approximately 250mm in length. Approved fertiliser shall be applied after placing of turf at suitable times and at rates of application approved by the Engineer.

All turf shall be regularly watered and fertilised to the satisfaction of the Engineer until the vegetation is satisfactory established. Any dead turf shall be replaced with new turf at the Contractor's own expense and time.

### **19.3   Seeding**

Seeding or hydroseeding shall be carried out as soon as practical on slopes and other areas as shown in the Drawings and/or as directed by the Engineer.

The Contractor shall submit to the Engineer for his consideration and approval, in advance of the proposed work, full details of his proposed method of seeding and hydroseeding. The information submitted shall include, but not necessarily be limited to, a full description of the following aspects of the work :

- (a) the penetration of the areas to be seeded or hydroseeded, including if appropriate the amount of topsoil to be used and its method of application;
- (b) the details and results of investigations to determine which types of grass or legume are comparable with the soil in the areas to be seeded;
- (c) the types of grass and legume (if any) and strains of seed to be used, and the function, root and growth characteristics of each type;
- (d) the rates of application of the grass and legume seeds;
- (e) the composition of fertiliser to be used at the time of seeding and its rate of application;
- (f) the composition of fertiliser to be used after seeding, the times of application after seeding, and the rates of application;
- (g) the type of mulch to be used and its method and rate of application;
- (h) the amount of lime or other chemicals (if any) to be applied to improve the soil before, during and/or after seeding;
- (i) the type and amounts of binding agents to be applied with the seeds, mulch, fertiliser, etc. as appropriate;
- (j) the proportions and methods of preparation of the seeding mix;
- (k) the equipment and method to be used in preparing and placing the seeding mix and other materials;
- (l) the cultivation and after-care of the seeded areas, including rates and frequencies of watering, fertilising, grass cutting and general maintenance for at least 1 year after seeding;
- (m) the time after seeding required for establishing permanent, dense growth of grasses, which will require minimal maintenance;
- (n) guarantees of success of the seeding work.

All grass shall be regularly watered until the vegetation is satisfactorily established to the satisfaction of the Engineer. Any dead grass shall be replaced at the Contractor's own expense.

## **20.0 CLASSIFICATION OF EXCAVATED MATERIALS**

Rates for excavation shall include for excavating in whatever type of soil formation that may be encountered, with the exception of rock which in the opinion of the Engineer is not removable by ordinary tools, bars or ordinary earth moving equipment and requires special methods of removal as defined hereafter.

### **20.1 Hard Materials Other Than Rock**

Materials such as laterite earth, gravel, disintegrated or decomposed masses, geologically semi-formed or weathered "rock" such as very dense cemented sand and other such hard,

composite materials that can nevertheless be excavated by standard use of ordinary earth moving machines, shall be deemed as ordinary materials. Excavation of these materials shall be paid for at normal excavation rates.

## **20.2 Unsuitable Materials**

Unsuitable materials shall include :

- (i) running silt, peat, logs, stumps, perishable or toxic material, slurry or mud, or
- (ii) any material
  - consisting of highly organic clay and silt;
  - which is clay having a liquid limit exceed 80% and/or a plasticity index exceed 55%;
  - which is susceptible to spontaneous combustion;
  - which has a loss of weight greater than 2.5% on ignition;
  - containing large amounts of roots, grass and other vegetable matter.

Materials that are soft or unsuitable merely because they are too wet or too dry for effective compaction are not to be classified as unsuitable, unless otherwise as defined by the Engineer.

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