

## SPECIFICATION FOR EARTHWORKS

### 1.0 GENERAL REQUIREMENTS

- 1.1 This Specification is to be read in conjunction with the conditions of contract, and all other specifications and drawings.
- 1.2 The Works shall consist of clearing, grubbing, stripping topsoil and excavation of all types of material, filling, compaction, forming building platforms and slopes, etc., as is necessary for the completion of the Works up to the formation levels, in accordance with the lines, grades, dimensions, shapes and typical cross-sections shown on the Drawings to the approval of the S.O.. It shall include the removal and proper utilisation and hauling, or disposal of all excavated materials, and constructing, shaping and finishing of all earthworks over the entire extent of the Works, in conformity with the drawings and this Specification.
- 1.3 Unless otherwise provided in the Contract, for the purpose of pricing the excavation and earthworks, the whole excavation shall be assumed to be without rock as defined hereunder. Excavation in rock shall respectively be measured and paid for as extra over to excavation and earthworks in accordance with the Provisional Bills of Quantities. The Contractor shall be entitled to extra payment for excavation of rock only if reasonable notice is given to the S.O to examine, classify the excavation and to take measurement prior to breaking up.
- 1.4 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 CODES OF PRACTICE

- 2.1 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 5930	Code of Practice for Site Investigation
BS 6031	Code of Practice for Earthworks
BS 8004	Code of Practice for Foundations
MS 1056	Soils for Civil Engineering Purposes - Test Method

- 2.2 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.
- 2.3 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 with the requisite expertise in these areas to supervise the erection or perform the design of the temporary structures.

### **3.0 CONTRACTOR'S RESPONSIBILITIES**

- 3.1 The Contractor shall be responsible for executing the earthworks strictly in accordance with the relevant local regulations 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.
- 3.2 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 Works. He shall allow and be responsible for making all necessary temporary works complete and safe for the purpose of earthworks. 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 S.O. and the local Authority.
- 3.3 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 S.O.. 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.
- 3.4 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.
- 3.5 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.
- 3.6 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 or service providers.
- 3.7 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 or as directed by the S.O.. 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.
- 3.8 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 S.O. 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.
- 3.9 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 S.O. 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.

- 3.10 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 S.O. 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.
- 3.11 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 S.O..
- 3.12 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 S.O.. 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.
- 3.13 Upon completion of construction operations, the Contractor shall remove all temporary works to the satisfaction of the S.O. 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.
- 3.14 The Contractor shall ensure all temporary works (e.g. temporary cut, fill, retaining structures, strengthening measures, etc.) that will be left behind and form part of the permanent works shall comply to the requirements, standards, specifications, factor of safety and serviceability conditions as the similar types of permanent works.

#### **4.0 SITE CONDITIONS AND CONSTRAINTS**

- 4.1 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, earthworks or associated temporary works. The Contractor shall satisfy himself that the existing ground and formation levels as shown on the drawings are correct.
- 4.2 The award of the Contract shall be based on the understanding that the Contractor is familiar with the geology 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.

## **5.0 SUBSOIL DATA**

- 5.1 A subsurface investigation report for the Site is available at the Tender Table for Contractor's information. The report is intended solely as a preliminary and approximate guide to the nature of ground stratification as it is known to the S.O.. The completeness and the accuracy of the information provided are neither guaranteed nor implied. No responsibility is assumed by the Employer or the S.O. for any opinion or conclusion given in the subsurface investigation report.
- 5.2 The subsurface 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 ground water fluctuations.
- 5.3 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.
- 5.4 The Contractor shall make his own verification of water table 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.
- 5.5 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.

## **6.0 SITE ACCESS**

- 6.1 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 with 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 PROTECTION OF PUBLIC AND PRIVATE SERVICES**

- 7.1 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.

- 7.2 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.
- 7.3 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 S.O. 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 S.O. and the local Authority if he should encounter services not known to have existed at the time of tender.
- 7.4 If during excavation, the Contractor's workmen uncover any cables, water or other service pipes, work shall be stopped immediately and shall not be again started until the matter has been reported to the S.O. who will notify the appropriate local Authority, and subsequently issue whatever directions he deemed appropriate.
- 7.5 If it becomes essential in the opinion of the S.O. 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.

## **8.0 PRESERVATION OF EXISTING TREES**

- 8.1 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 S.O. 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 DILAPIDATION SURVEY**

- 9.1 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 S.O., the local Authority, the adjacent Owners, and with any other party that the Employer may direct.
- 9.2 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.

## **10.0 STABILITY AND SETTLEMENT OF ADJACENT PROPERTIES**

- 10.1 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, 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.
- 10.2 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 S.O. for his record.

### **Limits On Ground Movement**

- 10.3 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 S.O. and the local Authority, all consequential damages to adjoining structures, roads and other properties arising from ground movements caused by excavation work.

## **11.0 GROUND MOVEMENT INSTRUMENTATION AND MONITORING**

- 11.1 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. All instrumentation and monitoring methodology or logistics must be submitted to the S.O. for approval prior to installation.
- 11.2 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 S.O. 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 S.O. may decide. The minimum distance perpendicular to the Site boundaries shall not be less than five times the depth of excavation, or such distances as the S.O. may decide.
- 11.3 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 S.O. not later than two (2) days after measurement, and immediately should movements be such as to endanger the stability of adjoining properties.

## **12.0 TEMPORARY WORKS**

- 12.1 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. All temporary works shall comply with requirements of BS 5975.

- 12.2 Temporary works means all planning and works carried out by the Contractor to construct the permanent works designed by the Consultant complying with all specifications, drawings and workscope. This includes but not limited to necessary field and laboratory tests, temporary tracks, excavation, filling, proper cover and protection to exposed slopes, sequence and timing of works, necessary temporary drainage, pumping of water, emergency contingency measures, safety of site, rectification and strengthening measures, methodology and method statement of all works, and etc.
- 12.3 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 cut off systems using jet grout piling, etc.
  - (c) Ground water recharging systems, surface and groundwater drainage system using surface or subsoil drains, sumps, etc.
  - (d) 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 re-fixing from time to time, etc.
- 12.4 Temporary works shall be the sole responsibilities of the Contractor. S.O.'s approval or consent of Contractor's method statement on all temporary works shall not relieve the Contractor's sole responsibilities to ensure all temporary works comply to good engineering practice, and Contractor's own time and cost to rectify any defects, non-compliance to good engineering practice or possible long term instability/failure and serviceability problems of the temporary works or caused by temporary works.
- 12.5 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 S.O. for the purpose of record.
- 12.6 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.
- 12.6 All temporary works especially but not limited to temporary accesses and temporary earthworks (temporary cut or temporary fill) shall not cause failure and shall not induce instability or serviceability problems in the long term. All temporary cut and fill by Contractor that will be left behind after completion of permanent works shall have the same Factor of Safety on stability and Serviceability conditions as permanent works. These temporary works by Contractor shall also comply with all requirements, specifications, drawings and workscope applicable for similar type of permanent works (e.g. slope angle, compaction of fill, surface drainage, retaining structures, strengthening measures if necessary, etc).
- 12.7 Temporary works by the Contractor that in the opinion of the S.O. will cause instability or serviceability problems (either short term or long term) in any way, the S.O. will order remedial works to be provided immediately at the Contractor's own expense with not additional performance time. Such instruction will not relieve the Contractor of his sole responsibility for the temporary works. The remedial works carry out shall comply to all requirements, specifications, drawings and workscope of similar type of permanent works (e.g. cut, fill, retaining walls, strengthening works, etc).
- 12.8 Any failures, instability, serviceability problems of the temporary works or caused by the temporary works shall be rectified to the satisfaction of the S.O. at the Contractor's own cost and time. The rectification works (e.g. regrading of slopes, excavation and re-compaction, strengthening by soil nails, retaining structures, etc) shall cover the failures or problems areas and other areas or structures affected by the failures or other serviceability problems. All rectification works shall comply to good engineering practice, Engineer's requirements,

specifications and drawings. The rectification works shall be designed by the Professional Engineer's registered with the Board of Engineers, Malaysia engaged by the Contractor at their own cost. The Professional Engineer's engaged by the Contractor shall have at least seven (7) years relevant geotechnical engineering experiences on slopes and hill-site development as per Board of Engineers, Malaysia accredited checker requirements. The rectification design shall be submitted to the S.O. within seven (7) days upon failures or being notified by the S.O. (verbal or written) unless otherwise agreed by the S.O.. The rectification design shall be agreed upon and approved by the S.O. prior to start works.

### **13.0 SITE CLEARING**

- 13.1 The whole Site shall be cleared to the extent as shown in the relevant drawings. These shall include clearing, grubbing and removing all trees, shrubs, vegetation and butts; and clearing, demolishing, breaking up and removing all structures above ground level such as buildings, walls, fences and other obstruction within the Site which have been designated to be demolished or removed. All spoil and debris shall be removed and disposed as approved by the S.O.
- 13.2 The Contractor shall take precaution to protect from damage, all existing trees and shrubs which are designated to be preserved as specified.
- 13.3 Grubbing shall consist of the removal and disposal of surface vegetation, the bases of stumps, roots, the underground parts of structures, and other obstructions to a depth of at least 0.5m below ground level, all to the agreement of the S.O.
- 13.4 Stripping topsoil shall consist of the removal of topsoil to an average depth of at least 150mm below ground level, and its stockpiling for use in the Works, and/or its disposal, as directed by the S.O.
- 13.5 All materials resulted from site clearing shall be dumped to the approved Contractor's dump site, unless otherwise directed by the S.O. Method statement on dumping with particular emphasis on prevention of environmental pollution shall be submitted for his agreement.

#### **Demolition of Existing Structures**

- 13.6 Any existing structures and other obstruction which are designated to be removed shall be demolished, broken up, removed and disposed as approved by the S.O.
- 13.7 All salvaged materials arising from the demolition work shall, unless otherwise specified, become the property of the Contractor, and shall be removed from Site as soon as possible.
- 13.8 Major structures are those which cannot practicably be cleared by bulldozer and/or hydraulic excavator, whose demolition required pneumatic tools, explosives and/or other specialised equipment. A brief description of each major structure (if any) and depth to which extent it shall be demolished is given in the Bill of Quantities.

#### **Topsoil**

- 13.9 Topsoil to be stockpiled for the Works shall be sufficiently fertile to promote and support the growth of vegetation, and shall be taken from such areas where clearing, grubbing and stripping topsoil is required as approved or directed by the S.O. Before stockpiling, topsoil shall be separated from objectionable materials, all to the agreement of the S.O. The Contractor shall arrange for stockpile sites either within or outside the project site, at his own expense, and all the agreement of the S.O.
- 13.10 Otherwise, topsoil removed during grubbing and stripping operations shall be separated from objectionable materials and spread within the project site or borrow areas, or otherwise



disposed of, as approved or directed by the S.O.

### **Disposal of Material**

- 13.11 Objectionable material from clearing, grubbing and stripping topsoil (including the demolition of structures) shall be disposed of as approved or directed by the S.O.
- 13.12 Combustible material including all timber (except timber to be salvaged or used, all brush, stumps, roots, vegetation and other combustible refuse may be piled up within the project site and burned, where burning is allowed.
- 13.13 All burning shall be subject to the prior approval of the relevant Government authorities, and shall be carried out in conformance with all pertinent regulations. Burning shall also be carried out at such places and at such time and in such a manner as to prevent fire from damaging vegetation and property within the project site designated to be preserved, and from spreading to areas adjoining the project site and damaging vegetation and property therein.
- 13.14 Where burning is not permitted at any time, or the Contractor elects not to burn objectionable material, combustible material, shall be disposed of together with incombustible material.
- 13.15 Incombustible material, including where appropriate the remains of burning, shall be disposed of in a safe and tidy manner at solid waste dumps outside the Site, unless otherwise approved or directed by the S.O. The Contractor shall be solely responsible for making the necessary agreements and paying expenses and claims arising from the use of such solid waste dumps whether on Government or private land.

## **14.0 PREPARATION OF SITE**

- 14.1 On side-long ground, drainage grips or trenches shall be excavated uphill of the area to be filled and compacted. Drainage shall be effected without causing siltation or erosion and water shall be disposed of in a manner to be agreed by the S.O..
- 14.2 The area to be filled, whether an existing excavation or otherwise undisturbed ground, shall be graded to falls, and sump pumping or other suitable dewatering facilities shall be provided by the Contractor to keep the base of the excavation dry at all times.
- 14.3 Where the area to be filled comprises an existing excavation, the excavation shall be inspected and subsequently monitored by the Contractor, to ensure that there is no danger of its collapse during the works with consequences for safety, for existing buildings or for other construction adjoining.
- 14.5 Unless otherwise noted, all soft and compressible soils or existing fill shall be removed and run to spoil in dumps provided by the Contractor and agreed by the S.O. (including licensed tips in the case of certain contaminated materials). The work shall be accomplished in such a way that there is no undercutting of the sides of existing excavations.
- 14.6 Existing foundations or ledges of hard rock, roots of trees or former pipelines or services at the base of the area to be filled shall be excavated and replaced with compacted general fill which shall be compacted to the same specification as adopted for subsequent compaction works.
- 14.7 Where unsuitable material has been excavated, the underlying natural ground shall be compacted to the same specification as adopted for subsequent compaction works.
- 14.8 The Contractor shall provide where necessary temporary water courses, ditches, drains,

pumping or other means of maintaining the earthworks free from water. Such provision shall include carrying out the work of forming the cuttings and fill platforms in such a manner that their surfaces have at all times a sufficient gradient to enable them to shed water and prevent ponding.

- 14.9 In pumping water out from excavations and in the lowering of water tables the Contractor shall pay due regard to the stability and settlement of all structures.
- 14.10 Adequate means of trapping silt shall be provided on all temporary drainage systems. Similar arrangements shall be made for all earthworks including excavations whether for pile trenches, foundations or cuttings.
- 14.11 Should the surface of completed areas be damaged by erosion or by any other cause, the Contractor shall at his own cost make good such areas to the agreement of the S.O.
- 14.12 The Contractor shall exercise care in preventing wastage of suitable material needed for construction of fill platform.
- 14.13 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.

## **15.0 EXCAVATION**

- 15.1 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.
- 15.2 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.
- 15.3 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.
- 15.4 If in the opinion of the S.O. 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.
- 15.5 The S.O. 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.
- 15.6 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.
- 15.7 Before commencement of earthwork, levels of existing ground as specified by the S.O. are to be verified by the Contractor's licensed surveyor. The survey shall be witnessed by the S.O.'s representative. The Contractor shall produce a survey drawing showing existing ground levels

for the S.O.'s pre-commencement approval.

- 15.8 The Contractor shall give at least 24 hours notice to the S.O. 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 S.O.. 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 50mm unless otherwise directed by the S.O..
- 15.9 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 S.O., failing which the S.O. 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.
- 15.10 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.
- 15.11 The Contractor shall inform the S.O. 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 S.O.. Compliance with any instructions from the S.O. 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 S.O..

#### **Mechanical Equipment**

- 15.12 Prior to the execution of trial excavation, the Contractor shall furnish the following documents to the S.O as evidence that the excavator is in good running condition:
- i) A copy of the Original Equipment Manufacturer (OEM) performance handbook or catalogue, with details of the operating weight, brake horse power and maximum drawbar pull of the excavator.
- 15.13 Relevant records showing that the excavator has been appropriately and routinely up-kept and adequately maintained in accordance with the recommendations of the OEM's schedule.

#### **Dimensional Tolerances**

- 15.14 Slopes in cutting shall be trimmed mechanically to neat and even surfaces which shall have gradients not steeper than that shown on the Drawings. Widths of excavations shall not exceed the dimensions shown on the Drawings by more than 300mm with obstruction free to complete the Works, unless otherwise approved by the S.O.

#### **Sides of Excavation**

- 15.15 The Contractor shall ensure that at all times, the sides of the excavation are maintained in a safe and stable condition, and shall be responsible for the adequate provision of all shoring and strutting including sheet piling required for this purpose.

#### **Bottom of Excavation**

- 15.16 Unless otherwise stated, the excavation, whether in open cut or in trench, shall be proceeded with in such portions at a time as the S.O. may approve, and shall not, in the first instance, be carried down to a depth nearer than 150mm above the required excavation level; the last

150mm of depth to the said level shall be carried out by manual labour immediately in advance of placing concrete.

- 15.17 Any pockets of soft material or loose rock in the bottom of pits and trenches shall be removed, and the resulting cavities and any large fissures filled with properly compacted blinding concrete (1:3:6). The Contractor shall take such steps as and when necessary, to prevent damage to the bottom of excavation due to exposure to the weather. After the placing of any blinding concrete, no trimming of the side faces shall be carried out for the next 24 hours.

#### Separation and Stockpiling of Suitable Material

- 15.16 Where excavation reveals a combination of suitable and unsuitable materials, the Contractor shall, wherever the S.O. considers it practicable, carry out the excavation in such a manner that the suitable materials are excavated separately for use in the Works without contamination by the unsuitable materials.

#### Removal of Unsuitable Material

- 15.18 Unsuitable material shall be excavated to such depth and over such area as directed by the S.O. and be transported and disposed of in an approved manner. Unless approval of the S.O. to dump and spread the unsuitable materials within the Site is obtained, the Contractor shall be responsible for providing his own dump site for such unsuitable materials. The Contractor shall comply with statutory requirements such as payment of royalties, environmental protection, etc. Voids created due to removal of unsuitable material shall be backfilled with suitable material compacted to a dry density not less than that of the surrounding material or that specified for the respective part of the earthworks or as directed by the S.O.
- 15.19 Where it is decided by the S.O. that replacement of unsuitable material shall be done under standing water, voids created due to removal of unsuitable material shall be backfilled with hard clean crushed rock, natural gravel or sand having grading within the respective limits specified in **Table 1**.

TABLE 1 - GRADING LIMITS OF MATERIALS FOR REPLACEMENT OF UNSUITABLE MATERIAL

B.S. Sieve Size	% Passing By Weight
Crushed Rock or Gravel	
63.0 mm	100
37.5 mm	85 – 100
20.0 mm	0 – 20
10.0 mm	0 – 5
Sand	
10.0 mm	100
5.0 mm	90 – 100
1.18 mm	45 – 80
300 µm	10 – 30
150 µm	2 – 10

#### 16.0 CLASSIFICATION OF EXCAVATED MATERIALS

- 16.1 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 S.O. is not removable by ordinary tools, bars or ordinary earth moving equipment and requires special methods of removal as defined hereafter.
- 16.2 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.

## **17.0 METHOD OF MEASUREMENT**

- 17.1 All measurement of excavation shall be based on the net 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.
- 17.2 Levels shall be taken before and after excavation, to calculate the volume for each method of excavation. Levels taken shall be subject to approval by the S.O. The levels taken shall be certified by the representatives of the Contractor and S.O, respectively.
- 17.3 The Contractor shall carefully maintain all boundary markers, bench marks and other such reference points which shall be offset before commencement of the Works. All offsets shall be carried out by a licensed surveyor.
- 17.4 Should any such markers be disturbed or destroyed, these references shall be replaced immediately and the S.O. informed of such replacement.

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

### **Surface and Percolating Water**

- 18.1 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 adequate slope protection.
  - (b) 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.
  - (c) 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.
- 18.2 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.

### **Surcharge**

- 18.3 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.

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

- 18.4 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.

- 18.5 Temporary protection shall not be removed until proper and adequate slope drainage (berm drains, cascade drains and toe drains) and permanent protection (close turving or hydroseeding) has been constructed as approved by S.O..
- 18.6 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 the S.O..

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

- 18.7 The excavation is at all times to be kept well drained and dry by means of temporary slopes, drains, sumps, etc and by pumping.
- 18.8 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 S.O..
- 18.9 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.
- 18.10 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.
- 18.11 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.

#### **19.0 TYPES OF TEMPORARY CONSTRUCTION FOR EXCAVATION**

- 19.1 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.
- 19.2 The method of construction of temporary works shall take into account the following considerations :
- (a) The geology along the length and depth of the cutting
  - (b) The water levels, hydrogeology and strata permeability 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

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

19.4 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**

19.5 Particular attention shall be given to avoid soil consolidation and ground loss next to the excavation caused by fluctuations in the water table level. In the event that temporarily pumping water out from excavations may lower down the water tables, the contractor should take due care in protecting the stability of all structures and prevent any non-allowable settlement from occurring on these structures.

#### **Steel Sheet Piling**

19.6 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.

19.7 Particular attention shall be given to ensuring compliance with permitted noise and vibration levels during the installation and removal of sheet piles.

#### **Timbered Excavation**

19.8 The Contractor shall ensure that the timber is providing proper support to the sides of excavation.

19.9 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 cut off system such as jet grout piling behind the timbering.

19.10 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**

19.11 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 pre-selected sequence of alternate panels.

#### **Open Cutting**

19.12 Particular attention shall be given to the stability of side slopes and the prevention of deterioration of the sides of excavation by prolong weathering.

19.13 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.

## **20.0 FORMATION SURFACES**

- 20.1 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 S.O.. It shall be the responsibility of the Contractor to prevent damage to the prepared formation from weathering, trampling by workmen and other construction activities.
- 20.2 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.
- 20.3 The Contractor shall satisfy the S.O. 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 S.O. 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 S.O..
- 20.4 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 S.O., replace such excess excavation and softened formation with approved granular fill. The Contractor shall have no claim for extra time in connection therewith.
- 20.5 Should the Contractor commence to place concrete without first having satisfied the S.O., 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 S.O. 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.

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

- 21.1 The rates for excavation and disposal of excavated materials are to include for any 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.
- 21.2 No excavated material shall be removed from the Site except on the direction or with the approval of the S.O. Should the Contractor be permitted to remove suitable materials from the Site to suit his operational procedure, then he shall make good any consequent deficit of fill material arising therefrom, at his own expense. Unless designated dump sites have been shown on the Drawings, the Contractor shall dispose of surplus suitable material at his own dump areas outside the Site as approved by the S.O. In doing so, the Contractor shall comply with statutory requirements such as payment of royalties, environmental protection, etc. 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. Method statement on dumping with particular emphasis on prevention of environmental pollution shall be submitted to the S.O. for his agreement prior to dumping.

## **22.0 EXCAVATION OF ROCK**

- 22.1 Rock shall mean those geological strata of hard material which necessitate the use of blasting or approved pneumatic tools for their removal. Rock excavation shall be carried out by methods appropriate to Site requirements as approved by the S.O.



22.2 Boulders or detached pieces are those individual masses of rock less than  $0.5\text{m}^3$ . For determining the volume of individual boulders, the average diameter of the boulder in three orthogonal directions should be taken and used to calculate the volume of the boulder.

22.3 Notwithstanding the above, rock shall not include material which in the judgement of the S.O. can be loosened by using a dozer mounted drawn ripper of the following description with a production rate not exceeding  $50\text{m}^3/\text{hour}$ :

**Tractor Unit** : Equipment with a minimum weight of 37 tons and a net horse power rating of 305 brake horse power or more. The tractor unit is to be in good condition and operated by experienced personnel skilled in the use of ripping equipment.

**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 abovementioned tractor should have a minimum penetration force of 120 kN. The ripper should have a single shank in good working condition with a sharpened cutting point.

22.4 Shale and clay boulders will not be considered as rock. The S.O.'s decision as to whether or not the materials of the excavation is classified as rock shall be final.

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

22.6 All material from rock excavations shall be used as far as is practicable in the Works.

22.7 Where the rock is of satisfactory quality, the Contractor may elect to crush and screen it to produce aggregates required for concrete, road base, subbase, or other purposes with the prior approval of the S.O.. Excavated rock needed for earthwork construction which the Contractor elects so to use for producing aggregate materials shall be replaced at the Contractor's own expense by borrow materials of satisfactory quality from alternative locations approved by the S.O.

22.8 Otherwise, excavated rock shall be used in the construction of embankment and fill as approved or directed by the S.O., to the fullest practical extent, in either of the two following ways :-

- i) excavated rock shall be broken down to a maximum particle size of 300 mm and used as rock fill
- ii) excavated rock shall be broken down to a maximum particle size of 150 mm, blended with suitable earth fill material in a proportion not exceeding 1 rock to 1 earth, and used as common fill.

22.9 The Contractor may only waste excavated rock with the approval of the S.O. Excavated rock needed for earthwork construction which the Contractor elects to waste shall be replaced at the Contractor's own expense by borrow materials of satisfactory quality from alternative locations approved by the S.O.

## 23.0 BLASTING

### General

23.1 Should blasting be allowed, it must be control-blasting and must be carried out with the written permission of the S.O. 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.

- 23.2 It is the Contractor's sole responsibility to ensure that his method of blasting is safe, that all statutory and imposed limitations are adhered to, and to obtain a permit to use explosives from the relevant authorities and to comply with the conditions of issue of the permit. In addition, the Contractor should be solely responsible for obtaining the necessary licences for the procurement, possession, transport, storage and handling of explosives and for ensuring the validity of such licences at all times. Before starting work, the contractor should satisfy the S.O. that all the required permits are in order and that this category of work is adequately covered in the insurance policies.
- 23.3 The Contractor must inform the S.O. 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.
- 23.4 Explosives shall be used in the quantities and manner recommended by the manufacturers and blasting specialist. Blasting shall be restricted to such periods as the S.O. may prescribe. If, in the opinion of the S.O., blasting would be dangerous to persons or properties 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 in large blasts, i.e. exceeding 9 kg of explosive, as in seams, drifts, shafts, pits, or large holes, is prohibited unless authorised in writing by the S.O. Such authorisation shall not in any way relieve the Contractor of his liabilities under the Conditions of Contract.
- 23.5 All necessary precautions shall be taken to preserve in the soundest possible condition the materials below and beyond the lines of all excavations. Delayed blasting to reduce shock waves shall be used to avoid damage to concrete and other works already completed. As the excavation approaches its final lines, blasting with pre-splitting technique of approved drillhole spacing shall be carried out to reduce blast damage and create reasonably even finished surface by means of parallel drill holes perpendicular to the toe of the excavation and parallel to the finally required face.

#### **Safety Measures**

- 23.6 When blasting is carried out close to properties or roads, safety rules complying to authorities' requirements shall be strictly adhered to. Where necessary or as directed by the S.O., the use of heavy mesh blasting mats shall be used to ensure that no damage is caused to persons or properties on or off Site. Special care shall be taken in wet ground to ensure that individual explosions are reduced to such size as to preclude damage to any buildings or structures, Plaster shooting will not be permitted within 400 metres of any building or structure. If traffic on any road or railway has to be interrupted for blasting operations, the Contractor shall obtain approval of his schedule for such interruption from the appropriate authorities and shall prove to the S.O. that he has obtained it, prior to the interruption.
- 23.6 When blasting is carried out with close proximity to sensitive structures and environmental sensitive areas, thresholds and criteria of vibration impact shall be established for monitoring purpose.

#### **Storage and Handling**

- 23.7 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.

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

### Blasting Shot

- 23.9 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)

- 23.10 The maximum permissible air overpressure must not exceed 110 dB. Blasting shall be restricted to such periods as the S.O. may prescribe. If in the opinion of the S.O., 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 S.O.
- 23.11 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.
- 23.12 Prior to the start of blasting operations, the Contractor, in the presence of the S.O. shall conduct a survey of all structures and services within 120 metres of the site where blasting is proposed and any other structures which the S.O. 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 S.O..
- 23.13 All blasting works shall be carried out within the hours as approved by local authority.

### Insecure Material

- 23.14 The slopes of cuttings shall be cleared of all rock fragments which move when prised with a crow-bar. Where, in the slopes of cuttings, layers of rock and soft material alternate and the S.O. considers that the slope, immediately after dressing, will not permanently withstand the effect of weather, the Contractor shall excavate any insecure material to an approved depth and build up

the resulting spaces with grade 15P / 20 concrete or masonry using rock similar to the adjoining natural rock so as to ensure a solid face.

## **24.0 FILLING**

- 24.1 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.
- 24.2 Fill materials for use in forming fill platforms shall be the suitable material obtained from excavation in cuttings. Where the quantity of such materials is inadequate, the Contractor shall obtain suitable materials from the designated borrow pits or from his own borrow pits which have been approved by the S.O.

### **Borrow Pit**

- 24.3 The Contractor shall be responsible for locating borrow pits. Designated borrow pits shown on the Drawings only indicate to the Contractor potential areas for borrow. Whether the Contractor obtains materials from the designated or his own borrow pit, it shall be his responsibility to ascertain the suitability of the pit with respect to the quantity and quality of the materials, which shall be subject to the approval of the S.O. The Contractor shall pay all necessary fees, taxes or royalties to the appropriate authorities and observe all relevant regulations. The Contractor shall keep the borrow pits free from ponding water and the excavation neat and tidy and shall carry out necessary erosion and environmental protection measures following the agreed method statement or as instructed by the S.O.
- 24.4 The contractor shall submit method statement on cutting or filling and turfing at the borrow pit or dump site for approval of the S.O.. After cutting or dumping, all the slopes shall be formed to a stable gradient and close turfed or protected by other approved surface protection method. Provision of drainage, siltation pond and preventive measures of pollution shall also be included in the method statement.

### **Soft Spots**

- 24.5 Where any undue movements due to the presence of soft unstable soil under the fill occur, or unsuitable material is encountered at the bottom of the fill, it shall be excavated to such depth and over such areas as approved by the S.O., and shall be removed to spoil. The resulting excavation shall be backfilled with suitable material as specified hereinbefore, and deposited in loose lifts not exceeding 225mm thick and compacted as described above, or with compaction equipment suitable for working in small excavation.
- 24.6 The Contractor shall allow for settlement or displacement of fill over soft areas, and shall build up to the required finished level with necessary compaction.

### **Filling under Floors, Aprons, beside Pilecaps and Trenches etc.**

- 24.7 Filling shall be provided and laid under floors, aprons, etc. where required. Filling shall be of suitable material as specified hereinbefore, deposited in loose lifts not exceeding 150mm loose thickness, and each loose lift well watered where necessary, rammed and compacted. No Generally, clay shall be used for filling under floors and aprons unless with the approval by the S.O. At areas where compaction is practically difficult due to space constraint, free draining coarse grained material as per Table 2.1 can be used for backfilling with the approval from the S.O.

## **25.0 FILL MATERIALS**

- 25.1 In general, fill material shall be well graded suitable fill material unless otherwise approved by the S.O.. Unsuitable fill and hazardous fill shall not be used at any location or part of the site, including landscaped areas. 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.
- 25.2 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 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.
- 25.3 The use of excavated materials as fill is subject to compliance with the requirements of the suitable fill material as specified with written approval of the S.O.. Notwithstanding any prior approval given in this regard, the S.O. 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.

#### **Unsuitable Fill**

- 25.4 Unsuitable fill shall include but not limited to:
- (a) cohesive soils having a liquid limit in excess of 80% or plasticity index in excess of 55%
  - (b) any material containing topsoil, wood, peat or waterlogged substances
  - (c) any material containing bio-degradable or organic material (more than 2.5%)
  - (d) any material containing scrap metal
  - (e) material from contaminated sites
  - (f) material which by virtue of its particle size or shape cannot be properly and effectively compacted (e.g. some slate wastes).
  - (g) Material susceptible to significant volume change (e.g. marine mud, swelling clays and collapsible soils)
- 25.5 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 S.O..

#### **26.0 DISPOSITION OF FILL**

- 26.1 Prior to placing any fill upon any area, all clearing and grubbing operations shall have been completed.
- 26.2 Prior to the disposition of fill, a series of trial compaction (trial run of 6, 8 and 10 passes) shall be carried out to determine the compaction thickness and numbers of passing required to achieve the specified compaction requirement.
- 26.3 All fill materials shall be deposited in layers and brought up at a uniform rate so that all parts of the Site reach finished level at the same time. The loose depth for each layer of fill shall be determined from the trial compaction. Each layer shall extend over the full width of the fill area. Each compacted layer shall be maintained at all times with a sufficiently even surface of longitudinal cross fall in order to drain away the surface water.
- 26.4 Where several different types of fill material are to be employed, they shall be deposited in such a way that all parts of the site receive roughly equal amounts of a given material, in roughly the same sequence, thus ensuring a uniform distribution of fill types over the whole fill thickness.
- 26.5 Where fill platform is to be constructed on ground with a cross-slope flatter than 1 (vertical) to 10 (horizontal) but steeper than 1 (vertical) to 30 (horizontal), the foundation material, except where

this is rock, shall be scarified to a depth of 100 mm, blended with fill material and compacted as described.

- 26.6 Where fill platform is to be constructed against existing ground with a cross-slope of steeper than 1 (vertical) to 10 (horizontal), the foundation shall be excavated in all materials (including hard rock) to form benches with horizontal and vertical faces from which construction of the fill platform shall proceed. The maximum vertical height of each bench shall not exceed 500mm. The benches shall be contiguous beneath the full width of the fill platform, and shall be of a suitable width to accommodate construction equipment such as motor-graders, trucks, rollers, etc. Scarifying of the horizontal and vertical faces of the benches shall not normally be required, and the material excavated in forming the benches may normally be used as fill in the platform as approved by the S.O.
- 26.7 Where a development contains landscaped areas on which no structures will be built, the underlying fill shall be selected, placed and compacted in the same way as the engineered fill, unless otherwise directed by the S.O.. Where some relaxation of the specification for fill compaction underlying landscaped areas is permitted, there shall be a transition zone between the fill underlying the landscaped area and the fill underlying the structure. The dimensions of the transition zone will depend on the degree to which fill compaction was relaxed for the fill in the landscaped area. The location and extent of fill placed to a reduced standard of compaction shall be recorded and approved by the S.O..
- 26.8 Fill materials shall generally be placed in loose layers not exceeding 300m thickness per layer unless otherwise specified by the S.O. The fill materials shall be uniformly compacted to the specified degree of compaction before the next layer of fill is carried out.
- 26.9 The Contractor shall take all necessary steps to ensure that the fill is placed at the moisture content necessary to achieve the specified level of compaction and shall, where necessary, add water to or dry the fill, in order to obtain the required value. Where it is necessary to add water, this shall be done as a fine spray and in such a way that there is time for the water to be absorbed into the fill before being rolled by the plant.
- 26.10 Cobbles, boulders, rock or waste fragments whose largest dimension is greater than two-thirds of the loose layer thickness shall not be incorporated into the fill.
- 26.11 No fill shall be placed and left uncompacted at the end of a working day. Compacted fill shall be graded to falls to ensure free runoff of rainwater to prevent ponding.
- 26.12 If weather conditions are such that the specified moisture content and density values cannot be achieved, the Contractor shall cease work until such time that the fill can be placed and compacted to meet specification requirements.

## **27.0 FILL COMPACTION**

- 27.1 All materials used in fill platforms and as fill elsewhere shall be compacted as soon as practicable after being placed and spread. Compaction shall be undertaken to the requirements of this Section by plant approved by the S.O. All compaction requirements shall be controlled by means of field density measurement.
- 27.2 The compaction plant selected, the number of passes made and the fill layer thickness and moisture content used shall have regard to the specified end product and the means and manner of control testing.
- 27.3 Compaction plant and compaction method shall be selected having regard to the proximity of existing trenches, excavations, retaining walls or other structures and all works shall be performed in such a way as to ensure that their existing stability is not impaired.

- 27.4 Fill materials shall generally be placed in layers, and uniformly compacted to the satisfaction of the Engineer before the next layer is applied. Loose thickness of each layer shall not be greater than 300mm to 400mm depending on the type of compaction machinery. In confined work spaces, the use of approved type mechanical rammers or compressed air compactors is permitted.
- 27.5 The compacted fill shall achieve dry density of not less than 90% of the maximum dry density at optimum moisture content as determined in the standard proctor laboratory tests. The top 1.5m fill below the finished level shall be compacted to not less than 95% of maximum dry density based on standard proctor laboratory tests. 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.
- 27.6 Compaction of each layer shall only be undertaken when at least 75% of the samples taken at a rate of one sample per 500 square metres show a moisture content within the limits of optimum moisture content  $\pm 3\%$  as determined by B.S. 1377 Test No. 13. 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.
- 27.7 For minimising infiltration of surface runoff into the fill material, the last 1.5m fill before reaching the finished level shall be compacted to at least 90% of maximum dry density for standard proctor test or to the requirement as specified in the drawings or by the Engineer.
- 27.8 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.
- 27.9 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. The resultant excavation shall be backfilled with suitable and approved materials deposited in layers, and compacted as hereinbefore specified, or with suitable compressed air compactors or mechanical rammers where the excavation work is limited.
- 27.10 For compaction of platform side slope, the Contractor may either extend each compacted lifts beyond the design slope surface by at least 600 mm and then trim back to the required slope angle, or he may employ an agreed tow type roller to compact the sloping surface.

#### **Small compaction work of less than 100 cu.m (without compaction trial)**

- 27.11 For compaction of backfilling in localised excavation, A a portion of the excavated material shall be returned, filled around walls, columns and the like in 225mm layers lifts and each layer lift thoroughly compacted using rammers or mechanical compactors as the S.O. may approve, until compaction is complete. However, only suitable and approved fill materials shall be returned for backfilling. The surplus excavated materials shall be deposited, spread and levelled on site or elsewhere as approved.
- 27.12 Shoring used for the sides of the excavation shall be withdrawn in stages as the compaction of backfilling proceeds.

#### **Finish to Formation Level**

- 27.13 Unless otherwise shown in the drawings, the upper surface of all platform shall be finished to a cross fall of 1:400 and where practicable, shall, in addition, be given a longitudinal fall to ensure rapid disposal of surface water.

- 27.14 For areas to be turfed, the formation shall be completed to an appropriate level below the finished level indicated, to allow for placement of top soil and turf.

### **Degree of Compaction**

- 27.15 The whole of the fill platform shall be compacted to not less than 95% (for cohesive material) or 100% (for cohesionless material) of the maximum dry density determined in the MS 1056 Compaction Test (2.5 kg-rammer method), unless otherwise specified in the Drawings. For non-structural platform, such as landscape or green areas where fill settlement will not affect the proper functioning of the utilities laid in or over the platform, the compaction requirement can be relaxed with the approval of the S.O.
- 27.16 If the results of control tests (Clause [6.0]) indicate that the fill is being placed and compacted in such a way that the desired level of compaction is not being achieved, the Contractor shall further compact or, if necessary, shall excavate the affected work and replace with new fill, compacted to meet the specification requirements.
- 27.17 If the results of control tests (Clause [6.0]) indicate that antecedent weather conditions (such as heavy rain) have caused deterioration of finished work such that the work no longer meets the specification, the Contractor shall bear the cost and time to take such steps as are necessary to bring the fill to specification requirements.

## **28.0 COMPACTION TRIALS**

- 28.1 The MS 1056 Compaction Test (2.5 kg rammer method) shall be used in determining the moisture versus density relation of soil.
- 28.2 The Contractor shall submit to the S.O. for his agreement the proposed method of compaction for each main type of material to be used in the fill platform. This shall include the type of compaction plant for each type of material and the number of passes in relation to the loose depth of material to achieve desired compaction. The maximum loose thickness for fill shall generally be limited to 400 mm unless trial compaction shows compliance with larger loose thickness and with the approval from the S.O. The Contractor shall carry out field compaction trials, supplemented by any necessary laboratory investigations, as required by the S.O. This shall be done by using the procedures proposed by the Contractor for earthworks and shall demonstrate to the S.O. that all the specified requirements regarding compaction can be achieved. Compaction trials with the main types of material likely to be encountered shall be completed before the works with the corresponding materials will be allowed to commence. Each trial area shall be not smaller than 8 m x 15 m.
- 28.3 For earthwork compaction of less than 100 cu.m, trial compaction can be waived with approval from the S.O., but field density testing as per Sub-Section 2.2.4.4 (d) is still remained necessary as and when instructed by the S.O..

## **29.0 QUALITY CONTROL**

- 29.1 The end product requirements selected in Clause [2.1] shall be controlled by in situ and laboratory testing as follows:-
- (a) in situ dry density (BS 1377: Part 9: 1990, Section 2) and moisture content determinations (BS 1377: Part 2: 1990, Section 3)
  - (b) where required these tests shall be augmented by moisture content–dry density relationships (BS 1377: Part 4: 1990, Section 3) and particle density (BS 1377: Part 2: 1990, Section 8).



- 29.2 At least fourteen working days before the start of site work, the Contractor shall provide the Engineer, for his or her approval, with a list of the equipment the Contractor proposes to use to undertake these tests.
- 29.3 Control tests shall be performed throughout the fill at minimum frequency of one test per 500m<sup>3</sup> for same type of material, and the locations shall be directed by the Engineer.
- 29.4 When requested by the Engineer, the Contractor shall make available a plot of in situ dry densities against in situ moisture content results on a graph showing that the results lie within or above the area as mentioned in Clause [2.3] or such area as has been selected by the Engineer. Should any results lie outside the selected area, the Contractor shall provide the Engineer with proposals for rectifying the existing situation and for improving future performance.
- 29.5 The Engineer will, from time to time and with reasonable notice, request the Contractor to make available equipment to enable the Engineer to perform his or her own control tests. The results of these tests shall be used by the Engineer in assessing the Contractor's performance.

#### Field Density Test

- 29.6 Field density tests on each layer of compacted earth fill shall be carried out using the sand replacement method in accordance with MS 1056 or by using other means of testing of comparable accuracy approved by the S.O.

#### Moisture Control

- 29.7 Each layer of earth fill shall be processed as necessary to bring its moisture content to a uniform level throughout the material, suitable for compaction. The optimum moisture content as determined by the MS 1056 Compaction Test (2.5 kg rammer method) shall be used as a guide in determining the proper range of moisture content, preferably on the wet side, at which each soil type shall be compacted. Water shall be added in fine spray for consistent moisture absorption in the fill, or the material aerated and dried to adjust the soil to the proper range of moisture content to obtain the required density. A satisfactory method and sufficient equipment as approved by the S.O. shall be used for the furnishing and handling of water.
- 29.8 If the natural water content of suitable materials is too high for the proper compaction to be carried out, the Contractor can either bring down the moisture content by aeration or drying or alternatively replace it with suitable materials of compactable moisture range at his own cost.

#### Air Voids

- 29.9 To reduce potential of collapse compression of unsaturated cohesive fill due to wetting, the moisture content range at fill placement shall be controlled to achieve a compacted fill with allowable air void content not exceeding 5%.

#### Frequency of Control Tests

- 29.10 For each compacted fill materials, the frequency of control tests shall be in accordance with Table 2.2. The control tests shall be evenly allocated to each compacted layer of the entire compacted fill. Each control test shall provide moisture content, dry density, and air void content.

TABLE 2.2 – FREQUENCY OF CONTROL TEST FOR FILL COMPACTION

Scope of Earthwork	Frequency of Field Density Tests
Large scale operation of more than 10,000 cu.m (Industrial lots)	One test / 500m <sup>3</sup>

Small scale operation of 1,000 to 10,000 cu.m (Residential lots)	One test / 300m <sup>3</sup>
Concentrated operation (Gullies filling, farm dam)	One test / 100m <sup>3</sup>
Confined operation (Filling behind structures)	One test / 2 layers / 50m <sup>2</sup>
Trenches	One test / 2 layers / 40m

29.11 If certain test methods are used for the reasons of speed and economy, calibration between such tests and the master test method as per MS 1056 shall be carried out at the interval of every 100 tests. The calibration is material specific and shall be performed for each material type. The non-master test method with variation of more than  $\pm 5\%$  shall be rejected.

### 30.0 ROCK FILL EMBANKMENT

30.1 Rock used in rock fill embankments shall be of maximum particle size of 300 mm so that it can be deposited in horizontal layers, each not exceeding 500 mm in compacted depth and extending over the full width of the embankment except for any specified external cover to slopes or new formation level. The materials shall be spread and levelled by a crawler tractor weighing not less than 15 tonnes. Each layer shall consist of reasonably well graded rock and all large voids with averaging dimension of exceeding 150 mm shall be filled with broken fragments before the next layer is placed, The top surface and side slopes of embankments so formed shall be thoroughly blinded with approved fine graded material to seal the surface.

30.2 There shall be a transition layer between rock fill and earth fill or the top 300 mm below formation level of at least 300 mm compacted thickness. This shall consist of uniformly graded crushed rock between 6 mm and 150 mm as approved by the S.O.

30.3 Each layer of rock used as rock fill in embankments shall be systematically compacted by at least 12 passes of a vibrating roller with a static load per 25 mm width of roll of at least 80 kg or a grid roller with load per 25 mm width of roll of at least 200 kg or other approved plant.

### 31.0 MONITORING OF FILL PERFORMANCE

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

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

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

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

### 32.0 FORMATION

32.1 Throughout the top 1500 mm below formation level and vertical thickness of at least 3000 mm on the side slope, the material shall be compacted to not less than 95% (for cohesive material) or 100% (for cohesionless material) of the maximum dry density determined in the MS 1056 Compaction Test (2.5 kg rammer method).

32.2 In cut area, the top 1500 mm below the foundation level shall be scarified and recompacted to 95% (for cohesive material) or 100% (for cohesionless material) of the maximum dry density determined in the MS 1056 Compaction Test (2.5 kg rammer method). If the S.O. is agreeable that the material at the formation level in its natural state possesses a density exceeding the requirements, then the surface of the formation level shall be trimmed and rolled to obtain a smooth finish.

32.3 Where the material in cut area is found to be unsuitable for use in the top 1500 mm below foundation level it shall be removed and replaced with suitable material which shall be compacted as indicated above.

i) Where rock surface extends over the whole width of the formation :-

The rock surface shall be trimmed to a free draining profile, at or below formation levels. No high spot shall protrude above the formation levels.

Any voids or cavities more than 0.5 metre below the formation level shall be filled up with approved crusher run, gravels or lean concrete having 7-day cube strength greater than 7 N/sq.mm. The rock surface shall then be brought up to the formation levels with approved crushed rock or gravel, regulated and blinded.

ii) Where rock outcrop occurs over part of the formation only :-

The rock outcrop shall be cut down to a level not less than 300 mm below the formation level. The surface shall then be brought up to level with compacted suitable subgrade material as indicated above.

### **33.0 PROTECTIVE VEGETATION FOR EROSION CONTROL**

33.1 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.

33.2 If due to unforeseen circumstances turfing or hydroseeding cannot be carried out within the duration as specified hereafter, temporary protection/cover (eg. plastic sheets or equivalent) shall be laid on exposed slopes by the Contractor.

#### **Topsoil**

33.3 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.

33.4 Topsoil stockpiled for the Works in accordance with Sub-Sections 2.1.1.3 and 2.1.2.3 shall be spread and lightly compacted to an even thickness of 50 mm as directed by the S.O. in areas to be turfed and/or hydroseeded, or used as the S.O. shall otherwise direct for tree planting and other purposes.

#### **Turfing**

33.5 Turfing shall be carried out within seven (7) days after formation of the final slope profile as shown in the Drawings and/or where directed by the Engineer. Otherwise, the Engineer

reserves the right to engage external party to carry out the work and deduct the additional cost incurred accordingly from the contract. The type of turf shall be as indicated in the Drawings or other alternative type as approved by the Engineer and shall be free of lalang and essentially free of weeds.

- 33.6 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.
- 33.7 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.
- 33.8 All turf shall be regularly watered and fertilised to the satisfaction of the Engineer until the vegetation is satisfactorily established. Any dead turf shall be replaced with new turf at the Contractor's own expense and time.
- 33.9 Turfing shall be carried out after the exposed slope surface exceeds 100 sq.m or within two weeks after cutting or one week during monsoon season, whichever is earlier on all earth slopes and other areas as shown on the Drawings and/or where directed by the S.O. The type of turf shall be as indicated on the Drawings or other alternative type as approved by the S.O. Turf shall be delivered to Site within 36 hours after removal from the nursery and when stored, turf shall be stacked grass to grass to a maximum height of one metre. Turf stored on Site for a period of more than 48 hours shall not be used without prior approval of the S.O.
- 33.10 Turf shall be obtained in unbroken sods with a substantial amount of topsoil and shall be approximately 250 mm x 250 mm in size and 50 mm thick, from an approved source, and shall be placed in position as soon as practicable after cutting.
- 33.11 Turf sods shall be stacked and watered when they cannot be laid immediately after cutting.
- 33.12 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) and 3 (horizontal) shall be anchored down with bamboo stakes approximately 200mm in length where required. Approved fertiliser shall be applied after placing of turf at suitable times and at rates of application approved by the S.O.
- 33.13 Where close turfing is specified, the turf shall be laid to a well bonded pattern with no gaps between turves and lightly tamped. When spot turfing is specified, the turf shall be laid in alternating and staggered diamond pattern with maximum gaps of not exceeding 100 mm.
- 33.14 All turf shall be regularly watered and fertilised until the vegetation is satisfactorily established. Any dead turf shall be replaced with new turf at the Contractor's own expense.

### **Seeding**

- 33.15 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.
- 33.16 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 if 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.
- 33.17 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.
- 33.18 Hydroseeding shall be carried out after the proposed slope surface exceeds 1000 sq.m or within two weeks after cutting or one week during monsoon season, whichever is earlier on all slopes and other areas as shown on the Drawings and/or directed by the S.O.
- 33.19 The Contractor shall submit to the S.O. for his consideration and approval, at least four weeks in advance of the proposed work, full details of his proposed method of hydroseeding. The information submitted shall include, but not necessarily be limited to, a full description of the following aspects of the work :-
- i) the preparation of the areas to be hydroseeded, including if appropriate the amount of topsoil to be used and its method of application;
  - ii) the details and results of investigations to determine which types of grass and legume are compatible with the soil in the areas to be seeded;
  - iii) 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;
  - iv) the rates of application of the grass and legume seeds;

- v) the composition of fertiliser to be used at the time of hydroseeding and its rate of application;
  - vi) the composition of fertiliser to be used after seeding, the times of application after hydroseeding, and the rates of application;
  - vii) the type of mulch to be used and its method and rate of application;
  - viii) the amounts of lime or other chemicals (if any) to be applied to improve the soil before, during and/or after hydroseeding;
  - ix) the type and amounts of binding agent to be applied with the seeds, mulch, fertiliser, etc., as appropriate.
  - x) the proportions and methods of preparation of the hydroseeding mix;
  - xi) the equipment and methods to be used in preparing and placing the hydroseeding mix and other materials;
  - xii) 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 hydroseeding;
  - xiii) the time after hydroseeding required for establishing permanent, dense growth of grasses, which will require minimal maintenance;
  - xiv) guarantees of the success of the hydroseeding work.
- 33.20 All grass shall be regularly watered until the vegetation is satisfactorily established to the requirements of this specification. Any dead grass shall be replaced at the Contractor's own expense.

**Penalty**

- 33.21 The Contractor who fails to implement the Works as per above Sub-sections 2.2.8.1, 2.2.8.2 and 2.2.8.3 shall bear the time and cost of turfing/hydroseeding works carried out by others under the direction of the S.O.

## TABLE OF CONTENTS

	<b>Description</b>	<b>Page</b>
1.0	GENERAL REQUIREMENTS.....	EWH1
2.0	STANDARDS AND CODES OF PRACTICE .....	EWH1
3.0	CONTRACTOR'S RESPONSIBILITIES .....	EWH2
4.0	SITE CONDITIONS AND CONSTRAINTS .....	EWH3
5.0	SUBSOIL DATA .....	EWH4
6.0	SITE ACCESS .....	EWH4
7.0	PROTECTION OF PUBLIC AND PRIVATE SERVICES .....	EWH4
8.0	PRESERVATION OF EXISTING TREES .....	EWH5
9.0	DILAPIDATION SURVEY .....	EWH5
10.0	STABILITY AND SETTLEMENT OF ADJACENT PROPERTIES.....	EWH6
11.0	GROUND MOVEMENT INSTRUMENTATION AND MONITORING.....	EWH6
12.0	TEMPORARY WORKS.....	EWH6
13.0	SITE CLEARING .....	EWH8
14.0	PREPARATION OF SITE .....	EWH9
15.0	EXCAVATION.....	EWH10
16.0	CLASSIFICATION OF EXCAVATED MATERIALS .....	EWH12
17.0	METHOD OF MEASUREMENT .....	EWH12
18.0	STABILITY OF EXCAVATION AND MAINTENANCE OF EARTHWORKS.....	EWH13
19.0	TYPES OF TEMPORARY CONSTRUCTION.....	EWH14
20.0	FORMATION SURFACES.....	EWH15
21.0	HANDLING AND DISPOSAL OF EXCAVATED MATERIALS .....	EWH16
22.0	EXCAVATION OF ROCK .....	EWH16
23.0	BLASTING .....	EWH17
24.0	FILLING.....	EWH19
25.0	FILL MATERIALS .....	EWH20
26.0	DIPOSITION OF FILL.....	EWH21
27.0	FILL COMPACTION .....	EWH22
28.0	COMPACTION TRIALS .....	EWH24
29.0	QUALITY CONTROL .....	EWH24
30.0	ROCK FILL EMBANKMENT .....	EWH25
31.0	MONITORING OF FILL PERFORMANCE.....	EWH26
32.0	FORMATION .....	EWH26
33.0	PROTECTIVE VEGETATION FOR EROSION CONTROL.....	EWH27