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3. EARTHWORK

3.0. SCOPE

Earth work shall include furnishing of all labour, material, tools, plants, equipments, instruments and services for;

i) Excavation and formation of embankment in all types of soils. It also covers lifting and transporting excavated material. Suitable material intended for use as backfill shall be placed in temporary stockpiles. All other excavated material shall be placed in spoil banks These works shall be performed and executed by the Contractor in accordance with stipulations and requirements set forth herein which shall apply except when they are specifically modified in writing by the Engineer-in-Charge for any particular item. The method of carrying out earthwork shall be subject to approval of the Engineer-in-charge in writing.

ii) Fill and backfill using selected excavated material or imported material obtained from approved sources or by blending the excavated and imported materials.

iii) Before commencement and during the execution of works, the Contractor shall be responsible for surveys and layout and their maintenance for execution of works according to contract and as approved by the Engineer-in-Charge.

3.1 CLASSIFICATION OF SOILS

The earthwork shall be classified under the following categories and measured separately for each category.

3.1.1 SAND OR SOFT SOIL

It comprises sand, silt and those soils which offer no resistance to excavation and sometime requires shoring when foundation of exact dimensions are required to be excavated. Ordinary kassi, shovels or spade can be used for excavation in such type of soils.

3.1.2 ORDINARY SOIL

It comprises earth and sandy loam, spoil or rubbish of every description and any other formation into which a spade, kassi, shovels or spade can excavate

3.1.3 HARD SOIL

It comprises stiff and heavy clayed soil (having specific gravity of 1.5 and above) and at times have small percentage say upto 15 of kankar or boulders mixed up, it can be excavated by repeated blows of kassi, or with pick or shovel.

3.1.4 SHINGLE OR GRAVEL

It comprises gravel formation, soft varieties of limestone, sandstone, fissured stone or any other formation which can be excavated by the use of pick, shovel, jumpers, wedges, hammers etc.

3.1.5 ORDINARY / SOFT ROCK

Generally any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging or similar means for excavation. If required light blasting may be resorted to for loosening the materials but this will not in any way entitle the material to be classified as ‘Hard rock’.

3.1.6 HARD ROCK

Generally any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, consolidated sand stone, massive bedded lime stone, leterite,

marble, schist, Mandrasite, dolorite, pegmatite and reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like.

3.1.7 HARD ROCK (BLASTING PROHIBITED)

Hard rock requiring blasting as described but where the blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging, use of rock hammers and cutters or any other agreed method.

3.1.8 ALL KIND OF SOILS

All kinds of soils are generally any strata, such as sand, gravel, loam, clay, mud, black cotton moorum, shingle, river or nullah bed boulders, siding of roads, paths etc. and hard core, macadam surface of any description (water bound, grouted tarmac etc.), lime concrete, mud concrete and their mixtures which for excavation yield to application of picks, showels, jumper, scarifiers, ripper and other manual digging implements.

3.2. ANTIQUITIES AND USEFUL MATERIALS

Any finds of archaeological interest such as relics of antiquity, coins, fossils or other articles of value shall be delivered to the Engineer-in-Charge and shall be the property of the Government. Any material obtained from the excavation which in the opinion of the Engineer-in-Charge is useful shall be stacked separately in regular stacks as directed by the Engineer-in-Charge and shall be the property of the Government.

In case of archaeological monuments within or adjacent to the area, the contractor shall provide necessary fencing all around such monuments as per the directions of the Engineer-in-Charge and protect the same properly during execution of works. Payment for providing fencing shall be made separately.

3.3. PROTECTIONS

Excavation where directed by the Engineer-in-Charge shall be securely barricaded and provided with proper caution signs, conspicuously displayed during the day and properly illuminated with red lights and/or written using fluorescent reflective paint as directed by Engineer in charge during the night to avoid accident. The Contractor shall take adequate protective measures to see that the excavation operations do not damage the adjoining structures or dislocate the services. Water supply pipes, sluice valve chambers, sewerage pipes, manholes, drainage pipes and chambers, communication cables, power supply cables etc. met within the course of excavation shall be properly supported and adequately protected, so that these services remain functional. However, if any service is damaged during excavation shall be restored in reasonable time.

Excavation shall not be carried out below the foundation level of the adjacent buildings until underpinning, shoring etc. is done as per the directions of the Engineer-in-Charge Any damages done by the contractor to any existing work shall be made good by him at his own cost. Existing drains, pipes, culverts, overhead wires, water supply lines and similar services encountered during the course of execution shall be protected against damage by the contractor. The contractor shall not store material or otherwise occupy any part of the site in manner likely to hinder the operations of such services.

3.4. SITE PREPARATION

Before the earthwork is started, the area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood, trees saplings removed up to a distance of 30 meters outside the periphery of the area under clearance. The roots of trees and saplings shall be removed to a depth of60cm below ground level or 30 cm below formation level or 15

cm below sub grade level, whichever is lower, and the holes or hollows filled up with the earth, rammed and levelled.

3.5. EXCAVATION IN ALL KINDS OF SOILS

3.5.1 EXCAVATION OPERATIONS

All excavation operations manually or by mechanical means shall include excavation and disposal of the excavated material for canals, drains foundations, trenches, basements, water tanks sewers and manholes; including excavation in hard soils and under water etc. The work shall include the depositing the excavated materials as specified. The disposal of the excavated material beyond free lead shall be either stated as a separate item or included with the items of excavation stating lead. During the excavation the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.

In firm soils, the sides of the excavations shall be kept vertical upto a depth of 2 meters from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 50 cms on either side after every 2 metres from the bottom. Alternatively, the excavation can be done so as to give slope of 1:4 (1 horz. : 4 vert.). Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or sides sloped or the soil shored up as directed by the Engineer-in- Charge. It shall be the responsibility of the contractor to prepare proposals for the stepping, sloping or shoring as required for excavation for various depths. The work shall be executed only after the proposal is approved by the Engineer-in-Charge.

The excavation shall be done true to levels, slope, shape and pattern as per drawings and directed by the Engineer-in-Charge. Only the excavation shown on the drawings or as approved by the Engineer-in-Charge shall be measured for payment. No separate measurement and payment shall be made for excavation for centering and shuttering and for contractor's convenience.

The excavation for foundation in trenches and other areas, the bed of excavations shall be to the correct level or slope and consolidated by watering and ramming and other means when necessary. If the excavation is done to a depth greater than that shown in the drawings unless it is required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost with the concrete of the mix used for levelling/ bed concrete for foundations. Soft/defective spots at the bed of the foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-Charge

While carrying out the excavation for drain work care shall be taken to cut the side and bottom to the required shape, slope and gradient. The surface shall then be properly dressed. If the excavation is done to a depth greater than that shown on the drawing or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost with stiff clay puddle at places where the drains are required to be pitched and with ordinary earth, properly watered and rammed, where the drains are not required to be pitched. In case the drain is required to be pitched, the back filling with clay puddle, if required, shall be done simultaneously as the pitching work proceeds. The brick pitched storm water drains should be avoided as far as possible in filled-up areas and loose soils.
In all other cases where the excavation is taken deeper by the contractor, it shall be brought to the required level by the contractor at his own cost by filling in with earth duly watered, consolidated and rammed. In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, additional filling wherever required on that account shall be done by the contractor at his own cost.

The excavation shall be done manually or by mechanical means as proposed by the contractor and approved by Engineer-in-charge considering feasibility, urgency of work,

availability of labour/mechanical equipments construction completion programme and other factors involved. Contractor shall ensure the safety measures for the workers fully complying with recognised procedures and state laws.

3.5.2 DISPOSAL OF EXCAVATED MATERIALS

The free lead for disposal of excavated materials where stated in the "Schedule of Quantities" against various items is the average lead for the disposal of excavated earth within the site of work. The subsequent disposal of the excavated material where required shall be either stated as a separate item or included with the item of excavation stating lead. The actual lead for the disposal of earth beyond free lead shall be measured for payment appropriately. The excavated earth shall be disposed off at the locations proposed by the Contactor and approved by the Engineer-in-Charge. The contractor has to take written permission about place of disposal of earth before the earth is disposed off, from Engineer-in-Charge.

3.6. EXCAVATION IN ORDINARY / HARD ROCK

3.6.1 GENERAL

All excavation operations shall include excavation and disposal of the excavated material as shown on drawings and approved by the Engineer-in-Charge. In case of excavation for trenches, basements, water tanks etc. the excavation shall include disposal of the excavated materials within free lead as specified. The disposal of the excavated material beyond free lead shall be stated as a separate item unless it is included with the item of excavation. During excavation, the natural drainage of the area shall be maintained; Excavation shall be done from top to bottom. Undermining or under cutting shall not be done.

3.6.2 ORDINARY / SOFT ROCK

In ordinary rock excavation shall be carried out by crowbars, pick axes or pneumatic drills and blasting operation shall not be generally adopted. Where blasting operations are not prohibited and it is practicable to resort to blasting for excavation in ordinary rock, contractor may do so with the permission of the Engineer-in-Charge in writing but nothing extra shall be paid for this blasting. Blasting shall be done as specified hereof.

If the required excavation is done to a depth greater than that shown in the drawings or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost with the concrete of the mix used for levelling/ bed concrete for foundations. Soft/ defective spots at the bed of foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-Charge.

In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, filling wherever required on this account shall be done by the contractor at his own cost. Only the excavation shown on the drawings or as required by the Engineer-in-Charge shall be measured and recorded for payment except in case of hard rock, where blasting operations have been resorted to, excavation shall be measured to the actual levels, provided the Engineer-in-Charge is satisfied that the contractor has not gone deeper than what was unavoidable.

3.6.3 HARD ROCK

(i) **General**

Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer-In-charge in writing for resorting to the blasting operations. Blasting operations shall be done as specified and chiselling shall be done to obtain correct levels, slopes, shape and pattern of excavation as per the drawings or as required by the Engineer-In-charge and nothing extra shall be payable for chiselling.

(ii) **Blasting**

Blasting operations shall be carried out under the supervision of a responsible licensed blasting authorized agent of the contractor (referred as agent), during specified hours as

approved in writing by the Engineer-in-Charge. The agent shall be conversant with the rules of blasting notified by Government from time to time. All blasting operations shall be carried out with due regard to safety regulations in force.

For blasting with dynamite or any other high explosive, the position of all the bore holes to be drilled shall be marked in circles with white paint. These shall be inspected by the contractor's agent. Bore holes shall be of a size that the cartridge can easily pass down. After the drilling operation, the agent shall inspect the holes to ensure that drilling has been done only at the marked locations and no extra hole has been drilled. The agent shall then prepare the necessary charge separately for each bore hole. The bore holes shall be thoroughly cleaned before a cartridge is inserted. Only cylindrical wooden tamping rods shall be used for tamping. Metal rods or rods having pointed ends shall never be used for tamping. One cartridge shall be placed in the bore hole and gently pressed but not rammed down. Other cartridges shall then be added as may be required to make up the necessary charge for the bore hole. The top most cartridge shall be connected to the detonator which shall in turn be connected to the safety fuses of required length. All fuses shall be cut to the length required before being inserted into the holes. Joints in fuses shall be avoided. Where joints are unavoidable a semi-circular nitch shall be cut in one piece of fuse about 2 cm deep from the end and the end of other piece inserted into the nitch. The two pieces shall then be wrapped together with string. All joints exposed to dampness shall be wrapped with rubber tape.

The maximum of eight bore holes shall be loaded and fired at one occasion. The charges shall be fired successively and not simultaneously. Immediately before firing, warning shall be given and the agent shall see that all persons have retired to a place of safety. The safety fuses of the charged holes shall be ignited in the presence of the agent, who shall see that all the fuses are properly ignited.

Careful count shall be kept by the agent and others of each blast as it explodes. In case all the charged bore holes have exploded, the agent shall inspect the site soon after the blast but in case of misfire the agent shall inspect the site after half an hour and mark red crosses (X) over the holes which have not exploded. During this interval of half an hour, nobody shall approach the misfired holes. No driller shall work near such bore until either of the following operations has been done by the agent for the misfired boreholes.

The contractor's agent shall very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper and withdraw the fuse, primer and detonator. After this a fresh detonator, primer and fuse shall be placed in the misfired holes and fired, or the holes shall be cleaned for 30 cm of tamping and its direction ascertained by placing a stick in the hole. Another hole shall then be drilled 15 cm. away and parallel to it. This hole shall be charged and fired. The misfired holes shall also explode along with the new one.

Before leaving the site of work, the agent of one shift shall inform the another agent relieving him for the next shift, of any case of misfire and each such location shall be jointly inspected and the action to be taken in the matter shall be explained to the relieving agent. The Engineer-in-Charge shall also be informed by the agent of all cases of misfires, their causes and steps taken in that connection.

(iii) **General Precautions**

For the safety of persons red flags shall be prominently displayed around the area where blasting operations are to be carried out. All the workers at site, except those who actually ignite the fuse, shall withdraw to a safe distance of at least 200 meters from the blasting site. Audio warning by blowing whistle shall be given before igniting the fuse.

Blasting work shall be done under careful supervision and trained personnel shall be employed. Blasting shall not be done within 200 metres of an existing structure, unless specifically permitted by the Engineer-in-Charge in writing.

All procedures and safety precautions for the use of explosives drilling and loading of explosives drilling and loading of explosives before and after shot firing and disposal of

explosives shall be taken by the contractor in accordance with safety code for blasting and related drilling operation.

(iv) Precautions against misfire

The safety fuse shall be cut in an oblique direction with a knife. All saw dust shall be cleared from inside of the detonator. This can be done by blowing down the detonator and tapping the open end. No tools shall be inserted into the detonator for this purpose.

If there is water present or if the bore hole is damp, the junction of the fuse and detonator shall be made water tight by means of tough grease or any other suitable material.
The detonator shall be inserted into the cartridge so that about one third of the copper tube is left exposed outside the explosive. The safety fuse just above the detonator shall be securely tied in position in the cartridge. Water proof fuse only shall be used in the damp bore hole or when water is present in the bore hole.
If a misfire has been found to be due to defective fuse, detonator or dynamite, the entire consignment from which the fuse detonator or dynamite was taken shall be got inspected by the Engineer-in-Charge or his authorized representative before resuming the blasting or returning the consignment.

3.7. EXCAVATION IN OR UNDER WATER AND /OR LIQUID MUD

3.7.1 GENERAL

Excavation, where water is encountered shall fall in this category. Steady water level in the trial pits before the commencement of bailing or pumping operations shall be the sub-soil water level in that area. Planking and strutting or any other protection work done with the approval of the Engineer-in-Charge to keep the trenches dry and/or to save the foundations against damage by corrosion of rise in water levels shall be measured and paid for separately. Bailing or pumping out water, accumulated in excavation, due to rains is included under respective items of earthwork and is not to be paid separately. In case item for dewatering is listed in the bid schedule, it will be paid as lumpsum item and will constitute full compensation for all labor, equiptments, tools and all other items necessary and incidental to the completion of the work.

3.7.2 CARE OF WATER/ DEWATERING

All water that may accumulate in excavations during the progress of the work from springs, tidal or river seepage, broken water mains or drains (not due to the negligence of the contractor), and seepage from subsoil aquifer shall be bailed, pumped out or otherwise removed by the contractor. The contractor shall take adequate measures for bailing and/or pumping out water from excavations and/or pumping out water from excavations and construct diversion channels, bunds, sumps, coffer dams etc. as may be required. Pumping shall be done directly from the foundations or from a sump outside the excavation or any other appropriate method proposed by Contractor in advance of undertaking the work and approved by the Engineer-in-Charge in such a manner as to preclude the possibility of movement of water through any fresh concrete or masonry and washing away parts of concrete or mortar. During laying of concrete or masonry and for a period of at least 24 hours thereafter, pumping shall be done from a suitable sump separated from concrete or masonry by effective means.

Capacity and number of pumps, location at which the pumps are to be installed, pumping hours etc. shall be proposed from time to time by the contractor and approved by the Engineer-in-Charge.
Pumping shall be done in such a way as not to cause damage to the work or adjoining property by subsidence etc. Disposal of water shall not cause inconvenience or nuisance in the area or cause damage to the property and structure nearby. To prevent slipping of

sides, planking and strutting may also be done with the approval of the Engineer-in-Charge.

The approval by the Engineer-in-Charge of the Method Statement for pumping shall not relieve the contractor of his responsibility for the adequacy sufficiency of operations. The applicable extra unit rate for wet and underwater excavation of earthwork includes full compensation for performance of the work and no separate payment shall be allowed, In case item for dewatering in not listed in the bid separately.

3.8. FILLING

3.8.1 GENERAL

(i) For fillings and embankment construction, the earth from excavation as far as practicable shall be directly used for filling and no payment for double handling of earth shall be admissible. All costs shall be deemed to be included in the unit rate for excavation.

(ii) The earth used for filling and embankment construction shall be free from all roots, grass, shrubs, rank vegetation, brushwood, tress, sapling and rubbish. Filling with excavated earth shall be done in regular horizontal layers each not exceeding 20 cm in thickness unless otherwise specified or approved by the Engineer-in-Charge. All lumps and clods exceeding 8 cm in any direction shall be broken.

(iii) Each layer shall be watered and consolidated with steel rammer or ½ tonne roller. Where specified, every third and top most layer shall also be consolidated with power roller of minimum 8 tonnes. Wherever depth of filling exceeds 1.5 meter vibratory power roller shall be used to consolidate the filing unless otherwise directed by Engineer-in-charge. The top and sides of filling shall be neatly dressed. The contractor shall make good all subsidence and shrinkage in earth fillings, embankments, traverses etc. during execution and till the completion of work unless otherwise specified.

3.8.2 LARGE SCALE LEVELLING WORK

a) In case of large scale levelling work involving both cutting and filling, an accurate site plan shall be prepared before the work is commenced by contractor for approval of the Engineer-in-Charge. The portions requiring cutting and filling shall then be divided into squares and corresponding squares into filling, which are complementary to the squares in cutting giving the same number.

b) A table may be written upon the plan showing leads involved between the various complementary squares. This would form a lead chart for the work to be done.

c) Before the work of levelling is commenced, the lead chart shall be checked in the presence of the contractor or his authorized representative, and his signatures shall be obtained on the same. This should form an integral part of the contract and should be duly signed by both the integral parties before commencement of the work.

d) The quantity payable for earthwork shall be lower of the quantity derived from cutting or filling. The payment for lead shall be based on lead chart prepared in the aforesaid manner.

3.8.3 BORROW SOIL

Materials required for fill and embankment construction not available from excavations be imported from pre-determined borrow areas approved by the Engineer-in-Charge before the start of the work. Wherever feasible, the average lead should be worked out and stipulated in the tender.

The borrow area shall be stripped carefully of topsoil, sod and other matter unsuitable for fill. Surface of borrow areas shall be left after completion in a reasonable smooth and even condition approved by Engineer-in-Charge.

The initial limits and levels of the area to be filled should be recorded and approved by Engineer-in-Charge. The levels should be properly checked during the progress of work and on completion.

The borrow pits for canals & drains shall comply with the provisions of Clause 3.9.

3.8.4 EXCAVATION IN TRENCHES FOR PIPES, CABLES ETC. AND REFILLING

(i) **General**

This shall comprise excavation to any depth in trenches for pipes, cables etc. and returning the suitable excavated material to fill the trenches after pipes, cables etc. are laid and their joints tested and passed, and disposal of surplus excavated material.

(ii) **Refilling**

Filling in trenches shall be commenced soon after the joints of pipes, cables, conduits etc. have been tested and passed. The space all around the pipes, cables conduits etc. shall be cleared of all debris, brick bats etc. Where the trenches are excavated in hard/ soft soil, the filling shall be done with earth on the side and top of pipes unless otherwise approved in layers not exceeding 20 cm in depth. Each layer shall be watered, rammed and consolidated. All clods and lumps of earth exceeding 8 cm in any direction shall be broken or removed before the excavated earth is used for filling. In case of excavation trenches in ordinary/ hard rock, the filling upto a depth of 30cm above the crown of pipe, cable, conduits etc. shall be done with fine material like earth, moorum or pulverized/ decomposed rock according to the availability at site. The remaining filling shall be done with boulders of size not exceeding 15cm mixed with fine material like decomposed rock, moorum or earth as available to fill up the voids, watered, rammed and consolidated in layers not exceeding 30cm. Excavated material containing deleterious material, salt peter earth etc. shall not be used for filling. Ramming shall be done with iron rammers where feasible and with blunt ends of crow bars where rammers cannot be used. Special care shall be taken to ensure that no damage is caused to the pipes, Cables, Conduits etc. laid in the trenches.

(iii) **Planking and Strutting - General**

When the depth of trench in soft/loose soil exceeds 2 metres, stepping, sloping and/ or planking and strutting of sides shall be done. In case of loose and slushy soils, the depths at which these precautions are to be taken, shall be as approved by the Engineer-in-Charge according to the nature of soil. Planking and strutting shall be 'close' or 'open' depending on the nature of soil and the depth of trench. The type of planking and strutting shall be as proposed by Contractor and approved by the Engineer-in-Charge. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches from collapse.

(iv) **Close Planking and Strutting**

Close planking and strutting shall be done by completely covering the sides of the trench generally with short upright, members called 'poling boards'. These shall be 250x38 mm in section or as approved by the Engineer-in-Charge.

The boards shall generally be placed in position vertically in pairs, one board on either side of cutting. These shall be kept apart by horizontal wallings of strong wood at a maximum spacing of 1.2 metres cross strutted with ballies, or as directed by Engineer-in-Charge. The length and diameter of the ballies strut shall depend upon the width of the trench.
Where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical 'wallings' which shall be strutted to similar timber pieces on the opposite face of the trench. The lowest boards supporting the sides shall be taken in the ground for a minimum depth of 75 mm. No portion of the vertical side of the trench shall remain exposed. The withdrawal of the timber members shall be done very carefully to prevent collapse of the trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged while removing the planks. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried, unless required by the Engineer-in-Charge to be left permanently in position.

(v) **Open Planking and Strutting**

In case of open planking and strutting, the entire surface of the side of the trench is not required to be covered. The vertical boards 250 mm wide & 38 mm thick, shall be spaced sufficiency apart to leave unsupported strips of 50cm average width. The detailed arrangement, sizes of the timber and the distance apart shall be subject to the approval of the Engineer-in-Charge. In all other respect, specifications for close planking and strutting shall apply to open planking and strutting.

3.8.5 FILLING IN PLINTH, UNDER FLOOR ETC.

i) **Earth filling**

Normally excavated earth from same area shall be used for filling. Earth used for filling shall be free from shrubs, rank, vegetation, grass, brushwood, stone shingle and boulders (larger than 75mm in any direction), organic or any other foreign matter. Earth containing deleterious materials, salt peter earth etc. shall not be used for filling. All clods and lumps of earth exceeding 8 cm in any direction shall be broken or removed before the earth is used for filling.

The space around the foundations and drains shall be cleared of all debris, brick bats etc. The filling unless otherwise specified shall be done in layers not exceeding 20 cm in depth. Each layer shall be watered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt end of crow bars where rammers cannot be used. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the trenches. In case of filling under floor, the finished level of filling shall be kept to the slope intended to be given to the floor.

ii) **Sand Filling in Plinth**

Sand shall be clean and free from dust organic and foreign matter. Sand filling shall be done in a manner similar to earth filling in plinth specified above except that consolidation shall be done by flooding with water. The surface of the consolidated sand filling shall be dressed to the required level or slope and shall not be covered till the Engineer-in-Charge has inspected and approved the sand filling.

3.9. EMBANKMENT CONSTRUCTION

3.9.1 SOURCE OF FILL MATERIAL

The fill material for construction of embankment shall comply with the provisions of Clause 3.8.and the work shall be carried out as shown on drawings and approved by the Engineer-in-Charge.

If sufficient suitable materials are not available from the required excavations to construct the embankment, diversion, coffer dams, backfill and other earthwork construction shown on the approved drawings or directed in writing by the Engineer-in-charge, suitable materials shall be excavated from borrow-pits located in specified areas.

In case of road embankments, the borrow pits may be excavated along the sides of the road so as to form road side drains with proper slopes and sections. The clear berm width between the toe of the bank and the inner edge of the borrow pits shall be specified by the Engineer-in-Charge but it shall not be less than 5 metres after making due allowance for future development.

Borrow pits shall be rectangular in shape with one side parallel to the centre line of the road. If on road land, these shall be dug as near the boundary as possible. Borrow pits shall not be dug continuously. Ridges of not less than 8 metres width should be left at intervals not exceeding 300 metres. Small drains should be cut through the ridges to facilitate drainage. Borrow pits shall be well drained. The bed level of the borrow pits, shall, as far as possible, slope down progressively towards the nearest cross drain, if any and shall not be

lower than the bed of the cross drain. Borrow pits shall not be dug within 0.8 km of towns or villages. If unavoidable these shall not exceed 30 cm in depth and shall be drained.

Where it becomes necessary to borrow filling materials from temporarily acquired cultivable lands the depth of borrow pits shall not exceed 45 cm. The top soil to a depth of 15 cm shall be stripped and stacked aside. Thereafter soil shall be dug out to a further depth not exceeding 30 cm and used in forming the embankment. The top soil shall then be spread back on the land.

In case of flood and marginal banks, earth shall be obtained from borrow pits on the river side of the banks. No borrow pit shall be excavated on the land side of the bank, unless permitted by the Engineer-in-Charge in writing depending upon the depth of borrow pits and height of embankment. However the minimum berm width between the toe of the bank and the edge of the borrow pits on the river side shall be 15 metres and that between the toe of the bank and the edge of the borrow pits on the land side 25 metres. Guide-banks shall be constructed from material obtained from excavation for laying stone aprons and further borrow pits excavated if necessary, according to the directions of the Engineer-in-Charge.

3.10. SITE CLEARANCE

The surface area of the ground to be occupied by all banks, spoils, borrow pits shall be cleared of all roots, grass, shrubs, brush, trees, fences and such other works as may either cause hindrance with the execution of works or may decay and form dangerous pockets. The clearance may be classified with following categories.

3.10.1 SURFACE DRESSING

Surface dressing before placement of fill and construction of embankment shall include cutting and filling upto a depth of 15 cm and clearing of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth upto 30 cm measured at a height of one metre above the ground level and removal of rubbish and other excavated material upto a distance of 50 metres outside the periphery of the area under surface dressing. High portions of the ground shall be cut down and hollows and depressions filled upto the required level with the excavated earth so as to give an even, neat and tidy look.

3.10.2 JUNGLE CLEARANCE

Jungle clearance shall comprise uprooting of rank vegetation, grass, brushwood, shrubs, stumps, trees and saplings of girth upto2.5 ft. measured at a height of one metre above the ground level.

3.10.3 UPROOTING OF VEGETATIONS

The roots of trees and saplings shall be removed to a depth of 60 cm below ground level or 30 cm below formation level or 15 cm below sub-grade level, whichever is lower. All holes or hollows formed due to removal of roots shall be filled up with earth rammed and levelled. Trees, shrubs, poles, fences, signs, monuments, pipe lines, cable etc., within or adjacent to the area which are not required to be disturbed during jungle clearance shall be properly protected by the contractor at his own cost and nothing extra shall be payable.

3.10.4 CLEARANCE OF GRASS

Clearing and grubbing operation involving only the clearance of grass including removal of rubbish upto a distance of 50 m. outside the periphery of the area under clearance shall not be measured and paid for separately. Its costs shall be deemed to be included in the unit rate for earthwork.

3.10.5 FELLING TREES

While clearing jungle, growth trees above 30 cm girth (measured at a height of one metre above ground level) to be cut, shall be approved by the Engineer-in-Charge and then marked at site. Felling trees shall include taking out roots upto 60 cm below ground level or 30 cm below formation level or 15 cm below sub-grade level, whichever is lower. All excavation below general ground level arising out of the removal of trees, stumps etc. shall be filled with suitable material in 20 cm layers and compacted thoroughly so that the surfaces at these points conform to the surrounding area. The trunks and branches of trees shall be cleared of limbs and tops and cut into suitable pieces as directed by the Engineer-in-Charge.

3.10.6 STACKING AND DISPOSAL

All useful materials obtained from clearing and grubbing operation shall be stacked in the manner as directed by the Engineer-in-Charge. Trunks and branches of trees shall be cleared of limbs and tops and stacked neatly at places indicated by the Engineer-in-Charge. The materials shall be the property of the Government. All unserviceable materials which in the opinion of the Engineer-in-Charge cannot be used or auctioned shall be removed up to a distance of 50 ft. outside the periphery of the area under clearance. It shall be ensured by the contractor that unserviceable materials are disposed off in such a manner that there is no likelihood of getting mixed up with the materials meant for construction.

3.10.7 OTHER PHYSICAL OBSTRUCTIONS

Other physical obstructions like structures, fencing appearing on ground shall be cleared and accounted as approved by the Engineer-in-Charge.

3.11. FOUNDATION PREPARATION & LAYOUT OF EMBANKMENTS

The foundations of the embankment shall be ploughed to a depth of 15 to 25 cm. All clods shall be broken into fine earth and the area roughly levelled. The surface shall then be well watered before the earth work is started. Before commencement of filling the centre and toe lines of the embankment shall be marked by pegs driven into the ground at 15 metres intervals and by continuous nicking (day belling) to indicate the limits of the construction. Bamboo and string profiles shall be erected at every 60 metres interval in straight reaches and 15 metres apart in curved portions.

3.12. FILL PLACEMENT FOR EMBANKMENT COMPACTION

3.12.1 FILL PLACEMENT

Embankment material shall be laid in 20 cm layers which shall be continuous and parallel to the finished grade. The placing of earth fill shall be done in the full width of embankment including slopes, and the section of formation shall be kept slightly sloping away from the centre to avoid pools of water forming due to rain. The height of filling in different sections shall be uniform as far as possible. All clods shall be broken while the earth is being placed. Organic matter of any kind shall be removed and disposed off as directed by the Engineer-in-Charge. Joining of old and new embankments shall be done by stepping in an overall slope of about 1 to 5. Each layer of earth shall be adequately watered to aid compaction. The specified compaction shall be achieved by using appropriate compaction equipment as approved by the Engineer-in-Charge.

If the material delivered for fill is too wet it shall be dried by aeration and exposure to the sun, till the moisture content is acceptable for compaction. The embankment if required shall be rolled with roller of minimum 1/2 tonne weight, not less than 5 times and further if required till it gets evenly and densely consolidated with wooden or steel rammers of 7 to 10 kg weight having a base of 20 cm square or 20 cm diameter. The labour for ramming shall be at-least one rammer to six diggers. Every third layer of earth and the top most layer shall be well consolidated with a power roller of minimum 8tonnes weight, rolled not less than 5 times, till the soil behaves as an elastic material and gets compressed only elastically under the load of roller.

3.12.2 DRESSING

The embankment shall be dressed neatly as per designed section and grade, after it has been completed and thoroughly consolidated. The top and slopes shall be protected from any damage and maintained, till the work is completed and handed over to the Engineer-in-Charge.

3.12.3 EMBANKMENT COMPACTION

3.12.3.1 GENERAL

The Compaction of the embankment may be required at specified relative density according to ASTM D 1556 at optimum moisture content or otherwise compaction as required.

3.12.3.2 EMBANKMENT CONSTRUCTION (Under Optimum Moisture Conditions)

(i) **General**

The optimum moisture contents for specified density shall be determined by contractor in laboratory in advance of start of construction.

The optimum moisture contents for specified density shall be determined by contractor in laboratory in advance of start of construction. Control on compaction in the field shall be exercised through frequent moisture content and density determinations. A systematic record of these shall be maintained. At all times during construction the top of the embankment shall be maintained in a profile to shed water and prevent pounding.

(ii) **Density Measurement and Acceptance Criteria**

Measurement of density shall be made for each 500sq.m of compacted area or for a smaller area as decided by the Engineer-in-Charge. Each measurement shall consist of at least 5 density determinations and the average of these 5 determinations shall be treated as the field density achieved.

In general the control at the top 40 cm thickness of the formation shall be more strict with density measurements being done at the rate of one measurement for 250 sq.m. of compacted area. Further for the determination of the mean density the number of tests in one measurement shall not be less than 10 and the work will be accepted if the mean dry density equals or exceeds the specified density.

When density measurements reveal any soft areas in the embankment, the Engineer-in-Charge shall direct that these be compacted further. If in spite of that the specified compaction is not achieved the material in the soft areas shall be removed and replaced by approved materials and compacted as specified to the satisfaction of the Engineer-in-Charge.

(iii) **Control Tests on Borrow Material**

Soil suitable for consolidation under O.M.C. conditions should preferably have the following characteristics :

a)	Minimum percentage of clay	10%
b)	Liquid limit	14%
c)	Plasticity index (ASTM D-4318)	4%
d)	Percentage of silt should not exceed	5%
e)	Peat, muck and organic soils are unsuitable	Nil

The Engineer-in-Charge may, however, relax these requirements taking into account availability of materials, cost of transportation and other relevant factors. Various test required to be conducted on the borrow material with their recommended frequency are indicated below. All the test need not be stipulated on every project. Depending upon site

condition etc. only some may be found necessary at a particular project. The frequency of testing indicated refers generally to the minimum number of tests to be conducted. The rate of testing must be stepped up as found necessary depending upon the variability of the materials and compaction methods employed at a project.

a) **Gradation:**

At least one test for each kind of soil. Usual rate of testing 1 to 2 tests per 8000 cum of soil.

b) **Plasticity:**

At least one test for each kind of soil. Usual rate of testing 1 to 2 tests per 8000 cum of soil.

c) **Proctor Tests:**

At the rate of 1 to 2 tests per 8000 cum of soil.

d) **Deleterious Contents:**

As required.

e) **Moisture contents:**

One test for every 250 Cu. M. of soil.

3.12.3.3 EMBANKMENT CONSTRUCTION (Without Optimum Moisture Conditions)

Materials used in embankments shall be earth moorum, gravel, a mixture of these or any other material approved by the Engineer-in-Charge. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment. The work shall be so planned and executed that the best available materials are saved for the top portion of the embankment. Highly expansive clays exhibiting marked swell and shrinkage properties may be deposited only at the bottom of the embankment and no such material shall be placed nor permitted to remain in the top 500 mm portion of the embankment below the sub-grade.

3.12.4 EMBANKMENT AROUND STRUCTURES

To avoid interference with the construction of abutments, wing walls or return walls of culvert/bridge structure, the contractor shall at points to be determined by the Engineer-in-Charge suspend work on embankments forming approaches to such structures, until such time as the construction of the latter are sufficiently advanced to permit the completion of approaches without the risk of interference of damage to the bridge works.

Unless directed otherwise, the filling around culverts, bridges and other structures upto a distance of twice the height of the embankment shall not be done. The fill material shall not be placed against any abutment or wing wall unless permission has been given by the Engineer-in-Charge but in any case not until the concrete or masonry has been in position for 14 days. The embankment shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer-in-Charge. Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter material shall conform to the requirements for filter medium as specified. Payment for providing filter material shall be made separately under relevant items.

Where it may be impracticable to use power roller or other heavy equipment, compaction shall be carried out by mechanical tempers or other methods approved by the Engineer-in-Charge. Care shall be taken to see that the compaction equipments does not hit or come too close to any structural member so as to cause any damage to it.

3.13. EARTHWORK FOR WIDENING EXISTING ROAD EMBANKMENT

i. **Embankment**

When an existing embankment is to be widened and its slope is steeper than 4:1 continuous horizontal benches each at least 0.3 metre wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment material to be added. The material obtained from cutting of benches could be utilised in the widening of the embankment. However, when the existing slope against which the fresh material is to be placed is flatter than 4:1 the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portion is insufficient to permit the use of standard rollers compaction shall be carried out with the help of sheep's foot roller mechanical tampers or other approved equipment. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other type of hauling equipment.

ii. **Cutting**

Where the formation level of the road is lower than the ground level, cutting shall be done up to formation level. Side slopes except in rock cutting shall be evenly and truly dressed.

iii. **Disposal of Surplus Earth**

Earth from cutting shall be utilised for filling in embankment as directed by the Engineer-in-Charge. Earth not required for embankment shall be disposed off as directed by the Engineer-in-Charge. The area where the surplus earth is disposed off shall be levelled and neatly dressed. The surplus earth is disposed off beyond free lead shall be paid as provided.

3.14. EARTHWORK BY MECHANICAL MEANS

Earth work by mechanical means involves careful planning keeping in view site conditions i.e. type of soil, nature of excavation, distances through which excavated soil is to be transported and working space available for employing these machines. The earth moving equipment should be accordingly selected.

The contractor shall submit for approval of the Engineer-in-Charge his detailed Method statement for carrying out the work. The approval of Method statement by the Engineer-in-Charge shall not relieve the contractor for carrying out the work according to Contract Agreement as approved by the Engineer. The earth moving equipment consists of excavating and transporting equipment. Excavating equipments may be further classified as excavators and tractor based equipments. The major items which may be used in Construction are listed below.

3.14.1 EXCAVATORS

Excavators generally used at site are as follows:

a) **Dipper–shovel**

It is used for excavating against a face or bank consisting of open-top bucket or dipper with a bottom opening door, fixed to an arm or dipper stick which slides and pivots on the jib of the crane. It is suitable for excavating all clay chalk and friable materials and for handling rock and stone. However, it is not suitable for surface excavation for which a skimmer is used.

b) **Backhoe**

It is similar to face shovel except that the dipper stick pivots on the end of the jib and the dipper or bucket works towards the chassis and normally has no bottom door but is emptied by swinging away from the chassis to invert the bucket. It may be designed to carry both a front–mounted bucket and a rear mounted backhoe. It is mainly used to excavate trenches and occasionally used for the excavation of open areas such as small basements.

In the backhoe mode the bucket lifts, swings and discharges materials while the undercarriage is stationary. When used in the 'loader' mode the machine loads or excavated through forward motion of the machine, and lifts, transports and discharges materials.

c) **Skimmer**

This arrangement is similar to the face shovel except that in this case the bucket slides on rollers directly along the jib and thus has a more restricted movement. It is used for surface excavation and levelling in conjunction with transport to haul away the excavated material.

d) **Dragline**

It is usually fitted with a long slender boom or jib and the bucket, which in operation faces towards the machine and has no door, is supported by cable only as on a crane. It works from the side of the excavation at normal ground level and is used for excavating large open excavations such as basements when the depth is beyond the limit of the boom of a backhoe. It is commonly used for open cast mining operations.

e) **Clamshell**

It comprises two hinged half-buckets or jaws pivoted to a frame which is suspended by cable from a long jib of an excavation. The grab is used for deep excavations of limited area on all types of soil except rock. Crane and Grab is a variant of this type of equipment.

3.14.2 TRACTOR BASED EQUIPMENT

It is a self–propelled crawler or wheeled machine used to exert a push or pull force through mounted equipment. It is designed either as attachments to normal tracked or wheeled tractors or as machines in which the earth moving attachments and the tractor are designed as a single integrated unit. A tractor, which is hydraulically operated, can be rigged as:

a) **Loaders**

It is used for loading, light dozing, scraping and grabbing operations, lifting and transporting the materials (loose earth, rubble, sand, gravel aggregate etc) at various sites through forward motion of the machine.

b) **Tractor Shovel**

This consists of a tipping bucket at the front attached by strong pivoted arms or booms to the frame of the machine. It is used for stripping top soil, excavating against a face, bulldozing and for loading spoil or loose materials. It is similar to crawler dipper-shovel.

c) **Trench Digger**

It operates on the same principle as a backhoe excavator except that the bucket is controlled by hydraulic rams instead of cables and pulleys.

d) **Scraper**

Scrapers provide unique capability to excavate, load, haul and dump materials. Scrapers are available in various capacities by a number of manufacturers with options such as self – loading with elevators, twin engines or push-pull capability. They are cost effective where the haul distance is too long for bulldozers, yet too short for trucks. This distance typically ranges from 120 m. to 1200m. however, the economics should be evaluated for each project. Scraper has an open bowl with a cutting edge positioned between the axles, which cuts, loads, transports, discharges and spreads through forward motion of the machine. Loading through forward motion of the machine can be assisted by a powered mechanism (elevator) fixed to the scraper bowl.

e) **Bulldozer and Angle-dozer**

The most common equipment used for clearing and levelling activities is a bulldozer. The term bulldozer is used to define a tractor mounted with a dozing blade. The bulldozer consists of a rectangular steel blade with renewable cutting edge set at right angles (capable of only tilting but not angling) to the direction of travel and attached by steel arms to the side frames of a crawler tractor. It may be used for excavating natural soil or for moving loose soil or debris, which is pushed forward as the tractor forces it ahead. Angle dozer is capable of both tilting and angling.

3.15. TRANSPORTING EQUIPMENT

This implies horizontal movement primarily but it can involve some vertical movement too.

a) Dumpers

These are self-propelled wheeled machines, having an open body. It is designed for the transport of excavated materials and consists of a shallow tipping hopper or skip mounted on a wheeled chassis, such as, power barrow, dumper, multi-skip dumpers, high discharge dumpers, dump truck, etc. These can be rear dump, side dump or bottom dump.

b) Vibratory Roller

It is a single Drum Vibratory Roller for compaction of embankments, etc. The smooth drum version is for compaction of granular and mixed soil. The sheep's foot Roller comprises a hallow cylindrical steel drum or drums on which projecting feet are mounted. These feet penetrate into the fill as a roller moves forward and cause compaction. The geometry of the foot may be sheep, club pyramid, cone or cylinder foot. Such rollers are employed for compaction (densification) of cohesive and semi-cohesive soils.

3.16 ANTI-TERMITE TREATMENT

Sub-terranean termites are responsible for most of the termite damage in buildings. Typically, they form nests or colonies underground. In the soil near ground level in a stump or other suitable piece of timber in a conical or dome shaped mound. The termites find access to the super-structure of the building either through the timber buried in the ground or by means of mud shelter tubes constructed over unprotected foundations.

Termite control in existing as well as new building structures is very important as the damage likely to be caused by the termites to wooden members of building and other household article like furniture, clothing, stationery etc. is considerable. Anti-termite treatment can be either during the time of construction i.e. pre-constructional chemical treatment or after the building has been constructed i.e. treatment for existing building.

Prevention of the termite from reaching the super-structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

3.16.1 MATERIALS

Chemicals: Any one of the following chemicals in water emulsion to achieve the percentage concentration specified against each chemical shall be used:

a. Chlorphriphos emulsifiable concentrate of 20%
b. Lindalemulsifiable concentrate of 20%

Anti-termite treatment chemical is available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, Chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration. For example, to dilute chemical of 20% concentration, 19 parts of water shall be added to one part of chemical for achieving 1% concentration.

Engineer-in-Charge shall procure the chemical of required concentration in sealed original containers directly from the reputed and authorized dealers, chemical shall be kept in the custody of the Engineer- in-Charge or his authorized representatives and issued for use to meet the day's requirements. Empty containers after washing and concentrated chemical left unused at the end of the day's work shall be returned to the Engineer-in-Charge or his authorized representative.

3.16.2 SAFETY PRECAUTIONS

Chemical used for anti-termite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

Persons using these chemical shall be warned that absorption though skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contact with concentrates and prolonged exposure to dilute emulsion shall also be avoided. After handling the concentrates or dilute emulsion. Workers shall wash themselves with soap and water and wear clean clothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs which serve as source of drinking water.

3.17 ANTI-TERMITE TREATMENT - CONSTRUCTIONAL MEASURES

The construction measures specified below should be adopted for protection against subterranean termites originating both internally from within the plinth and externally from the area surrounding the building.

Earth free from roots, dead leaves, or other organic matter shall be placed and compacted in successive horizontal layers of loose material not more than 200 mm thick. Dry brick shall be inserted at last 50 mm in brick masonry for providing apron floor around the periphery.

3.18 TREATMENT FOR EXISTING BUILDING (Post Construction Treatment)

3.18.1 CHEMICALS

Any one of the following chemicals conforming to international Standards in water emulsion may be used for soil treatment in order to protect a building from termite attack.

Chemical with Percent (Active ingredient)	Concentration by weight
Chlorpyrfos20EC	1.0
Lindane20EC	1.0

These chemicals are available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, chemicals should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemicals with water in the required proportion to achieve the desired percentage of concentration. For example, to dilute chemical of 20% concentration, 19 parts of water shall be added to one part of chemical for achieving 1% concentration. Oil or kerosene based solution of chlorpyrifos 20 EC or Lindane 20 EC, 1.0 percent (by weight) concentration is useful for treatment of wood. Engineer-in-charge shall procure the chemical of required concentration in sealed original containers directly from the reputed and authorized representative. Chemical shall be kept in the custody of the Engineer-in-charge or his authorized representatives and issued for use to meet the day's requirements. Empty containers after washing and concentrated chemical left unused at the end of the day's work shall be returned to the Engineer-in-charge or his authorized representative.

3.18.2 SAFETY PRECAUTIONS

The containers having emulsifiable concentrates shall be clearly labelled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons carrying out chemical

soil treatments should familiarize themselves and exercise due care when handling the chemicals whether in concentrated or in diluted form. After handling the concentrates or dilute emulsion, worker shall wash themselves with soap and water and wear clean clothing especially before eating and smoking. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

The use of chemical shall be avoided where there is any risk of wells or other water supplies becoming contaminated.

3.18.3 TREATMENT

Once the termites have an ingress into the building, they keep on multiplying and destroy the wooden and cellulosic materials, and as such it becomes essential to take measures for protection against termites. Anti-termite measures described below are necessary for the eradication and control of termites in existing building. To facilitate proper penetrations of chemical in to the surface to be treated, hand operated pressure pump shall be used. To have proper check for uniform penetration of chemical, graduated containers shall be used. Proper check should be kept so that the specified quantity of chemical is used for the required area during the operation. Chemical treatment for the eradication and control of sub-terranean termites in existing building shall be done. Treatment shall be got done only from the approved specialized agencies using the chemical procured directly by the Engineer-in-Charge from reputed and authorized dealers.

i) **Treatment along outside of foundations**

The soil in contact with the external wall of the building shall be treated with chemical emulsion at the rate of 7.5 litres per square metre of vertical surface of the sub-structure to a depth of 300 mm. To facilitate this treatment, a shallow channel shall be excavated along and close to the wall face. The chemical emulsion shall be directed towards the wall at 1.75 litres per running metre of the channel. Rodding with 12 mm. diameter mild steel rods at 150 mm apart shall be done in the channel. If necessary, for uniform dispersal of the chemical to 300 mm depth from the ground level. The balance chemical of 0.5 litre per running metre shall then be used to treat the backfill earth as it is returned to the channel directing the spray towards the wall surface.

If there is a concrete or masonry apron around the building, approximately 12 mm diameter holes shall be drilled as close as possible to the plinth wall about 300 mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to soak the soil below at the rate of 2.25 litres per linear metre. In soils which do not allow percolation of chemicals to desired depth, the uniform disposal of the chemical to a depth of 300 mm shall be obtained by suitably modifying the mode of treatment depending on site condition.

In case of RCC foundations the soil (backfill) in contact with the column sides and plinth beams along with external perimeter of the building shall be treated with chemical emulsion at the rate of 7.5 litres/sq.m. of the vertical surface of the structure. To facilitate this treatment, trenches shall be excavated equal to the width of the shovel exposing the sides of the column and plinth beams upto a depth of 300 mm or upto the bottom of the plinth beams, if this level is less than 300 mm. The chemical emulsion shall be sprayed on the backfill earth as it is returned into the trench directing the spray against the concrete surface of the beam or column as the case may be.

iii) **Treatment of Soil under Floors**

The points where the termites are likely to seek entry through the floor are the cracks at the following locations:

a. At the junction of the floor and walls as result of shrinkage of the concrete;
b. On the floor surface owing to construction defects;

c. At construction joints in a concrete floor, cracks in sections; and
d. Expansion joints in the floor.

Chemical treatment shall be provided in the plinth area of ground floor of the structure, wherever such cracks are noticed by drilling 12 mm holes at the junction of floor and walls along the cracks on the floor and along the construction and expansion joints at the interval of 300 mm to reach the soil below. Chemical emulsion shall be squirted into these holes using a hand operated pressure pump to soak the soil below until refusal or upto a maximum of one litre per hole. The holes shall then be sealed properly with cement mortar 1:2 (1 cement: 2 coarse sand) finished to match the existing floors. The cement mortar applied shall be cured for at least 10 days as per instruction of Engineer-in-charge.

iv) **Treatment of Voids in Masonry**

The movement of termites through the masonry wall may be arrested by drilling holes in masonry wall at plinth level and squirting chemical emulsions into the holes to soak the masonry. The holes shall be drilled at an angle of 45 degree from both sides of the plinth wall at 300 mm intervals and emulsion squirted through these holes to soak the masonry using a hand operated pump. This treatment shall also be extended to internal walls having foundations in the soil. Holes shall also be drilled at wall corners and where door and window frames are embedded in the masonry or floor at ground. Emulsion shall be squirted through the holes till refusal or to a maximum of one litre per hole. Care shall be taken to seal the holes after the treatment.

v) **Treatment at Points of Contact of Wood Work**

The wood work which has already been damaged beyond repairs by termites shall be replaced. The new timber shall be dipped or liberally brushed at least twice with chemical in oil or kerosene. All existing wood work in the building which is in contact with the floor or walls and which is infested by termites, shall be treated by spraying at the points of contacts with the adjoining masonry with the chemical emulsion by drilling 6 mm holes at a downward angle of about 45 degree at junction of wood work and masonry and squirting chemical emulsion into these holes till refusal or to a maximum of half a litre per hole. The treated holes shall then be sealed.

Infested wood work in chowkats, shelves, joints, purlins etc., in contact with the floor or the walls shall be provided with protective treatment by drilling holes of about 3 mm diameter with a downward slant to the core of the wood work on the inconspicuous surface of the frame. These holes should be at least 150 mm centre to centre and should cover in entire frame work. Chemicals shall be liberally infused in these holes. If the wood is not protected by paint or varnish two coats of the chemicals shall be given on all the surfaces and crevices adjoining the masonry.

3.19. EXCAVATION & GRADING OF ROCKS

a. **Excavation Methods For Rock**

The Method relates to rock strength and fracture density.

Direct excavation: possible in fractured lock and In all soils; using face shovel, backhoe, clam shell grab or dragline.

Ripping: needed to break up slightly stronger rock, using tractor-mounted ripper, or breaking with boom-mounted hydraulic pick (pecker).

Blasting: generally required in stronger, less fractured rock. Rock is loosened in the ground by undercharged blasting in some quarries: on urban sites can be broken by hand-held pneumatic drill or by pecker. Massive rock of moderate or high strength needs to be fractured normally by blasting; where blasting is unacceptable, breaking by pecker or hydraulic breaker is very slow. "Annex - A Fig. 2" shows the excavation type and ranges with respect to UCS and Fracture spacing.

ii) Cut Slopes In Rock

Sound rock can be cut to vertical faces; normally raked back by 10° and benched at 10 m intervals to improve safety.

Inclined fractures are main hazard, notably dipping 30-70° Dips> 50° normally required cutting face back to clean bedding or fracture.

Shale beds may weather and undercut slopes in strong sandstone or limestone.

Hillside excavations may undercut unstable weathered rock, old landslides or soliflucted head. Annex - "A" Fig. 1 shows the ranges of stable cutting slopes in rocks and soil.

iii) Cut Slopes In Clay

Drainage changes stability over time where face is cut into clay with initial water table near the surface.

Excavation permits stress relief, pore water pressure (pwp) decreases.

Pwp rises to regain equilibrium (drained state); strength and stability therefore decrease.

Slope ultimately drains (or is artificially drained) to new lower water table; reduced pwp then increases stability.

Premature failure occurs where stability is due to temporary pore water suction; failure may be in minutes or hours so faces are battered back for longer safety. Clay, un-weathered, may cut to 65° slopes to 8 m high where small slips can be tolerated. Stiff glacial till may stand close to vertical for some months at less than critical height, so retaining walls can be built in front. Weep horizons on sand layers cause instability. Lateral stress relief in slopes cut in over-consolidated clay may cause outward movement. Settlement adjacent to stable cut slope may be *1-2%*of excavation depth.

Material	Cohesion	Critical Height, H	
		Un-fissured	Fissured
Soft Clay	25 KPa	5 m	3 m
Firm Clay	50 KPa	10 m	6 m
Stiff Clay	12 KPa	24 m	15 m
Values for typical fissure depth = z = 1.5 c/y			

Excavation and Strength Properties of Rock

Grade	Material/Rock Type and name	U.C.S.(unconfined compressive strength) MPa	Dry Density t/m^3	Field Properties of Rocks	Work Type
I	Coal	2-100	1.4	Crumble under blows break with hammer and hand	Pick work/ Jumper work
	Gypsum	20-30	2.2	Dent by finger nail white in color	Jumper Work.
	Salt	5-20	2.1	Show cubical cleavage ductile deformation in stress	Jumper Work.
	Clay (Cretaceous)	1-4	1.8	Mold by finger, break by hammer if compacted.	Pick work.
II	Musdtone (Carboniferous)	10-50	2.3	Break by hammer crumble under pick blows. Break by hand.	Pick work/ Jumper work
	Shale (Carboniferous)	05-30	2.3		Pick work/ Jumper work
	Chalk (Carboniferous)	05-30	1.8		Jumper Work.
III	Limestone (carboniferous)	50-150	2.6	Moderately strong rock, break by hammer lime stone.	Jumper work / Blasting work.
	Dolomite	50-150	2.5		
IV	Gneiss	50-200	2.7	Strong break by hammer	Jumper work / Blasting work
	Marble	60-200	2.6	Moderately strong rock, break by hammer.	
	Schist	20-100	2.7		
	Slate	20-250	2.7	Ripping needs to break.	
V	Sandstone (Greywacke)	100-200	2.6	Blasting generally required.	Blasting work/ Chiseling
	Conglomerate	variable	variable	Ripping & blasting required if cemented conglomerate.	Jumper work / Blasting work.
	Weathered sandstone	5-40	1.9		
VI	Granite	50-350	2.7	Blasting, Chiseling and ripping required to break, very strong rocks. Mostly rocks are igneous and metamorphic.	Blasting work/ chiseling
	Basalt	100-350	2.9		
	Quartzite	100-350	2.7		Blasting Work.

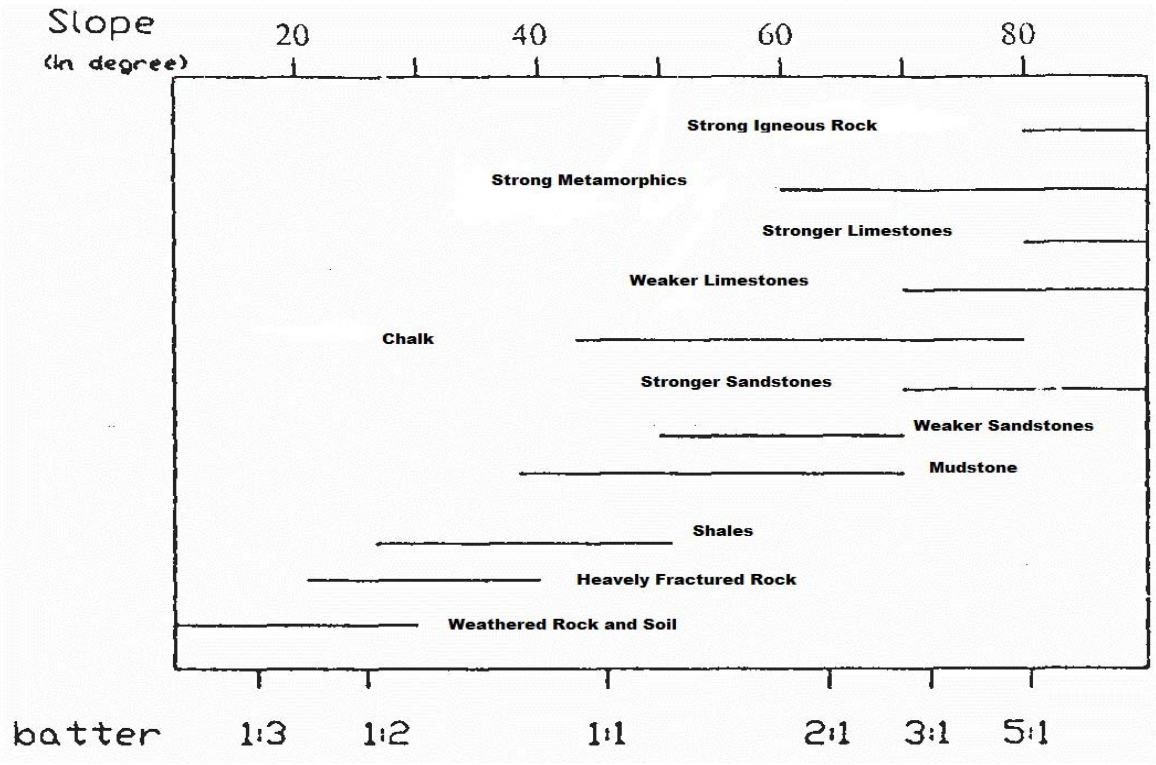

Fig 1:
Parameters for Stable Cutting Slopes in rocks and Soils

3.20 MEASUREMENT AND PAYMENT

3.20.1 LABOUR RATE

The measurement and payment for the items of the work of Earthwork hereof shall be made corresponding to applicable CSR item as provided in Contract Agreement and shall constitute full compensation for procurement transportation, performance in all respects and completion of work as specified including site clearance, as approved by the Engineer-in-Charge except the cost of materials to be provided by Department at designated location as defined in the Contract Agreement.

3.20.2 QUANTIFICATION

The unit of measurement shall be measured as mentioned below in accordance with corresponding CSR items.

1. For Volumetric items, the unit of measurement shall be cubic meter or cubic foot. Following items of CSR shall be measured according to this criteria;

Item No.: 3-1 to 3-18, 3-21 to 3-28, 3-30, 3-33, 3-37 to 3-42, 3-45 to 3-46 and 3-56 to 3-57

2. For surface area items, the quantity of work shall be measured by superficial area. Following items of CSR are measured according to this criteria;
   Item No.: 3-20, 3-32, 3-35, 3-43 to 3-44 and 3-49 to 3-55.
3. For linear items, the quantity of work shall be measured linearly along centre line of structure. The unit of measurement shall be running meter or running foot. Following items of CSR are measured according to this criteria;
   Item No.: 3.19, 3-29, 3-31, 3-34 and 3-36
4. The following items shall be measured as Each;
   Item No.: 3-47 and 3-48
5. The following item shall be measured Per Hecter or Per Acre;
   Item No.: 3-51
6. The following item shall be measured per Kilogram or Pound;
   Item No.: 3-58

3.21 GLOSSARY

Burjis:
Short pillars of brick/ stone having top surface finished with cement plaster for marking etc.

Formation or Profile:
Final shape of the ground after excavation or filling up.

Lead:
All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Route other than shortest practical route may be considered in cases of unavoidable circumstances and approved by Engineer-in-charge along with reasons in writing.

Lead distance:
It shall mean the shortest possible horizontal route between the center of gravity of the material excavated and centre of gravity of the material finally placed

Lift:
The vertical distance for removal with reference to the ground level.

Safety Rules:
Safety rules as laid down by the statutory authority shall be followed.