

**S.12: ADDITIONAL SPECIFICATION FOR EARTHWORK
IN METRO RAILWAY FORMATION****12.1 General:**

Earthwork for Metro Railway Formation (Embankment and Cutting) shall be as per RDSO's Comprehensive Guidelines and Specifications for Railway Formation, Specification No. RDSO/2020/GE: IRS-0004 (September 2020) and latest Guidelines for Earthwork in Railway Projects with latest correction slips, as applicable for suitability of soil, construction processes, sampling, testing and acceptance. This has been summarized hereunder for general guidelines and for details, aforesaid Guidelines may be referred to.

12.2 Site Clearance:

Before work is started, the site shall be properly and effectively cleared by the contractor of all small trees (of girth upto 30 cm), roots, bushes, heavy grass etc. The Contractor shall arrange removal of rubbish and other excavated material excluding earth from the periphery of the area under site clearance. High portions of the ground shall be cut down and hollow depressions filled upto the required level with the excavated earth so as to give an even neat and tidy look. The work of this nature will be covered by the initial rate for earth work, unless stated to the contrary in the agreement.

Trees of girth over 30 cm, measured at a height of 1m above ground level, shall be considered as large trees. Cutting down of large trees shall be paid extra at the rate specified when stumps are grubbed up in addition. Large trees shall not be cut without specific orders from the Engineer. As few trees shall be cut as is absolutely necessary for the execution of work. 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 subgrade 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, pipelines, cable, etc. adjacent to the area which are not required to be disturbed during site clearance shall be properly protected by the contractor at his own cost and nothing extra shall be payable. In case any damage to the pipelines, cables, etc. is done due to negligence on part of the contractor the necessary damage charges will be recovered accordingly.

Any trees cut down or building materials released from dismantling of structures shall be stacked by the contractor within a distance of 500 metres outside the periphery of the area under site clearance as per instructions of the Engineer. The contractor shall have no claim to the trees or other material removed during site clearance and the same shall be the property of the Client.

12.3 Demarcation and Profiles:

Centreline of the alignment with a (@ 20 m c/c or so) and full construction width should be demarcated with reference pegs/dug belling. This is to be considered as part of the setting out of work, and preliminary to contractor being allowed to start the work. The cost of this is included in the initial rate for earthwork.

The contractor before starting any work, shall take charge of all benchmarks, centre line, demarcation and other field stones and reference pegs and be responsible for their subsequent preservation, and should they disappear or be destroyed after he has taken them over, he shall pay the cost of their replacement or replace them at his own level in consultation with the department.

12.4 Measurements:

Cutting and banks are to be excavated and made up neatly to the lines shown in the cross section as per approved construction drawing. No payment will be made for excess work done outside these lines except when such work is so ordered in writing by the Engineer. However, if any bulges are left in the slopes of cuttings due to practical difficulties and are permitted, deduction as per actual measurements

will be made. Similar action will be taken in case of concave surfaces in the slopes of embankments, if permitted.

Should the Engineer so desire, he may, at any stage of the work, order the Contractor to increase or reduce the slopes of any cutting or bank or alter the formation level, in which case the amount of work actually done will be paid for in accordance with the specifications and the BOQ.

In computing the quantity of earth work in cuttings and side drains, no cognizance will be taken of the additional excavation, which may be necessitated during the progress of the work due to the presence of boulders or other material, and payment will only be made for the quantity as per cross sections required to be provided.

12.5 **Payment:**

It must be clearly understood that the Contract rates are intended to cover the full cost of finished work. Banks and cuttings are to be carefully dressed to formation with such slopes as may be specified in each case. The payment for the quantity of earth work in cutting / bank shall normally be made on cross sectional measurements. The existing ground / bank profile shall be taken and plotted by the Authorised representative of the Engineer in the presence of contractor or his authorized agent before commencement of the work. The profile of the bank or the cutting required to be provided including allowance of settlement in case of embankment, shall also be plotted on the same sheets. The levels and cross sections shall be signed by both the Authorised representative of the Engineer and the contractor / his authorized agent. (The profiles of the bank or cutting as required to be provided are for the guidance of the contractor and not for the purpose of measurements).

The profiles of the finished and plotted bank/ cutting shall like-wise be taken in the presence of the contractor or his authorised agent and super-imposed on the original ground profile. These profiles are to be taken at locations as directed by the Engineer, at least at 15m intervals on straight and at least at every 10m on Curves with radii sharper than 600m and at extra locations in special cases such as irregular or side long ground etc.. The gross volume of earth work shall be calculated from the original and finished profile of the bank/ cutting.

12.6 **Suitability of Sub-Soil:**

Field tests are required to be conducted on sub-soil strata, i.e. Plate load test for determination of Elastic Modulus in second cycle of loading(Ev2), Standard Penetration test to determine N-value, and Unconfined Compression Test or Vane Shear Test to determine unconfined compressive strength or undrained cohesion, cu. If any of these parameters, as specified in following para do not meet with specified requirement then ground improvement or removal/replacement of weak sub-soil needs to be undertaken.

Sub-Soil needs to conform to the following specification:

- (i) Ev2 value (PLT) \geq 20MPa, or
- (ii) Undrained cohesion of soil (C_u) \geq 25 kPa, only for soils having particles finer than 75 microns exceeding 12%, or
- (iii) N-value (SPT) < 5 ,

12.7 **Earth Work in Embankments:**

- i) **Formation Width:** The formation widths are to be as shown in the drawings.
- ii) **Side Slopes:** The side slopes will ordinarily be 2:1 or as specified in the drawing. The side slopes shall be carried up simultaneously with the rest of the work and not filled in afterwards. This can only be ensured by insisting on the whole width of embankment from the toes of the slope coming up simultaneously.

- iii) **Dressing of earthwork:** After completion of earth work the slopes shall be neatly dressed to the correct profiles, and shall be made up where required during the maintenance period. The top should be neatly dressed off sloping at an inclination of 1 in 30 either side from the centre line unless otherwise specified in the drawings.
- iv) **Selection of Earth:** The disturbed / undisturbed soil samples along with the test results as per specifications will be submitted by the contractor for approval of the source from where the earth is proposed to be borrowed before the Earth work in embankment is started or in case of change in location of the source.
- v) **Specification of Subgrade:** The specifications prepared subgrade, subgrade should conform to the Soil Quality Class SQ1/SQ2/SQ3 as specified in the RDSO's Comprehensive Guidelines and Specifications for Railway Formation (RDSO/2020/GE: IRS-0004, September- 2020) and Latest Guidelines.

12.8 Blanketing:

The specification and work of blanketing material should conform to the specifications provided in RDSO's Comprehensive Guidelines and Specifications for Railway Formation (RDSO/2020/GE: IRS-0004, September- 2020) and Latest Guidelines. Normally, the blanket material shall be produced mechanically by crushing the stones and/or by mixing, naturally available materials using suitable equipment/plants like pugmill, wet mix plant, crusher etc. as specified in the Appendix-A of RDSO's Comprehensive Guidelines and Specifications for Railway Formation (RDSO/2020/GE: IRS-0004, September- 2020) and Latest Guidelines. No extra payment shall be made in case of mechanical production of blanket material. However, if naturally available material conforms to the specifications, the same can also be used.

The parent material of the blanket material so chosen should be chemically inactive and sturdy in normal working environment. Brickbats, factory slag, weak dissolvable stones like lime, shale, laterite etc. need not be selected as blanket material.

The contractor should submit for approval by the Engineer samples of the Blanketing material. The material to be used by the contractor for blanketing should strictly adhere to the quality of material as approved by the Engineer.

12.9 Mechanical Compaction:

- i) The spreading of material in layers of 200 to 300 mm thickness over the entire width of embankment should be done by mechanical means and finished by a motor grader. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the slope and grade.
- ii) Compaction to specified levels of RD or percentage of MDD shall be carried out through a number of passes of vibratory rollers of 100-120 kN static weight or of equivalent capacity as approved by the Engineer. A combination of vibrating rolling initially, and static finishing rolling may be established through trials. Speed of roller shall not exceed 5 km/hr. However, the Contractor should get the Engineer's approval for the type of equipment to be deployed for compaction.
- iii) Density of soil will increase with the number of passes of roller but after optimum number of passes, further increase in density is insignificant for additional number of passes. For determination of optimum number of passes for given type or roller and optimum thickness of layer at a predetermined moisture content, a field trial for compaction is necessary which will be arranged by the Engineer for which the Contractor shall make all arrangements and bear the cost of test / tests as required.
- iv) If natural moisture content (NMC) of the soil is less than the OMC, calculated amount of water based on the difference between OMC and NMC and quantity of earthwork being done at a time,

- should be added with sprinkler attached to water tanker and mixed with soil by motor grader or by other means for obtaining uniform moisture content. When soil is too wet, it is required to be dried by aeration to reduce moisture content near to OMC. Efforts should be made to keep moisture content level of the soil in the range of OMC + 2% at the time of compaction.
- v) Fill shall be placed and compacted in layers of specified thickness. The rate of progress should be, as far as possible, uniform so that the work is completed to final level almost at the same time.
 - vi) The rolling for compaction of fill material should commence from edges towards center with minimum overlap of 200mm between each run of the roller. In final pass, roller should simply move over the surface without vibration so that top surface is properly finished.
 - vii) Extra bank width of 500mm on either side shall be rolled to ensure proper compaction at the edges. The extra soil would be cut and dressed to avoid any loose earth at the slopes. This should preferably be done with help of grade cutter. The earth so cut in final stages will not be paid but can be used at other places by the contractor.
 - viii) At the end of the working day, fill material should not be left uncompacted. Care should be taken during rolling to provide suitable slope on toe of the bank to facilitate quick shedding of water and avoid ponding on formation.
 - ix) Top of the formation should be finished to cross slope of 1 in 30 from one end to other towards cess / drain in multiple lines and from center of formation to both sides in single line or as indicated in the drawing.

12.10 Quality Control of Earthwork

Quality of execution of formation earthwork shall be controlled through exercise of checks on the fill material, blanket material, compaction process, drainage system, longitudinal & cross-sectional profiles of the finished embankment. The details of quality control procedure are as follows:

- 12.10.1 Suitability tests at source of Embankment fill/prepared subgrade/Blanket Material:** Fill/Blanket material proposed to be used would have to be assessed for its suitability, as stipulated in this specification, after conducting soil classification and other relevant tests as per site requirement. Once the material has been found fit for use as fill material for Embankment, further lab tests, to assess OMC, MDD/ Relative Density, need to be conducted. The type and frequency of tests to be conducted will be as per table 7.2 of RDSO's Comprehensive Guidelines and Specifications for Railway Formation (RDSO/2020/GE: IRS-0004, September- 2020) and Latest Guidelines.

12.10.2 Quality Control Checks on Finished Earthwork

- 12.10.2.1 Compacted Earth:** Degree of compaction of each layer of compacted soil/blanket should be ascertained by measurement of dry density/Relative Density of soil at locations selected in specified pattern. The method of sampling and method of tests to be conducted to be adopted are as stipulated in the RDSO's Comprehensive Guidelines and Specifications for Railway Formation (RDSO/2020/GE: IRS-0004, September- 2020) and Latest Guidelines unless otherwise approved by the engineer.

- a) **Frequency of Tests:** Density check would be done for every layer of compacted fill/blanket material as per following minimum frequency:
 - i. At least one density check for every 30 m length for blanket layers and top one metre of prepared subgrade/subgrade along the alignment in a staggered pattern of each compacted layer.
 - ii. At least one density check for layers other than as specified in (i) above, every 500 m² or 75 m c/c whichever occurs earlier along the alignment in a staggered pattern of each compacted layer.

12.10.2.2 Acceptance Criteria

- i) The blanket material, which contains fines passing 75 micron IS Sieve, upto 5 percent should have the Density Index (Relative Density) a minimum of 70% as obtained in accordance with IS: 2720 (Part 14)) – 1983(Reaffirmed 2015).
- ii) For other materials, field dry density should not be less than maximum attainable dry density obtained in field compaction trial. However, in field compaction trial, the maximum attainable dry density should not be less than 98% of MDD values as obtained by Heavy Compaction Test (IS: 2720 (part 8) – 1983) in the laboratory. In case, there are difficulties in achieving 98% of the MDD values as obtained by Laboratory test, in the field trials, the same may be relaxed upto 95% of MDD with the specific approval of Engineer, recording reasons of such relaxation.

12.10.2.3 Deformation Modulus (Ev2) measurement: It is a parameter expressing the deformation characteristics of a soil. It is calculated taking values from the load settlement curve obtained from the second cycle of loading in the Plate Load Test. It is to be determined in the field on top of each formation layer i.e. at top of compacted Blanket layer/Prepared sub-grade/Subgrade- Top & Lower layer.

12.11 Formation Level: Finished top of sub-grade level may have variation from design level by + 25 mm and finished top of blanket layer may also be permitted to have variation from design level by plus 25mm.

12.12 Cross Slope: Cross slope should be within 1 in 28 to 1 in 30.

12.13 Side Slopes: Side slope should be 2H: 1V or flatter as per design.

12.14 Formation Width: Formation width should not be less than the specified width.

12.15 Quality Control Records: At least, following records of quality control as per proforma approved by the Engineer-In-Charge needs to be maintained.

- a) Characteristics of fill/sub-grade materials.
- b) Quality of blanket materials.
- c) Field compaction trial computation sheet details.
- d) Quality of compaction of earthwork including blanket material.
- e) Quality of material and its compaction for backfill behind bridge.
- f) Details of machineries engaged in execution of earth work including its output.