

Part - II
Technical specification

Section - T1
Technical specification for excavation and filling

1. Scope

- 1.1 This section of the specification covers the technical requirements for excavation and filling for industrial plots in & around structures, buildings, pipes, foundations, trenches, pits, drains, channels, cable ducts, underground facilities & similar works. It also covers filling areas and plinths with selected materials, conveyance and disposal of surplus soils and/or stacking them properly as directed by the Engineer.
- 1.2 The contractor shall be fully responsible for getting necessary permission from government authorities to excavate soil from the sources mentioned in the tender and should pay necessary charges to government authorities as per rules.
- 1.3 The Contractor shall be fully responsible for proper setting out of works, profiling in excavation, stacking, etc., taking adequate safety measures etc. The Contractor shall carry out all works meant within the intent of this specification even if not explicitly mentioned herein. All work shall be executed to the satisfaction of the Engineer.
- 1.4 Existing trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, drains, sewers, or other surface or subsurface systems / drains / facilities within or adjacent to the works being carried out which are not to be disturbed, shall be protected from damage by the Contractor shall provide and install suitable safeguards approved by the Engineer for this purpose.
- 1.5 During excavation, the Contractor shall take all necessary precautions against soil erosion, water & environmental pollution and where required to undertake additional works to achieve this objective. Before start of operations, the Contractor shall submit to the Engineer for approval, his work plan and the procedure he intends to follow for disposal of waste materials etc. and the schedule for carrying out temporary and permanent control works. However, the approval of the Engineer to such plans and procedures shall not absolve the Contractor of his responsibility for safe and sound work.

2. General requirements

- 2.1 The Contractor shall make his own surveying arrangements for locating the coordinates and positions of all work and establishing the reduced levels (RL's) at these locations based on two

reference grid lines and one bench mark which will be furnished by the Owner. The Contractor has to provide at site all the required survey instruments, along with qualified surveyors, to the satisfaction of the Engineer so that the work can be carried out accurately and according to the specification and drawings.

- 2.2 The Contractor shall furnish all skilled and unskilled labour, plant, tools, tackle, equipment, men, materials required for complete execution of the work in accordance with the drawings and as described herein and/or as directed by the Engineer.
- 2.3 The Contractor shall control the grade in the vicinity of all excavations so that the surface of the ground will be properly sloped or dyed to prevent surface water from running into the excavated areas during construction.
- 2.4 All materials obtained from excavation shall remain owner's property. All salvaged materials of archaeological importance or of value (in the opinion of the Engineer) shall be segregated from the other materials and both stacked separately and in regular manner at locations indicated by the Engineer.
- 2.5 Excavation shall include removal of trees including roots & organic remains, vegetation, grass, bushes, shrubs, plants, poles, fences, etc. that are in the area to be excavated as well as beyond the excavation line so as to ensure safety of the excavated side slopes, and of men and equipment operating in the area. Before start of excavation work, joint measurements of ground level shall be taken after cleaning all grass, vegetation, etc.
- 2.6 Excavation shall include the removal of all materials required to execute the work properly and shall be made with sufficient clearance as decided by the Engineer to permit the placing and setting of forms, inspection and completion of all works to the satisfaction of the Engineer for which the excavation was done.
- 2.7 Wherever reference is made to 'drawings' in this specification it shall mean the latest issue of the approved drawings.

3. Codes and standards

- 3.1 All standards, specifications, acts, and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

3.2 In case of conflict between this specification and those (IS standards, codes etc.) referred to herein (in para 3.3) the former shall prevail.

3.3 Some of the relevant Indian standards, Acts and Codes are referred to here below:

IS:383	Specification for coarse and fine aggregates from natural sources for concrete
IS:2720 (Part-II, IV to VIII, XIV, XXI, XXIII, XXIV, XXVII to XXIX, XL)	Methods of tests for soils - determination of water content etc.
IS: 3764:	Safety code for excavation work
IS: 4081:	Safety code for blasting and related drilling operations
IS:4701:	Code of Practice for earth work on canals
IS:9759:	Guide lines for Dewatering during construction.
IS: 10379:	Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.
IS: 3812	Pulverized fuel ash – specification part 2 for use as admixture in cement mortar and concrete

4. Excavation

4.1 Excavation in all types of soils, soft and disintegrated rock (ordinary rock), and hard rock shall be done up to the required level. Excavation shall also include breaking of existing concrete RCC, Masonry work, tar and bitumen surfaces, and paving works etc. In case blasting is required the same shall be subject to the approval of Engineer. Sides and bottoms of excavation shall be cut sharp and true to line and level. Undercutting shall not be permitted. When machines are used for excavation, the last 300 mm before reaching the required level shall be excavated manually or by such equipment that soil at the required final level will be left in its natural condition. Suitability of strata (at the bottom of excavations) for laying the foundation thereon shall be determined by the Engineer.

- 4.2 Excavation for foundations shall be to the bottom of lean concrete and as shown on drawings or as directed by the Engineer. The bottom of all excavations shall be trimmed to required levels and when excavation is carried below such levels, by error, it shall be brought back to specified level by filling with concrete of nominal mix 1:3:6/1:4:8 (cement & Fly ash (20% replacement ratio of cement with fly ash): coarse sand : 20mm down aggregates) as directed by the Engineer.
- 4.3 The Contractor shall ascertain for himself the nature of materials to be excavated and the difficulties, if any, likely to be encountered in executing this work. Cofferdams, Sheet piling, shoring, bracing, maintaining suitable slopes, draining etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.
- 4.4 All excavation for installation of underground facilities, such as piping, sewer lines, drain lines, etc. shall be open cuts. For deep and huge excavations and in other excavations, if required by the Engineer, the Contractor shall submit for Engineer's approval (as already mentioned under Clause 1.5) an "Excavation scheme" showing the methodology to be adopted for excavation in order to maintain the stability of side slopes, means for ensuring safety of existing facilities nearby, dewatering as required etc. However, the Contractor shall be fully responsible for the scheme irrespective of any approvals granted. Benching shall be provided for deeper excavation wherever required.
- 4.5 When excavation requires bracing, sheet piling or shoring etc., the Contractor shall submit drawings to the Engineer, showing arrangements and details of proposed installation. The Contractor shall also furnish all supporting calculations as called for and shall not proceed until he has received written approval from the Engineer. However, the responsibility for adequacy of such bracing, sheet piling, shoring etc. will rest with the Contractor, irrespective of any approval of the Engineer. All precautions shall be taken while excavations near existing structures are to be carried out till the backfilling is completed.
- 4.6 The Contractor shall have to constantly pump out any water collected in excavated pits and other areas due to rain water, ground water, springs etc. and maintain dry working conditions at all times until the excavation, placement of reinforcement, sheet piling, concreting, backfilling is completed. The Contractor shall remove all slush/muck from the excavated areas to keep the work area dry. Sludge pumps, if required, shall be employed by the Contractor for this purpose.
- 4.7 The Contractor shall remove all materials arising from excavations from the vicinity of the work either for direct filling, stacking and subsequent filling or for ultimate disposal as directed by the Engineer. In no case shall the excavated soil be stacked within a distance of 1.5m from the

edge of excavation or one third the depth of excavation whichever is more. Material to be used for filling shall be kept separately as directed by the Engineer.

5. Filling

5.1 Materials

- a) Materials to be used for filling purposes shall be stone, sand or other inorganic materials and they shall be clean and free from shingle, salts, organic, large

roots and excessive amount of sod. Lumps concrete or any other foreign substances which could harm or impair the strength of the substructure in any manner. All clods shall be suitably broken to small pieces. When the material is mostly rock boulders, these shall be broken into pieces not larger than 150mm size. Sand used for filling shall be clean, medium grained and free from impurities. Fines less than 5 microns shall not be more than 20%. In any case, the materials to be used for filling purposes shall have the prior written approval of the Engineer.

- b) If excavated materials are to be used for filling, then the Contractor shall select the materials from the stockpile, load and transport this material and execute the filling. This shall include excavation of earth which may become hard due to laying in stack yard for a long period of time.

- c) In case the materials have to be brought from pits/quarries, then it shall be the Contractor's responsibility for identification of such quarry areas, obtaining approval for their use from concerned authorities, excavation/quarrying, loading and carriage of such material, unloading and filling at specified locations. The Contractor shall pay any fees, royalties etc. that may have to be paid for utilization of borrow areas.

5.2 Filling procedure

- a) After completion of foundation, footings, walls and other construction below the elevation of the final grades, and prior to filling, all temporary shoring, timber, etc. shall be sequentially removed and the excavation cleaned of all trash, debris and perishable materials. Filling shall begin only with the written approval of the Engineer. Also, areas identified for filling shall be cleared of all soft pockets, vegetation, bushes, slush etc. In case of plinth and similar filling the ground shall be dressed and consolidated by ramming and light rolling.

- b) Fill materials shall not be dropped directly upon or against any structure or facility where there is danger of displacement or damage. Filling shall be started after the concrete/masonry has fully set and shall be carried out in such manner so as not to cause any undue lateral thrust on any part of the structure.
- c) All space between foundation (concrete or masonry) and the sides of excavation shall be filled to the original surface after making allowance for settlement. Fill shall be placed in horizontal layers not exceeding 200mm loose thickness. Each layer shall be watered and compacted with proper moisture content and with such equipment as may be required to obtain a compaction/density as specified. Trucks or heavy equipment for depositing or compacting fill shall not be used within 1.5 metres of building walls, piers or other facilities which may be damaged by their weight or operations. The methods of compaction shall be subject to the approval of the Engineer. Pushing of earth for filling shall not be adopted under any circumstances.
- d) Fill adjacent to pipes shall be free of stones, concrete, etc. and shall be hand placed and compacted uniformly on both sides of the pipe and where practicable upto a minimum depth of 300mm over the top of pipes. While tamping around the pipes, care should be taken to avoid unequal pressure.
- e) Filling shall be accurately finished to line, slope, cross section and grade as shown on the drawings. Finished surface shall be free of irregularities and depressions and shall be within 20mm of the specified level.
- f) Where filling with stone from excavated materials is required, as per design and functional requirements, it shall be from broken pieces of boulders. At first a 75mm thick cushion of selected earth shall be laid over which the 200mm thick graded stones shall be laid in loose layers of 200mm and then the interstices filled with properly graded fine materials consisting of selected earth brought from borrow areas. Each layer shall be watered and compacted to the required density as per design and functional requirements before the next layer is laid. However, no cushion shall be required where filling is over non-rocky surface.
- g) Where clean stone fill is required as per design and functional requirements it shall consist of clean selected stone metal of 40mm nominal size. It shall be

laid in layers not exceeding 150mm (loose) and lightly tamped before the next layer is laid. No compaction shall be required for this type of stone filling.

5.3 Compaction

- a) Where compaction of 90% Standard Proctor Density is called for, such compaction shall be by mechanical means but the contractor may be permitted to adopt manual means only if the Engineer finds that the desired compaction is achievable in the field.
- b) Where compaction to 95% Standard Proctor Density is called for, it shall be by mechanical means only. Where access is possible, compaction shall be 12 tonne rollers smooth wheeled, sheep foot or wobbly wheeled and directed by the Engineer. A smaller weight roller may be permitted by the Engineer in special cases, but in any case not less than 10 passes of the roller will be accepted for each layer. Each layer shall be wetted or the material dried by aeration to a moisture content of 3-5% above the Optimum Moisture Content to be determined by Contractor. Each layer shall be watered, rammed and compacted to the density as specified in the Schedule of Quantities.
- c) For compacting each sand layer, water shall be sprayed over it to flood it and it shall be kept flooded for 24 hours to ensure maximum compaction. Vibrocompactors shall also be used if necessary to obtain the required degree of compaction. Any temporary works required to contain sand under flooded condition shall also be undertaken. The surface of the consolidated sand shall be dressed to required levels or slope.
- d) After the compacted fill has reached the desired level, the surface shall be flooded with water for 24 hours, allowed to dry and then rammed and consolidated to avoid any settlement, at a later date. The compacted surface shall be properly shaped, trimmed and consolidated to an even gradient or level. All soft spots shall be excavated, filled and consolidated.
- e) The degree of compaction of compacted fill in place will be subject to tests in accordance with relevant Indian Standards as desired by the Engineer. As the work progress, the Contractor shall provide the necessary facilities to make such tests. If any test indicates that the compaction achieved is less than the required as per design and functional requirements degree of compaction, the Engineer may require all fill placed subsequent to the last successfully test to be removed and re-compacted by the Contractor. Compaction procedure shall be amended as necessary to obtain satisfactory results.
- f) When semi-compacted fill is required as per design and functional requirements by the Engineer, the Contractor shall fill up such areas with available earth from stock piles or

borrow pits or directly from excavation without special compaction except that obtained by moving trucks, etc.

6. Sampling testing and quality control

6.1 General

- a) The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and/or International Standards and shall conduct such tests as are called for by the Engineer. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Engineer. Tests shall be done in the field and at a laboratory approved by the Engineer and the Contractor shall submit to the Engineer, the test results in triplicate within three days after completion of a test. The Engineer may, at his discretion, waive some of the stipulations given below, for small and unimportant operations.
- b) Work found unsuitable for acceptance shall be removed and replaced by the Contractor. The work shall be redone as per specification requirement and to the satisfaction of the Engineer.
- c) Only as a very special case and that too in non-critical areas, the Engineer may accept filling work which is marginally unacceptable as per the criteria laid down. For such accepted work, payment shall be made at a reduced rate prorated to the compaction obtained against that stipulated.

6.2 Quality assurance programme

The Contractor shall submit and finalize a detailed field Quality Assurance Programme within 30 days from the date of award of the Contract according to the requirements of the specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of format for record, Field Quality Plan, etc. On finalized field quality plan, the owner shall identify customer hold points beyond which work shall not proceed without written approval from the Engineer.

6.3 Frequency of sampling and testing including the methods for conducting the tests are given in **Table No.1**. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to carry out or call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications.

6.4 Acceptance criteria

Following acceptance criteria shall be followed.

- a) All individual samples collected and tested should pass without any deviation when only one set of sample is tested.
- b) For re-test of any sample two additional samples shall be collected and tested, and both should pass without any deviation.
- c) Where a large number of samples are tested for a particular test than 9 samples out of every 10 consecutive samples tested shall meet the specification requirement.
- d) Tolerance on finished levels for important filling areas at approved intervals shall be + 20 mm. However, for an unimportant area, tolerance up to + 57 mm shall be acceptable at the discretion of the Engineer. However, these tolerances shall be applicable for localized areas only.

Table No. 1: Frequency of sampling and testing

Sl. No.	Nature of test/ characteristics	Methods of test	No. of samples & frequency of test	Remarks
I.	Suitability of fill materials			
	(a) Grain size analysis	IS:2720 (Part-IV)	One in every 2000 Cum. for each type and each source of fill material subject to a minimum of	Test for sand
	(b) Liquid limit and plastic limit	IS:2720 (Part-V)	two samples	Test for soil
	(c) Shrinkage limit	IS:2720 (Part-VI)	One in every 5000 cum. for each type	The frequency of Test shall be
	(d) Free swell index	IS:2720 (Part-XL)	and each source of fill materials.	increased depending on type of soil
	(e) Chemical Analysis	IS:2720		
	i. Organic matter	Part XXII	One in every 5000 Cum for each type and each source of	Test for sand and soil.
	ii. Calcium carbonate	Part XXIII	fill materials.	

	iii. pH	Part XXVI		
	iv. Total soluble sulphate	Part XXVII		
II.	Standard proctor test	IS:2720 (Part VII)	One in every 2000 cum. for each type and each source of fill materials	Test for soil for determining optimum moisture content, Dry Density etc.
III.	Moisture content of Fill before compaction.	IS:2720 (Part II)	-do-	Test for soil
IV.	Degree of compaction of fill		(i) For foundation filling, one for every ten foundations for each	Test for soil
	(a) Dry density by core	IS:2720 (Part	Compacted layer.	

Sl. No.	Nature of test/ characteristics	Methods of test	No. of samples & frequency of test	Remarks
	cutter method	XXIX)	However, each layer for location of important and heavily loaded	
	or			
	Dry density in place by sand displacement method	IS:2720 (Part XXVIII)	Foundations resting on fill shall be tested.	
			(ii) For area filling one for every 1000 Sqm area for each compacted layer.	
	(b) Relative density index	IS:2720 (Part XIV)	-do- (i) & (ii)	Test for sand
	(c) Dry density by proctor needle penetration	Standard Practice	Random checks to be carried out for each compacted layer in addition to tests mentioned under IV (a) above.	Test for soil