भारतीय मानक

नदी घाटी परियोजनाओं के निर्माण, प्रचालन और रखरखाव की सुरक्षा संहिता

भाग 8 खुदाई

Indian Standard

SAFETY CODE FOR CONSTRUCTION, OPERATION AND MAINTENANCE OF RIVER VALLEY PROJECTS

PART 8 OPEN EXCAVATION

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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Safety in Construction, Operation and Maintenance of River Valley Projects Sectional Committee had been approved by the River Valley Division Council.

The job of excavation for foundation and seating of structures such as concrete and masonry dams, barrages and power houses, stripping of ground, excavation for cut off trenches for earth and rockfill embankments, excavation for canals and approach and exit channels, etc, forms the first and foremost major activity in the construction of the above-mentioned structures. Normally excavation is carried out (depending on the type of structure and depth of excavation) in different kinds of strata, excavation in soil, excavation in soft rock, excavation in bouldery strata and excavation in hard rock (where necessary). It is essential that the excavated slopes which are to be backfilled later need to be stable during the construction period.

The slopes which are exposed have to be stable during construction periods and also during life of the structure. Where blasting operations are resorted to necessary precautions need to be taken for the safety of the men and machinery as well as for the structure. This standard lays down requirements that should be followed with regard to safety aspects during open excavation work.

The recommendations made in this standard are for general guidance and may need modification depending upon individual site conditions.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*).' The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SAFETY CODE FOR CONSTRUCTION, OPERATION AND MAINTENANCE OF RIVER VALLEY PROJECTS

PART 8 OPEN EXCAVATION

1 SCOPE

1.1 This standard lays down requirements for the safety aspects to be taken during excavation for structures like dams, barrages, power houses, canals, channels and such other structures associated with river valley projects.

2 REFERENCES

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 GENERAL SAFETY REQUIREMENTS

3.1 The matter of safety and accident prevention is the responsibility of every person employed on the job. All persons need to be alert to dangerous conditions and to take necessary precautions for their own safety as well as that of others working at site.

Normally the work is done outdoors. Workmen are exposed to hazardous conditions of heat and cold, rain, wind and movement of heavy machinery. Hence safety measures required to be taken assume greater significance.

3.2 The safety requirement during excavation for any structure may vary according to the type of structure, type of strata encountered and number of men and type of machinery deployed at site.

3.3 Proper education and organization is necessary for safety requirements to be implemented in a proper manner. The workmen are required to be made aware of the importance of observing the safety rules.

3.4 The contractor carrying out the work should employ a safety engineer/manager who should be familiar with all potential hazards on the job and whose duty would be to educate the workmen as well as to supervise installation and maintenance of safety equipment, first aid stations, machinery guards and other safeguards.

3.5 The shape and slopes adopted for excavation should be safe over the entire period of construction of the structure barring unforeseen causes.

3.6 Reference should also be made to IS 10386 (Part 1) : 1983 and IS 10386 (Part 2) : 1982.

4 INVESTIGATION DATA

4.1 Before proceeding with the work of excavation, sufficient knowledge of sub-surface strata is essential.

4.2 The nature, location and depths of various zones of sub-surface like over burden, soft/weathered rock, and hard rock, seams/faults and joint patterns in rock strata, water tables etc, should be available prior to excavation work.

4.3 The physical and engineering properties of the over burden material should also be determined well in advance of the excavation work if the depth of over burden is 10 m and above.

5 DESIGN DATA

5.1 Design details like probable foundation level or bed levels, in case of approach and exit channels, as well as design cross-sections of the structure under construction should be made ready before commencement of the excavation work. Various excavation slopes and benches/berms and consequently top width of the excavation required to commence the work should also be fixed in advance.

6 EXCAVATION SLOPES

6.1 Excavation slopes adopted in the field should be safe against sliding or slip during the entire period of construction so they do not endanger the safety of men and machinery, as also the structure under construction, adjacent to the area of excavation. This is essential as the construction of river valley projects continues over years, during which time many normal and abnormal monsoons and other hazardous field conditions may be encountered.

6.2 For general guidance, the following slopes may be adopted for open excavation work up to 10 m depth.

i)	Soil over burden/ bouldery strata	2 horizontal to 1 vertical to 1 horizonal to 1 vertical.
ii)	Soft/weathered rock	0·5 horizontal to 1 vertical
iii)	Hard rock	0·25 horizontal to 1 vertical

In case the soil overburden depth is 10 m and above slope stability analysis should be carried out.

6.3 Berms or benches of suitable width should be provided from consideration of slope stability, ease of excavation, transportation of excavated material etc, depending on the site conditions and requirements. The berms should normally be at maximum vertical intervals of 10 m and width of berms/bench should generally be about 3 m.

In special cases where the requirement of berm width is impracticable and/or not felt necessary, reduced width may be adopted but in no case should it be less than 1.0 m, provided the material being excavated is sufficiently stable. In all such cases substantial toe boards should be provided to prevent 'roll back' into the excavated trench.

7 TOOLS, PLANT AND MACHINERY

7.1 Care should be taken to keep tools such as shovels, pickaxes, etc, far away from the edge of the trench.

7.2 Heavy machinery deployed during excavation should be kept away from the excavated sides at a distance of not less than 6 m when in the idle condition and also from the road traffic, if any, in the near vicinity [*see also* IS 10386 (Part 3) : 1992].

7.3 The use of trucks or wagons and heavy machinery in and around the excavation trenches should be done under the supervision of experienced foremen or supervisors. Movement of vehicles and machines should not be permitted near the lip of the excavation and hence roads, leading to or from the excavation trenches should be carefully located. Care should be exercised by the foreman or supervisor when guiding vehicles for loading, so that they are not backed into the walls of the pit. When loading vehicles manually, a constant watch should be kept for any bend slides or boulders rolling down the excavated slope.

8 ACCESS AND ESCAPE WAYS

8.1 Pathways should be non-slippery and of adequate width. They should be strong enough to withstand the movement of workers.

8.2 Gangways should be strong and of proper construction. Planks used should be of uniform thickness. Gangways should be kept clear of excavated material or other obstructions.

8.3 Ladders when used should extend for at least one metre above the top of the cut to provide a hand hold for stepping on, or off, the ladder. Ladders should be properly constructed, used, maintained and periodically inspected in accordance with IS 3696 (Part 2) : 1991.

9 LIGHTING, WARNING SINGALS ETC

9.1 Adequate lighting arrangements should be provided in the excavation area for night work.

9.2 All pathways and roadways in the vicinity of the excavation area, should be provided with proper warning signals wherever necessary, to ensure safety of pedestrians and vehicular traffic.

At all approaches and exit points of the site of excavation, danger and warning signals should be placed. In risky locations, a flagman with red flag should be posted to warn the public and approaching vehicles and to guide them in proper directions.

In any bend/crossing of pathways/roadways proper direction of the pathway/roadway should be displayed.

9.3 Whenever a workman is required to climb up or down a excavation slope he should do so with a safety rope tied securely to a safety belt on his person so that in case of an emergency he can be assisted or drawn to safety.

9.4 Lone workers should not be permitted to work in the area of excavation.

10 DRILLING AND BLASTING OPERATIONS

10.1 Whenever drilling and blasting operations are involved in the excavation process, safety precautions as laid down in IS 10386 (Part 4) : 1982 should be strictly followed. During excavation of rock by blasting, safety of adjacent structures is required to be taken care of by adopting controlled blasting, presplitting method, use of delay detonators etc.

10.2 Loose rock masses or fragments thrown up during blasting and resting at different levels on excavated slopes, berms etc, should be removed promptly to avoid the danger of their falling down on workmen working at lower levels.

11 OVERHANGS

11.1 Overhangs in the excavated face are hazardous as these may come down unexpectedly and result in fatal accidents to workmen working at lower levels. Such overhangs should be removed before further work in that area is continued.

11.2 All excavated faces, on which work is going on or work is temporarily suspended, should be

maintained or left at safe slopes, so that danger from caving in or sliding is eliminated.

11.3 Excavated slopes rendered unstable by nearby blasting operations, rain, freezing and thawing action or by operation or movement of machinery should be made safe by breaking them down until a stable slope is achieved. During such trimming of slopes no person should be permitted to work in the area immediately below and no material should be removed from the bottom, until the work of stabilizing the slope is completed.

12 EXCAVATION NEAR ABUTMENTS

12.1 Abutment faces, when excavated for abutting dams, are generally of steeper slopes and of greater height. Care should be exercised to monitor the safety of such slopes until abutment blocks are constructed. Periodic inspection of excavated faces for any sign of instability of the hill slopes should be carried out and any instability taken note of. Immediate remedial measures should be taken to prevent sliding of slopes and hillmass.

13 VISITORS

13.1 Visitors should not generally be permitted to enter the area of excavation unless they are accompanied by a supervisor or foreman. Adequate precautions should be taken to prevent workers and visitors from approaching potentially dangerous areas.

14 POWER LINES

14.1 Live wires and cables are laid in the area of excavation for blasting operations, drilling of holes and other operations involving the use of electric power. Where such cables are laid, care should be taken to see that these cables are not laid in a haphazard manner. Supervisors, foremen and the construction staff should ensure that workmen or visitors are kept away from live wires. Wherever necessary, warning signals should be posted. Cables which are cut or open should be promptly replaced [*see* IS 10386 (Part 5) : 1992].

15 DEWATERING

15.1 During excavation work, adequate arrangements should be provided for dewatering and bailing out water from the excavated area to prevent slippery surfaces and sliding of slopes due to standing water.

15.2 Dewatering (for lowering the water table) in the excavated trench/area should be done in such a way that it does not result in excessive drawdown which may endanger the stability of the excavated slopes.

15.3 Adequate measures should be taken to drain the water from the upper surfaces of excavated slopes or benches. This will prevent saturation of soil which could result in slips of the excavated slopes.

16 DAMAGE TO ADJACENT STRUCTURES

16.1 Due to improper design of blasting charges during excavation in weathered/hard rock, the vibrations caused in the process may endanger the safety of adjacent structures.

16.2 Where danger to the safety of structures adjacent to the area of blasting is expected, delay detonators should be used to reduce the shockwaves. Practices such as line drilling method should be adopted.

17 COMMON HAZARDS IN EXCAVATION

17.1 The officer incharge of excavation work should familiarize himself with the nature of material to be excavated, machinery deployed for the work, blasting operations required to be carried out, and also the factors he has to specially look for and guard against. Some important factors are given below.

a) *Safe Slopes* — Safe slopes to be adopted for different types of subsurface materials.

b) *Water Content or Degree of Saturation* — The side walls of an excavated trench which are stable when dry may become highly unstable due to saturation of earth following heavy rain or water entering the area from other sources. The side walls of the excavated trench may also become unstable due to excessive drawdown during the dewatering operation for lowering the water table.

c) *Freezing and Thawing* — Due to expansion of water when frozen, rock fragments, joints in the rock, boulders etc, are generally loosened. Therefore, side walls of the excavation need to be constantly watched for any signs of opening of the joints/cracks during thawing, which may endanger the stability of excavated slopes.

d) *Vibration from nearby Sources* — Vibration due to movement of machinery, vehicles, railroad, blasting and other sources, may have an effect on slope stability.

e) *Adjacent Loose Fill* — The possibility of encountering pockets of unstable materials requires special investigation, attention and care.

f) *Damages to Adjacent Structure* — Due to heavy blasting operations adopted during excavation work there may be a possiblity of

damage to adjacent structures. Delay detonators to reduce shock waves, or practices such as line drilling method should be employed.

g) *Slope Protection* — The slope of the excavated face may be temporarily protected by shoring and strutling and/or other suitable methods as per site conditions, if warranted.

h) *Post-Blasting Slope Inspection* — When open excavations, with steep side slopes, are carried out by means of blasting, after every blasting operation, side slopes of excavations shall be carefully examined by a competent person. To prevent rock falls work inside the excavation shall not commence until all loose rock on the sides is first removed.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
IS : 3696 (Part 2) : 1991	Safety code for scaffolds and ladders: Part 2 Ladders	(Part 2) : 1982	Part 2 Ameneties, protective clothing and equipment
IS : 10386	Safety code for construction operation and maintenance of river valley projects:	(Part 3) : 1992	Part 3 Plant and machinery
		(Part 4) : 1992	Part 4 Handling, transportation and storage of explosives
(Part 1) : 1983	Part 1 General aspects	(Part 5) : 1992	Part 5 Electrical aspects

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