IS 3764 (1992): Code of safety for excavation work [CED 29: Construction Management including safety in Construction]

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(Reaffirmed 2002)

भारतीय मानक

खुदाइ कार्य – सुरक्षा संहिता

(पहला पुनरीक्षण)

Indian Stadnard

EXCAVATION WORK — CODE OF SAFETY

(First Revision)

UDC 624·133 : 69·055 : 614·8

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Price Group 6

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Safety in Construction Sectional Committee had been approved by the Civil Engineering Division Council.

A large number of workmen, skilled and unskilled, are employed in the numerous construction works, big and small, under execution, in the country. Due to the increased tempo of such works and large scale mechanisation, hazards of accidents have increased considerably. It has, therefore, become imperative that adequate safety rules are laid down for every phase of work, and that these are meticulously followed.

Excavation is one of the important phases of construction in any building activity. Due to insufficient attention to the safety aspects, it sometimes becomes a major hazard and cause of many serious accidents. Safety aspects in some of the constructions may assume such a great importance that instead of merely deputing supervisory staff in adequate strength to look after the safety aspects, it may become desirable to have a separate organization to control this important aspect. This standard has, therefore, been formulated to lay down such basic principles which take care of safety aspects involved in the hazardous operations involved in carrying out any excavation work. Adoptions of these measures would reduce the frequency of accidents considerably and bring confidence in the workmen who could work with greater efficiency.

The safety precautions to be observed for working of machines and vehicles have not been specifically included in this standard. Since it is an important aspect for an overall safety, detailed instructions issued by the maker of the machinery and vehicles and the organization undertaking the work shall be strictly followed by the workers and a check shall be exercised by the supervisory staff.

This standard was first published in 1966. This revision has been taken up with a view to incorporating the modifications found necessary as a result of experience gained with the use of this standard. The important modifications carried out in this revision are :

a) Inclusion of protective measures required while working in soils infested with insects, leeches, vermins and snakes;

b) Inclusion of safety measures against poisonous plants and some recommendations regarding use of lifelines; and

c) Making some recommendations regarding use of sheet piling in excavation.

Indian Standard

EXCAVATION WORK – CODE OF SAFETY

(First Revision)

1 SCOPE

1.1 This standard lays down the requirements for carrying out safely the excavation work, such as trenches, test pits, cellars, borrow pits, cuttings for rail, canal and road formations and all excavations on which the sides of excavations are not trimmed simultaneously to a stable slope.

1.2 The requirements laid down in this standard do not apply to the following:

a) Any part of a trench where the depth is less than 1.5 m;

b) A trench into which no person is required to enter for any purpose; and

c) Any part of a trench made for a pipeline or conduit if the trench is mechanically excavated, the sections of the pipeline or conduit are permanently assembled before being mechanically placed in the trench and the trench is mechanically back-filled.

2 REFERENCES

2.1 The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
2314 : 1986	Steel sheet piling section (*first revision*)
3696 (Part 2) : 1991	Scaffolds and ladders — Code of safety : Part 2 Ladders (*first revision*)
4081 : 1986	Safety code for blasting and related drilling operation

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions shall apply (*see* Fig. 1).

3.1 Cleat

A short member of shoring and timbering which directly resists the downward movement of strut or wale.

3.2 Sheathing

The vertical members of shoring and timbering which directly resist pressure from the side of a trench.

3.3 Strut

A transverse member of shoring and timbering which directly resists pressure from sheathing or wales.

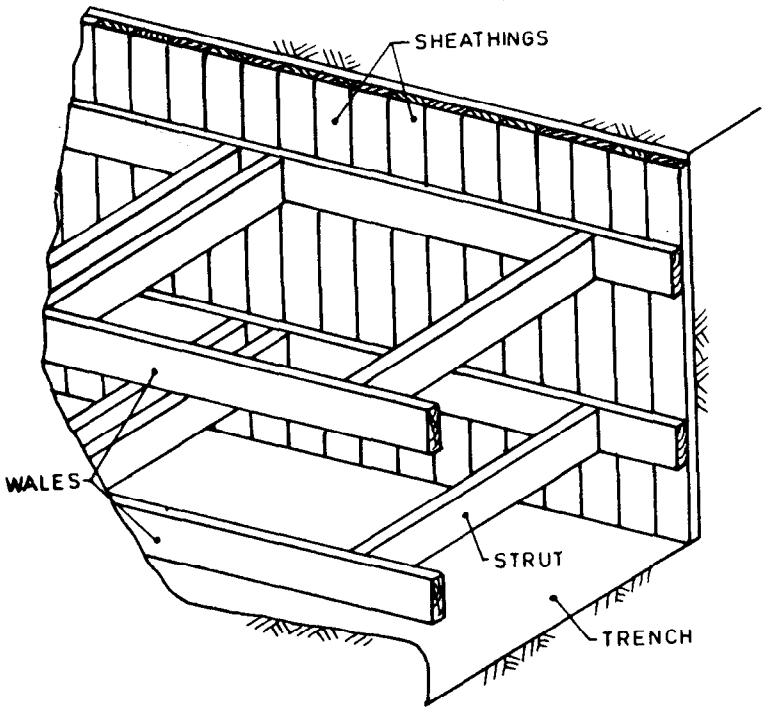

FIG. 1 ILLUSTRATIVE SKETCH SHOWING TIMBERING IN LOOSE SOIL

3.4 Trench

Any excavation in the ground where the depth of the excavation exceeds the width.

3.5 Wale

A longitudinal member of shoring and timbering which directly resists pressure from sheathing.

3.6 Sheet Piling

A line of piles driven in the soil to create a barrier or retaining wall.

4 GENERAL RECOMMENDATIONS

4.1 Responsibilities of Foremen and Supervisors

In all works, an experienced and competent foreman or supervisor shall be placed in charge of the work whose authority and responsibilities have been made clear to him and his subordinates. The foreman or supervisor shall be made responsible for the strict observance of the safety rules. He shall have full authority to enforce the rules, guard against the use of defective safety appliances, rigging, tools and materials, to see that no man is permitted to do work for which he is not qualified, and to brief all workmen on the plan of work before work is started with special emphasis on all potential hazards and on the ways to eliminate or guard against them.

4.1.1 Sides of excavation shall be inspected by foreman or supervisor during the course of excavation from time to time and after every rain, storm or other hazard — increasing occurrence and protection against slides and cavings shall be increased, if necessary.

4.1.2 Complete information on the underground structures (such as water pipelines, sewers, gas mains, electrical conduit system and other civic facilities) is essential before doing the excavation work. Proper precautions shall be taken to prevent accident to the workmen engaged in excavation work and calamities for the general public.

4.1.3 No excavation or earthwork below the level of any foundation of building or structure shall be commenced or continued unless adequate steps are taken to prevent danger to any person employed, from collapse of the structure or fall of any part thereof.

4.1.4 Where medical facilities are not available nearby, first aid facilities like a first-aid kit shall be maintained at the site of work. This shall be kept at a conspicuous place in the charge of trained person(s). The kit shall be recouped periodically.

4.2 Workers

4.2.1 Workers shall be instructed to use safety devices and appliances provided to them whenever it is necessary to do so.

4.2.2 Workers who are not aware of the hazards peculiar to the work shall not be permitted to proceed with the work without being properly instructed. They should preferably be under the close watch of a properly qualified and authorized person whose instructions shall be obeyed by these workers.

4.2.3 In case any worker feels that he cannot perform a work safely, he shall immediately inform the foreman or supervisor of his inability to carry on with the work.

4.2.4 Safety helmets shall be worn by all persons entering trench where hazards from falling stones, timber or other materials exist.

4.2.5 Appropriate safety footwear (rubber boots, protective covers, etc) shall be worn by workers/employees who are engaged in work requiring such protection.

5 SHORING AND TIMBERING

5.1 General

5.1.1 All trenches in soil more than 1.5 m deep shall be securely shored and timbered.

5.1.2 All trenches in friable or unstable rock exceeding 2 m in depth shall be securely shored and timbered.

NOTES

1 The above requirements do not apply in cases where the sides of the trenches are sloped to within 1.5 m of the bottom. The slope that is provided for such purposes shall be inspected and certified as stable by the persons in charge of work in all cases.

2 Notwithstanding anything said above, it shall be understood that the need for shoring is a matter which shall receive careful and frequent consideration even in trenches less than 1.5 m or 2 m in depth (as the case may be) and where there is any doubt as to the safety of the work without shoring, no further excavation or other work shall be continued until adequate shoring is provided.

5.1.3 Where the sides of trenches are sloped as specified in **5.1.2** but not to within 1.5 m of the bottom, the vertical sides shall be shored and the shoring shall extend at least 30 cm above the vertical sides. When open spaced sheathing is used, a toe board shall be provided to prevent material rolling down the slope and falling into the part of the trench with vertical walls.

5.1.4 Shoring and timbering shall be carried along with the opening of a trench but when conditions permit, protection work, such as sheet piling may be done before the excavation commences.

5.2 Composition of Materials

5.2.1 Approved quality of sal wood shall be used for shoring and timbering a trench. Any other structural material having strength not less than that of sal wood may also be used for the purpose.

5.3 Erection of Shoring and Timbering

Provisions detailed in **5.3.1** to **5.3.4** shall be followed

while erecting different members of shoring and timbering (*see* Fig. 1).

5.3.1 *Sheathing*

The sheathing shall be placed against the side of the trench so that length of each piece of sheathing is vertical. The sheathing shall be held securely in place against the wales by ensuring that sheathing is kept firmly pressed against the wall of the trench. Where the trench is excavated in loose, sandy or soft soil or soil which has been previously excavated or soil which is under hydrostatic pressure, each piece of sheathing shall be driven into the bottom of the trench so as to be firmly held in place.

5.3.1.1 Where two or more pieces of sheathing are used one above another, the sheathing shall be so arranged so that the lower pieces of sheathing overlap the lowest wales supporting the pieces of sheathing next above it. These pieces of sheathing shall be firmly driven into the soil and securely supported by wales and struts as the trench is made deeper.

5.3.2 *Wales*

The wales shall be parallel to the bottom or the proposed bottom of the trench. Each wale shall be supported on cleats spiked to the sheathing or by posts set on the wales next below it and in the case of lowest wale on the bottom of the trench itself. Where necessary, wedges may be provided between a wale and the sheathing it supports so that roughly uniform support is given to all individual pieces of sheathing.

5.3.3 *Struts*

Struts shall be horizontal and at right angles to the wales or sheathing supported thereby. Struts shall be cut to the proper length required to fit in tightly between the wales. Where necessary, the struts shall be held securely in place by wedges, driven between the struts and the wales.

5.3.4 Struts shall be placed on cleats spiked or bolted to posts supporting wales.

5.3.5 It shall be ensured that no nails are protruding out of wooden planks to cause any injury.

5.4 Sizes and Spacing of Members

5.4.1 The sizes and spacing of sheathing, wales and struts used for shoring and timbering for different depths of trench shall be as given in Table 1 for hard soil, Table 2 for soil which may crack or crumble, Table 3 for loose, sandy or soft soil and soil which has been previously excavated, and Table 4 for soil under hydrostatic pressure. Where the section of a wale or strut is rectangular the longer side shall be kept vertical.

5.4.1.1 Where distinctly different types of soil strata are encountered each strata shall be treated separately as is required by its characteristics.

5.4.2 Where a wedge is used in shoring and timbering of a trench, the thick end of the wedge shall be at least 50 mm wide.

5.5 Sheet Piling

In case of deep and wide open cut excavations, any of the following situations may arise:

i) where providing safe stable slopes for excavated pit may be economically impractical due to quantities of excavated material to be relocated.

ii) where slopes required for excavation may be infeasible due to proximity of nearby structure(s).

iii) where excavation of slope may be undesirable due to fluid condition of the erratic material being worked.

In such situations sheet-piling may be resorted to for side protection. This procedure may provide a kind of retaining wall to contain the materials adjacent to the excavation. The piles may be of timber, concrete, steel or composite materials depending upon the depth of excavation, strength and life of sheet piles required. For steel sheet piling refer IS 2314 : 1986.

5.6 Inspection and Examination

5.6.1 No person shall work in any excavation, shaft, or earthwork, unless all timbering and plant used therein are inspected by a competent person before work is started and also after explosives have been used in or near the excavation, shaft or earthwork.

5.6.2 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 excavations shall not commence until all loose rock on the sides is first removed. All workers engaged in such excavations shall use helmets.

5.6.3 Inspection shall be carried out after heavy rain or storms to ensure safe working conditions.

6 LOOSE SIDE MATERIAL

6.1 All loose stones, projecting clumps of earth, pockets of unstable material which might come down on the workers in the trench or any condition which is a hazard, shall be either removed or the excavated sides adequately braced and the trench suitably guarded. On steep slopes workmen shall not be permitted to work one above the other.

6.2 Stockpiles of these materials shall be so located, as to provide easy access for withdrawing. These stockpiles shall not be located in the immediate vicinity of overhead powerlines.

6.3 Materials shall not be piled against walls as this may endanger the walls.

Table 1 Hard Soil

(*Clause* 5.4.1)

Item No.	Depth of Trench	Sheathing		Wales		Struts			
						Section		Spacing	
		Section	Horizontal Spacing, *Max*	Section	Vertical Spacing, *Max*	*Width of Trench not More than 2 m*	*Width of Trench Between 2 m and 4 m*	*Verti-cal*	*Hori-zontal*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	m	cm	m	cm	m	cm	cm	m	m
1.	Over 2 but not over 3	5 × 20	2	15 × 15	1.5	10 × 10	10 × 15	1.5	3
2.	Over 3 but not over 5	5 × 20	1.5	15 × 15	1.5	10 × 15	15 × 15	1.5	3
3.	Over 5 but not over 6.5	5 × 20	1	20 × 20	1.5	15 × 15	15 × 15	1.5	3
4.	Over 6.5 but not over 8	5 × 15	Width of member	25 × 25	1.5	15 × 20	20 × 20	1.5	3
5.	Over 8 but not over 10	8 × 20	Width of member	20 × 30	1.5	20 × 20	20 × 25	1.5	3

Table 2 Soil Which May Crack or Crumble

(*Clause* 5.4.1)

Item No.	Depth of Trench	Sheathing		Wales		Struts			
						Section		/ Spacing	
		Section	Horizontal Spacing, *Max*	Section	Vertical Spacing, *Max*	*Width of Trench not More than 2 m*	*Width of Trench Between 2 m and 4 m*	*Verti-cal*	*Hori-zontal*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	m	cm	m	cm	m	cm	cm	m	m
1.	Over 1.5 but not over 2.5	5 × 20	1.5	10 × 15	1.5	10 × 10	—	1.5	3
2.	Over 2.5 but not over 3	5 × 20	1	15 × 15	1.5	10 × 10	15 × 15	1.5	3
3.	Over 3 but not over 5	5 × 20	0.5	15 × 20	1.5	10 × 15	15 × 15	1.5	3
4.	Over 5 but not over 6.5	5 × 15	Width of member	20 × 25	1.5	15 × 15	20 × 20	1.5	3
5.	Over 6.5 but not over 8	5 × 15	Width of member	25 × 25	1.5	15 × 20	20 × 20	1.5	3
6.	Over 8 but not over 10	8 × 20	Width of member	20 × 30	1.5	20 × 20	20 × 25	1.5	3

Table 3 Loose Sandy or Soft Soil or Soil Which Has been Previously Excavated

(*Clause* 5.4.1)

Item No.	Depth of Trench	Sheathing		Wales		Struts			
		Section	Horizontal Spacing, *Max*	Section	Vertical Spacing, *Max*	Section		Spacing	
						Width of Trench not More than 2 m	*Width of Trench Between 2 m and 4 m*	*Verti-cal*	*Hori-zontal*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	m	cm	m	cm	m	cm	cm	m	m
1.	Over 1.5 but not over 2.5	5 × 20	0.4	10 × 15	1.5	10 × 10	10 × 15	1.5	3
2.	Over 2.5 but not over 3	5 × 15	Width of member	15 × 20	1	10 × 15	15 × 15	1	3
3.	Over 3 but not over 5	5 × 15	Width of member	20 × 20	1.5	15 × 15	15 × 15	1.5	3
4.	Over 5 but not over 6.5	5 × 15	Width of member	20 × 25	1.5	15 × 15	15 × 20	1.5	3
5.	Over 6.5 but not over 8	8 × 20	Width of member	20 × 25	1.5	15 × 20	20 × 20	1.5	3
6.	Over 8 but not over 10	8 × 20	Width of member	25 × 25	1.5	20 × 20	20 × 20	1.5	3

Table 4 Soil Under Hydrostatic Pressure

(*Clause* 5.4.1)

Item No.	Depth of Trench	Sheathing		Wales		Struts			
						Section		Spacing	
		Section	Horizontal Spacing, *Max*	Section	Vertical Spacing, *Max*	*Width of Trench not More than 2 m*	*Width of Trench Between 2 m and 4 m*	*Verti-cal*	*Hori-zontal*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	m	cm	m	cm	m	cm	cm	m	m
1.	Over 1.5 but not over 2.5	5 × 15	Width of member	15 × 20	1.5	10 × 10	15 × 15	1.5	3
2.	Over 2.5 but not over 3	5 × 15	Width of member	15 × 25	1	10 × 15	15 × 15	1.5	3
3.	Over 3 but not over 5	8 × 20	Width of member	25 × 25	1.25	15 × 15	15 × 15	1.25	3
4.	Over 5 but not over 6.5	8 × 20	Width of member	25 × 30	1.25	20 × 20	20 × 20	1.25	3
5.	Over 6.5 but not over 8	10 × 20	Width of member	25 × 35	1	20 × 20	20 × 25	1	3
6.	Over 8 but not over 10	10 × 20	Width of member	35 × 35	1	20 × 25	25 × 25	1	3

7 MINIMUM BERM

7.1 Excavated material shall be kept away from the edge of the trench to provide a clear berm of a width of not less than one third the final depth of excavation or as required by design.

7.1.1 In special cases, where the disposal area is limited or where the application of this requirement is impracticable, the person in charge may adopt a berm of reduced width in any case not less than 1 m provided the material being excavated is sufficiently stable and the shoring is designed to carry the additional load. In all such cases substantial toe-boards shall be provided to prevent 'roll backs' into the trench.

8 EDGE OF EXCAVATION TO BE KEPT CLEAR

8.1 Care shall be taken to keep tools or material, such as wheel barrows, shovels, picks, tile, cement and lumber, far enough from the edge of the trench to prevent their being inadvertently knocked into the trench.

8.2 No material or load shall be placed or stacked or removed near the edge of any excavation, shaft, pit or opening in the ground as it may endanger the persons employed below.

9 PLANT AND MACHINERY

9.1 Heavy equipment, such as excavating machinery and road traffic shall be kept back from the excavated sides at a distance not less than the depth of trench or at least 6 m for trench deeper than 6 m.

9.2 Power Shovels and Drag-Lines

The use of power shovels or draglines in a trench, because of his violent thrust or blows delivered, rapidly renders the banks of the trench unstable and dangerous to people working nearby. These conditions shall be watched for and suitably remedied or eliminated.

9.3 Vehicles

The use of trucks or wagons in and about the trenches shall be under the control of an experienced foreman or supervisor. The vehicle shall not be permitted to be driven near the lip of the excavation and for this reason, care shall be exercised in locating roads leading to or from it. The foreman or supervisor shall see that in spotting the vehicles for loading, they are not backed into the wall of the pit and that when loading vehicles by hand, a constant watch is kept for slides or boulders rolling down the slope.

9.3.1 Adequate and well anchored stop block shall be provided on the surface to prevent operating vehicles from falling accidently into excavation pit.

9.4 Tools

Workers shall be provided with proper tools. Where break-down work is required, tools of ample length shall be provided. The men shall be warned to guard against the danger arising through the sudden movement of material, which might throw them off-balance or cause them to come in path of dislodged boulders or other falling objects. The workmen shall be adequately spaced to avoid being accidently struck by tools of fellow workmen.

10 MEANS OF ACCESS AND ESCAPE

10.1 Pathways

Pathways shall be non-slippery and shall be of adequate width not less than 75 cm. They shall be strong enough to withstand the intended use.

10.2 Gangways

Gangways shall be of proper construction and adequate width. If planks are used, they shall be laid parallel to the length of gangway and fastened together against displacement. Planks shall be uniform in thickness and shall be provided with cleats to ensure safe walking. Gangways shall be kept clear of excavated material or other obstruction. Wherever pathways and gangways are suspended, these must have guard rails and side supports on both sides to prevent fall of workmen into the excavation.

10.3 Ladders

Excavations shall have at least one ladder per 15 m of length or fraction thereof in case of hazardous work and per 30 m of length or fraction thereof in case of relatively less hazardous works. Ladders shall extend at least one metre above the top of the cut to provide a hand hold when stepping on or off the ladder. Ladders shall be constructed, used, maintained and inspected in accordance with the requirements laid down in IS 3696 (Part 2) : 1991.

11 PROVISION OF FENCES, GUARDS, ETC

At every part of a trench likely to be frequented by the public such fences, guards or barricades as will prevent a person or livestock from falling into the trench shall be provided and maintained in place at all times.

12 PROVISION OF LIGHTING AND WARNING SIGNALS

12.1 Excavation areas shall be adequately lighted for night work.

12.1.1 During the hours of darkness all public side walks and walkways shall be adequately illuminated and warning lights shall be placed in proper sites to ensure safety of pedestrians and the vehicular traffic.

12.1.2 At all approaches and exits of the sites of excavations, danger and warning signals shall be placed. In busy or otherwise risky locations a flagman with a red flag shall be posted to warn the public and the approaching trucks and to guide them in proper direction. At every part of a trench likely to be frequented by public, suitable warning signal/red light to prevent a person from falling into the trench shall be provided and maintained in place at all times.

12.1.3 Where inflammable substances are stored or present, all electrical installations shall be explosion-proof. Portable lamps/flash lights, if required, shall be of approved explosion-proof type.

13 USE OF SAFETY ROPE

13.1 When a workman is required to enter a hazardous trench (the sides of which shall be properly braced) or to scale rock from the side slopes of a trench a safety rope shall be securely tied to the safety belt worn by him so that, if necessary, he may be assisted or drawn to safety.

13.2 Lifelines shall be secured to at least two substantial anchorages or structural members. Manila lifelines, used for supporting personnel on safety belts, shall be at least 20 mm in diameter and shall have a wire core.

14 LONE WORKERS

A lone worker shall not be permitted in trenches unless there is at least one worker on the ground close by on duty.

15 HARMFUL GASES AND FUMES

15.1 It shall be ensured that no harmful gases or fumes are present in the trench to such a degree as may endanger the health or safety of persons working in them.

15.2 Where gases and fumes are likely to be present in a trench or tests show their presence therein, sufficient mechanical ventilation to protect the health and safety of persons working there shall be provided.

15.2.1 Air shall be considered unfit for workmen to breath if it contains any of the following :

a) Less than 19 percent of oxygen by volume,

b) More than 1 percent of carbon dioxide by volume,

c) More than 0.01 percent of carbon monoxide by volume,

d) More than 0.002 percent of hydrogen sulphide gas by volume, and

e) More than 0.002 percent of nitrous oxide by volumes.

Where presence of a harmful gas is established at a worksite, suitable arrangements be made to check the percentage of such a gas to ensure that the gas after ventilation is within safe limits. Such tests shall be carried out as frequently as necessary.

15.3 Where mechanical ventilation may not adequately supply uncontaminated air for the personnel in a trench, such personnel shall be provided with and shall use respiratory protective equipment furnishing air from an uncontaminated source.

15.4 Where explosive mixtures of gases may be present, sufficient ventilation shall be provided to render the area safe by test before workmen enter the trench. Air containing more than 1.5 percent by volume of flammable gas shall be considered dangerous.

15.5 No internal combustion engine shall be operated in a trench unless adequate provisions are made to ensure that the exhaust gases and fumes are rendered harmless or are discharged to a point sufficiently remote from the trench to prevent their return to or accumulation in the trench.

16 DRILLING AND BLASTING OPERATIONS

Where drilling and blasting operations are to be encountered, safety precautions as laid down in 4081 : 1986 should be taken.

17 INSECTS – LEECHES – VERMINS – SNAKES

Protection against hazards involving insects, vermins, leeches or snakes shall include the following controls as are pertinent :

a) Instructions regarding potential hazards.

b) Boots, hoods, netting, gloves, masks, or other necessary personal protection.

c) Repellents.

d) Drainage or spraying of breading areas.

e) Burning or destruction of nests.

f) Use of smudge pots for protecting small areas.

g) Elimination of unsanitary conditions which propagate insects or vermins.

h) Extermination measures against rodents.

j) Fumigation.

k) Inoculation.

m) Approved first-aid remedies for the affected.

18 POISONOUS PLANTS

In areas where workers are exposed to poison ivy, oak, surmac or other poisonous plants, the following protective measures, as pertinent, shall be provided :

a) All workers shall be instructed in identification of the plants and preventive measures.

b) Where practicable, the plants shall be removed or destroyed.

c) Appropriate protective clothing, gloves, etc, shall be worn.

d) Protective ointments shall be provided.

e) Soap and water shall be available for washing exposed parts.

f) Approved first-aid remedies shall be provided for treatment of affected skin areas.

g) Immunisation treatments, where applicable.

19 OVERHANGS AND SLOPES

19.1 An overhang is generally made up of overburden frozen or cemented gravel, sand, boulders or consolidated clay which juts out from the trench wall, or it may be part of the wall which is standing in a more or less perpendicular position. These may come down unexpectedly. They shall be removed before further material is taken from that part of the trench where they occur.

19.2 In cases where power-driven machinery is employed in the excavation of a trench, steep working faces may necessarily result from the nature of the machinery used. These steep faces shall be broken down to a stable slope as they occur, except at the working face. In such cases, however, every precaution shall be taken to prevent unprotected workmen from entering the zone of danger either on the surface above the face or at the bottom of the trench near the face.

19.3 The walls of the excavation, other than the working face, and the latter when operations in the pit are suspended temporarily or finally completed, shall be maintained and left at such a slope that the danger from caving or sliding is eliminated.

19.4 Break Downs

Walls rendered unstable by blasting, by the action of alternate freezing and thawing or by the operation or movement excavating or transporting equipment shall be put in a safe condition by breaking them down until a stable slope is made; while these operations are underway no man shall be permitted to work in the trench immediately below, and no material shall be removed from the bottom of the slope until the breaking down is completed.

20 UNDER CUTTING

Borrowing or mining or what is known as 'gophering' shall not be allowed. In any trench where such methods have been followed, the cavities left shall be eliminated by cutting back the bank slope before removing any further material from the section of the trench.

21 SHELTER

A suitable shelter shall be provided at a safe location where the workmen may take their lunches or find shelter from sudden storms. This will obviate the danger, always present, when men seek shelter against the elements or to take lunches under the steep walls of the pit. Such unsafe practices shall be prohibited.

22 TEMPORARY SUPPORTS FOR FOUNDATIONS

Foundations, adjacent to and below which excavation is to be made, shall be supported by shoring, bracing or underpinning as long as the trench remains open.

23 WALK-WAYS AND BRIDGES

All trenches over which men or equipment are required to cross shall be provided with walk-ways or bridges. Where the trenches are more than 2 m deep guard rails shall be provided.

24 DANGEROUS AREAS

Visitors shall not be permitted to enter the scene of excavations unless they are accompanied by a supervisor or foreman. Adequate measures shall be taken to prevent workers and spectators from approaching the dangerous areas.

25 COMMON HAZARDS IN EXCAVATION

The person-in-charge of excavation work shall familiarize himself with the nature of material to be excavated and the factors he has to specially look for and guard against. More important of them are given below :

a) *Quicksand*

The tendency of quicksand to run necessitates the use of close continuous sheathing; while damp sand, being more stable, may require only bracing. Rock shall be sealed as often as necessary to ensure against falling fragments.

b) *Water Content or Degree of Saturation*

The side walls of a trench which may be reasonably stable when dry, may become highly unstable due to saturation of the earth following a heavy rainfall.

c) *Effect of Freezing and Thawing*

Due to expansion of water when freezing rock fragments, and boulders, etc, are frequently loosened. The side walls of the excavation shall be constantly watched for signs of cracks during a thaw. When depending in whole or in part of freezing to support the side walls great care shall be taken during thaws to provide suitable bracing or remedy the condition by sealing of the loose material from the sides.

d) *Vibration from Nearby Sources*

Vibration due to adjacent machinery, vehicles, rail-roads, blasting and other sources require that additional bracing precautions are to be taken.

e) *Adjacent Loose Fills*

The possibility of pockets of unstable material, such as dry and quicksand or old fills adjacent to a trench requires special investigation and care. Such material may be separated from the pit by only a thin wall of stable material which might easily collapse and allow the unstable material to flow into the cut.

f) *Surcharge Imposed by Adjacent Buildings, Lumber Piles, etc*

Proximity of buildings, piles of lumber, crushed rock, sand and other construction materials, derricks, concrete mixtures, crawler, cranes and other plants, large trees or other heavy objects may impose such a surcharge on the side of the trench to cause a slide unless precautions are taken. Under these conditions additional bracings shall be provided to support the sides of trench.

Standard Mark

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Revision of Indian Standards

Indian Standards are reviewed periodically and revised, when necessary and amendments, if any, are issued from time to time. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition. Comments on this Indian Standard may be sent to BIS giving the following reference :

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