1.0 Objective: This procedure describes the safety precautions and protective systems those help to protect workers from excavation hazards as mentioned in 3.1.

2.0 Scope:

This standard is applicable to all large, medium and small scale manufacturing units.

3.0 Procedure:

3.1 Associated Hazards:

Excavation is one of the major critical activities in execution of any civil engineering project. While excavation is always hazardous, it becomes even more hazardous during rainy season or by seepage of water into pit, due to reduction of shear strength of soil. This may lead to collapse of soil into pit resulting into injury to people or even fatality. The excavation in hilly terrains is critical due to presence of loose rocks, boulders and due to instability of slopes above the excavation pits. In some cases, excavation may lead to damage to the underground utility service installations of the plants and that of other agencies like railways, local municipal bodies.

Hazards associated with excavation are given below. These are to be addressed while planning for excavation work and appropriate corrective measures are to be taken before allowing people to go inside an excavated pit.

i) Falling of persons into excavation pit.

ii) Collapse of excavation sides and falling of excavated material onto persons working in excavation pit.

iii) Collapse of temporary structure made to support sides of excavation.

iv) Collapse of adjacent building or structure due to an excavation made nearby.

v) Persons working in excavation pit, struck by parts of machine, falls of spoil from excavator buckets and other objects dropped on them.

vi) Striking underground electric cables with resulting flash burns and electric shock.

vii) Striking and breaking other underground service lines – gas (fire and explosive hazard), water (flooding), and sewage (toxic gases).

viii) Fire and explosion from flammable gases heavier than air and vapors, especially LPG, entering excavation.

ix) Poisoning from gases heavier than air such as hydrogen sulphide or carbon dioxide present in ground itself, or entering the excavation from outside.

x) Poisoning from carbon monoxide produced from torches, burns, etc. used in excavation with insufficient ventilation, or from exhaust gases produced by plants and machinery used in connection with the excavation, including pumps for dewatering.

xi) Toxic and radioactive hazards from the ground itself, usually resulting from its previous occupancy.

xii) Flooding with risk of drowning.

xiii) Accidental explosion through use of explosive in excavation. Falling of workmen through bottom of excavation into disused mine shaft or other cavities in the ground. ***(Refer Annexure-I: Illustrations for Cave-in Hazards)***

3.2 Definitions:

i) **Bell-bottom Pier Hole:** A type of shaft or footing excavation in which the bottom is made larger than the cross section above to form a belled shape.

ii) **Benching (benching system):** A method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal

levels or steps, usually with vertical or near-vertical surfaces between levels.

iii) **Cave-in:** The separation of a mass of soil or rock material from the side of an excavation, or loss of soil from under a trench shield or support system, and its sudden movement into the excavation in quantity that it could entrap, bury, injure, or immobilize a person.

3.3 Classification of soil:

From construction point of view, soil can be classified in four groups viz. Stable rock, Type-A, Type-B and Type-C. Stability is greatest in stable rock and decreases through Type A and B to Type C, which is the least stable.

Stable rock is defined as natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Type-C soils include the following:

i) Granular soils including gravel, sand and loamy sand.
ii) Loose backfilled soil.
iii) Submerged soil or soil from which water is freely seeping.
iv) Black-cotton soil – This type of soil is expansive in nature and swells when in contact with water. When dried up, cracks can be observed. This type of soil generally appears on the upper strata of the ground up to a shallow depth.
v) Mica-schist – This type of soil can be identified by light yellowish colour and presence of shining mica particles. Mica-schist swells when in contact with water and has negligible shear strength when wet. This type of soil is frequently found inside Plant. Collapse of excavated pit in such soil is almost certain and special care must be taken to prevent excavation failure during construction.

Type-B soils include the following:

i) The soil has been previously disturbed.
ii) Soil that is fissured(cracked).
iii) The soil that is subject to vibration from heavy traffic, pile driving or similar effects.
iv) Dry rock that is unstable, found in hilly area like Noamundi, Joda etc.

Type-A soils include the following:

i) Cohesive soils with very high strength.

3.4 Competent person: One who can identify existing or predictable hazards in the surroundings that are unsanitary, hazardous, or dangerous to employees. Also has authorization or authority by the nature of their position to take prompt corrective measures to eliminate them. The person shall be knowledgeable about the requirements of this part.

3.5 Drilling: Work performed above grade with small tools in order to make holes on any “blind” surface.

3.6 Cross braces: The horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or walls.

3.7 Excavation: Any man-made cut, cavity, trench, or depression in the earth's surface, formed by earth removal.

3.8Failure: The breach, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities.

3.9Hazardous atmosphere: A atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

3.10Protective system: A method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and

other systems that provide the necessary protection.

3.11Qualified person - One who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his or her ability to solve or resolve problems related to the subject matter, the work, or the project.

3.12Ramp: An inclined walking or working surface that is used to gain access to one point to another, and is constructed from earth or from structural materials such as steel or wood.

3.13 Sheeting: The members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

3.14 Shield (shield system): A structure that is able to withstand the forces imposed on it by a cave-in and thereby protects employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses.

3.15 Shoring (shoring system): A structure such as a hydraulic, mechanical, or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

3.16 Sloping (sloping system): A method of protecting employees from cave-ins by excavating to form sides of an excavation that is inclined away from the excavation so as to prevent cave-ins. The angle of inclination required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

3.17 Stable rock: A natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or by another protective system that has been designed by a qualified / competent engineer.

3.18 Structural ramp: A ramp built of steel, usually used for access. Ramps

made of soil or rocks are not considered structural ramps.

3.19 Support system: A structure such as underpinning, bracing or shoring, which provides support to an adjacent structure, underground installation, or the sides of an excavation.

3.20 Trench (trench excavation): A narrow excavation in relation to its length made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than4.5m.

4.0 General protection requirements:

Many excavation accidents are the direct result of inadequate initial planning. The construction engineer is responsible for planning the job. He or she must involve the site's competent person in planning all phases of the work. Every effort should be made during the design stage of the excavation to ensure safety by providing necessary protective systems.

4.1 Planning: The steps to be followed for excavation planning are given below.

i) Prepare a layout of the excavation showing plan and cross-sectional elevation of the proposed excavated pit as per requirement.
ii) Identify and mark all nearby structures, buildings, drains, sewer lines, railway tracks, roads, slope of an existing embankment etc. on the layout. Underground drains and sewer lines can be identified by locating the manholes over ground.
iii) Identify and mark all nearby overhead utilities like power cables, water and gas lines etc. if any.
iv) Identify and mark nearby water bodies like ponds, lakes etc. if any.
v) Collect information regarding the depth of foundations of nearby structures and underground drains and sewer lines. Show this in cross-sectional elevation of proposed excavated pit.

vi) Collect information regarding the presence of any underground utility lines, electric cables, fiber-optic cables, telephone cables etc. This may be done by referring to the GIS map of the concerned site, if available and by discussion with the concerned owner department.

vii) Identify all sources of vibration nearby e.g. movement of railway wagons, traffic movement on road, vibrating equipment, balling operation, pile driving etc.

viii) Collect information regarding the type of soil by visual inspection or by soil test report of the site. Classify the soil as stable rock, type A, type B or type C, as per the criteria given above.

ix) Weather condition: During rainy season, soil will be wet and weak. Also, there is a possibility of rising of ground water table.

4.2 Minimum Precaution: Following minimum precautionary measures must be taken by the construction engineer, before starting an excavation.

i) All persons in an excavation site, must use appropriate PPEs.

ii) Erect either warning barricades or rigid, protective barricades. If warning barricades are used, place them at minimum of 1.5 meters distance from the edge of excavation. A spoil pile of minimum 1 meter high can be used as a barricade on one side of the excavation. Barricades must be marked with warning lights if they are in or near walkways or roadways.

iii) Provide warning systems such as barricades, hand or mechanical signals, or stop logs to alert operators of mobile equipment that they are approaching the edge of excavations.

iv) Keep spoil dirt and any light material or equipment that may fall into an excavation at least 1 meter from the edge.

4.3 Surface encumbrances: All surface encumbrances that are located so as to create a hazard to employees shall be removed or supported, as necessary, to safeguard employees.

4.4 Underground installations.

i) Locating underground installations – Trial Trench

The location of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work, shall be located prior to opening an excavation. Supervisor shall obtain excavation clearance from E&P division (or other concerned department, i.e. Civil Engineering, Electrical Department, Design Department) before start of the work so as to prevent the hazards due to the underground installations **(Refer Annexure-II for Format of Excavation Clearanc**e). After obtaining the excavation clearance, the excavation area is examined by cable/metal detector to identify underground cables/utilities and then trial trench excavation shall be undertaken by manual means only.

The layout of the trial trench shall be such that it exposes every cable loop/utilities inside the excavation area. Trial trench of 1.5 meter depth shall first be cut, below the ground surface. This job will be done manually with every precaution, anticipating presence of underground cables/utilities etc. If presence of cables/utilities is not detected mechanized excavation up to a depth of 1.2 meter may be permitted.

For excavating further down, cable/metal detector shall again be deployed to look for presence of cable/utilities at level below 1.5 meter. Again trial trench shall be cut manually for an additional depth of 1.5 meter with the same pre-cautions as above. In case no cable/utility is detected, mechanized excavation can be permitted up to 2.7 meter from the ground level. This sequence shall be continued till the final depth of excavation is reached. In case cables/utilities are detected at any level, necessary precautions shall be taken to avoid any damage to these cables/utilities, and these should be adequately supported.

For Green Field Project sites or in areas where there is no underground installations, trial trench may be avoided with due approval from a competent person or Competency Team on Excavation. For piling job, trial trench may be restricted upto the bottom of pile cap.

i) While the excavation is open, underground installations shall be protected, supported, relocated or removed as necessary.
ii) If needed, shoring should be done in the trial trench, to protect the workmen from collapse of soil.

4.5 Stability of adjacent structures:

i) Where the stability of adjoining buildings, walls, or other structures is endangered by excavation, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures.
ii) Excavation below the level of the base of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees shall not be permitted without approval of site in charge.
iii) Possibility of collapse of soil, adjacent to and below the foundations shall be checked by the approver giving the excavation clearance.

4.6 Damage to Railway track:

i) For any excavation in the vicinity of a railway track, necessary approval is to be taken from the owner of the track line. In no case, excavation which will lower the strength of railroad formation shall be done without taking shutdown.
ii) After completion of the job, the railway track is to be restored back and handed over to the owner department.

4.7 Excavation near HT lines:

Care shall be taken while excavating near power lines, so that no excavator comes close to power lines. Stability of towers shall be ensured before

starting excavation. Minimum clearance to be maintained from the nearest HT line shall be as per Indian Electricity Act. A knowledgeable electrical engineer may be contacted for this.

4.8 Protection of people from soil collapse:

Side wall collapse of an excavated pit is a common phenomenon. This leads to injury of people and equipment inside a pit. In many cases, due to lack of adequate protective system, collapse of side wall lead to fatality. Therefore, adequate protection system must be in place, before allowing people inside a pit.

Side wall collapse in an excavated pit happens due to four major factors viz.

i) type and condition of soil

ii) size of excavation

iii) seepage of water, and

iv) vibration.

Protective system to prevent soil collapse is given in Clause-8 of this safety standard. Appropriate protective system is to be selected by the site-in-charge considering the site conditions.

4.9 Protection from hazards associated with water accumulation:

i) Employees shall not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless necessary precautions have been taken to protect people against the hazards posed by water accumulation. The precautionary measures necessary for protection of people vary from site to site. These include special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or use of a safety harness and lifeline.

ii) If water is controlled or prevented from accumulating by the use of water removal equipment, the water removal equipment and operations shall be monitored by a competent person to ensure proper operation.

iii) If excavation work interrupts, the natural drainage of surface water such as streams, drain etc., diversion ditches, dikes, or other suitable means shall be adopted used to prevent surface water from entering the excavated pit. Required drainage of the area adjacent to the excavation shall be provided. Excavations subject to runoff from heavy rains will require an inspection by a competent person.

4.10 Protection of people and equipment from loose rock or soil:

Required protection shall be provided to protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face. Such protection shall consist of removal of loose material from side wall and edge of excavated pit; installation of protective barricades at intervals as necessary on the face to stop and contain falling material; or other means that provide equivalent protection. Safety net if provided on the side walls for protection against fall of boulders and loose materials must be well anchored at the top.

4.11 Protection of people from hazardous atmosphere:

i) In case of presence of harmful gas, necessary arrangements for ventilation shall be provided to restrict the exposure within safe limits. Such tests shall be carried out frequently.

ii) Explosive mixed gases may also be present in the trenches; air containing more than 1.5 percent of flammable gases by volume is dangerous.

iii) 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 0.0025 percent of hydrogen sulphide gas by volume and More than 0.002 percent of nitrous oxide by volumes.

iv) No internal combustion engine should be operated in a trench unless adequate ventilation measures are taken for discharge of exhaust gases.

v) Dusty Atmosphere: When the excavation activity causes dust generation which can be harmful to the employees, necessary action must be taken to suppress it (e.g. spraying water) or employees must wear proper PPE while working in such atmosphere.

4.12 Access and Escape:

i) It is recommended that one ladder should be provided for every length of 15 m or fraction thereof, in the case of hazardous work, and 30 m of length or fraction thereof, in the case of relatively less hazardous work.

ii) Ladder shall extend at least 1 meter top of the cut to provide a hand hold when stepping on or off.

iii) Quite often the pathways become slippery due to accumulation of mud, sand or gravel. This should be avoided. Further, the pathway should be strong enough to withstand the intended use. Similarly gangway should be of superior construction.

iv) The planks used should be strong and parallel to the length of the gangway and fastened together against displacement. They should be thick and have cleats for safe walking. Gangways should be kept clear of excavated material and other obstruction.

4.13 Exposure to falling loads:

No employee shall be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand at least 5m away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped.

4.14 Excavations as Confined space:

If the competent person feels that the excavation has the hazards of confined space then all the necessary precautions must be taken which are applicable while working in confined space. For this refer the standard of Working in Confined Space.

4.15 Emergency rescue:

i) The supervisor or foreman shall make the employees aware about the location of the First Aid box/Competent First Aiders/OHS Centre of the Plant.
ii) Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment shall be attended when in use.

4.16 Fall protection:

Walkways shall be provided where employees or equipment are required or permitted to cross over excavations. Adequate barrier for physical protection shall be provided at all remotely located excavations. All wells, pits, shafts, etc., shall be barricaded or covered. Upon completion of exploration and similar operations, temporary wells, pits, shafts, etc., shall be backfilled.

4.17 Cathode Protection Systems:

These systems are used to prevent corrosion of certain underground piping. Special cathodes and / or anodes are used to circumvent corrosive damage to the pipeline by use of electrical currents. If these systems are in the vicinity of an excavation, they must be de-energized and positively isolated.

4.18 Inspections:

i) Daily inspections of excavations, the adjacent areas, and protective systems shall be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. An inspection shall be conducted by the competent person prior to the start of work and as needed throughout the shift. Inspections shall also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee's exposure can be reasonably anticipated. Format for inspection report is shown in **Annexure-IV.**

ii) Where the competent person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions, employees working there shall be asked to evacuate the area until the necessary precautions have been taken to ensure their safety.

5.1 Protective systems:

5.1.1 Personal protective system

The worker shall be provided proper briefing about the Cave-in and other Hazards before proceeding to work by supervisor/foreman.

Safety helmet and Shoes shall be worn by all persons entering trench/ excavation site.

i) Tools or materials such as wheel borrow, shovels, picks, tiles, cement, lumbar shall not be kept close to the edges of the trench.

ii) Warning notices shall be displayed at the site. All excavations must be provided with Guard rails or Metal Plank Guards as per safety standard on barricades.

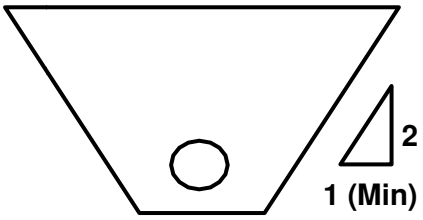
iii) Every accessible part of an excavation, pit or opening in the ground into which there is a danger of falling of person, shall be suitably fenced with a barrier as shown in standard sketch of barricades.

5.1.2 Prevention of soil collapse in trenches:

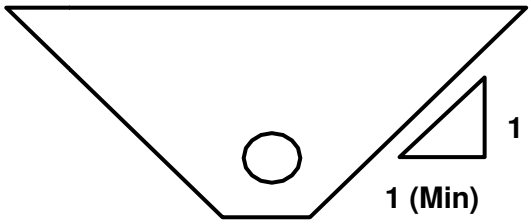
Soil collapse in a trench can be prevented either by side slope or by benching of side wall or by shoring. Selection of a particular method is made depending on the site and soil condition.

iv) Side slope: Soil collapse can be prevented by cutting the side of an excavated pit in slope as shown in Figure-1. The slope will be decided by the site engineer, considering the type and condition of the soil and the depth of excavation.

Side slope for Type-A soil



Side slope for Type-B soil



Side slope for Type-C

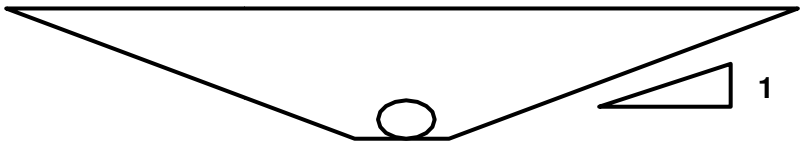


Figure-1 : Side slopes in different kinds of soil

v) Benching: If sufficient space is available on the sides of a trench, benching is the preferable method for slope stability. Benching is to be done considering the type of soil and the depth of excavation as per Figure-2. If depth of excavation is less than 1.5m, then benching may not be required and cutting in slope may be sufficient. However, when the depth of excavation is more than 1.5m, one bench must be provided at a height of 1.5m from the bottom of excavation. Number of additional benches required will be decided by the site engineer, depending upon site condition and depth of excavation. For the required benching width, designer shall be consulted. However, minimum 1m benching width is to be provided.

However, sometime sufficient space may not be available for benching or providing side slopes. In such cases, side of a trench is to be protected by shoring.

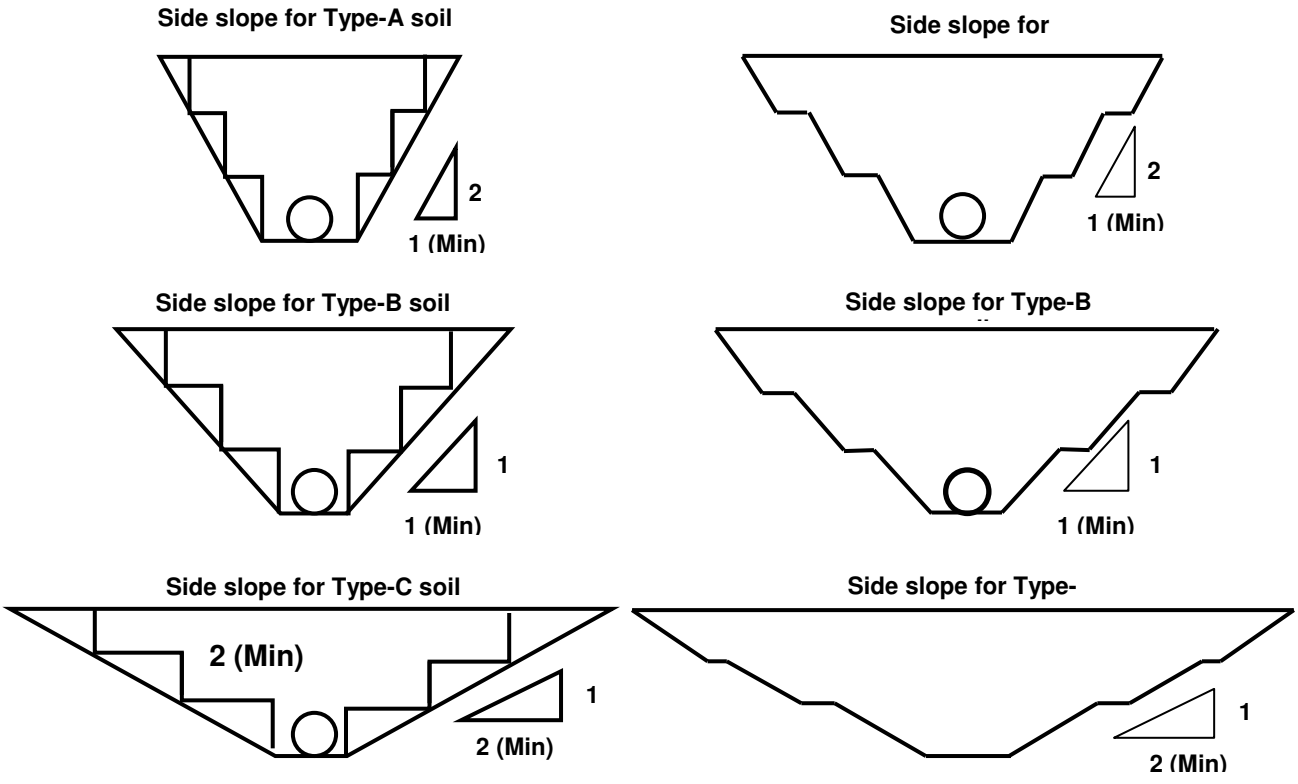


Figure-2 :Benching for different kinds of soil

vi) Shoring: Unless the side of an excavated pit is protected by providing adequate slope on sides or by benching, shoring must be done to protect the side of an excavated trench against collapse. Following guideline is to be followed:

a. All trenches deeper than 1.5 m shall be securely shored. In case of Type-C soil shoring may be required even for depth less than 1.5 m. A typical shoring arrangement is given in Figure-3. However, shoring arrangement is to be approved by a competent person.
b. All trenches in friable or unstable rock exceeding 2 m in depth shall be securely shored and timbered.
c. In case of any doubt with respect to the safety of the work, the requirement for providing shoring shall be carefully considered, even in trenches less than 1.5 meter or 2 meter in depth, and decision should be taken accordingly.
d. Where the sides of trenches are sloped, as specified above 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 of the excavations. Care to be taken to prevent material rolling down the slope and falling into the part of the trench.
e. 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.
f. Approved quality of Sal wood should be used for shoring and timbering a trench. Any other material can also be used, but shall not have the strength less than the Sal wood.
g. Cutting shall be done from top to bottom. No undercutting of side of excavation shall be allowed. In case, where undercutting is a must, written approval from a competent engineer shall be taken.

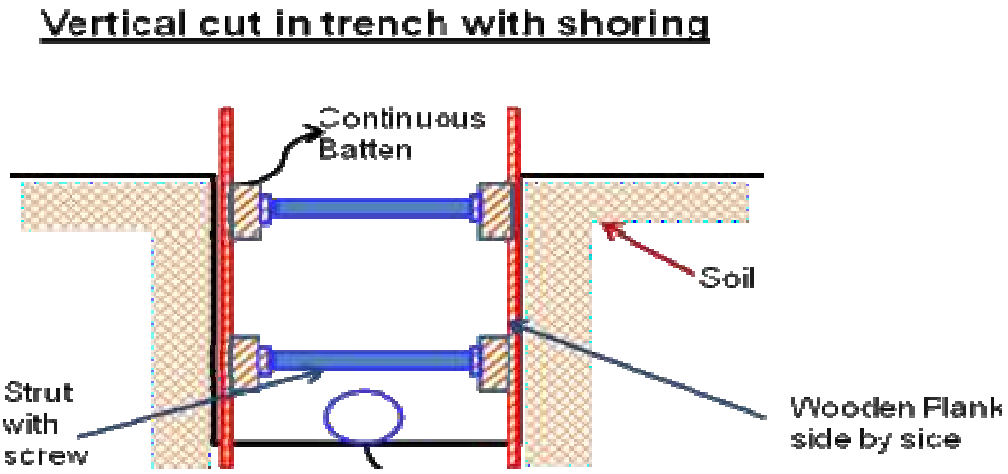


Figure-3: Shoring in trench

vii) **Timber Shoring:** As far as possible, the installation of shores should be done from the surface, that is, vertical shores should be placed from surface and the first horizontal braces should be installed just below the surface from above. The operator should go down in the trench with the help of a ladder which is long enough to install the next lower brace or trench jacks, etc. Thus, the trench is made safe for him to descend to install additional horizontal braces. The trench jacks or horizontal braces should never be used as a ladder for getting in or out of a trench, as they are not designed to take vertical load. (The erection of shoring and timbering shall be as per IS:3764 for Hard Soil, Soil which may crack or crumble, loose sandy or soft soil or soil which has been previously excavated, soil under hydraulic pressure respectively).

viii) **Sheet Piling:** In case of deep and wide open cut excavation, sheet piling may be followed for side protection. The piles may be of timber, concrete or composite material depending upon the depth of excavation and life of sheet piles required (the sheet piling shall be done as per IS:2314)

ix) **Removal:** When the removal of shoring is planned, the possible collapse of trench sides should be anticipated. The newly installed utility line will then be safeguarded in the normal course by being covered with loose or

compact fill before shores are removed. If the trench is likely to cave or shelter in on removal of the shores, it can be filled up to the bottom of the horizontal braces. It is a safe way for the workers to go down on the ladder and remove this brace, after which additional trench space can be filled up to the next horizontal brace or screw jack.

If the trench is to stay after the removal of shoring, the latter should not be removed till all work within the trench is completed and the newly installed utility line has been protected or covered.

A worker can then use a ladder to descend to the bottom of the horizontal trench jack and remove it. The remaining horizontal jacks should be removed as he ascends the ladder. The removal of shoring is a hazardous work. A worker should never be permitted to engage in this work single handed.

x) **Minimum Berm:** A provision of clear berm of a width not less than one-third of the final depth of excavation is recommended to keep away the excavated material from falling into the trench.

In areas where this width of the berm is not feasible, the reduced berm width of not less than 1 meter should be provided. It is always better to provide substantial toe board to prevent roll back into the trench.

xi) P**lant and Machinery:** The excavating equipment should be parked at distance of not less than the depth of the trench or at least 6 m away from excavated sides for trenches deeper than 5m.

With the use of power shovels, the banks of trenches become unstable and thus dangerous for the persons working nearby. These conditions should be watched and suitably remedied.

The vehicles should not be permitted to be driven too close to the pit. Care should be taken for loading roads leading to or from the pit. While loading manually, the vehicle should not be taken too near the wall of the

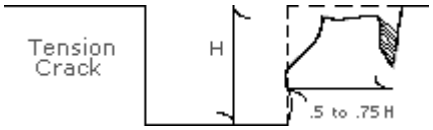
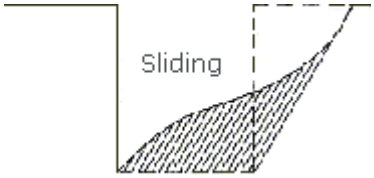
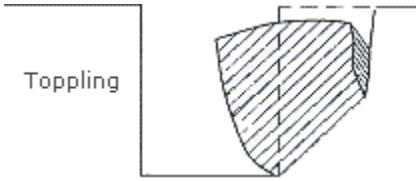
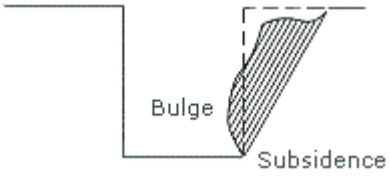
pit. Use of stop logs or blocks will reduce risk of accidents where the vehicle is reversed for loading.

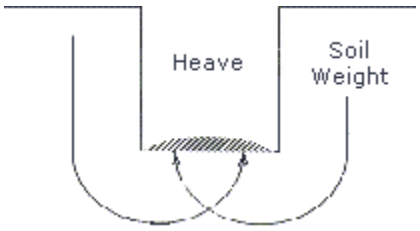
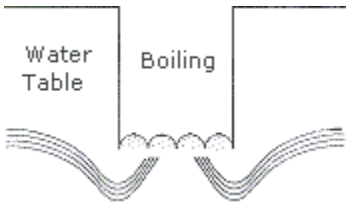
9.0 Monitoring and Reviewing

Frequency	Daily and before the start of each shift	After every rain
Mechanism	Inspection	Examination of • soil condition, • condition of side slope, benching and shoring, • fissures, tension cracks, sloughing, undercutting • water seepage, bulging at the bottom, water logging • any indication of change or movement in adjacent structures. Fresh work permit to be issued after rain.
Record	Inspection Record	Inspection Record
Responsibility	Executing departme nt, Consultan ts, Contractors	Contractors Consultants, Executing department

ANNEXURE-I :

CAVE-IN HAZARDS

a) **TENSION CRACKS**. Tension cracks usually form at a horizontal distance of 0.5 to 0.75 times the depth of the trench, measured from the top of the vertical face of the trench. See the accompanying drawing for additional details.	
b) **SLIDING** or sluffing may occur as a result of tension cracks, as illustrated below.	
c) **TOPPLING**. In addition to sliding, tension cracks can cause toppling. Toppling occurs when the trench's vertical face shears along the tension crack line and topples into the excavation.	
d) SUBSIDENCE AND BULGING. An unsupported excavation can create an unbalanced stress in the soil, which, in turn, causes subsidence at the surface and bulging of the vertical face of the trench. If uncorrected, this condition can cause face failure and entrapment of workers in the trench.	

e) HEAVING OR SQUEEZING. Bottom heaving or squeezing is caused by the downward pressure created by the weight of adjoining soil. This pressure causes a bulge in the bottom of the cut, as illustrated in the drawing above. Heaving and squeezing can occur even when shoring or shielding has been properly installed.	
f) BOILING is evidenced by an upward water flow into the bottom of the cut. A high water table is one of the causes of boiling. Boiling produces a "quick" condition in the bottom of the cut, and can occur even when shoring or trench boxes are used.	

ANNEXURE-II:

CLEARANCE FORM FOR MECHANISED EXCAVATION/GRADING

Project / Job :					
Location :					
Drawing indicating Under Ground Services in the area					
Sl.No.	Drawing Number			Remarks	
1					
2					
Excavation plan showing the layout of trial trench					
Sl.No.	Drawing / Sketch Number			Remarks	
1					
2					
Note : Excavation plan is to be prepared by the Contractor and to be approved by Consultant and Plant engineer					
Use of Cable Detector					
Used before start of Trial Trench				Y / N	
Used inside trial trench, bottom and side wall				Y / N	
Findings by visual inspection of trial trench and/or by cable detector					
Electric Cables	Y / N	Supported / Diverted / Defunct		Telephone Cables	Y / N	Supported / Diverted / Defunct
FO Cables	Y / N	Supported / Diverted / Defunct		Water Pipe lines	Y / N	Supported / Diverted / Defunct
Storm water pipes	Y / N	Supported / Diverted		Sewer Line	Y / N	Supported / Diverted

		/ Defunct				/ Defunct

Declaration

Trial trench excavated upto a minimum depth of 1500 mm manually. Clearance is hereby given to the contractor to proceed with mechanized excavation/grading upto a depth of 1200mm, after ensuring cables/pipes/structures in use do not exist in the area earmarked for excavation.

Department	Name	Signature	Date	Remarks
Electrical				
Mechanical				
i) Other departments				
ii) Other departments				
ITS				
Telecommunication				
Consultant				
Executing agency				

- It is possible that in spite of tests and investigations conducted ,there may still be certain services remain in the area .The contractor shall therefore, be vigilant during mechanized excavation and shall inform Plant/Consultant on finding any services in course of excavation/grading.
- Plant/ConsultantengineershallinformrespectiveownerandProjectManagerincaseofpunctureofanycable /pipes/structure as applicable.

ANNEXURE-III:

APPROVAL FROM A COMPETENT PERSON OR COMPETENCY TEAM ON EXCAVATION

Project / Job :	
Location :	

Check before Excavation	
Items	**Remarks**
Foundation Drawing and other related civil drawings	
Soil test report and recommendations of soil testing agency	
Soil condition – Loose, Backfilled, fissures, Rain cuts etc.	
Adjacent Structures	
Foundation drawings of adjacent Structures	
Adjacent Water bodies	
Adjacent railway trucks or HT Lines	
Plan for excavation equipment	
Plan for protection against potential soil collapse	
Work schedule for excavation and concreting inside pit.	

Recommendations :				
Name:		**Signature**		**Leader**
Name:		**Signature**		**Member**
Name:		**Signature**		**Member**
Name:		**Signature**		**Member**
Name:		**Signature**		**Project Team Representatives**
Name:		**Signature**		**Consultant**

ANNEXURE-IV: EXCAVATION INSPECTION REPORT

Project / Job :	
Location :	
Depth of excavation	

SOIL		SOIL			
LOOSE		HARD		CRACKED	
BACKFILLED		SOFT		RAIN-CUT	
MICA-SCHIST		WET		UNDER CUT	
COHESIVE SOIL		DRY			
GRANULAR					
DRY ROCK					

EXCAVATED PIT				
	GOOD	REJECTED	N/A	REMARKS
SLOPE RATIO				
SHORING				
SHIELDING				
BARRICADES				
WATER REMOVAL				
TRAFFIC CONTROL				
SPOIL PILE				
SIDE WALL OF PIT				
STABILITY OF ADJACENT				
RECOMMENDATIONS :				
SIGNATURE:		NAME:		
		DATE:		

Reference: IPSS: 1-11-031-17

TSL Safety Standard, SS/ENGG-04