TECHNICAL STANDARD (TS)

EXCAVATION AND PILING SAFETY

Prepared by	Reviewed and verified by	Authorized by
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1. PURPOSE

This standard is for the protection of persons from injury and illness and the protection of property (including equipment) during excavation & piling works.

This procedure establishes the requirements for excavating, trenching, and shoring. It includes such operations as spiking; driving of poles, piles, and pipes; chasing; and excavations.

The Standard also describes the systematic approach for planning and executing excavation & piling works including the practices and procedures necessary for carrying out safely.

2. SCOPE

This standard also applies to all open excavations made in the earth's surface and piling works.

This procedure shall apply to all AMNS project sites and related work areas including subcontractors to meet –

- Legal and regulatory requirements
- AMNS HSE requirements
- The BOCW Act, 1996
- Gujarat State BOCW Rules, 2003
- 29 CFR 1926.652
- ISO 45001 and ISO 14001 standard requirements
- Company HSE Policy

3. DEFINITIONS AND ABBREVIATIONS

3.1. DEFINITIONS

Accepted engineering practices means those requirements which are compatible with standards of practice required by a registered professional engineer.

Actual slope: The slope to which an excavation face is excavated.

Aluminium Hydraulic Shoring means a pre-engineered shoring system comprised of aluminium hydraulic cylinders (cross braces) used in conjunction with vertical rails (uprights) or horizontal rails (walers). Such system is designed, specifically to support the sidewalls of an excavation and prevent cave-ins.

Authorised Gas Tester: Authorised Gas Tester shall be

- Equipped with the knowledge to use the multi gas detector to conduct gas tests for oxygen levels, flammable and toxic gas safely
- Trained and skills must be assessed either internally or through approved training consultant.

Bell-bottom pier hole means a type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a belled shape.

Benching (Benching system) means 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. Benching – A method of

protecting employees from cave-ins in Class A or B soil (benching is not allowed in Class C soil) by shaping the sides of an excavation to form one or more horizontal levels or steps, usually with vertical or near-vertical surfaces between levels

Backfilling: It is an activity to fill in (with soil) a trench that is no longer needed and returning the area around its original condition.

Cave-in means the separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

Competent person means one who can identify existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Cross braces mean the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or Wales.

Excavation means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal. Relatively large volume of earth is involved. Generally, have relatively equal dimensions of width and length. Depth will vary but usually is lesser than the smaller dimension. Used for basements, installation or maintenance of underground tanks and pipelines, piling, culverts, and larger spread footings. Size generally makes sloping of banks more economical than shoring.

Note: An excavation is defined as any ground breaking with power or hand tools, including removal of slabs on-grade and blacktop. At the discretion of the construction supervisor, small ground breaking penetration, such as the driving of concrete form stakes, may be excluded from this definition provided the total depth of the penetration does not exceed 15 centimetres.

Faces or sides means the vertical or inclined earth surfaces formed because of excavation work.

Failure means the breakage, displacement, or permanent deformation of a structural member or connection to reduce its structural integrity and its supportive capabilities.

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

Kickout means the accidental release or failure of a cross brace.

Maximum allowable slope: The steepest incline of an excavation face that is acceptable for the most favourable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

Manual Excavation: The Excavation work without using power equipment or excavating machinery such as backhoe, loader, Jack Hammer etc.

Mechanical Excavation: The Excavation work with using powered equipment or excavating machinery such as backhoe, loader, Jack Hammer etc.

Metal Detector: It is a device to screen the excavation area to mitigate the risk of damaging unknown pipelines, cable and utilities.

Protective system means 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.

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

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

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

Shield (Shield system) means a structure that can withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either pre-manufactured or job-built in accordance with Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

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

Sloping (Sloping system) means a method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation to prevent cave-ins. The angle of incline 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.

Stable rock means natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is 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 registered professional engineer.

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

Structural ramp means a ramp built of steel or wood, usually used for vehicle access. Ramps made of soil or rock are not considered structural ramps.

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

Trench (Trench excavation) means 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 than 15 feet (4.6 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

Trench -Generally long, narrow, and deeper than its width, but the width of a trench is not greater than 4.5 Meters (15 feet). Relatively small volume of earth involved. Used for installation or maintenance of underground pipelines, conduit, cables, or footings for buildings without basement. Size generally makes shoring more economical than sloping of banks.

Trench Shield: A structure that protects personnel inside it by withstanding the forces imposed by sidewall cave-in of two (2) sides.

Uprights means the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. Uprights placed so that individual members are closely spaced, in contact with or interconnected to each other, are often called "sheeting."

Wales means horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth. A longitudinal member of shoring and timbering which directly resists pressure from sheathing

3.2. ABBREVIATIONS

HSE	:	Health Safety and Environment
PPE	:	Personal Protective Equipment
TBT	:	Toolbox Talk
PTW	:	Permit To Work
TS	:	Technical Standard
JSA	:	Job Safety Analysis
IS	:	Indian Standard
BOCW	:	Building & Other Construction Work
Ft	:	Feet
H	:	Horizontal
V	:	Vertical
Kpa	:	Kilo Pascal
Tsf	:	Tonnes per square feet
mm	:	millimeter
PH	:	Project Head

4. ROLES & RESPONSIBILITIES

The Project Head and the Site HSE Manager are responsible for ensuring that the project is in compliance with the requirements those mentioned in this Standard.

4.1. Project Head (PH)

Project Head has the responsibility to implement this standard.

- He is responsible for the management of all excavation activities on the site.
- The places where demolition is performed with respect to criteria indicated in this standard to control associated hazards with respect to access and working at elevated workplace.
- Conduct risk assessment for each such elevated work area and identify potential hazards and control measures required.
- List out the gaps at each of such sites, finalize improvement plan as per priority based on level of risks and implement.
- Ensure implementation of Permit to Work system for all kind of excavation job which meets work at height criteria. Ensure that those involved in such activities are medically fit, appropriately trained and competent. Ensure that all management personnel are aware of and follow the requirements.
- Provide personal protective equipment (PPE), adequate control measures to prevent fire; and
- Maintain periodic inspection and assurance processes.
- Management of all excavation activities on the site.
- Ensuring excavation work in safe manner.

4.2. Sectional Heads are responsible to ensure consistent implementation and enforcement of this standard.

4.3. Line Management ((Field Executives)

- HIRAC and Job Safety Analysis (JSA) is prepared
- To ensure that all provisions and requirement for controlling risks of Excavation work are implemented
- Ensure adherence to PTW system
- Carry out a prior survey of the area to establish presence of underground utilities;
- Evaluate the effects on buildings or constructions nearby;
- Establish ground conditions, compaction qualities and water table;
- Identify the presence of any overhead-underground utilities and its permits;
- Adjacent operations personnel Safety briefing;
- Stop the work in emergency
- Brief about safe working practices of Excavation to crew involved
- Provision of equipment its maintenance and certification.
- Provision of Barriers, Flashing lights and Signs.
- Provision of access while carrying trenches work

- Ensuring that the Excavation & Piling procedures are being followed by all employees engaged in the excavation activities;
- Ensuring only trained employees perform mechanized excavation
- Ensuring that employees are provided with PPE as necessary before the start of excavation activities.
- Ensure availability of ramps as a means of access or egress from an excavation.
- Monitor water removal operations for control or prevention of accumulation of water in an excavation.
- Evaluate excavations more than 1.5 meters (5 feet) deep for the application of a protective (Shoring) system
- Ensure ground markings identifying underground obstructions are present.
- Conduct daily inspections of excavations, adjacent areas, and protective systems for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, and for hazardous atmospheres or other hazardous conditions. Inspections will be conducted before employees enter excavations or trenches, as well as after every rainstorm or other potential hazard-increasing event.
- Testing for hazardous atmospheres when such atmospheres exist or are reasonably likely to exist.
- Follow the checklists for inspections, and document results on an inspection log.
- Maintain daily inspection logs at the site until the field work is completed.
- When inspection reveals evidence of a situation that could result in a possible cave in, indications of protective systems failure, hazardous atmospheres, or other hazardous conditions, remove employees from the hazardous area until the necessary precautions have been taken to ensure their safety.
- Promptly take whatever measures are appropriate to correct or eliminate potentially hazardous conditions associated with the excavation before any additional work in that section of the excavation

4.4. Employees (Workers)

- Workers involved in excavation activities shall comply with all applicable requirements contained in this Standard and with the specific PTW
- Employees shall immediately report any potential hazard to their supervisor for appropriate corrective action.

4.5. HSE Staff is responsible for

- Conduct Periodical inspection of excavation
- Check adherence to PTW
- Advice to Engineer / Supervisor for corrective measures.
- Input to Site Specific Risk Assessment & JSA
- Ensure and verification of Approval and authorization of excavation.
- Authority to stop work

5. EXCAVATION AND PILING – SAFETY ASSURANCE PROCESS

5.1 HAZARDS ASSOCIATED WITH EXCAVATIONS AND PILING

The hazards associated with excavation are:

- Fall of persons/ equipment/ vehicles in to excavated area
- Falling material rolling from the top edges over personnel
- Collapse of structures while excavating under/ near structures
- Oxygen deficiency/ presence of toxic substances
- Improper access/ egress leading to slip/trip/ fall
- Poor communication
- Improper illumination
- Breaking of pipelines/ electrical cables (Underground services)
- Cave in of trench/ excavation
- Seepage of water/ water flooding (Surface and ground water)
- Reptile/ scorpions

The hazards associated with piling are:

- Fall of persons in to pile hole
- Improper ground conditions due to slurry/ mud causing slip/ trip/ fall
- Breaking of pipelines/ electrical cables (Underground services)
- Failure of rig machine components posing drop object hazards
- Toppling of rig machine
- Poor communication between rig operator and crew
- Caught by rotating parts/ caught between piling components

5.2 GENERAL HSE REQUIREMENTS FOR EXCAVATION/ PILING

- No excavation work shall be carried out without Permit To Work (PTW).
- Obtain piping and underground cable diagrams from relevant departments/ authorities and ensure the area to be excavated is free from pipe line/ electrical cables. Use cable detector if required for such purposes where ever applicable.
- The swing radius of the excavator/pile rig shall be barricaded to prevent unauthorized entry.
- Prior to shifting a excavator / pile rig machine, the ground level should be checked for firmness. Approach should be well compacted and free from sludge and mud.

5.2.1 EXCAVATION

- The sides of all excavation to be hard barricaded 1meter away from the edge, along with warning tape or other protective means and to provide suitable warning signs and warning lights to ensure personnel, vehicles or equipment do not fall into an excavation.
- Take adequate measures to protect persons from loose rock or soil that could pose a hazard by falling or rolling from the excavation face. As an example, keep all equipment

at least two meters from the edge of the excavation or use retaining devices on the surface of the walls of excavations. Excavated earth shall not be stored close to the trench edges and a minimum distance of at least one and a half times the depth of the trench or 1.5 meters shall be observed.

- The sides of trench shall be adequately shored where material can fall onto a person working inside the trench, because of the nature, shape and slope of excavation.
- Stop work and reported immediately to the Section Head/ HSE Officer if buried cables or pipelines unexpectedly encountered during excavation work.
- In hazardous areas all excavations of 1.2 meters or more in depth should be treated as confined space and a confined space entry certificate must be obtained, because of the potential for presence of flammable and/or toxic gases and oxygen deficiency. Gas testing shall be conducted if required.
- Personnel shall not be permitted to work in any excavation if fumes are present.
- Ladders used as access ways shall extend from the bottom of the excavation to not less than 3 feet above the surface.
- When persons are working in excavations a responsible person (Banksman/ Buddy) shall attend at all times to ensure that safe working practices are used.
- Walkways or bridges with standard guardrails shall be provided where the people or equipment are required or permitted to cross over excavations.
- Where personnel are required to enter excavations over 2 feet depth, sufficient steps/ stairs/ ramps or ladders shall be provided.
- Personnel shall stand away from vehicles being loaded or unloaded to avoid being struck by spillage of falling materials.
- Excavation close to any scaffold or structure prohibited.
- Seepage water shall be removed continuously. Risk assessment shall be carried out as the work progressing and personnel shall be allowed to work inside the excavation only if it is safe to enter.
- Trucks / dumpers used for the removal of soil will be controlled by a banks man and will be placed at least at 2 metres from the excavation.
- Risk of Water flooding shall be assessed during/after heavy rains prior to recommence the work inside the excavation.
- Personnel engaged in hand digging operations will be briefed on the actions to be taken when uncovering marker tiles, cables, pipework etc; and should be provided with insulated hand tools like shovel, crow bar etc.
- For any excavations beyond 5m depth, an excavation scheme is required.

5.2.2. PILING

- Piling rig shall not erect in dangerous proximity to Overhead power lines.
- Piling rigs shall not be marched with mast in upright position.
- Piling rigs shall be positioned on stable ground or on metal sheets for stability.
- Experienced and authorized operator only to operate piling rigs
- Inspected and approved piling rigs only to be deployed
- All bolts and nuts which are likely to get loosened due to vibration during pile driving shall be checked prior to start on daily basis and tightened accordingly
- All hoses/ clamps shall be inspected for integrity on daily basis by operator

- The hoses used for supplying bentonite solution from tank to bored pile shall be connected through proper hose connector and further tightened using hose pipe clamp.
- Portable hard barricades should be used in all piling activities. A casing also can be used as barricade, by raising it to 1m above ground level. After removing the casing from bore, hard barricade or grating should be provided till bore is back filled completely.
- No manual intervention is allowed in cage handling with piling rig.

5.2.3. WATER ACCUMULATION

Employees will not work in excavations where water is accumulating unless adequate precautions are taken to protect them against the hazards posed by water accumulation. If water accumulation is controlled or prevented by water removal equipment, the supervisor must monitor the removal activities.

5.2.4. ENDANGERED ADJACENT STRUCTURES

If an excavation or trench endangers the stability of buildings or walls shoring, bracing, or underpinning will be provided. Excavations and trenches that are adjacent to backfilled excavations or trenches, or subject to vibrations from railroad or highway traffic, or the operation of machinery (such as shovels, derricks, cranes, and trucks), must be made safe by a support system, shield system, or other protective systems (such as sheet pile shoring or bracing).

5.2.5. BARRICADES AND SIGNAGE

Barricades are erected with "Danger" signs boards and tags at all excavated / piling locations.

Barriers and signs will be erected to keep unauthorised personnel clear; they will be placed at 1m from the excavated edge.

5.2.6. FALL PROTECTION

Fall protection shall be provided for employees under the following conditions

- If a vertical excavation is 1.8 meters (6 feet) or more in depth
- For shafts, pits, and wells that are1.2 meters or more in depth

Fall protection for employees exposed to the above conditions must be implemented.

Only authorised worker shall be allowed to work near a bored pile. Such workman shall wear a full body safety harness secured to a concrete square block (having anchorage facility/arrangement) having minimum dimension of 1200mm X 1200mm X 200mm. The concrete block shall be secured in its position, such that it does not move from its position due to jolts. Such concrete block shall be kept a minimum distance of 1.5 m away from the edge of the bored pile.

For temporary situations (such as an open excavation with vertical walls 1.8 meters (6 feet) in depth or more that is occupied for a short period of time), physical barriers or personal fall arrest/restraint systems are provided. Shafts, wells, and pits are covered and barricaded, and the covering is labelled "Hole Covering – Do Not Remove"

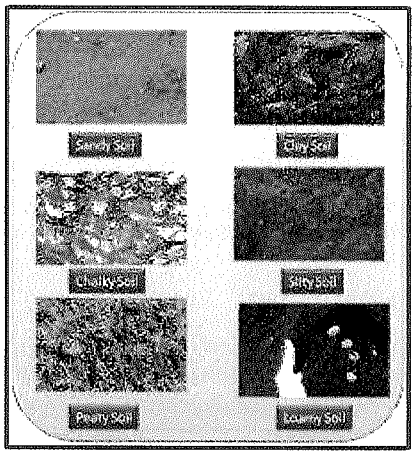
5.3 SOIL CLASSIFICATION

When using protective systems, each soil and rock deposit must be classified by a Competent Person as "Stable Rock, Type A, Type B, or Type C." The classification will be made based on the results of at least one visual and at least one manual analysis conducted by the Competent Person.

Manual tests will consist of soil plasticity dry strength, thumb penetration, pocket penetrometer, or result from a hand-operated shear vane. Manual tests will be documented, signed, and dated by the Competent Person conducting the test(s).

The soil classification system means a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability.

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



Type A Soil means cohesive soils with an unconfined compressive strength of 1.5 ton per square foot (tsf) (144 kPa) or greater. Examples of cohesive soils are clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered Type A. However, no soil is Type A if:

- The soil is fissured; or
- The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or
- The soil has been previously disturbed; or
- The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater; or
- The material is subject to other factors that would require it to be classified as a less stable material.

Type B Soil means:

- Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or
- Granular cohesionless soils including angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.
- Previously disturbed soils except those which would otherwise be classified as Type C soil.

- ❖ Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or
- ❖ Dry rock that is not stable; or
- ❖ Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontals to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

Type C Soil means:

- ❖ Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; or
- ❖ Granular soils including gravel, sand, and loamy sand; or
- ❖ Submerged soil or soil from which water is freely seeping; or
- ❖ Submerged rock that is not stable; or
- ❖ Material in a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or steeper.

Unconfined compressive strength means the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, or estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

Wet soil means soil that contains significantly more moisture than moist soil, but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit cohesive properties when moist will lose those cohesive properties when wet.

5.4 SLOPING & BENCHING

Maximum allowable slope. The maximum allowable slope for a soil or rock deposit shall be determined. Actual slope shall not be steeper than the allowable slope.

The actual slope shall be less steep than the maximum allowable slope when there are signs of distress. If that situation occurs, the slope shall be cut back to an actual slope which is at least ½ horizontal to one vertical (½ H:1V) less steep than the maximum allowable slope.

When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope and shall assure that such reduction is achieved. Surcharge loads from adjacent structures shall be evaluated in accordance with "Stability of adjacent structures."

Soil or Rock Type	Maximum Allowable Slope (H:V) For Excavation less than 20 Feet
Stable Rock	Vertical (90° sides)
Type A Soil	¾ foot to 1 foot (53° sides)
Type B Soil	1 foot to 1 foot (45° sides)
Type C Soil	1-½ foot to 1 foot (34° sides)

Notes :

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.

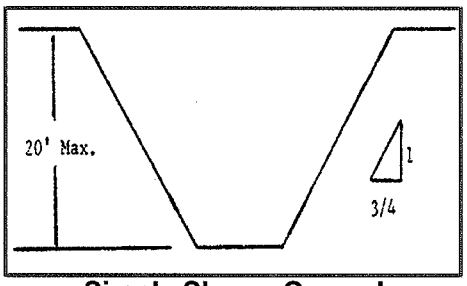
2. A Short-term maximum allowable slope of ½ H:1V (630) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum slopes for excavations greater than 12 feet (3.67 m) in depth shall be ¾ H:1V (530)
3. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

Slope Configurations:

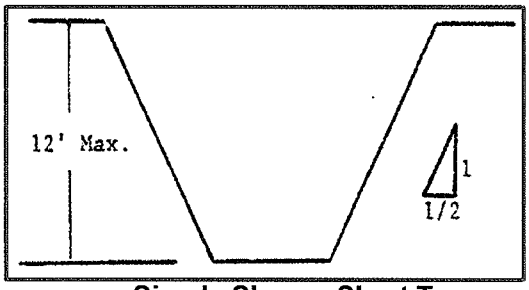
Excavations made in Type A soil.

All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of ¾ :1.

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of ½ :1.

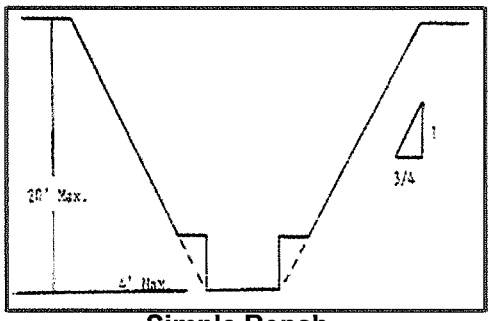


Simple Slope - General

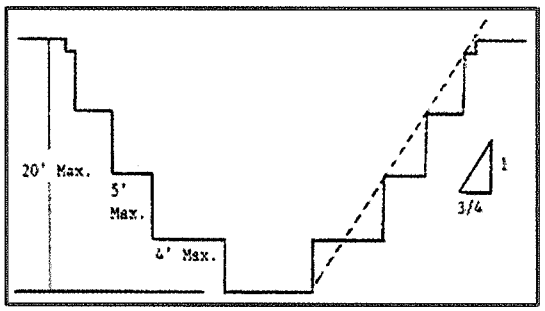


Simple Slope – Short Term

All benched excavations 20 feet or less in depth shall have a maximum allowable slope of ¾ to 1 and maximum bench dimensions as follows:

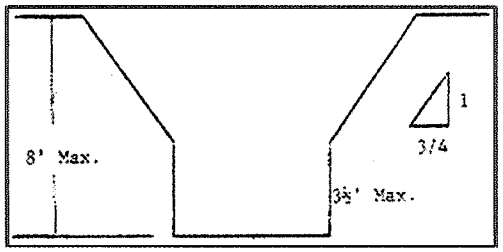


Simple Bench

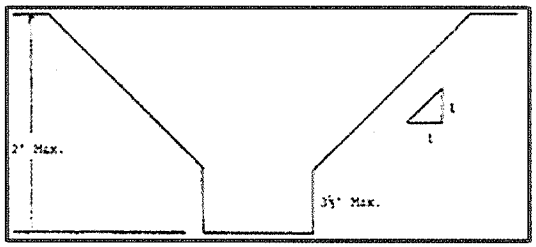


Multiple Bench

All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3½ feet.



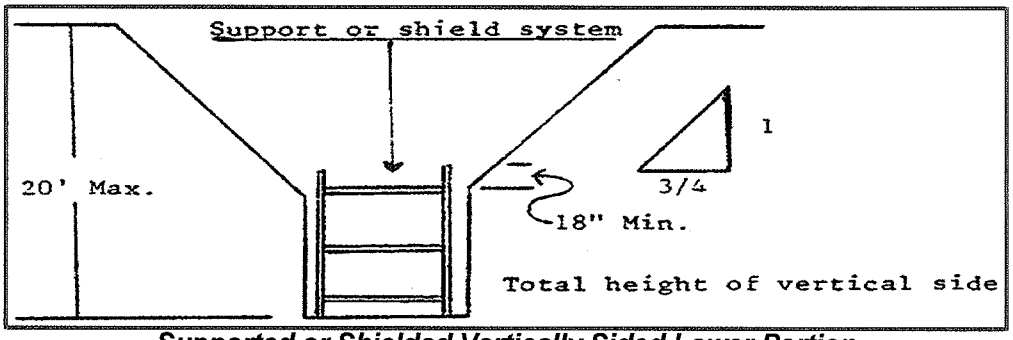
Unsupported Vertically Sided Lower Portion - Max. 8 feet in Depth



Unsupported Vertically Sided Lower Portion- Max. 12 feet in Depth

All excavations more than 8 feet but not more than 12 feet in depth which unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3½ feet.

All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under Requirements for protective system.

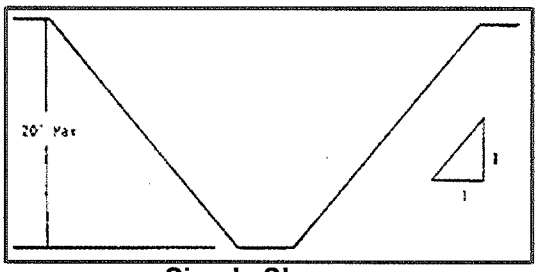


Supported or Shielded Vertically Sided Lower Portion

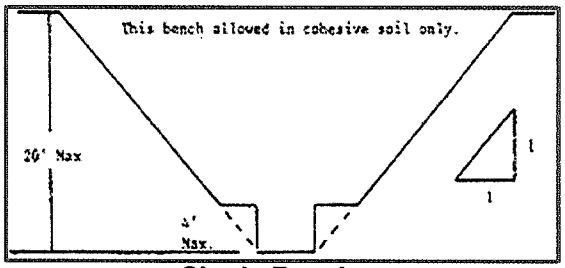
Excavations Made in Type B Soil

All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.

All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:



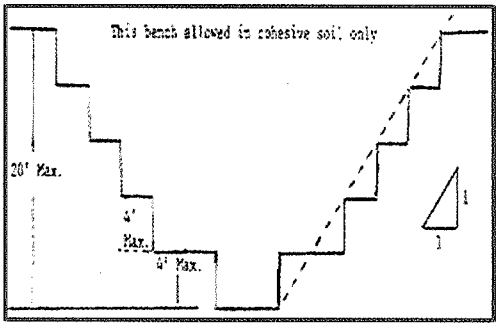
Simple Slope



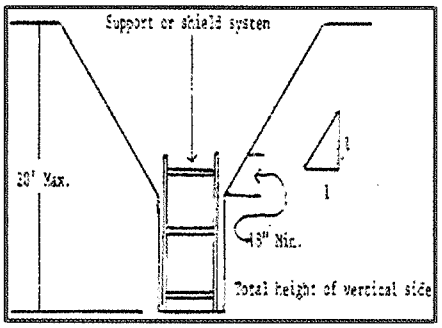
Single Bench

All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.

All other sloped excavations shall be in accordance with the other options permitted in Requirements for protective system.



Multiple Bench



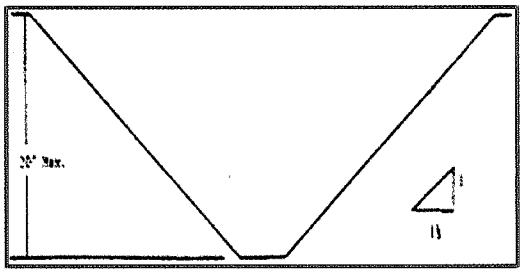
Vertically Sided Lower Portion

Excavations Made in Type C Soil

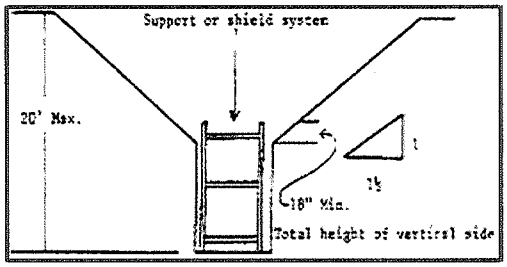
All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.

All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.

All other sloped excavations shall be in accordance with the other options permitted in Requirements for protective system.



Type C - Simple Slope

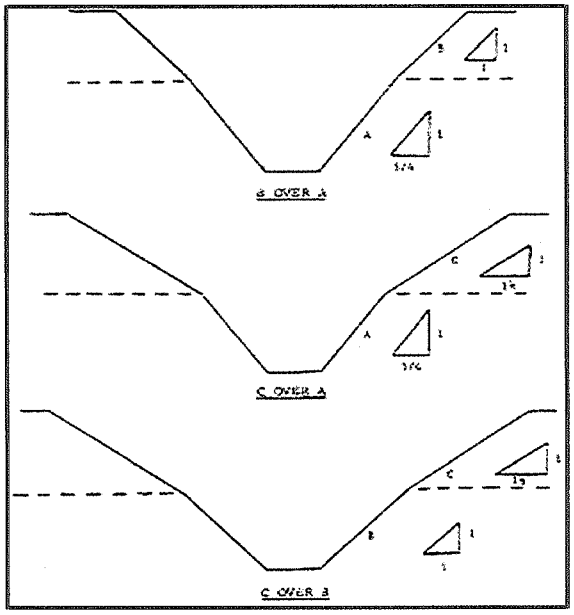


Type C- Vertical Sided Lower Portion

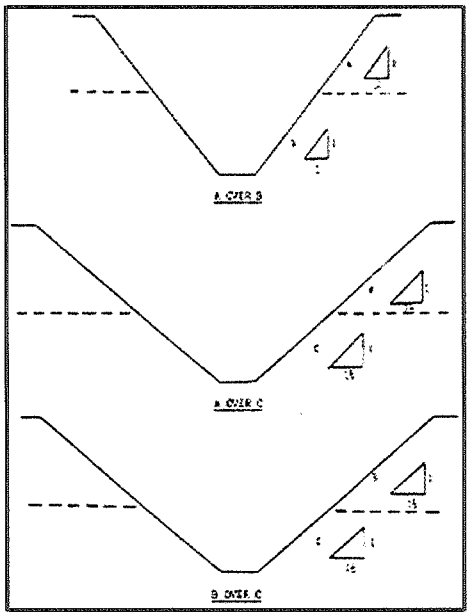
Excavations made in Layered Soil

All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below.

All other sloped excavations shall be in accordance with the other options permitted in Requirements for protective system.



Excavations made in layered soil

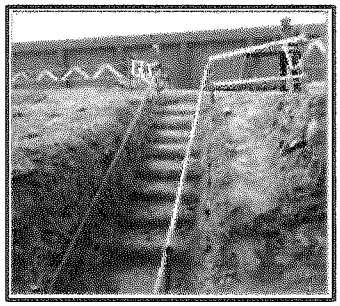


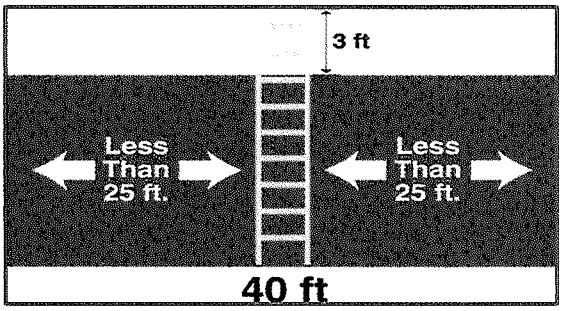
Excavations made in layered soil

5.5 HSE CONSIDERATION IN EXCAVATION ACTIVITY

5.5.1 General Excavation Requirements

Access and Egress





Access and Egress

- In trenches 1.2 meters (4 feet) or more in depth, ladders, steps, ramps, or other safe means of access/egress will be provided and located no more than 7.6 meters (25 feet) apart laterally. If ladders are used, the ladder will extend 1.0 meter (3 feet) above the original surface of the ground and must be secured.
- Walkways, ramps, or bridges with standard guardrails will be provided at all excavations and trenches where employees may cross over. The crossing structure will be made of tightly secured and uniformly sized planking or other similar material.

Using excavation machinery:

The use of excavating machinery (such as backhoe, hack hammer, loader etc) near above / underground services will require Excavation Permit. The following precautions are to be taken while using mechanical means of excavation:

- Extreme care shall be taken to prevent any damage to above / underground services or power lines while using mechanical excavators;
- A mechanical excavator shall not be used until all underground obstructions have been uncovered through manual excavation
- The machinery operator shall follow banksman instruction while turning the excavator to prevent any accidental strike to the workers or equipment at location
- The bucket must always be lowered to the ground when equipment not in operation.
- The machinery operator shall take necessary care to prevent exhaust gases entering the nearby trench or pit, in case personnel are working inside it.

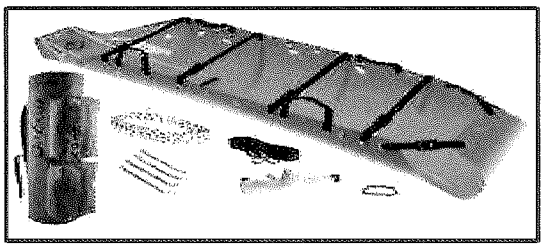
Hazardous Atmosphere

Testing and controls. In addition to the requirements set forth in and) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements shall apply:

- Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than 4 feet (1.22 m) in depth.

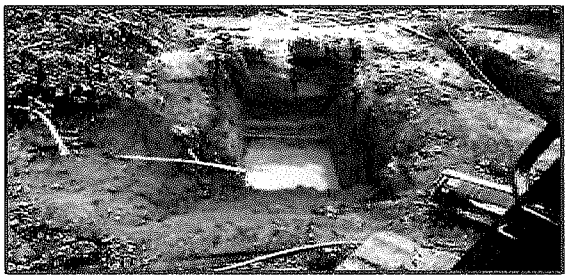
- Adequate precautions shall be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous atmospheres. These precautions include providing proper respiratory protection or ventilation in accordance with and respectively.
- Adequate precaution shall be taken such as providing ventilation, to prevent employee exposure to an atmosphere containing a concentration of a flammable gas more than 20 percent of the lower flammable limit of the gas.
- When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.

Emergency Rescue Equipment:



- Emergency rescue equipment, such as breathing apparatus, a safety harness and life 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.
- Employees entering bell-bottom pier holes, or other similar deep and confined footing excavations, shall wear a harness with a lifeline securely attached to it. The lifeline shall be separate from any line used to handle materials

Protection from hazards associated with water accumulation / Dewatering



Water accumulation in excavated pit

- Employees shall not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation and cave-in.
- If water spills controlled or prevented from accumulating using water removal equipment, the water removal equipment and operations shall be monitored by a competent person to ensure proper operation.

- If excavation work interrupts the natural drainage of surface water (such as streams), diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering the excavation and to provide adequate drainage of the area adjacent to the excavation.
- Excavations subject to runoff from heavy rains will require an inspection by a competent person and compliance with of this section.
- For dewatering purpose, use of submersible electric pump is prohibited.

Stability of Adjacent structures

Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of employees.

Excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees shall not be permitted except when:

- A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure; or
- The excavation is in stable rock; or
- A structural engineer has approved the determination that the structure is sufficiently removed from the excavation to be unaffected by the excavation activity; or
- A structural engineer has approved the determination that such excavation work will not pose a hazard to employees.

Sidewalks, pavements, and appurtenant structure shall not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures.

Protection of employees from loose rock or soil.

Each employee in an excavation must be protected from cave-ins by adequate and approved protection systems.

Protection systems must have the capacity to resist all loads that are intended, or could reasonably be expected, to be applied or transmitted to the system.

- Adequate 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 scaling to remove loose material; installation of protective barricades at intervals as necessary on the face to stop and contain falling material; or other means that provide equivalent protection.
- Employees shall be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations. Protection shall be provided by

placing and keeping such materials or equipment at least 2 feet (.61 m) from the edge of excavations, or by the use of retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations, or by a combination of both if necessary.

Sides, slopes, and faces of all excavations will be scaled, benched, rock-bolted, wire-meshed, or secured by other approved equally effective means. Portable trench boxes or sliding trench shields may be used instead of shoring or sloping. Such boxes or shields must be of strength at least equivalent to the sheeting or shoring that would be required for the composition of the soil or material in which the trench is being made. The requirements below, for the appropriate option, must be followed and properly documented

Backfilling and Reinstatement

Backfill operations shall be carried out in accordance with the following guidelines.

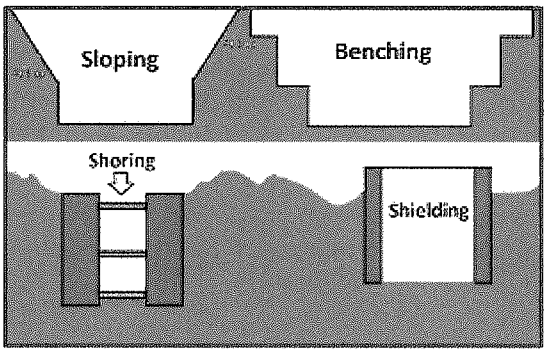
- Backstops will be provided for vehicles dumping material to prevent them over running the edge;
- Consideration will be given to the specification for compaction qualities, need for tile markers and tiles and other protection measures necessary for the protection of equipment;
- Redundant soil not backfilled will be removed to an area identified in advance;
- A Safe system of work will be identified and implemented for the removal of timber supports, steel sheeting and piles. Consideration will include provision of lifting appliances suitable to take the load of embedded sheet piles without damage.

Inspection

- Daily inspections of excavations, the adjacent areas, and protective systems shall be made by the supervisor 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 as per PTW checklist and as needed throughout the shift. Inspections shall also be made after every rain/ storm.
- Employees shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.
- All materials to be used in shoring & support must be inspected for its suitability
- The timbering and shoring must be checked for any strain or slackness before commencement of daily work. They must also be checked carefully after heavy rains and or exposure to high temperature.
- If an unsafe conditions is found or suspected, work in trenches must stop until the necessary precautions have been taken to control the hazards.

Design of sloping and benching systems.

The slopes and configurations of sloping and benching systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements as follows:



Design of Sloping and Benching Systems

Installation and removal of support

General.

- Members of support systems shall be securely connected to prevent sliding, falling, kickouts, or other predictable failure.
- Support systems shall be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.
- Individual members of support systems shall not be subjected to loads exceeding those which those members were designed to withstand.
- Before temporary removal of individual members begins, additional precautions shall be taken to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.
- Removal shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.
- Backfilling shall progress together with the removal of support systems from excavations.

Confined Space

All trenches and excavation1.2 meters (4 feet) or deeper will be assessed regularly for designation as a confined space in accordance with Procedure Confined Space Entry.

In such situations the requirement as applicable to Confined Space Entry Permit will be adhered. Designation, monitoring, emergency preparedness, etc., will be implemented based on entry permit requirements.

Dust

Airborne dust will be kept to a minimum by the use of water or other means.

5.6 HSE CONSIDERATION IN PILING OPERATION

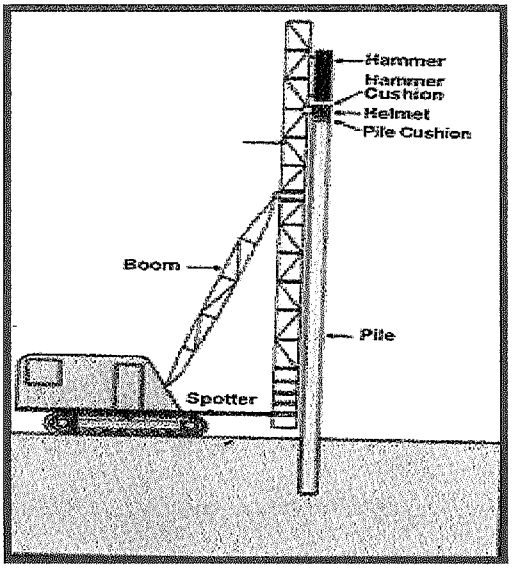
5.6.1. Piling Rig

- Piling rig shall not erect in dangerous proximity to electric overhead power lines.

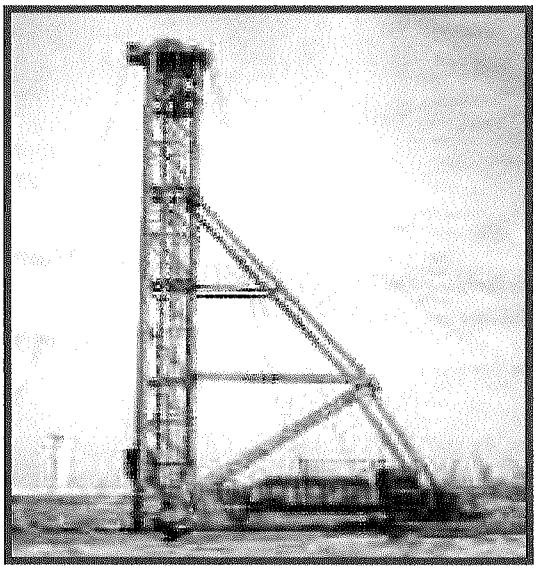
- It two pile drivers are erected at one place shall be separated by a distance at least equal to the longest in either rig.
- The frame of any rig shall be structurally safe for all anticipated dead, live or wind loads. Whenever there is any doubt about the structural strength, suitable test shall be carried out and the results of the test recorded. No pile –driving equipment shall be taken into use until it is inspected and found to be safe.
- Pile drivers shall be firmly supported on heavy timber sills, concrete beds, or other secure foundation. If necessary to prevent danger, pile drivers shall be adequately guyed.
- When the driven piling rig is not in use, extra precautionary measures for stability such as securing them with minimum 4 guys shall be adopted to prevent any accidents due to wind, storm, gales, and earthquake.
- Access to working platform and the top pulley shall be provided by ladders and the work platforms shall be provided with guard rails.
- In tall driven piling rigs or rigs of similar nature where a ladder is necessary for regular use, ladder shall be securely fastened and extended for the full height of the rig. The ladder shall also be always maintained in good condition.
- Exposed gears, fly wheels, etc shall be fully enclosed. Hoisting drums and brakes shall be kept in good condition and sheltered from weather, wherever possible.
- Pile driving equipment in use shall be inspected by a competent engineer at regular intervals not exceeding 3 months. Also, a register shall be maintained at the site of work for recording the results of such inspections. Pile lines and pulley blocks shall be inspected by the person in charge before the beginning of each shift, for any excess wear or any other defect.
- Defective parts of pile drivers such as sheaves, mechanism slings and hose shall be repaired by only competent person and duly inspected by plant & machinery engineer and the results recorded.
- No air equipment shall be repaired while it is operation or under pressure.
- Hoisting ropes on pile drivers shall be of Independent Wire Rope Core (IWRC) type.
- All bolts and nuts which are likely to get loosened due to vibration during pile driving shall be checked regularly and tightened.
- Airlines shall be controlled by easily accessible shut-off valves. These lines shall consist of armored hose or its equivalent. The hose of air hammers shall be securely lashed onto the hammer to prevent it from whipping if a connection breaks. Couplings of hoses shall be additionally secured by clamps, ropes, or chains
- When not in use, the hammer shall be in dropped (down) position and shall be held in place by a cleat, timber, or any other suitable means.
- Hoisting appliances used for the handling piles etc. shall be marked with the safe working load and they shall not be loaded beyond the safe working load except for the purpose of testing.
- Motor gearing, transmission, electrical wiring, and other dangerous parts of the hoisting appliances should be provided with safeguards. Hoisting appliances shall be provided with such means as will reduce, to the minimum, the risk of accidental descent of the load and adequate precautions shall be taken to reduce the minimum,

the risk of any part of suspended load becoming accidentally displaced. Sheaves on pile drivers shall be guarded so that workers may not be drawn into them.

- When loads must be inclined:
  - ❖ They shall be adequately counter-balanced and
  - ❖ The tilting device shall be secured against slipping.
- Adequate precautions shall be taken to prevent a pile driver from overturning if a wheel breaks.
- Adequate precautions shall be taken by providing stirrups or by other effective means, to prevent the rope from coming out of the top pulley or wheel.
- Adequate precautions shall be taken to prevent the hammer from missing the pile.
- If necessary to prevent danger, long piles and heavy sheet piling should be secured against falling.
- Where electricity is used as power for piling rig, only armored cable conforming to the relevant Indian standard shall be used and the cable shall be thoroughly waterproofed.
- The pin of the D-shackle, which connects bailer/chisel and winch rope, is more prone to wear & tear. Frequent check is essential. Further, as the pin is liable to get removed from the shackle; it is preferable to use a shackle which has a provision to lock the pin.



Piling Rig



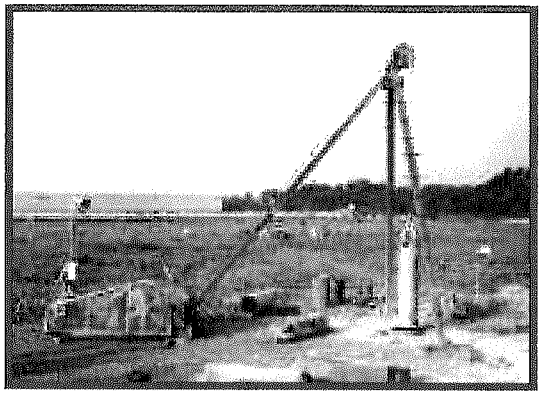
Driven Piling Rig

5.6.2. Bored Piling

Tripod

- Base support of the tripod shall be suitably designed and it shall have adequate length and width.
- Base of the tripod legs shall be anchored in the ground at both ends.

- Fastening arrangement of tripod leg with base support shall preferably have HT bolt and nut with split pin.
- Splice joint is not recommended in the rear leg of the tripod. If the joint is unavoidable, the position of the splice joints should be at the lowest point so that the vibration is minimized. Vibration shall be maximum at the centre. Frequent inspection should be ensured.



Tripod Bored Piling

Winch

- Rotating/moving parts of winch shall be guarded.
- Winch shall be tested once in a year by competency authority.
- Friction brake & mechanical brake shall be kept intact and inspected at least once in a week.
- Wire rope shall be free from defects. Splicing/Clamping of wire rope shall be done as per standard.
- Pulleys, D- shackles and bulldog clamps shall be in order.
- Main pulley and it's pin are prone to wear & tear. Frequent check is essential.
- Similarly, the pin of the D-shackle, which connects Bailer/Chisel and winch rope is also more prone wear & tear. Frequent check is essential.

General

- Distance between the piling rigs should be not less than the length of longest leg of the tripods.
- Earth slush should be removed, and passage should be kept clear.
- Exposed reinforcement heads should be properly covered/ barricaded.
- Hard barricade shall be provided around bentonite pit to prevent fall persons inside.
- Workmen shall not wear loose clothes as they may entangle with the rotating and moving parts of the winch.
- Pile boreholes shall be kept covered or barricaded.

Bored and Cassion Piling Rig

- During pile driving operation all workmen shall be at safe distance from piling area.
- All holes which are left unattended, shall be adequately and securely covered or shall have as effective barrier placed as close to the edge as is practicable.
- Before any person enters a hole, the ground surface next to the hole shall be cleared and all loose soil, materials, loose tools, ropes etc. removed.
- A person shall not remain in a hole for more than one hour at a time and this time shall be suitably reduced depending on circumstances.
- Persons entering holes shall be lowered or raised in suitable skips or cages using properly constructed cranes and winches and other devices suitable for the purpose.
- In water bearing and unstable over burdens or where the slides of the hole are likely to collapse, lining tubes shall be used and those shall be used and those shall be penetrated wherever possible sufficiently into any impermeable stratum or rock to secure seal against ingress of ground water into the unlined hole below.
- When working at night, flood lighting shall be provided for the working area. Hand lamps used for illuminating the bottom of the hole shall be of flameproof construction of not more than 24-volt rating, when men are working in the hole.
- Detector lamp capable of indicating the presence of dangerous quantities of flammable gases and vapours or a serious oxygen deficiency or an excess of carbon –dioxide shall be a part of the working gear, where poisonous gases may be present in the sub-soil.
- Before first lowering men into a borehole suitable step shall be taken to investigate the likely presence of poisonous gas subsoil of the site.

Precast Piling Operation

- Piles shall be prepared at a distance at least equal to twice the length of the longest pile from the pile driver.
- Piles being hoisted in the rig should be so slung that they do not have to be swung round, and may not inadvertently, swing or whip round. A hand rope (Tagline) shall be fastened to a pile that is being hoisted to control its movement. While a pile is being guided into position in the leads, workers shall not put their hands or arms between the pile and the inside guide or on top of the pile but shall use a rope for guiding.
- While a pile is being hoisted all workers not actually engaged in the operation shall keep at a distance, which ensures safety.
- When piles are driven at an inclination to the vertical, if necessary to prevent danger, these should rest in a guide.
- No airline shall be blown down until all workmen are at a safe distance.

Protection to Neighboring Structures and Underground Services

- In driven piles vibration is set up which may cause damage to adjoining structures or service lines depending on the nature of soil condition and the construction standard of such structures and service lines. Possible extent of all such damages

shall be ascertained in advance and operation and mode of driving shall be planned with appropriate measures to ensure safety.

- Wherever in the vicinity of a site where bored or driven piling works are to be carried out there are old structures, which are likely to be damaged, tell tales shall be fixed on such structures to watch their behaviour and timely precautions taken against any undesirable effect.
- In case of bored or cassion piles measures shall be taken to ensure that there is no appreciable movement of soil mass into the borehole which may cause subsidence to any existing foundation in the close proximity.

6. CHECKING, CORRECTIVE AND PREVENTIVE ACTION

Periodic audits shall be carried out to assess the compliance to the procedure and effectiveness of the controls. Any deviations shall be reported to Project Manager/ Head of Department for corrective/preventive actions if needed.

7. TRAINING

All personnel involved in excavation and piling works shall be trained in requirements of this procedure

8. MANAGEMENT OF RECORDS

S. No.	Record Name	Maintained by	Retention period
01	Site Permit and Audit checklists	HSE department	Until the completion of Project
02	Periodical Inspection checklist	HSE department	Until the completion of Project

9. REFERENCE DOCUMENTS

Format No.	Standard Name
AMNS/Project/TS/HSEM/09	Plant and Machinery Operations
AMNS/Project/TS/HSEM/14	Personal Protective Equipment
AMNS/Project/TS/HSEM/15	Working in confined space
AMNS/Project/TS/HSEM/18	(SIMOP) Simultaneous Operations
AMNS/Project/TS/HSEM/23	Night Work
AMNS/Project/TS/HSEM/24	Environment
BOCW, The BOCW Act, 1996.	
BOCW, Gujarat State BOCW Rules, 2003.	
29 CFR 1926.650, "Scope, Application, and Definitions".	
29 CFR 1926.651, "Specification Excavation Requirements".	

29 CFR Subpart P - Excavation, "Excavations - Requirements of Protective Systems".
29 CFR 1926:652, "Requirements for Protective System".
29 CFR 1926 Subpart P, "Appendix A - Soil Classification".
29 CFR Subpart P, "Appendix B - Sloping and Benching".
29 CFR subpart P, "Appendix C - Timber Shoring for Trenches".
29 CFR Subpart P, "Appendix D - Aluminium Hydraulic Shoring for Trenches".
29 CFR Subpart P, "Appendix E - Alternatives to Timber Shoring".
29 CFR Subpart P, "Appendix F - Selection of Protective Systems".
IS 5121 – 1969 Safety Code for piling and other deep foundation, "Safety Code for piling and other deep foundation".

10. ANNEXURES

AMNS-Project-SS-HSEM-10-F04 – PTW Excavation Checklist