

VI. CONSTRUCTION SAFETY

1.0 General Construction Guidelines

1.1 Construction work can be particularly hazardous. Personal protective equipment, fire safety, electrical safety, confined space entry, emergency preparedness, biological safety, chemical safety, hazardous waste disposal, vehicle safety and other precautions are essential for safe construction work. Refer to other chapters in this manual for more information. Follow these guidelines when visiting or working at construction sites:

1.1.1 Do not walk, stand, or work under suspended loads. If you raise a load, be sure to crib, block, or otherwise secure the load as soon as possible.

1.1.2 Avoid placing unusual strain on equipment or materials.

1.2 Be prepared for unexpected hazards. **BE ALERT!**

2.0 Barriers and Guards

2.1 University employees must use barriers and guards as necessary to protect employees, students, contractors, and visitors from physical hazards. If you suspect a hazard is not sufficiently protected, notify the attending workers or Environmental Health & Safety immediately.



NOTE: Barriers, guards, and warning signs are required to ensure safety against existing hazards.

3.0 Types of Barriers and Guards

3.1 Standard types of barriers and guards include the following:

3.1.1 Guardrails and handholds

3.1.2 Saw horses

3.1.3 Tape

3.1.4 Toeboards

3.1.5 Cones

3.1.6 Other physical barriers and solid separators (dust barriers, hazard barriers, temporary walkways, etc.)



NOTE: Signs that state **DANGER**, **WARNING**, or **CAUTION** are also important when barriers or guards are necessary. Remember to make signs legible, visible, and brief.

4.0 Areas that Need Barriers or Guards

4.1 Any area that poses a physical threat to workers and/or pedestrians requires barriers or guards. Areas that typically require permanent or temporary protection include the following:

- 4.1.1 Stairways
- 4.1.2 Hatches
- 4.1.3 Chutes
- 4.1.4 Open Manholes
- 4.1.5 Elevated platforms
- 4.1.6 Areas with moving machinery
- 4.1.7 Excavation sites
- 4.1.8 Construction sites
- 4.1.9 Temporary wall or floor openings

5.0 Using Barriers and Guards

5.1 The following list provides guidelines for using barriers and guards:

- 5.1.1 When necessary, reroute pedestrian and vehicular traffic to completely avoid a construction site.
- 5.1.2 Guard any permanent ground opening into which a person could fall with a guardrail, load-bearing cover, or other physical barrier.
- 5.1.3 Ensure that temporary floor openings, such as pits and open manholes, are guarded by secure, removable guardrails. If guardrails are not available, have someone guard the opening.
- 5.1.4 Ensure that all stairways, ladderways, hatchways, or chute floor openings have handrails or hinged covers.
- 5.1.5 Ensure that enclosed stairways with four or more steps have at least one railing, and that open stairways with four or more steps have two railings.
- 5.1.6 Ensure that all platforms and walkways that are elevated or located next to moving machinery are equipped with handrails, guardrails, and toeboards.
- 5.1.7 Barricade any wall openings through which a person or tools could fall. Use gates, doors, guardrails, or other physical barriers to block the opening.
- 5.1.8 Mark and guard any excavation that is deeper than 12 inches.
- 5.1.9 Mark and/or guard potholes and sidewalk damage as appropriate.
- 5.1.10 Protect smoke detectors with some type of cover when construction work, such as dust or fume producing activities, may affect smoke detectors.



Remove protectors immediately at the end of the activity or at the end of the each day.

6.0 Heavy Equipment Safety

6.1 When using heavy equipment, there are five basic guidelines that employees must always follow to ensure safety:

6.1.1 Know how to properly operate the equipment you are using. Training on proper operation shall be documented.

6.1.2 Do not use heavy machinery when you are drowsy, intoxicated, or taking prescription medication that may affect your performance.

6.1.3 Use only equipment that is appropriate for the work to be done.

6.1.4 Inspect your equipment to ensure that it is in good working condition before beginning a job. In addition, ensure that regular inspections and maintenance are conducted as appropriate.

6.1.5 Do not stress or overload your equipment.



6.2 Accidents do not just happen, they are caused. Therefore, employees should also follow these guidelines:

6.2.1 Ensure the following before leaving equipment unattended:

6.2.1.1 All buckets, blades, etc. are on the ground.

6.2.1.2 Transmission is in neutral.

6.2.1.3 Engine is off.

6.2.1.4 Equipment is secure against movement.

6.2.1.5 Never get on or off moving equipment.

6.2.1.6 Do not attempt to lubricate or adjust a running engine.

6.2.1.7 Turn the engine off before refueling.

6.2.1.8 Keep all shields and safety guards in place.

6.2.1.9 Avoid underground utilities and overhead power lines.

6.3 The following sections provide basic guidelines for working with forklifts, front-end loaders, and backhoes. Refer to the product documentation that accompanied your equipment for more information and specific instructions.

7.0 Forklifts

7.1 Only authorized employees may operate forklifts. The following list provides general safety guidelines:



- 7.1.1 Do not allow riders. Do not raise people on a forklift.
 - 7.1.2 Always wear your safety belt.
 - 7.1.3 Never leave keys in an unattended forklift.
 - 7.1.4 Do not speed.
 - 7.1.5 Drive up and back down ramps.
 - 7.1.6 Do not walk, stand, or work under the elevated portion of a forklift (even if it is not loaded).
 - 7.1.7 Ensure that the forklift has an overhead barrier to protect the operator from falling objects.
- 7.2 In addition, follow these guidelines for safe forklift operation:
- 7.2.1 Always work within the capacity limits of your forklift. Consult with the manufacturer before modifying the operation or capacity limits of a forklift.
 - 7.2.2 Do not operate a forklift in areas with hazardous concentrations of acetylene, butadiene, hydrogen, ethylene, or diethyl ether, or other explosive environment.
 - 7.2.3 Never lift a load while moving. Wait until you are completely stopped before raising the mast.
 - 7.2.4 Be sure the top load sits squarely on the stack. An uneven load could topple.
 - 7.2.5 Travel with loads slightly tilted back to provide stability.
 - 7.2.6 Travel with loads at the proper height. A stable clearance height is usually 4 to 6 inches at the tips and 2 inches at the heels of fork blades.
 - 7.2.7 Lift stacked loads in the same manner as loads on the floor.
 - 7.2.8 When preparing to leave the forklift unattended, lower the mast, neutralize the controls, shut the power off, and set the brakes. The forklift is "unattended" when the operator is more than 25 feet away or the forklift is out of view.
 - 7.2.9 When ascending or descending a grade in excess of 10 percent, drive the forklift with the load upgrade.
 - 7.2.10 If you cannot see over a load, drive in reverse. Do not try to look around a load and drive forward.
- 7.3 Contact the Environmental Health and Safety Occupational Safety for Forklift training and certification information.

8.0 Backhoes

- 8.1 Only authorized employees may operate backhoes and front-end loaders. The following list offers general safety guidelines for both types of machinery:
- 8.1.1 Always operate at a safe speed.

- 8.1.2 Travel with the bucket low to the ground.
- 8.1.3 Always lower the bucket before servicing the equipment or leaving the loader unattended.
- 8.1.4 Use a rigid-type coupler when towing loads.
- 8.1.5 Always check with the utility company before digging.
- 8.1.6 Be extremely careful when operating near banks and slopes.
- 8.1.7 When cutting a bank, be careful not to cause a cave-in. Do not drive on an overhang.



9.0 Hoists

- 9.1 Only authorized employees may use hoists to move heavy objects and equipment. When using hoists, remember to follow the five safety guidelines for working with heavy equipment found above in section 6.0. In addition, follow the guidelines in the following sections.



10.0 Hoisting Guidelines

- 10.1 The following are general guidelines for working with hoists:
 - 10.1.1 Never walk, stand, or work beneath a hoist.
 - 10.1.2 Isolate hoisting area with barriers, guards, and signs, as appropriate.
 - 10.1.3 Never exceed the capacity limits of your hoist.
 - 10.1.4 Wear gloves and other personal protective equipment, as appropriate, when working with hoists and cables.
 - 10.1.5 Ensure that hoists are inspected regularly before each use.
 - 10.1.6 Ensure that hoists are inspected annually by a certified inspector through [EHSD-EHS](#).
 - 10.1.7 Always hold tension on the cable when reeling it in or out.
 - 10.1.8 When the work is complete, always rig the hoist down and secure it.
 - 10.1.9 When the load block or hook is at floor level or its lowest point of travel, ensure that at least two turns of rope remain on the drum.
 - 10.1.10 Be prepared to stop operations immediately if signaled by the safety watch or another person.

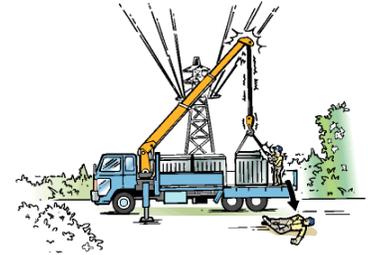
11.0 Picking Up Loads with Hoists

- 11.1 Ensure that the hoist is directly above a load before picking it up. This keeps the hoist from becoming stressed. Picking up loads at odd angles may result in injury to people or damage to the hoist.

- 11.2 Do not pick up loads by running the cable through, over, or around obstructions. These obstructions can foul the cable or catch on the load and cause an accident.

12.0 Avoiding Electrical Hazards with Hoists

- 12.1 Do not hoist loads when any portion of the hoisting equipment or suspended load can come within 6 feet of high-voltage electrical lines or equipment.
- 12.2 If you need to hoist near high-voltage electrical lines or equipment, obtain clearance from your supervisor first.



13.0 Inspecting Hoists

- 13.1 Hoists should be inspected daily. If there is any question about the working condition of a hoist, do not use it.
- 13.2 Hoist inspectors should note the following:
 - 13.2.1 The hooks on all blocks, including snatch blocks, must have properly working safety latches.
 - 13.2.2 All hooks on hoisting equipment should be free of cracks and damage.
 - 13.2.3 The maximum load capacity for the hoist must be noted on the equipment.
 - 13.2.4 Cables and wiring should be intact and free of damage.

14.0 Mobile Crane Safety Procedures

- 14.1 In the initial survey of crane operations, look for crane stability, physical obstructions to movement or operation, and proximity of electrical power lines, as well as the following:
 - 14.1.1 *Leveling* Has the crane operator set the crane up level and in a position for safe rotation and operation?
 - 14.1.2 *Outriggers* Are the outriggers, where applicable, extended and being used in accordance with manufacturer's recommendations?
 - 14.1.3 *Stability* The relationship of the load weight, angle of boom, and its radius (the distance from the cranes center of rotation to the center of load) to the center of gravity of the load. Also, the condition of crane loading where the load moment acting to overturn the crane is less than the moment of the crane available to resist overturning.

14.1.4 *Structural Integrity* The crane's main frame, crawler, track and outrigger supports, boom sections, and attachments are all considered part of structural components of lifting. In addition, all wire ropes, including stationary supports, help determine lifting capacity and are part of the structural elements of crane operations.

14.1.5 *Access to Job Site* The site must be secured by barricades (caution tape or fencing) to prevent unauthorized entry to the area by: Faculty, Staff, Students, Visitors, and Construction Personal. The barricades must encompass the length the boom is extended and the area the boom will swing.

14.2 Crane operators and personnel working with cranes need to be knowledgeable of basic crane capacities, limitations, and specific job site restrictions, such as access restrictions to job site, location of overhead electric power lines, and high wind conditions. Personnel working around crane operations also need to be aware of hoisting activities or any job restrictions imposed by crane operations, and ensure job site coordination of cranes. Crane operators should be aware of these issues and, prior to starting crane activity, take time to observe the overall crane operations with respect to load capacity, site coordination, and any job site restrictions in effect.

14.3 Accidents can be avoided by careful job planning. The person in charge must have a clear understanding of the work to be performed and consider all potential dangers at the job site. A safety plan must be developed for the job and must be explained to all personnel involved in the lift.

15.0 Fall Protection Program

15.1 Fall Protection Requirements

This Program prescribes the duty to provide fall protection, sets the criteria and practices for fall protection systems, and required training.

15.2 In the construction industry in the U.S., falls are the leading cause of worker fatalities. Each year, on average, between 150 and 200 workers are killed and more than 100,000 are injured as a result of falls at constructions sites alone.

15.3 Standards for fall protection deal with both the human and equipment-related issues in protecting workers from fall hazards. Employers and employees are required to do the following:

15.3.1 Where protection is required, select fall protection systems appropriate for given situations.

15.3.2 Use proper construction and installation of safety systems.

- 15.3.3 Supervise employees properly.
 - 15.3.4 Use safe work procedures.
 - 15.3.5 Train workers in the proper selection, use, and maintenance of fall protection systems.
- 15.4 This Program covers everyone except those inspecting, investigating, or assessing workplace conditions prior to the actual start of work or after all work has been completed.
- 15.5 This Program identifies areas or activities where fall protection is needed. These include, but are not limited to, ramps, runways, and other walkways, excavations, hoist areas, holes, formwork and reinforcing steel, leading edge work, unprotected side and edges, overhand bricklaying and related work, roofing work, precast concrete erection, wall openings, residential construction, and other walking/working surfaces. The rule sets a uniform threshold height of 6 feet, thereby providing consistent protection. This means that employers must protect employees from fall hazards and falling objects when ever an affected employee is 6 feet or more above a lower level. Protection also must be provided for workers who are exposed to the hazard of falling into dangerous equipment.
- 15.6 General Fall Protection
- 15.6.1 Employers must assess the workplace to determine if the walking or working surfaces on which employees are to work have the strength and structural integrity to safely support the workers. Once the employer has determined that the surface is safe for the employees to work on, the employer must provide the proper fall protection for the fall hazard that is present. The employer must provide fall protection for employees, after identifying and evaluating fall hazards and providing specific training.
- 15.7 Controlled Access Zones
- 15.7.1 A controlled access zone is a work area designated and clearly marked in which certain types of work (such as overhand bricklaying) may take place without the use of conventional fall protection systems-guardrail, personal arrest or safety-net to protect the employees working in the zone. Controlled access zones are used to keep out workers other than those authorized to enter work areas from which guardrails have been removed. Where there are no guardrails, masons are the only workers allowed in controlled access zones. Controlled access zones, when created for leading edge work is taking place, must be defined by a control line or by any other means that restricts access. Control lines shall consist of ropes, wires, tapes or equivalent materials, and supporting stanchions, and must be:

- 15.7.1.1 Flagged or otherwise clearly marked at not more than 6-foot intervals with high-visibility material.
- 15.7.1.2 Rigged and supported in such a way that the lowest point is not less than 39 inches from the walking/working surface and the highest point is not more than 45 inches (50 inches for overhand bricklaying) from the walking/working surface.
- 15.7.1.3 Strong enough to sustain stress of not less than 200 pounds. Control lines shall extend along the entire length of the unprotected or leading edge and shall be approximately parallel to the unprotected or leading edge.
- 15.7.1.4 Control lines also must be connected on each side to a guardrail system or wall

15.8 Guardrail Systems

15.8.1 If the employer chooses to use guardrail systems to protect workers from falls, the systems must meet the following criteria:

- 15.8.1.1 Toprails and midrails of guardrail systems must be at least one-quarter inch nominal diameter; it must be flagged at not more than 6 feet intervals with high-visibility material, and must be inspected as frequently as necessary to ensure strength and stability. The top edge height of toprails or guardrails must be 42 inches plus or minus 3 inches above the walking/working level.
- 15.8.1.2 When midrails are used, they must be installed at a height midway between the top edge of the guardrail system and the walking/working level and there shall be no openings in the guardrail system more than 19 inches.
- 15.8.1.3 The guardrail system must be capable of withstanding a force of at least 200 pounds applied within 2 inches of the top edge in any outward or downward direction and must not deflect to a height less than 39 inches above the walking/working level.
- 15.8.1.4 Midrails, screens, mesh, intermediate vertical members, solid panels, and equivalent structural members shall be capable of withstanding a force of at least 150 pounds applied in any downward or outward direction at any point along the midrail or other member.
- 15.8.1.5 When guardrail systems are used at hoisting areas, a

- chain, gate or removable guardrail section must be placed across the access opening between guardrail sections when hoisting operations are not taking place.
- 15.8.1.6 At holes, guardrail systems must be set up on all unprotected sides or edges. When holes are used for the passage of materials, the hole shall not have more than two sides with removable guardrail sections.
 - 15.8.1.7 If guardrail systems are around holes that are used as access points (such as ladderways), gates must be used or the point of access must be offset to prevent accidental walking into the hole.
 - 15.8.1.8 If guardrails are used at unprotected sides or edges of ramps and runways, they must be erected on each unprotected side or edge.
 - 15.8.1.9 Around holes (including skylights) that are more than 6 feet above lower levels.
 - 15.8.1.10 Excavation of 6 feet or more deep shall be protected from falling and where walkways are provided to permit foot traffic to cross over excavations, guardrails are required on the walkway if the fall would be 6 feet or more to the lower level.

15.9 Personal Fall Protection Systems

- 15.9.1 This includes any of the following: an anchorage, connectors, and a full body harness and may include a deceleration device, lifeline, or suitable combinations.
- 15.9.2 If a personal fall arrest system is used for fall protection, it must do the following:
 - 15.9.2.1 Limit maximum arresting force on an employee to 1,800 pounds when used with a body harness;
 - 15.9.2.2 Be rigged so that an employee can neither free fall more than 6 feet nor contact any lower levels;
 - 15.9.2.3 Bring an employee to a complete stop and limit maximum deceleration distance an employee travels to 3.5 feet.
 - 15.9.2.4 Have sufficient strength to withstand twice the potential impact energy of an employee free falling a distance of 6 feet or the free fall distance permitted by the system, whichever is less.

15.9.3 Personal fall protection systems must be inspected prior to each use for wear damage, and other deterioration. Defective components must be removed from service.

15.9.4 Snaphooks shall be sided to be compatible with the member to whom they will be connected, or shall be a locking configuration.

15.9.5 Horizontal lifelines shall be designed, installed, and used under the supervision of a qualified person, as part of a complete personal fall arrest system that maintains a safety factor of at least two. Lifelines shall be protected against being cut or abraded.

15.9.6 Full body harnesses are the only acceptable harness and must be used at all times on all personnel lifting equipment, including scissor lifts (NO BELT HARNESSSES ALLOWED).

15.10 Safety Monitoring Systems

15.10.1 When no other alternative fall protection has been implemented, the employer shall implement a safety monitoring system. Employers must appoint a competent person to monitor the safety of workers and the employer shall ensure that the safety monitor:

15.10.1.1 Is competent in the recognition of fall hazards.

15.10.1.2 Is capable of warning workers of fall hazard dangers and in detecting unsafe work practices.

15.10.1.3 Is operating on the same walking/working surfaces of the workers and can see them.

15.10.1.4 Is close enough to work operations to communicate orally with workers and has no other duties to distract from the monitoring function.

15.10.2 Mechanical equipment shall be used or stored in areas where safety monitoring systems are being used to monitor employees engaged in roofing operations of low-sloped roofs. No worker, other than one engaged in roofing work (on low-sloped roofs) or one covered by a fall protection plan, shall be allowed in an area where an employee is being protected by a safety monitoring system. All workers in a controlled access zone shall be instructed to promptly comply with fall hazard warnings issued by safety monitors.

15.11 Toeboards

15.11.1 When toeboards are used as protection from falling objects, they must be erected along the edges of the overhead walking or working surface for a distance sufficient to protect persons working below. Toeboards shall be capable of withstanding a force of at least 50 pounds applied in any downward outward direction at any point along the toeboard. Toeboards shall be a minimum of 3.5 inches tall from their top edge to the level of the walking/working surface, have no more than 0.25 inches clearance above the walking/working surface, and be solid or have openings no larger than 1 inch in size. Where tools, equipment, or materials are piled higher than the top edge of a toeboard, paneling or screening must be erected the walking/working surface or toeboard to the top of a guardrail system's top rail or midrail, for a distance sufficient to protect employees below.

15.12 Hoist Areas

15.12.1 Each employee in a hoist area shall be protected from falling 6 feet or more by guardrail systems or personal fall arrest systems. If guardrail systems (or chain gate or guardrail) or portions thereof must be removed to facilitate hoisting operations, as during the landing of materials, and a worker must lean through the access opening or out over the edge of the access opening to receive or guide equipment and materials, that employee must be protected by a personal fall arrest system.

15.13 Ramps, Runways, and Other Walkways

15.13.1 Each employee using ramps, runways, and other walkways shall be protected by guardrails systems against falling 6 feet or more.

15.14 Steep Roofs

15.14.1 Each employee on a steep roof with unprotected sides and edges 6 feet or more above lower levels shall be protected by either guardrail systems with toeboards, a safety net system, or a personal fall arrest system.

15.15 Wall Openings

15.15.1 Each employee working on, at, above, or near wall openings (including those with chutes attached) where the outside bottom edge of the wall opening is 6 feet or more above lower levels and the inside bottom edge of the wall opening is less than 39 inches above the walking/working surface must be protected from falling by the use of either a guardrail system, a safety net system, or a personal fall arrest system.

15.16 Ladders

15.16.1 Ladders can make many tasks easier, but they are also a continual safety hazard. Even the best ladder is not safe unless you are trained and proficient in using ladders. Each year, many people suffer serious injuries from accidents involving ladders. Before you use a ladder, take a moment to think about doing it safely.

15.16.2 A secure, well made ladder is necessary for safe ladder use. Ladders come in different styles, including step, straight, and extension. They also vary in construction and may consist of wood, aluminum, or fiberglass. Choose the correct type and size ladder for the job. All ladders sold within the U.S. are rated as follows:

Type IA: Heavy-duty industrial ladder rated to hold up to 300 pounds.

Type II: Medium-duty commercial ladder rated to hold up to 225 pounds.

Type III: Light-duty household ladder rated to hold up to 200 pounds

15.16.3 Follow these guidelines for safe ladder usage:

15.16.3.1 Always inspect a ladder before you climb it. Make sure the steps are sturdy and the locking mechanisms are in good working order.

15.16.3.2 Carry ladders horizontally with the front end slightly higher than the back end.

15.16.3.3 To open a stepladder, make sure the spreader is locked and the pail shelf is in position. To open an extension ladder, brace the bottom end and push the rungs or rails out.

15.16.3.4 Place ladders on a solid, level surface to ensure safety.

15.16.3.5 Watch for overhead obstructions and power-lines.

15.16.3.6 To prevent ladders from sinking into soft ground, use a large board under the feet of the ladder.

- 15.16.3.7 Position a straight or extension ladder so that the use of the ladder is one foot away from the vertical support for every four feet of working ladder height (e.g., if you are working with eight feet of ladder, place the base of the ladder two feet from the wall).
- 15.16.3.8 Do not place the top of a ladder against a window or an uneven surface.
- 15.16.3.9 Tie the top of a straight or extension ladder to supports.
- 15.16.3.10 An extension ladder used for access to a roof must extend at least 3 feet beyond the support point.
- 15.16.3.11 Use a wooden or plastic ladder if you must work near electrical sources.
- 15.16.3.12 Do not place a ladder in front of a door unless you lock and barricade the door and post a warning sign on the opposite side of the door.
- 15.16.3.13 Use common sense when climbing or working on ladders.
- 15.16.3.14 Wear shoes with slip-resistant soles and make sure they are dry before climbing.
- 15.16.3.15 Never allow more than one person on a ladder.
- 15.16.3.16 To climb or descend a ladder, face the ladder and firmly grip the rails, not the rungs, with both hands.
- 15.16.3.17 Keep your body between the rails at all times. Do not shift your weight to one side.
- 15.16.3.18 Have somebody steady the ladder if it cannot be secured otherwise.
- 15.16.3.19 Do not stand on the top four rungs of an extension ladder or the top two rungs of a step ladder.
- 15.16.3.20 When working on a ladder, keep two feet and one hand on the ladder at all times.
- 15.16.3.21 Do not stand on the bucket shelf of a ladder.
- 15.16.3.22 When working on a ladder, carry small tools on a tool belt. Use a rope to raise and lower heavy tools.

- 15.16.3.23 Never leave a raised or open ladder unattended.
- 15.16.3.24 Store ladders away from heat and moisture. Destroy damaged or unsafe ladders.

15.17 Glossary

- 15.17.1 Anchorage- A secure point of attachment for lifelines, lanyards or deceleration devices.
- 15.17.2 Body harness- Straps that may be secured about the person in a manner that distributes the fall-arrest forces over at least the thighs, pelvis, waist, chest, and shoulders with a means for attaching the harness to other components of a personal fall arrest system.
- 15.17.3 Connector- A device that is used to couple (connect) parts of a personal fall arrest system or positioning device system together.
- 15.17.4 Controlled access zone- A work area designated and clearly marked in which certain types of work (such as overhand bricklaying) may take place without the use of conventional fall protection systems-guardrails, personal arrest or safety net- to protect the employees working in the zone.
- 15.17.5 Deceleration device- Any mechanism-such as rope, grab, rip-stitch lanyard, specially-woven lanyard, tearing or deforming lanyards, automatic self-retracting lifelines/lanyards-which serves to dissipate a substantial amount of energy during a fall arrest, or otherwise limits the energy imposed on an employee during fall arrest.
- 15.17.6 Deceleration distance- The additional vertical distance a falling person travels, excluding lifeline elongation and free fall distance, before stopping, from the point at which a deceleration device begins to operate.
- 15.17.7 Guardrail system- A barrier erected to prevent employees from falling to lower levels.
- 15.17.8 Hole- A void or gap 2 inches or more in the least dimension in a floor, roof, or other walking/working surface.
- 15.17.9 Lanyard- A flexible line of rope, wire rope, or strap that generally has a connector at each end for connecting the body belt or body harness to a deceleration device, lifeline, or anchorage.
- 15.17.10 Leading Edge- The edge of a floor, roof, or formwork for a floor or other walking/working surface (such as the deck) which changes location

as additional floor, roof, decking, or formwork sections are placed, formed or constructed.

- 15.17.11 Lifeline- A component consisting of a flexible line for connection to an anchorage at one end to hang vertically (vertical lifeline), or for connection to anchorages at both ends to stretch horizontally (horizontal lifeline) and that serves as a means for connecting other components of a personal fall arrest system to the anchorage.
- 15.17.12 Low-slope roof- A roof having a slope less than or equal to 4 in 12 pitch (vertical to horizontal).
- 15.17.13 Opening- A gap or void 30 inches or more high and 18 inches or more wide, in a wall or partition, through which employees can fall to a lower level.
- 15.17.14 Personal fall arrest system- A system including but not limited to an anchorage, connectors, and a body harness used to arrest an employee in a fall from a working level. As of January 1, 1998, the use of a body belt for fall arrest is prohibited.
- 15.17.15 Positioning device system- A body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a wall, and work with both hands free while leaning backwards.
- 15.17.16 Rope grab- A deceleration device that travels on a lifeline and automatically, by friction, engages the lifeline and locks to arrest a fall.
- 15.17.17 Safety-monitoring system- A safety system in which a competent person is responsible for recognizing and warning employees of fall hazards.
- 15.17.18 Self-retracting lifeline/lanyards- A deceleration device containing a drum-wound line which can be slowly extracted from, or retracted onto, the drum under minimal tension during normal employee movement and which, after onset of a fall, automatically locks the drum and arrests the fall.
- 15.17.19 Snaphook- A connector consisting of a hook-shaped member with a normally closed keeper, or similar arrangement, which may be opened to permit the hook to receive an object and, when released automatically closes to retain the object.
- 15.17.20 Steep roof-A roof having a slope greater than 4 in 12 pitch (vertical to horizontal).

15.17.21 Toeboard- A low protective barrier that prevents material and equipment from falling to lower levels and which protect personnel from falling.

15.17.22 Unprotected sides and edges-Any side or edge (except at entrances to points of access) of a walking/working surface (e.g., floor, roof, ramp, or runway) where there is no wall or guardrail system at least 39 inches high.

15.17.23 Walking/working surface- Any surface, whether horizontal or vertical, on which an employee walks or works, including but not limited to floors, roofs, ramps, bridges, runways, formwork, and concrete reinforcing steel. Does not include ladders, vehicles, or trailers on which employees must be located to perform their work duties.

15.17.24 Warning line system- A barrier erected on a roof to warn employees that they are approaching an unprotected roof side or edge and which designates an area in which roofing work may take place without the use of guardrail or safety net systems to protect employees in the area.

16.0 Scaffolding (Included in Fall Protection Program)

16.1.1 When employees must conduct construction work above the ground and away from solid platforms, scaffolds may be appropriate. The following list provides guidelines for using small scaffolds. Larger scaffolds must be designed and erected in accordance with applicable standards.

16.1.2 Ensure that scaffold anchors are sound, rigid, and capable of supporting the maximum intended load without shifting.



***NOTE:** Scaffolds and their components should be capable of supporting at least four times their maximum load.*

16.1.3 For freestanding, mobile scaffolds, the height should not exceed four times the minimum base dimension. If workers are riding the scaffolding, however, the base dimension should be at least one half the heights.

16.1.4 Do not use unstable objects such as barrels, boxes, bricks, or blocks to support scaffolds or planks.

16.1.5 Keep floors free of debris where mobile scaffolds are used.

- 16.1.6 Lock scaffolds with wheels into position.
- 16.1.7 Install guardrails, midrails, or toeboards on the open sides and ends of platforms that are more than 4 feet above the ground or floor level. Use lifelines for scaffolds that are more than 10 feet off the ground.
- 16.1.8 Either overlap multiple planking and platforms by 12 inches or secure them to ensure stability.

NOTE: Planks must extend over end supports between 6 and 18 inches.

- 16.1.9 Secure scaffolds to permanent structures with anchor bolts or other means.
- 16.1.10 Do not load scaffolds in excess of their maximum load limits.
- 16.1.11 Repair damaged scaffolds immediately.
- 16.1.12 Do not work on scaffolds in high winds or during storms.
- 16.1.13 Remove ice or snow from scaffolds and apply sand to the wood before conducting work in winter weather.
- 16.1.14 Do not allow tools, equipment, or other debris to accumulate on scaffolds.
- 16.1.15 Dismantle and remove scaffolds when they are no longer needed. Do not use temporary scaffolding as a permanent installation.

17.0 Trenching

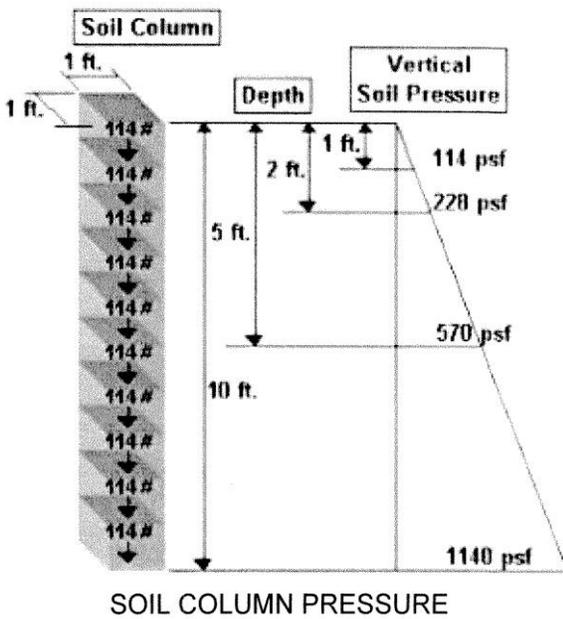
- 17.1 29 CFR 1926.651 “Excavation Requirements”
 - 17.1.1 Controls the trenching and excavation requirements for construction (excluding tunnels)
 - 17.1.2 Provides requirements for employee entrance, working environment, and egress to/from open surface trenches and excavations
- 17.2 Pre-excavation requirements
 - 17.2.1 The estimated location of utility installations such as sewer, telephone, fuel, electric, water lines, or other underground installations that reasonably may be encountered during excavation work shall be determined prior to opening an excavation
 - 17.2.2 Utility companies or utility locator should be contacted to precisely locate such utilities
 - 17.2.3 Excavation may proceed with CAUTION if:
 - 17.2.3.1 Utility Company/Locator can not be located or contacted
 - 17.2.3.2 Utility Company/Locator can not locate utility

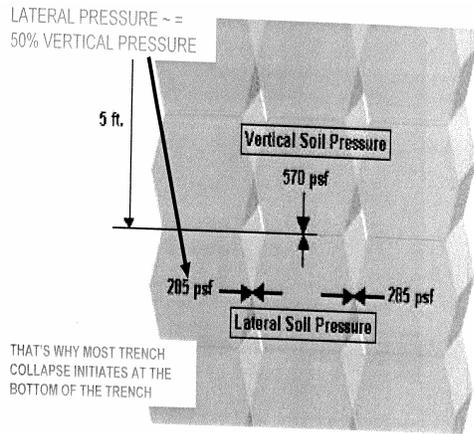
- 17.3 Excavation opening requirements
 - 17.3.1 When excavating operations approach the location of underground utilities, the exact location shall be determined by safe and acceptable means
- 17.4 While excavation is open, underground installations shall be protected, supported, or removed as necessary to safeguard employees
- 17.5 Excavation access/egress
 - 17.5.1 Structural ramps/runways used for access/egress
 - 17.5.2 If constructed of two or more members, shall have members connected together
 - 17.5.3 if constructed of two or more members, shall have members of uniform thickness
 - 17.5.4 Cleats or other connections shall be attached to bottom of runways/ramps
 - 17.5.5 Runways/ramps shall be anchored to prevent movement or slipping
 - 17.5.6 Ladders
 - 17.5.6.1 Shall be of proper design
 - 17.5.6.2 Shall be secured from movement or slippage
 - 17.5.6.3 Shall extend 3' above top of excavation
- 17.6 Employee protection
 - 17.6.1 Employees exposed to public vehicular traffic shall be provided with and wear vest or other suitable garments marked with high visibility materials
 - 17.6.2 No employee shall be permitted underneath loads handled by digging or lifting equipment
 - 17.6.3 When mobile equipment is operated near excavation; barricades, hand and mechanical signals, or stop logs shall be used to protect employees in excavations.
- 17.7 Hazardous atmospheres
 - 17.7.1 Excavations of greater than 4' depth that are located in or near hazardous materials, liquids, or gases shall be tested for the presence of hazardous atmospheres prior to employee entry

- 17.7.2 An atmosphere shall be considered hazardous if the level of atmospheric contaminants exceeds 20% of the PEL
- 17.7.3 Excavation of greater 4' depth shall be regularly tested for oxygen deficiency (less than 19.5% oxygen)
- 17.7.4 Ventilation and respiratory protection shall be provided where hazardous atmospheres are encountered
- 17.8 Emergency rescue equipment
 - 17.8.1 Where hazardous atmospheres exist or may be expected to occur, the following rescue equipment shall be readily available for use:
 - 17.8.1.1 Safety Harnesses and lines
 - 17.8.1.2 Basket stretcher
 - 17.8.1.3 Breathing apparatus equipment
 - 17.8.1.4 Employees entering bell-bottomed holes shall wear harness and life line protection
 - 17.8.1.5 Employees shall not work in excavations where there is accumulated water unless adequate safety precautions (shoring, etc.) have been taken
- 17.9 Stability of adjacent structures
 - 17.9.1 Excavations near structures or buildings shall be protected by shoring or other means to assure stability of the affected structure
 - 17.9.2 Diversion ditches, dikes, or other suitable means shall be provided to prevent surface water intrusion where natural drainage has been interrupted
 - 17.9.3 Excavations near foundation footings, sidewalks, pavement, or other appurtenant structures shall be protected by underpinning or other suitable means to maintain stability
- 17.10 Stability of excavated materials and excavation walls
 - 17.10.1 Excavated materials shall be kept a minimum of 2' from the edge of excavations or by the use of retaining devices
 - 17.10.2 Excavated materials may require further clearance from excavations in accordance with soil types (see table)

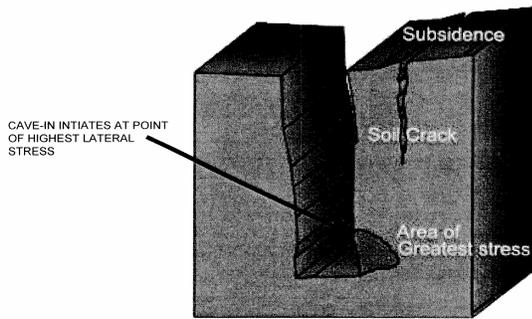
17.10.3 Excavation wall slopes or other wall protection shall be used in accordance with soil type, moisture levels, and other criteria as specified in the soil tables (see table)

17.11 Figures associated with trenching are depicted below

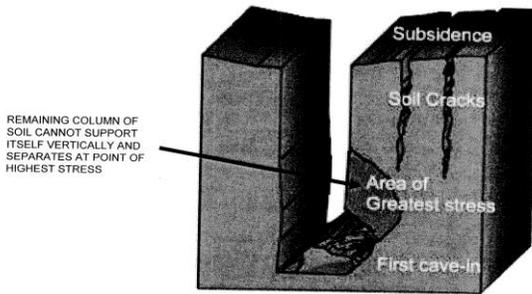




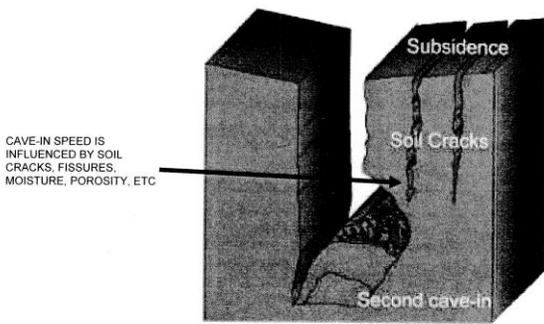
SOIL LATERAL COLUMN PRESSURE



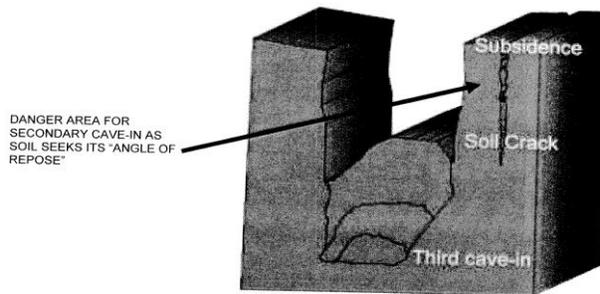
ANATOMY OF A CAVEIN - ONSET



ANATOMY OF A CAVEIN - GROWTH STAGE



ANATOMY OF A CAVEIN – FULLY DEVELOPED



ANATOMY OF A CAVEIN – COMPLETION

- There is a "natural angle of repose" for soil. It means that over time the soil will go to a certain slope (usually its natural angle).

- Excavation protection is a function of soil type

OSHA categorizes soil and rock deposits into four types as follows:

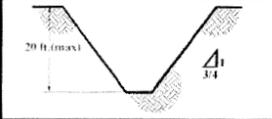
- STABLE ROCK** is a natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed. Most of the time it is identified by a rock name such as granite or sandstone.
- TYPE 'A' SOILS** are cohesive soils with an unconfined compressive strength of 1.5 tons per square foot or greater. These types of soils are often clay, silt clay, sandy clay, clay loam and in certain cases, silty clay loam and sandy clay loam.
- TYPE 'B' SOILS** are cohesive soils with an unconfined compressive strength greater than 0.5, but less than 1.5 tons per square foot. Examples include angular gravel silt, silt loam, and/or previously disturbed soils
- TYPE 'C' SOILS** are cohesive soils with an unconfined compression strength of 0.5 tons per square foot or less. Granular soils like gravel, sand and loamy sand, submerged soil, soil from which water is freely seeping, and submerged rock that is not stable fall into the Type 'C' soil category.

Option	Type A	Type B	Type C
 Simple Slope	Yes	Yes	Yes
 Short-term Slope	Yes	No	No
 Simple Bench	Yes	Yes	No
 Multiple Bench	Yes	Yes/No*	No
 Slope with Shoring/Shielding	Yes	Yes	Yes

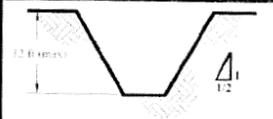
*Multiple bench allowed only in cohesive Type B soil

TRENCH SLOPES VS. SOIL TYPE

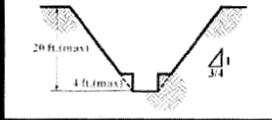
Slope Configurations



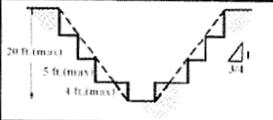
**SIMPLE SLOPE - GENERAL
TYPE A SOIL**
20 ft. or less in depth
maximum allowable slope of 3/4:1



**SIMPLE SLOPE - SHORT TERM*
TYPE A SOIL**
12 ft. or less in depth
maximum allowable slope of 1/2:
*open 24 hours or less

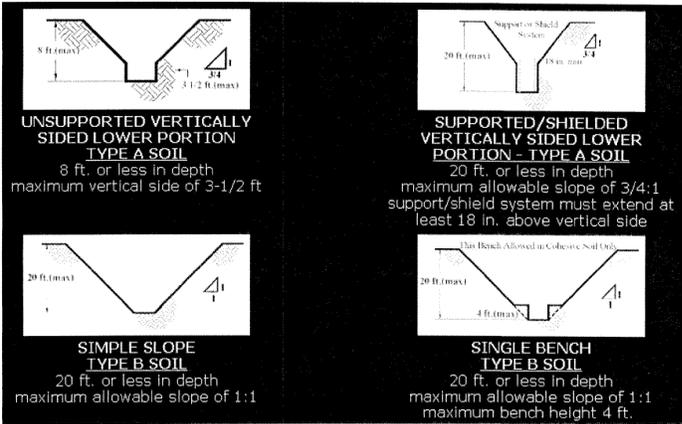


**SINGLE BENCH
TYPE A SOIL**
20 ft. or less in depth
maximum allowable slope of 3/4:1
maximum bench height 4 ft.

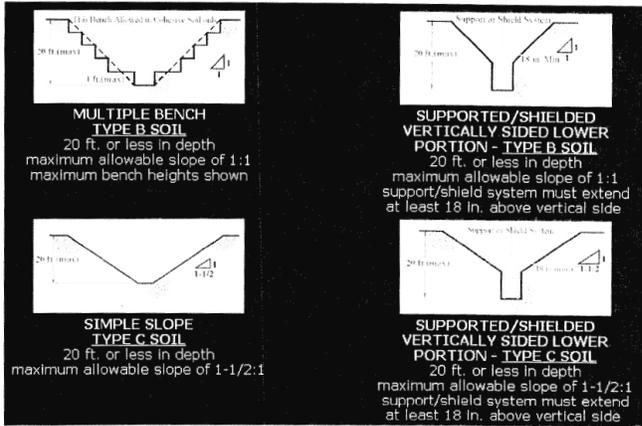


**MULTIPLE BENCH
TYPE A SOIL**
20 ft. or less in depth
maximum allowable slope of 3/4:1
maximum bench heights shown

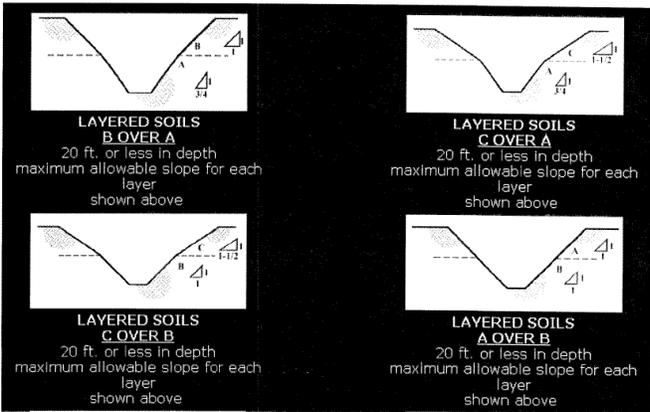
TRENCH SLOPES CONFIGURATIONS – PG 1



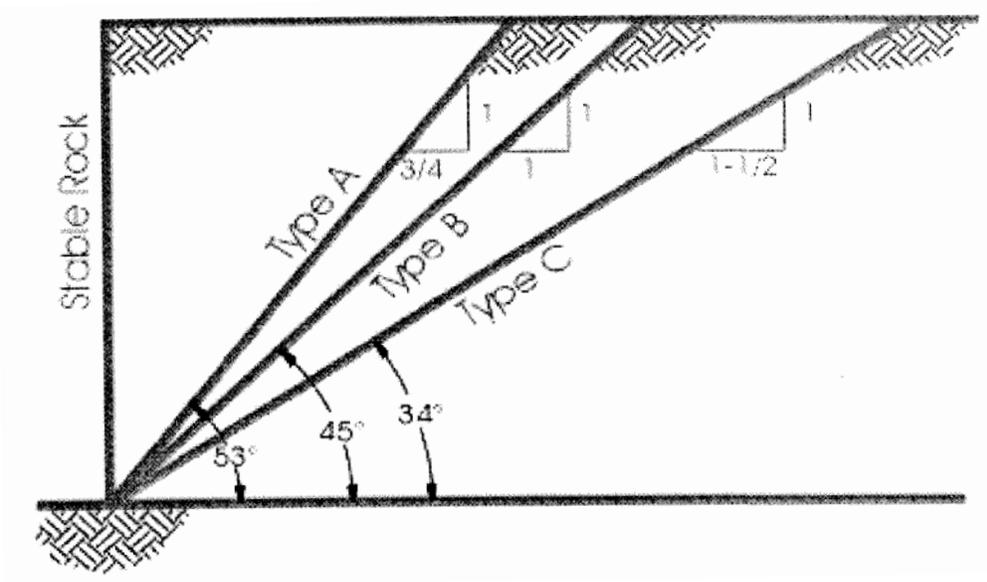
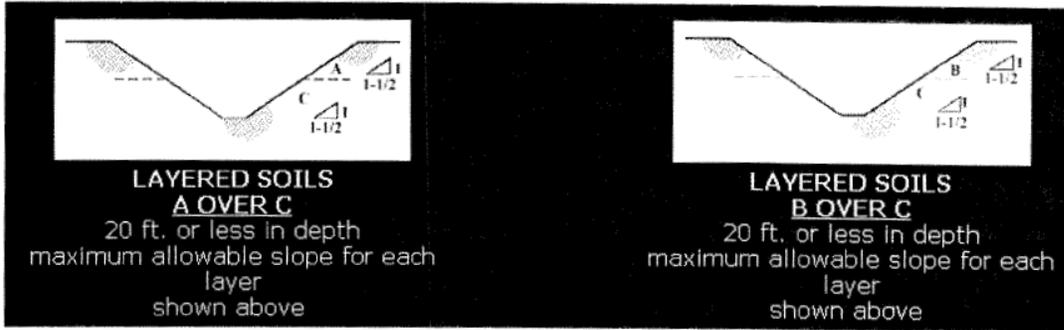
TRENCH SLOPES CONFIGURATIONS - PG 2



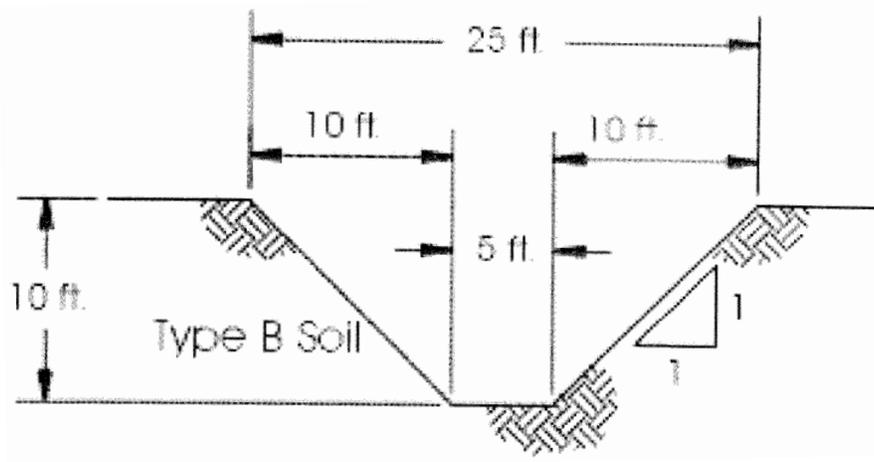
TRENCH SLOPES CONFIGURATIONS - PG 3



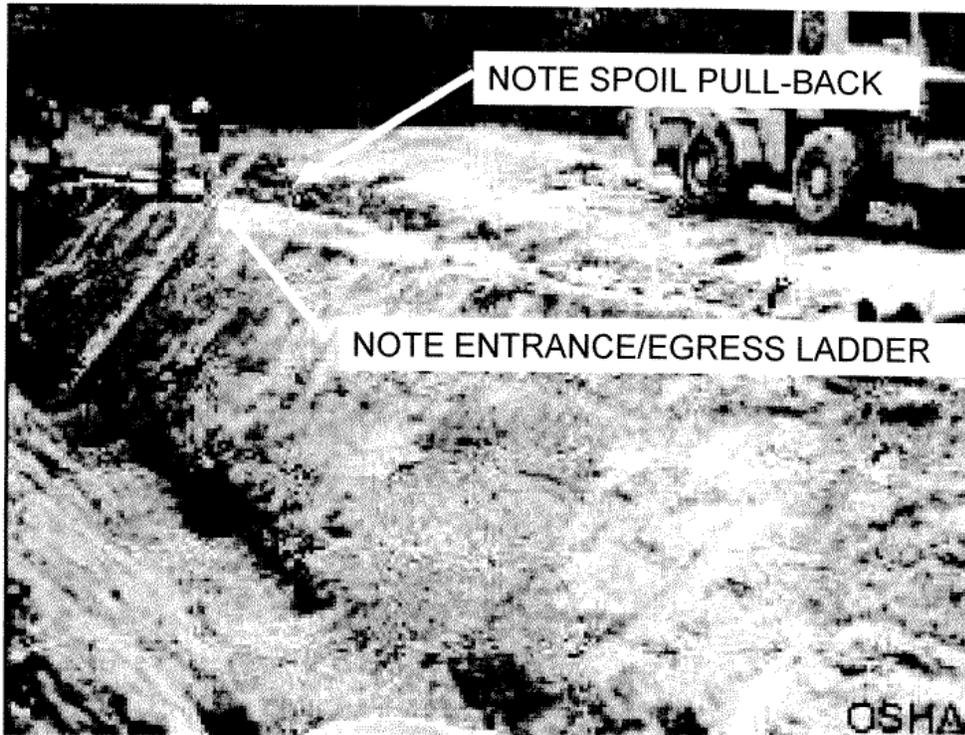
TRENCH SLOPES CONFIGURATIONS - PG 4



Trench slope angles

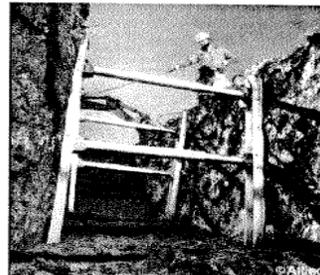
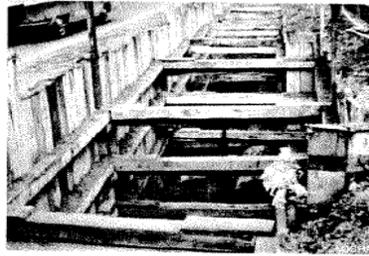
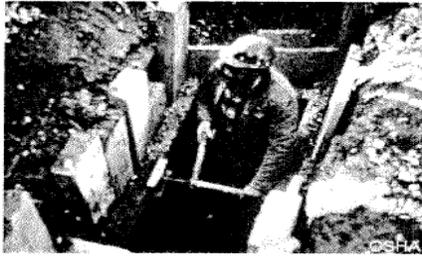
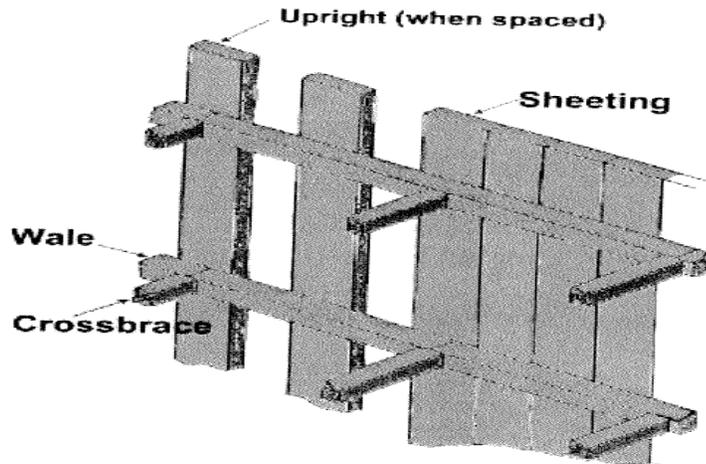


Trench typical dimensions

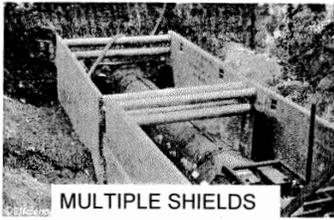


Typical sloped trench

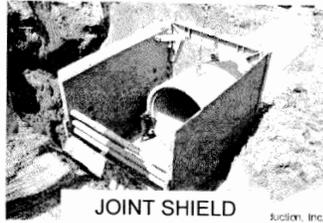
Shoring System Components



TRENCH SHORING EXAMPLES

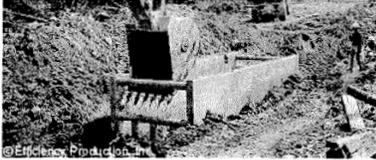


MULTIPLE SHIELDS



JOINT SHIELD

Judson, Inc.



© Efficiency Production, Inc.

SLIDING SHIELD



SHIELD TRANSPORT

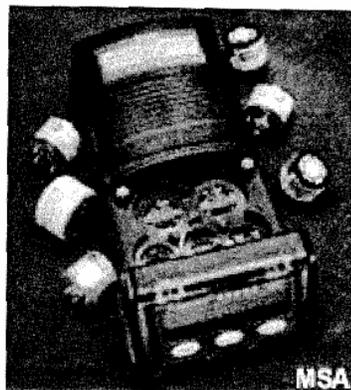
Oxygen Content and Worker Level								
Activity	Oxygen Content in the Work Space (%)							
Level	21	20	19	18	17	16	15	14
Resting	A	A	A	A	A	A	A	A
Walking	A	A	A	A	A	A	A	
Moderate Work	A	A	A	A	A			
Heavy Work	A	A	A	A				
	A	Blood Oxygen Content Adequate						
		Blood Oxygen Content Likely Inadequate						

RESPIRATORY PROTECTION REQ'D

SAFE WORKING OXYGEN LEVELS IN TRENCHES



ATMOSPHERIC MONITORING PPE



GAS MONITOR WITH GAS SAMPLE
CANISTERS

SAFE WORKING OXYGEN LEVELS IN TRENCHES

END OF SECTION