Excavations: Protective Systems

Entering excavations, or "man-made cuts, cavities, trenches, or depressions in an earth surface, formed by earth removal" are governed by OSHA and PESH regulations on the State University of New York campus at Geneseo. These regulations can be found at 29 CFR 1926.650, .651, and .652.

OSHA has produced an Instructional Manual, CPL 2.20B CH-3 (August 22, 1994) which is appended to this Policy detailing the requirements of the OSHA regulations.

This purpose of this document is to assist SUNY Geneseo employees in their understanding and comprehension of the inspection and Protective Systems requirements of the OSHA Excavation regulations. These regulations must be followed prior to allowing any SUNY Geneseo employee or other person enter an excavation.

Contractors, whether contracted to SUCF, DASNY, SUNY Geneseo, or other entity, are wholly responsible for compliance with all applicable OSHA regulations while working on the SUNY Geneseo campus or adjacent properties. Contractors will not be allowed to enter an excavation created by SUNY Geneseo personnel unless all applicable OSHA regulations are complied with.

Soil Types
Due to prior disturbances and filling activities, all soils on the SUNY Geneseo Campus are classified as Type C Soils.

Excavations less than 5 feet in depth
Unless identified as having no opportunity for cave-in by a competent person, excavations less than 5 feet in depth are subject to all requirements of this policy and applicable OSHA regulations.

Competent Person
The following persons are considered competent persons:

Director of Facilities Services
Grounds Manager
Plant Utiliies Engineer 3
Plant Utilities Engineer 2

Other persons may be designated and trained as competent persons.

These persons must conduct inspections of all excavations using the attached form or other similar form at each excavation site:

? Daily and before each shift
? After any precipitation, windstorm, thaw, vehicular movement or other activity that might increase hazards
? When fissures, tension cracks, sloughing, undercutting, water seepage, bottom bulging, or other similar circumstances occur
? When there is any change in the size, location or placement of the spoil pile
? When there is any indication of change or movement in adjacent structures

Competent persons have the authority and the responsibility to immediate cease activities within a excavation should a dangerous condition be observed.

Shoring, Shielding, Sloping and Benching

These methods for securing soil, preventing it from falling on any person required to enter an excavation, must meet specific design criteria. These design criteria are limited to:

? Manufacturer's specifications, recommendations and limitations,
? Professional Engineer Approved tabulated data

- ? Design by a Professional Engineer
- ? Specific slopes as identified in the OSHA regulations

Shoring
Shoring involves placing boards or other bracing against the excavation walls and maintaining separation between the boards with a post, screw jack, or hydraulic cylinder.

Shielding
Trench boxes are the most common form of shielding. Trench boxes are rated for a specific maximum load. Use above this load rated is prohibited.

Sloping
All soils on the SUNY Geneseo campus are classified a Type C soils. OSHA has specified the maximum allowable slope for excavations in Type C soils that are less than 20 feet as 1.5 (height) to 1 (depth). This produces a maximum slope angle of 34 degrees. Using this slope an excavation of 10 feet in depth would require a horizontal width of 30 feet.

Benching
Benching is not permitted in Type C soil and therefore is not approved for use as a soil stabilizing method on the SUNY Geneseo campus.

It is the responsibility of the Director of Facilities Services to ensure that trench boxes or other devices are available for use, appropriate for the intended use, and are used by SUNY Geneseo persons required to enter excavations.

Spoil Piles
Two types of Spoil Piles are generated during excavation. The first is Temporary and must be no closer than 2 feet from the edge of the excavation. Soil placed in the Temporary Spoil Pile is to be removed to a Permanent Spoil Pile, located a great distance from the excavation, prior to workers entering the excavation.

Water from the Temporary Spoil Pile must be directed away from the excavation.

Water in the Excavation
Water in an excavation, whether groundwater, from precipitation or as a results of a utility line failure, must be removed from the excavation prior to persons entering the excavation. Persons are not permitted to be in an excavation during a rainstorm.

Unattended excavations
It is expected that work in an excavation will be completed prior to leaving the area, allowing the excavation to be filled in. However, in situation where that is not possible, the excavation may be temporarily filled in or, if expected to be completed during the next calendar day, the excavation must be completely secured prior to releasing personnel from the site. Means of egress must be removed. Means of preventing vehicular and pedestrian traffic or entrance into the area must be secured. University Police are to be notified of any unattended excavation locations.

Excavations are not permitted to remain open and unattended for more than 2 consecutive calendar days.

Coordination with Other Programs
Excavation deeper than 5 feet are defined by OSHA as "confined spaces". Work in excavation deeper than 5 feet is also subject to the requirements of the Confined Space Entry Program.

Lockout/Tagout may also be applicable to some work in excavations.

Sample Excavation Checklist:

To be completed by Competent Person:

- Daily and before each shift
- After any precipitation, windstorm, thaw, vehicular movement or other activity that might increase hazards
- When fissures, tension cracks, sloughing, undercutting, water seepage, bottom bulging, or other similar circumstances occur
- When there is any change in the size, location or placement of the spoil pile
- When there is any indication of change or movement in adjacent structures

Surface Conditions

- ☐ No Cracks or Cracking
- ☐ Spoil piles set back 2 feet from edge
- ☐ No equipment or materials stored near edge
- ☐ Water in excavation pumped out
- ☐ No sources of vibration

Access and Egress

- ☐ Trench access every 25 feet
- ☐ Stairs, ladders, and ramps set properly
  - Extend 36" above excavation
  - No metal ladders near electrical lines

Shoring and Shielding

- ☐ In place
- ☐ Appropriate for loads expected
- ☐ Hydraulic cylinders, if used are not leaking

Banks and Sides of Slope or Trench

- ☐ No Cracks or Cracking
- ☐ No Spalling
- ☐ Slope of 1.5 (width) to 1 (depth)

Existing Utilities

- ☐ Support adequate
- ☐ Utilities identified and protected

Sources of fumes or gases

- ☐ Eliminated in area of Excavation

Vehicular Traffic

- ☐ Eliminated in area of Excavation

Surface Crossing

- ☐ Prohibited unless
  - Rated for 4 times expected load
  - Minimum 20" wide
  - Fitted with Railings at base and 36" height
  - Extend 24" past trench walls on each side

Spoil Piles

- ☐ Temporary Pile at least 2 feet from excavation
- ☐ Permanent Pile location and transportation means identified prior to initiating excavation
- ☐ Any water leaking from Temporary Pile directed away from excavation

Any other potential hazards: ______________________________

____

Note Weather conditions: ______________________________

Name: ______________ Signature: ______________

Date: ______________ Excavation Purpose: ______________

OSHA Instruction CPL 2.20B CH-3
August 22, 1994
Directorate of Technical Support

CHAPTER 19

EXCAVATIONS: HAZARD RECOGNITION IN TRENCHING AND SHORING

A. INTRODUCTION

Excavating is recognized as one of the most hazardous construction operations. OSHA recently revised **Subpart P, Excavations,** of 29 CFR 1926.650, .651, and .652 to make the standard easier to understand, permit the use of performance criteria where possible, and provide construction employers with options when classifying soil and selecting employee protection methods.

This chapter is intended to assist OSHA Technical Manual users, safety and health consultants, OSHA field staff, and others in the recognition of trenching and shoring hazards and their prevention.

B. DEFINITIONS

Accepted Engineering Practices are procedures that are compatible with the standards of practice required of a registered professional engineer.

Adjacent Structure Stability refers to the stability of the foundation(s) of adjacent structures whose location may create surcharges, changes in soil conditions, or other disruptions that have the potential to extend into the **failure zone** of the excavation or trench.

Competent Person is an individual who is capable of identifying existing and predictable hazards or working conditions that are hazardous, unsanitary, or dangerous to employees, and who **has authorization to take prompt corrective measures to eliminate or control these hazards and conditions.**

Confined Space is a space that, by design and/or configuration, has limited openings for entry and exit, unfavorable natural ventilation, may contain or produce hazardous substances, and is not intended for continuous employee occupancy.

An **excavation** is any man-made cut, cavity, trench, or depression in an earth surface that is formed by earth removal. A **trench** is a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth of a trench is greater than its width, and the width (measured at the bottom) is not greater than 15 feet (4.6 m). If a form or other structure installed or constructed in an excavation reduces the distance between the form and 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.

Hazardous Atmosphere is 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 to persons exposed to the atmosphere.

Ingress and Egress are terms meaning "entry" and "exit," respectively. In trenching and excavation operations, these terms refer to the provision of safe means for employees to enter or exit an excavation or trench.

Protective System refers to a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, and 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.

Registered Professional Engineer is a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer who is registered in any state is deemed to be a "registered professional engineer" within the meaning of Subpart P when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

Support System refers to structures such as underpinning, bracing, and shoring that provide support to an adjacent structure or underground installation or to the sides of an excavation or trench.

Subsurface Encumbrances are underground utilities, foundations, underground streams, high water tables, and transformer vaults as well as geological anomalies.

Surcharge means an excessive vertical load or weight caused by spoil, overburden, vehicles, equipment or activities that may affect trench stability.

Tabulated Data are tables and charts approved by a registered professional engineer and used to design and construct a protective system.

Underground Installations include, but are not limited to, utilities (sewer, telephone, fuel, electric, water, as well as other product lines), tunnels, shafts, vaults, foundations, and other underground fixtures or equipment that may be encountered during excavation or trenching work.

Unconfined Compressive Strength is the load per unit area at which soil will fail in compression. This measure can be determined by laboratory testing, or it can be estimated in the field using a pocket penetrometer, by thumb penetration tests, or by other methods.

TERMS NO LONGER USED

For a variety of reasons, several terms commonly used in the past are no longer used in revised Subpart P. These include:

- **Angle of Repose** - conflicting and inconsistent definitions have led to confusion as to the meaning of this phrase. This term has been replaced by **Maximum Allowable Slope.**

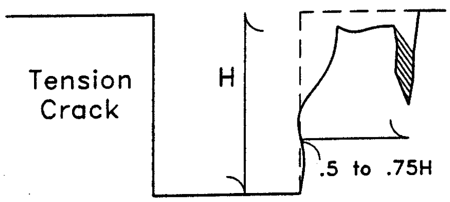
- **Bank, Sheet Pile,** and **Walls** - previous definitions were unclear or were used inconsistently in the former standard.

- **Hard Compact Soil and Unstable Soil** - the new soil classification system in revised Subpart P uses different terms for these soil types.

C. OVERVIEW: SOIL MECHANICS

A number of stresses and deformations can occur in an open cut or trench. For example, increases or decreases in moisture content can adversely affect the stability of a trench or excavation. The following diagrams show some of the more frequently identified causes of trench failure.

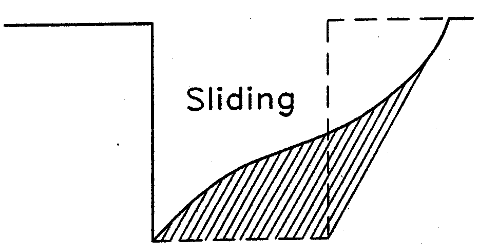
TENSION CRACKS



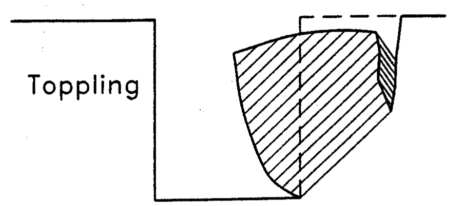
Tension cracks usually form at a horizontal distance of .5 to .75 times the depth of the trench, measured from the top of the vertical face of the trench. See the above drawing for additional details.

SLIDING

Sliding or sluffing may occur as a result of tension cracks. The illustration below illustrates sliding.

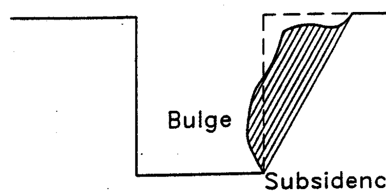


TOPPLING



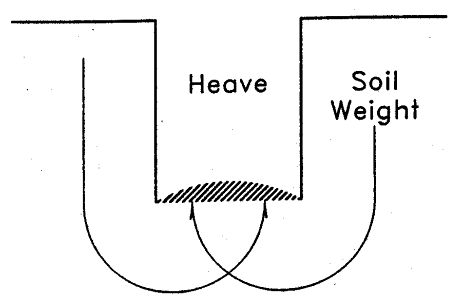
In addition to sliding, **tension cracks** can cause **toppling.** Toppling occurs when the trench's vertical face shears along the tension crack line and topples into the excavation.

SUBSIDENCE AND BULGING



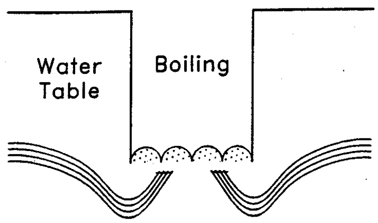
An unsupported excavation can create an unbalanced stress in the soil, which, in turn, causes **subsidence** at the surface and **bulging** of the vertical face of the trench. If uncorrected, this condition can cause face failure and entrapment of workers in the trench.

HEAVING OR SQUEEZING



Bottom heaving or squeezing is caused by the downward pressure created by the weight of adjoining soil. This pressure causes a bulge in the bottom of the cut, as illustrated in the above drawing. Heaving and squeezing can occur even when shoring or shielding has been properly installed.

BOILING



Boiling is evidenced by an upward water flow into the bottom of the cut. A high water table is one of the causes of boiling. Boiling produces a "**quick**" condition in the bottom of the cut, and can occur even when shoring or trench boxes are used.

Unit Weight of Soils refers to the weight of one unit of a particular soil. The weight of soil varies with type and moisture content. One cubic foot of soil can weigh from 110 to 140 pounds or more, and one cubic meter (35.3 cubic feet) of soil can weigh as much as a pickup truck, i.e., in excess of 3000 pounds.

D. DETERMINATION OF SOIL TYPE

OSHA categorizes soil and rock deposits into four types. Each type is briefly described below.

STABLE ROCK

Stable rock is natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed. Determining whether a deposit is of this type may be difficult unless it is known whether cracks exist and whether or not the cracks run into or away from the excavation.

TYPE A SOILS

Type A soils are cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kPa) or greater. Examples of Type A cohesive soils are: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. (No soil is Type A if it is fissured, is subject to vibration of any type, has previously been disturbed, is part of a sloped, layered system where the layers dip into the excavation on a slope of 4 horizontal to 1 vertical (4H:1V) or greater, or has seeping water.

TYPE B SOILS

Type B soils are cohesive soils with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa). Examples of Type B soils are: angular gravel; silt; silt loam; previously disturbed soils unless otherwise classified as Type C; soils that meet the unconfined compressive strength or cementation requirements of Type A soils but are fissured or subject to vibration; dry unstable rock; layered systems sloping into the trench at a slope less than 4H:1V (only if the material would be classified as a Type B soil).

TYPE C SOILS

Type C soils are cohesive soils with an unconfined compressive strength of 0.5 tsf (48 kPa) or less and include granular soils such as gravel, sand and loamy sand, submerged soil, soil from which water is freely seeping, and submerged rock that is not stable. Also included in this classification is material in a sloped, layered system where the layers dip into the excavation or have a slope of four horizontal to one vertical (4H:1V) or greater.

All soils on the SUNY Geneseo Campus are Type C Soils.

LAYERED GEOLOGICAL STRATA

Where soils are configured in layers, i.e., where a layered geologic structure exists, the soil must be classified on the basis of the soil classification of the weakest soil layer. Each layer may be classified individually if a more stable layer lies below a less stable layer, i.e., where a Type C soil rests on top of stable rock.

All soils on the SUNY Geneseo campus are Type C Soils.

E. TEST EQUIPMENT AND METHODS FOR EVALUATING SOIL TYPE

Many kinds of equipment and methods are used to determine the type of soil prevailing in an area. These are described below.

POCKET PENETROMETER

Penetrometers are direct reading, spring-operated instruments that are used to determine the unconfined compressive strength of saturated cohesive soils. Once pushed into the soil, an indicator sleeve displays the reading. The instrument is calibrated in either tons per square foot (tsf) or kilograms per square centimeter (kPa). However, penetrometers have error rates in the range of $\pm$ 20-40 percent.

SHEARVANE (TORVANE)

To determine the unconfined compressive strength of the soil with a **shearvane**, the blades of the vane are pressed into a level section of undisturbed soil, and the torsional knob is slowly turned until soil failure occurs. The direct instrument reading must be multiplied by 2 to provide results in tons per square foot (tsf) or kilograms per square centimeter (kPa).

THUMB PENETRATION TEST

The **thumb penetration** procedure involves an attempt to press the thumb firmly into the soil in question. If the thumb makes an indentation in the soil only with great difficulty, the soil is probably Type A. If the thumb penetrates no further than the length of the thumb nail, it is probably Type B soil, and if the thumb penetrates the full length of the thumb, it is Type C soil. The thumb test is subjective and is therefore the least accurate of the three methods.

DRY STRENGTH TEST

Dry soil that crumbles freely or with moderate pressure into individual grains is **granular**. Dry soil that falls into clumps that subsequently break into smaller clumps (and the smaller clumps can only be broken with difficulty) is probably **clay in combination with gravel, sand, or silt**. If the soil breaks into clumps that do not break into smaller clumps (and the soil can only be broken with difficulty), the soil is considered **unfissured** unless there is visual indication of fissuring.

PLASTICITY OR WET THREAD TEST

This test is conducted by molding a moist sample of the soil into a ball and attempting to roll it into a thin thread approximately 1/8 inch (3 mm) in diameter (thick) by two inches (50 mm) in length. The soil sample is held by one end. If the sample does not break or tear, the soil is considered cohesive.

VISUAL TEST

A visual test is a qualitative evaluation of conditions around the site. In a visual test, the entire excavation site is observed, including the soil adjacent to the site and the soil being excavated. If the soil remains in clumps, it is cohesive; if it appears to be coarse-grained sand or gravel, it is considered granular. The evaluator also checks for any signs of vibration.

During a visual test, the evaluator should check for crack-line openings along the failure zone that would indicate tension cracks, look for existing utilities that indicate that the soil has previously been disturbed, and observe the open side of the excavation for indications of layered geologic structuring.

The evaluator should also look for signs of bulging, boiling, or sluffing, as well as for signs of surface water seeping from the sides of the excavation or from the water table. If there is standing water in the cut, the evaluator should check for "quick" conditions (see page 19-3).

In addition, the area adjacent to the excavation should be checked for signs of foundations or other intrusions into the failure zone, and the evaluator should check for surcharging and the spoil distance from the edge of the excavation.

OSHA Instruction CPL 2.20B CH-3
August 22, 1994
Directorate of Technical Support

F. SHORING TYPES

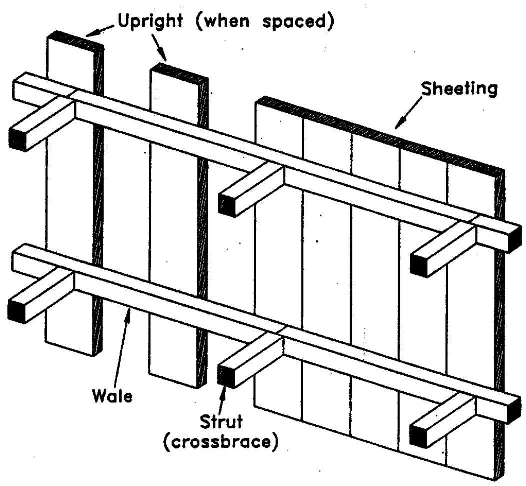


Figure 19-1. Timber Shoring.

Shoring is the provision of a **support system for trench faces** used to prevent movement of soil, underground utilities, roadways, and foundations. Shoring or shielding is used when the location or depth of the cut makes sloping back to the maximum allowable slope impractical. There are two basic types of shoring, **timber** and **aluminum hydraulic.**

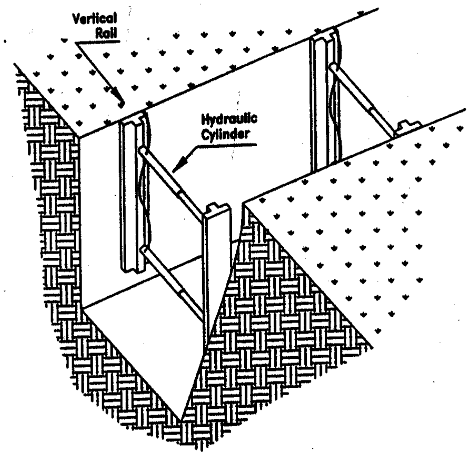
Shoring systems consist of posts, wales, struts, and sheeting. The trend today is toward the use of **hydraulic shoring,** a prefabricated strut and/or wale system manufactured of aluminum or steel. Hydraulic shoring provides a critical safety advantage over timber shoring because workers do not have to enter the trench to install or remove hydraulic shoring. The following advantages of most hydraulic systems are that they:

- Are light enough to be installed by one worker;
- Are gauge-regulated to ensure even distribution of pressure along the trench line;
- Can have their trench faces "pre-loaded", thereby using the soil's natural cohesion to prevent movement;
- Can easily be adapted to suit various trench depths and widths.

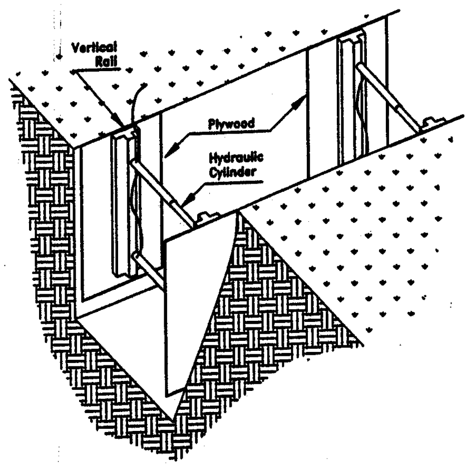
All shoring should be installed from the top down and be removed from the bottom up. Hydraulic shoring should be checked at least once per shift for leaking hoses and/or cylinders, broken connections, cracked nipples, bent bases, and any other damaged or defective parts.

PNEUMATIC SHORING

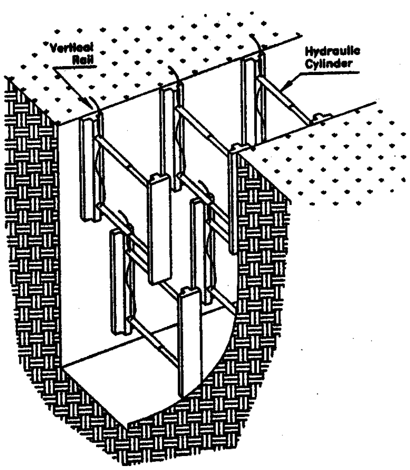
Pneumatic shoring works in a manner similar to hydraulic shoring. The primary difference is that pneumatic shoring uses air pressure in place of hydraulic pressure. A disadvantage to the use of pneumatic shoring is that an air compressor must be on site.



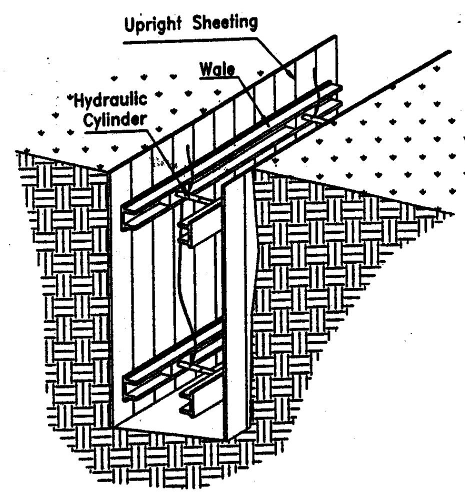
Vertical Aluminum Hydraulic Shoring
(Spot Bracing)



Vertical Aluminum Hydraulic Shoring
(with Plywood)

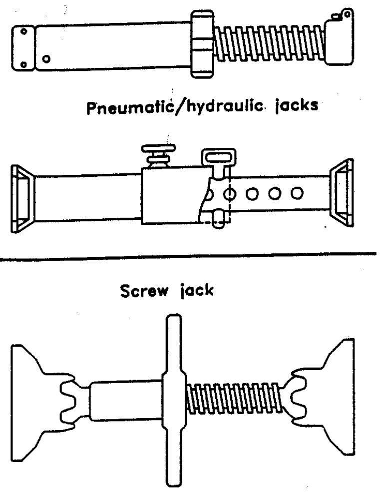


Vertical Aluminum Hydraulic Shoring
(Stacked)



Aluminum Hydraulic Shoring Waler System
(Typical)

Figure 19-2A. Shoring Variations-Typical Aluminum Hydraulic Shoring Installations.



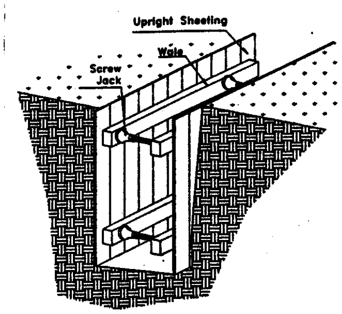


Figure 19-2B. Shoring Variations.

SCREW JACKS

Screw jack systems differ from hydraulic and pneumatic systems in that the struts of a screw jack system must be adjusted manually. This creates a hazardous condition because the worker is required to be in the trench in order to adjust the strut. In addition, uniform "preloading" cannot be achieved with screw jacks, and their physical weight creates handling difficulties.

SINGLE-CYLINDER HYDRAULIC SHORES

Shores of this type are generally used in a waler system, as an assist to timber shoring systems, and in shallow trenches where face stability is required.

UNDERPINNING

This process involves stabilizing adjacent structures, foundations, and other intrusions that may impact the excavation. As the term indicates, underpinning is a procedure in which the foundation is physically reinforced. Underpinning should be conducted only under the direction and with the approval of a registered professional engineer.

G. SHIELDING TYPES

Trench boxes are different from shoring because, instead of shoring up or otherwise supporting the trench face, they are intended primarily to protect workers from cave-ins and other similar incidents.

The excavated area between the outside of the trench box and the face of the trench should be as small as possible. The space between the trench boxes and the excavation side are backfilled to prevent lateral movement of the box. Shields may not be subjected to loads exceeding those which the system was designed to withstand.

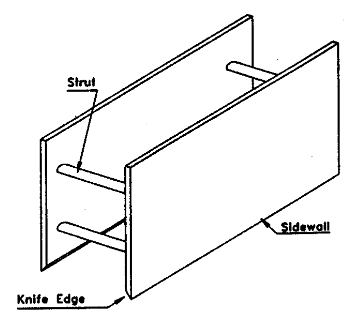


Figure 19-3. Trench Shield.

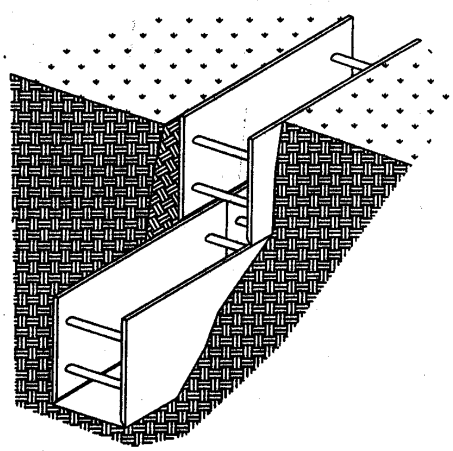


Figure 19-4. Trench Shield, Stacked.

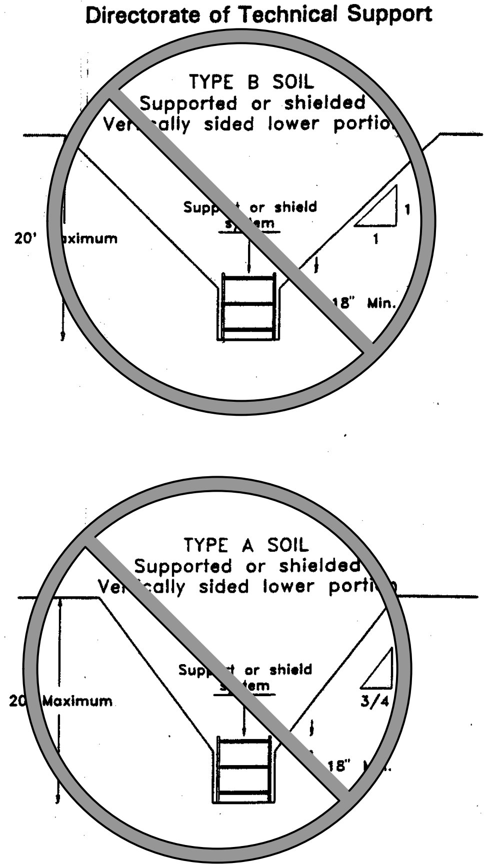
Trench boxes are generally used in open areas, but they also may be used in combination with sloping and benching. The box should extend at least 18 inches (.45 m) above the surrounding area if there is sloping toward excavation. This can be accomplished by providing a benched area adjacent to the box.

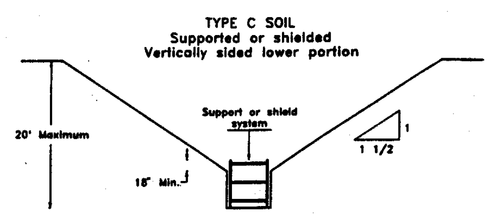
Earth excavation to a depth of 2 feet (.61 m) below the shield is permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench and there are no indications while the trench is open of possible loss of soil from behind or below the bottom of the support system.

Conditions of this type require observation on the effects of **bulging, heaving,** and **boiling** as well as **surcharging, vibration, adjacent structures,** etc. on excavating below the bottom of a shield.

Careful visual inspection of the conditions mentioned above is the primary and most prudent approach to hazard identification and control.

OSHA Instruction CPL 2.20B CH-3
August 22, 1994
Directorate of Technical Support





All soils on SUNY Geneseo campus are Type C soils.

Figure 19-5. Slope and Shield Configurations.

OSHA Instruction CPL 2.20B CH-3
August 22, 1994
Directorate of Technical Support

H. SLOPING AND BENCHING

SLOPING

Maximum allowable slopes for excavations less than 20 feet (6.09 m) based on soil type and angle to the horizontal are as follows:

Soil Type	Height/Depth Ratio	Slope Angle
Stable Rock	Vertical	90°
Type A	¾:1	53°
Type B	1:1	45°
Type C	1½:1	34°
Type A Short term (For a maximum excavation depth of 12 feet)	½:1	63°

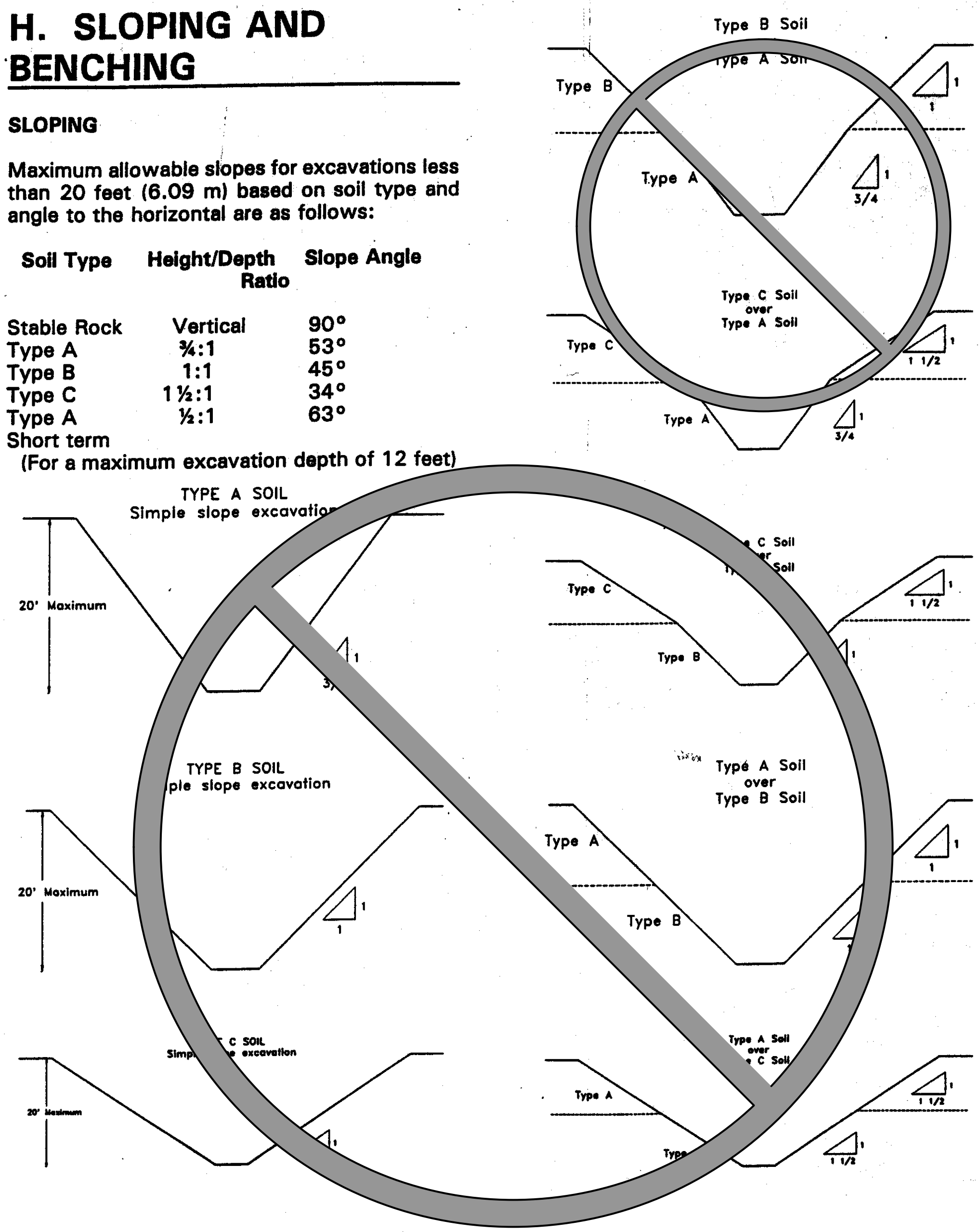
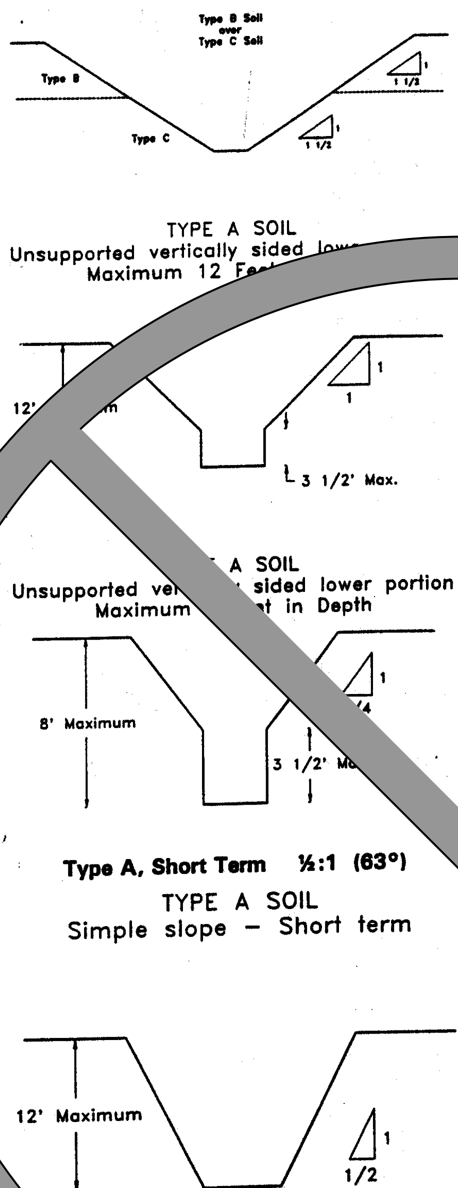


Figure 19-6. Slope Configurations-Excavations Made in Layered Soils.

All soils on SUNY Geneseo Campus are Type C Soils.



BENCHING

There are two basic types of benching, simple and multiple. The type of soil determines the horizontal to vertical ratio of the benched side.

As a general rule, the bottom vertical height of the trench must not exceed 4 feet (1.2 m) for the first bench. Subsequent benches may be up to a maximum of 5 feet (1.5 m) vertical in Type A soil and 4 feet (1.2 m) in Type B soil to … nch depth of 20 feet (6.0 m). All … ches must be below the maximum allow… e for that soil type. For Type B soil the … xcavation is permitted in cohesive soil only.

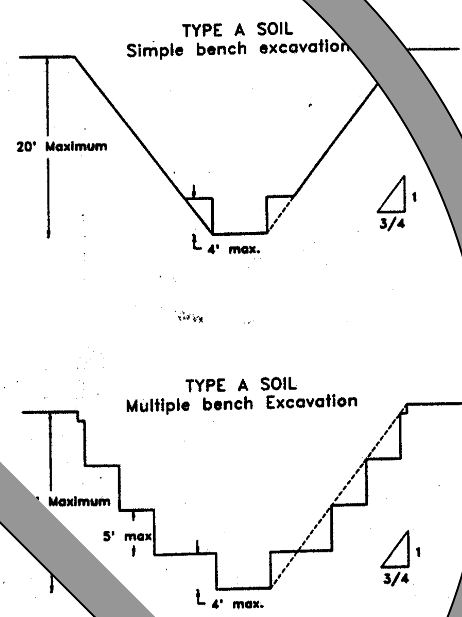


Figure 19-7. Excavations Made in Type A Soil.

OSHA Instruction CPL 20B CH-3
August 22, 1994
Directorate of Techn Support

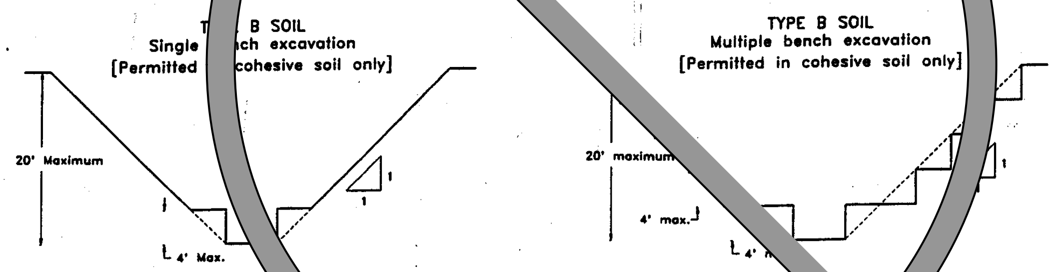


Figure 8. Excavations Made in Type B Soil.

I. SPOIL

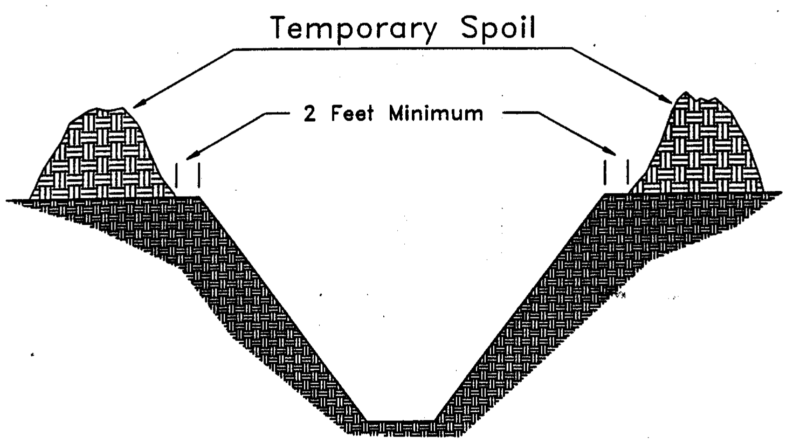


Figure 19-9. Spoil Placement.

TEMPORARY SPOIL

Temporary spoil must be placed no closer than 2 feet (0.61 m) from the surface edge of the excavation, measured from the nearest base of the spoil to the cut. This distance should not be measured from the crown of the spoil deposit. The reason for this distance requirement is to ensure that loose rock or soil from the temporary spoil does not fall on employees working in the trench.

Spoil should be placed so that it channels rain water and other run-off water away from the excavation. Spoil should be placed so that it cannot accidently run, slide, or fall back into the excavation.

- Requiring a designated and trained flagperson along with signs, signals, and barricades when necessary.

EXPOSURE TO FALLING LOADS

Employees must be protected from loads or objects falling from lifting or digging equipment. Procedures designed to ensure their protection include:

- Employees are not permitted to work under raised loads.
- Employees are required to stand away from equipment that is being loaded or unloaded.
- Equipment operators or truck drivers may stay in their equipment during loading and unloading if the equipment is properly equipped with a cab shield or adequate canopy.

WARNING SYSTEMS FOR MOBILE EQUIPMENT

The following steps should be taken to prevent vehicles from accidently falling into the trench:

- Barricades must be installed where necessary.
- Hand or mechanical signals must be used as required.
- Stop logs must be installed if there is a danger of vehicles falling into the trench.
- Soil should be graded away from the excavation; this will assist in vehicle control as well as the channeling of runoff water.

HAZARDOUS ATMOSPHERES/ CONFINED SPACES

Employees shall not be permitted to work in hazardous and/or toxic atmospheres. Such atmospheres include:

- Atmospheres having less than 19.5% or more than 23.5% oxygen.
- Atmospheres having a combustible gas concentration greater than 20% of the lower flammable limit.
- Atmospheres containing concentrations of hazardous substances that exceed those specified in the Threshold Limit Values for airborne contaminants established by the ACGIH (American Conference of Governmental Industrial Hygienists).

All operations involving such atmospheres must be conducted in accordance with OSHA requirements for occupational health and environmental controls (see Subpart D of 29 CPR 1926) and for personal protective equipment and lifesaving equipment (see Subpart E, 29CFR 1926). Engineering controls (e.g., ventilation) and respiratory protection may be required.

Testing for atmospheric contaminants.

- Testing should be conducted before employees enter the trench and should be done on a recurring basis to ensure that the trench remains safe. The frequency of the testing should be increased if equipment is operating in the trench.
- Testing frequency should also be increased if welding, cutting, or burning is conducted in the trench.

Employees required to wear respiratory protection must be trained, fit tested, and enrolled in a respiratory protection program.

Some trenches qualify as confined spaces. When this occurs, compliance with the Confined Space Standard is also required.

EMERGENCY RESCUE EQUIPMENT

Emergency rescue equipment is required when a hazardous atmosphere exists or can reasonably be expected to exist. Requirements are as follows:

- Respirators must be of the type suitable for the exposure. Employees must be trained in their use and a respirator program must be instituted.
- Attended **(at all times)** lifelines must be provided when employees enter bell-bottom pier holes, deep confined spaces, or other similar hazards.
- Employees who enter confined spaces must be trained.

STANDING WATER/WATER ACCUMULATION

Methods for controlling standing water or water accumulation must be provided and should consist of the following if employees are permitted to work in the excavation:

- The use of special support or shield systems approved by a registered professional engineer.
- Water removal equipment, i.e., well pointing is used and monitored by a competent person.
- Safety harnesses and life lines are used in conformance with 29 CFR 1926.104.
- Surface water is diverted away from the trench.
- Employees are removed from the trench during a rain storm.
- Trenches are carefully inspected by a competent person after each rain storm and before employees are permitted to re-enter the trench.

INSPECTIONS

Inspections shall be made by a competent person and should be documented. The following guide specifies the frequency and conditions requiring inspections to be conducted:

- Daily and before the start of each shift.
- As dictated by the activity taking place in the trench.
- After each and every rain storm.
- After other phenomena that would increase the hazard, e.g., snowstorm, windstorm, thaw, earthquake, etc.
- When fissures, tension cracks, sloughing, undercutting, water seepage, bulging at the bottom, or other similar circumstances occur.
- When there is any change in the size, location, or placement of the spoil pile.
- When there is any indication of change or movement in adjacent structures.

K. BIBLIOGRAPHY

29 CFR 1926, Subpart P, Excavations.

Construction Safety Association of Ontario. Trenching Safety. 74 Victoria St., Toronto, Ontario, Canada M5C2A5.

International Labour Office (ILO). Building Work, A Compendium of Occupational Safety and Health Practice. International Occupational Safety and Health Information Centre (CIS): ILO, Geneva, Switzerland.

National Safety Council. Accident Prevention Manual for Industrial Operations, Engineering and Technology. 9th ed. Chicago, IL: National Safety Council.

National Safety Council. Protecting Worker's Lives, A Safety and Health Guide for Unions. Chicago, IL: National Safety Council.

National Safety Council. Industrial Data Sheets:
I-482, General Excavation, and
I-254, Trench Excavation.
Chicago, IL: National Safety Council.

National Utility Contractors Association, Competent Person Manual-1991.

NBS/NIOSH, Development of Draft Construction Safety Standards for Excavations.
Volume I, April 1983. NIOSH 83-103, Pub. No. 84-100-569.
Volume II, April 1983. NIOSH 83-2693, Pub. No. 83-233-353.

Scardino, A. J., Jr. 1993. Hazard Identification and Control--Trench Excavations. Lagrange, TX: Carlton Press.

APPENDIX 19-1. SITE ASSESSMENT QUESTIONS

During first and subsequent visits to a construction or facility maintenance location, the compliance officer (or the site's safety/competent person) may find the following questions useful.

Is the cut, cavity, or depression a **TRENCH** or an **EXCAVATION?**

Is the cut, cavity, or depression **more than 4 FEET (1.2 m) in DEPTH?**

Is there **WATER** in the cut, cavity, or depression?

Are there adequate means of **ACCESS** and **EGRESS?**

Are there any **SURFACE ENCUMBRANCES?**

Is there exposure to **VEHICULAR TRAFFIC?**

Are **ADJACENT STRUCTURES STABILIZED?**

Does **MOBILE EQUIPMENT** have a **WARNING SYSTEM?**

Is a **COMPETENT PERSON IN CHARGE** of the operation?

Is **EQUIPMENT OPERATING** in or around the cut, cavity, or depression?

Are procedures required to monitor, test, and **CONTROL HAZARDOUS ATMOSPHERES?**

Does a competent person **DETERMINE SOIL TYPE?**

Was a **SOIL TESTING DEVICE** used to determine soil type?

Is the **SPOIL** placed **2 (0.6 m) or MORE FEET FROM THE EDGE** of the cut, cavity, or depression?

Is the **DEPTH 20 feet (6.1 m) or MORE** for the cut, cavity, or depression?

Has a **REGISTERED PROFESSIONAL ENGINEER APPROVED** the procedure if the depth is more than 20 feet (6.1 m)?

Does the procedure require **BENCHING/MULTIPLE BENCHING?** or **SHORING?** or **SHIELDING?**

If provided, do **SHIELDS EXTEND** at least **18 INCHES (0.5 m) ABOVE** the surrounding area if it is sloped toward the excavation?

If shields are used, is the **DEPTH OF THE CUT MORE THAN 2 FEET (0.6 m) BELOW** the bottom of **THE SHIELD?**

Are any required **SURFACE CROSSINGS** of the cut, cavity, or depression the **PROPER WIDTH AND FITTED WITH HAND RAILS?**

Are means of **EGRESS** from the cut, cavity, or depression **NO MORE THAN 25 FEET (7.6 m) FROM THE WORK?**

Is **EMERGENCY RESCUE EQUIPMENT** required?

Is there **DOCUMENTATION OF THE MINIMUM DAILY EXCAVATION INSPECTION?**