

TRENCHING AND SHORING PROCEDURES

A. SCOPE & APPLICATION

EAGLE INDUSTRIAL INSTRUMENTATION policy sets forth the official practices required for excavations made by employees. All employees shall be instructed in the health and safety significance of the excavation procedure. Each new employee shall be instructed in the purpose and use of the excavation procedure. The field supervisor in charge of the excavation will make a copy of this procedure available before the start of any work. All personnel not involved in the actual trenching procedures will be given basic awareness information on all operations.

B. GENERAL REQUIREMENTS

All excavations shall be made in accordance with the rules, regulations, requirements, and guidelines set forth in 29 CFR 1926.650, .651, and .652; the Occupational Safety and Health Administration's standard on Excavations, except where otherwise noted below.

C. INSPECTION/

1. Procedures

A competent person shall be placed in charge of all excavations.
Underground utilities must be located and marked before excavation begins.
Employees are not allowed in the excavation while heavy equipment is digging.
All open holes or trenches must be protected.

2. Inspections

The competent person shall conduct inspections:

- Daily and before the start of each shift.
- As dictated by the work being done in the trench.
- After every rain storm.
- After other events that could increase hazards, such as snowstorm, windstorm, thaw, earthquake, dramatic change in weather, etc.
- When fissures, tension cracks, sloughing, undercutting, water seepage, bulging at the bottom, or other similar conditions occur.
- When there is a change in the size, location, or placement of the spoil pile.
- When there is any indication of change or movement in adjacent structures.

(For excavations 4 feet or greater in depth, a trench inspection form shall be filled out for each inspection.)

D. SOIL TYPES

Type A -Most stable: clay, silty clay, and hardpan (resists penetration). No soil is

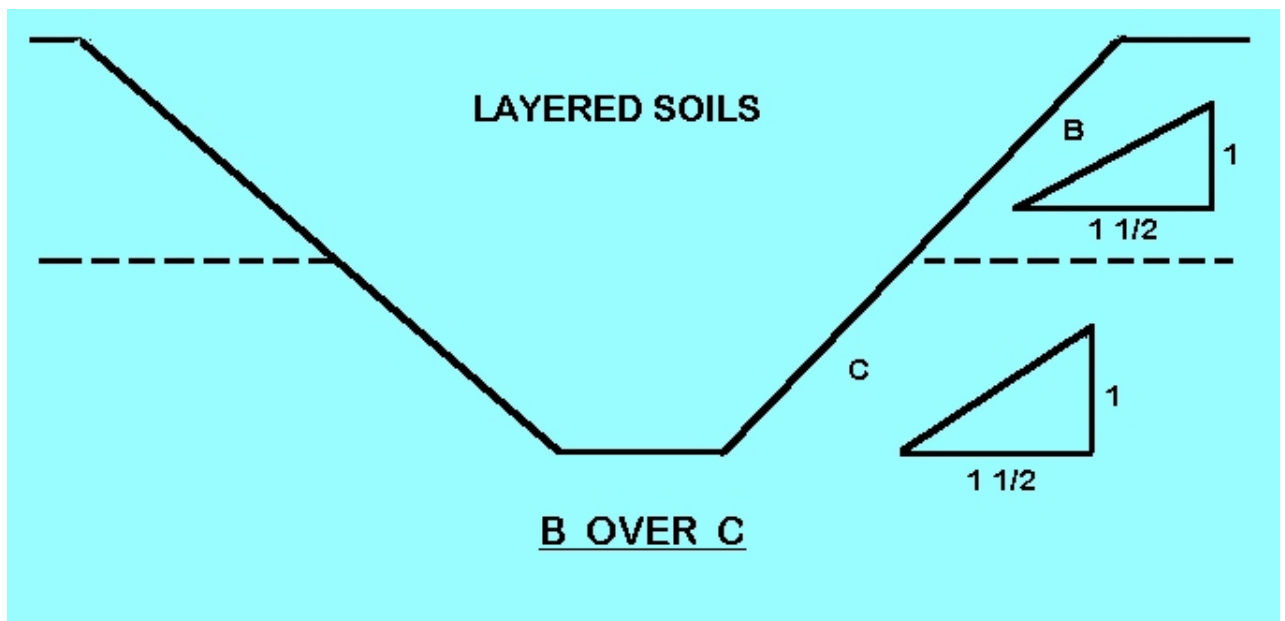
Type A if it is fissured, is subject to vibration of any type, has previously been disturbed, or has seeping water.

Type B - Medium stability: silt, sandy loam, medium clay and unstable dry rock; previously disturbed soils unless otherwise classified as Type C; soils that meet the requirements of Type A soil but are fissured or subject to vibration.

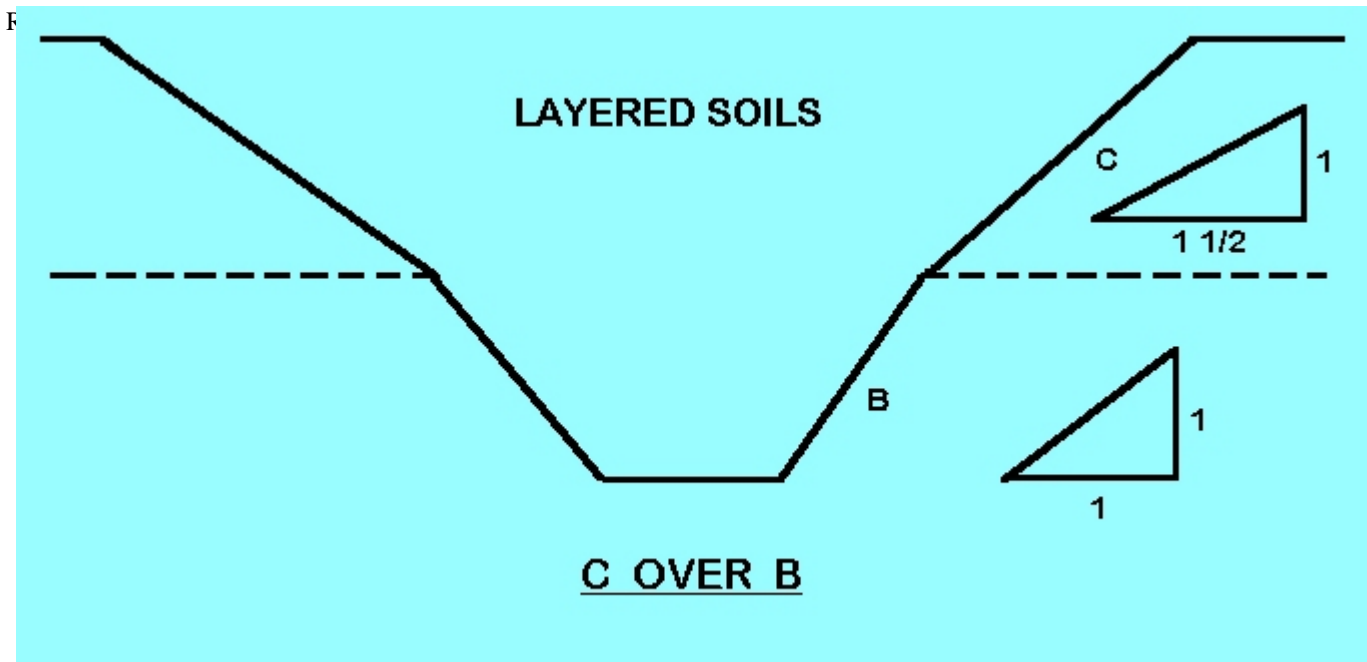
Type C - Least stable: gravel, loamy sand, soft clay, submerged soil or dense, heavy unstable rock, and soil from which water is freely seeping.

Layered geological strata - 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.

Because most excavations will be conducted in order to repair / replace existing pipelines or equipment (i.e. the soil has been previously disturbed), **excavations shall be made to meet the requirements for Type B or Type C soils only**, as appropriate.



Layered Geological Strata



E. TESTING METHODS

The competent person in charge of the excavation shall be responsible for determining whether the soil is Type B or C. If the competent person wants to classify the soil as Type C, they do not need to do any tests. However, tests must be conducted to determine if the soil can be classified as Type B. To do this, the competent person shall use a visual test coupled with one or more manual tests.

1. Visual test

In addition to checking the items on the trench inspection form, the competent person should perform a **visual test** to evaluate the 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. The competent person also checks for any signs of vibration.

During the visual test, the competent person 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 been previously disturbed, and, if so, what sort of backfill was used, and observe the open side of the excavation for indications of layered geologic structuring.

This person should also look for signs of bulging, boiling, or sloughing, as well as for signs of surface water seeping from the sides of the excavation or from the water table.

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.

F. SPOIL

1. **Temporary spoil** shall be placed no closer than 2 feet 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. This distance requirement ensures that loose rock or soil from the temporary spoil will not fall on employees in the trench.

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

2. **Permanent spoil** should be placed some distance from the excavation.

G. SURFACE CROSSING OF TRENCHES

Surface crossing of trenches should not be made unless absolutely necessary. However, if necessary, they are only permitted under the following conditions:

- **Vehicle crossings** must be designed by and installed under the supervision of a registered professional engineer.
- **Walkways or bridges** must:
 - have a minimum clear width of 20 inches,
 - be fitted with standard rails, and
 - extend a minimum of 24 inches past the surface edge of the trench.

H. INGRESS AND EGRESS

Trenches 4 feet or more in depth shall be provided with a fixed means of egress.

Spacing between ladders or other means of egress must be such that a worker will not have to travel more than 25 feet laterally to the nearest means of egress.

Ladders must be secured and extend a minimum of 36 inches above the landing.

Metal ladders should not be used when electric utilities are present.

I. EXPOSURE TO VEHICLES

Employees exposed to vehicular traffic shall be provided with and required to wear reflective vests or other suitable garments marked with or made of reflectorized or high-visibility materials.

Trained flag persons, signs, signals, and barricades shall be used when necessary.

J. EXPOSURE TO FALLING LOADS

All employees on an excavation site must wear hard hats.

Employees are not allowed to work under raised loads.

Employees are not allowed to work under loads being lifted or moved by heavy equipment used for digging or lifting.

Employees are required to stand away from equipment that is being loaded or unloaded to avoid being struck by falling materials or spillage.

Equipment operators or truck drivers may remain in their equipment during loading and unloading if the equipment is properly equipped with a cab shield or adequate canopy.

K. WARNING SYSTEMS FOR MOBILE EQUIPMENT

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

- **Barricades** must be installed where necessary,
- **Hand or mechanical signals** must be used as required,
- **Trenches left open overnight** shall be fenced and barricaded.

L. HAZARDOUS ATMOSPHERES AND CONFINED SPACES

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

- less than 19.5% oxygen,
- a combustible gas concentration greater than 20% of the lower flammable limit, and,
- concentrations of hazardous substance that exceed those specified in the Threshold Limit Values for airborne contaminants established by the ACGIH.

All operations involving such atmospheres must be conducted in accordance with OSHA requirements for occupational health and environmental controls for personal protective equipment and for lifesaving equipment. Engineering controls (such as ventilation) and respiratory equipment may be required.

M. TESTING FOR ATMOSPHERIC CONTAMINANTS

If there is any possibility that the trench or excavation could contain a hazardous atmosphere, atmospheric testing must be conducted prior to entry. Conditions that might warrant atmospheric testing would be if the excavation was made in a landfill area or if

the excavation was crossed by, was adjacent to, or contained pipelines containing a hazardous material (for example, natural gas lines).

Testing should be conducted before employees enter the trench and should be done regularly to ensure that the trench remains safe. The frequency of testing should be increased if equipment is operating in the trench.

Testing frequency should also be increased if welding, cutting, or burning is done 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 OSHA's Confined Space is also required.

N. STANDING WATER AND WATER ACCUMULATION

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

- Use of special support or shield systems approved by a registered professional engineer.
- Water removal equipment, such as pumps, used and monitored by a competent person.
- Employees removed from the trench during rainstorms
- Trenches carefully inspected by a competent person after each rain and before employees are permitted to re-enter the trench.

O. BENCHING, SLOPING, SHORING, AND SHIELDING REQUIREMENTS

All excavations or trenches 4 feet or greater in depth shall be appropriately benched, shored, or sloped according to the procedures and requirements set forth in OSHA's Excavation standard, 29 CFR 1926.650, .651, and .652.

Excavations or trenches 20 feet deep or greater must have a protective system designed by a registered professional engineer.

Excavations under the base of footing of a foundation or wall requires a support system designed by a registered professional engineer.

Sidewalks and pavement shall not be undermined unless a support system or another method of protection is provided to protect employees from their possible collapse.

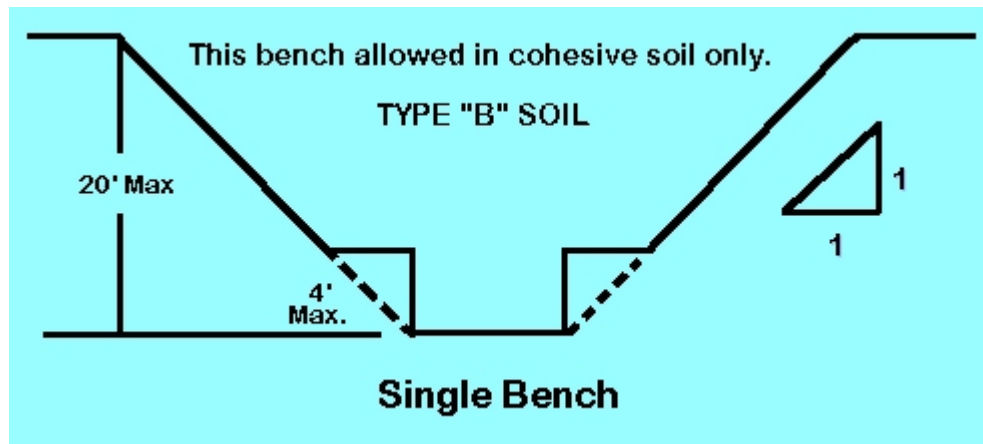
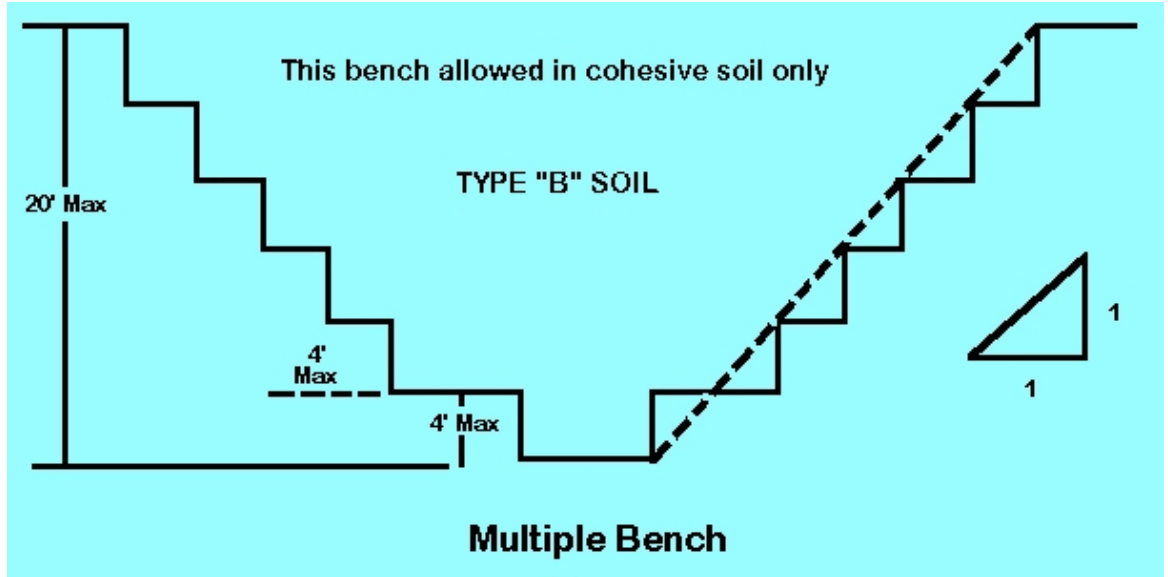
P. BENCHING

There are two basic types of benching, single and multiple, which can be used in conjunction with sloping.

All benched excavations 20 feet or less in depth shall have a maximum allowable

slope of 1:1.

Basic Types of Benching



In Type B soil, the vertical height of the benches must not exceed 4 feet. Benches must be below the maximum allowable slope for that soil type. In other words, a 10-foot deep trench in Type B soil must be benched back 10 feet in each direction, with the maximum of a 45-degree angle.

Benching is not allowed in Type C soil.

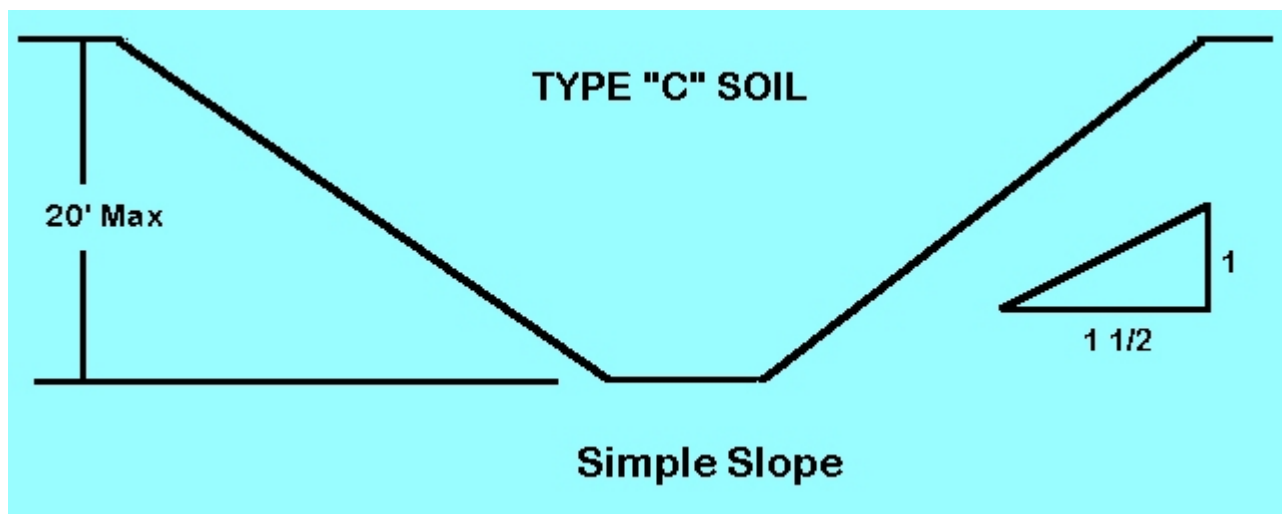
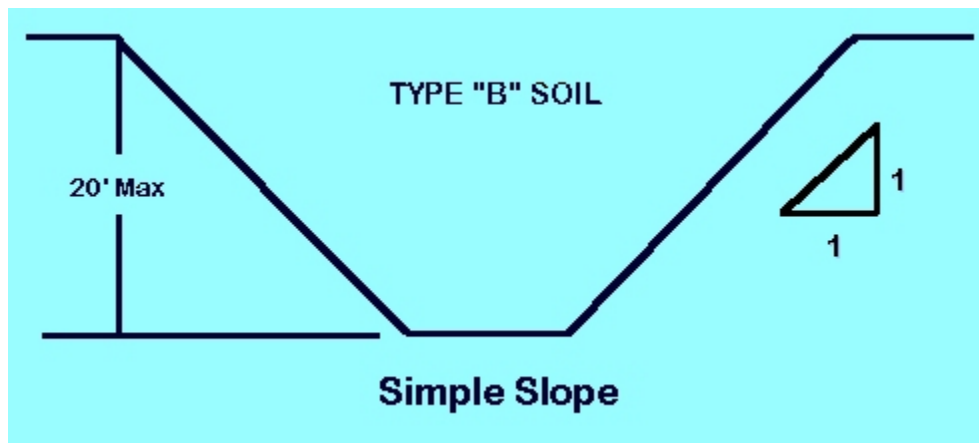
Q. SLOPING

Maximum allowable slopes for excavations less than 20' based on soil type and angle to the horizontal are as follows:

Soil Type	Height/depth ratio	Slope angle
Type B	1:1	45 degrees
Type C	1 1/2:1	34 degrees

A 10-foot-deep trench in Type B soil would have to be sloped to a 45-degree angle, or sloped 10 feet back in both directions. Total distance across a 10-foot-deep trench would be 20 feet, plus the width of the bottom of the trench itself. In Type C soil, the trench would be sloped at a 34-degree angle, or 15 feet back in both directions for at least 30 feet across, plus the width of the bottom of the trench itself.

Illustration of Simple Slope Trenching in B and C Type Soils



R. SHORING

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.

Because the Physical Plant has aluminum hydraulic shores, they will be the focus of this section. Hydraulic shoring provides a critical safety advantage over timber shoring because workers do not have to enter the trench to install them. They are also light enough to be installed by one worker; they are gauge-regulated to ensure even distribution of pressure along the trench line; and they can be adapted easily to various trench depths and widths. However, if timber shoring is used, it must meet the requirements of 29 CFR 1926.650, .651, and .652.

All shoring shall be installed from the top down and removed from the bottom up. Hydraulic shoring shall 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.

The top cylinder of hydraulic shoring shall be no more than 18 inches below the top of the excavation.

The bottom of the cylinder shall be no higher than four feet from the bottom of the excavation. (Two feet of trench wall may be exposed beneath the bottom of the rail or plywood sheeting, if used.)

Three vertical shores, evenly spaced, must be used to form a system.

Wales are installed no more than two feet from the top, no more than four feet from the bottom, and no more than four feet apart, vertically.

S. SHIELDING

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 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 box and the excavation side must be backfilled to prevent lateral movement of the box.** Shields may not be subjected to loads exceeding those which the system was designed to withstand.

Trench boxes are generally used in open areas, but they also may be used in combination with sloping and benching.

The box must extend at least 18 inches above the surrounding area if there is sloping toward the excavation. This can be accomplished by providing a benched area adjacent to the box.

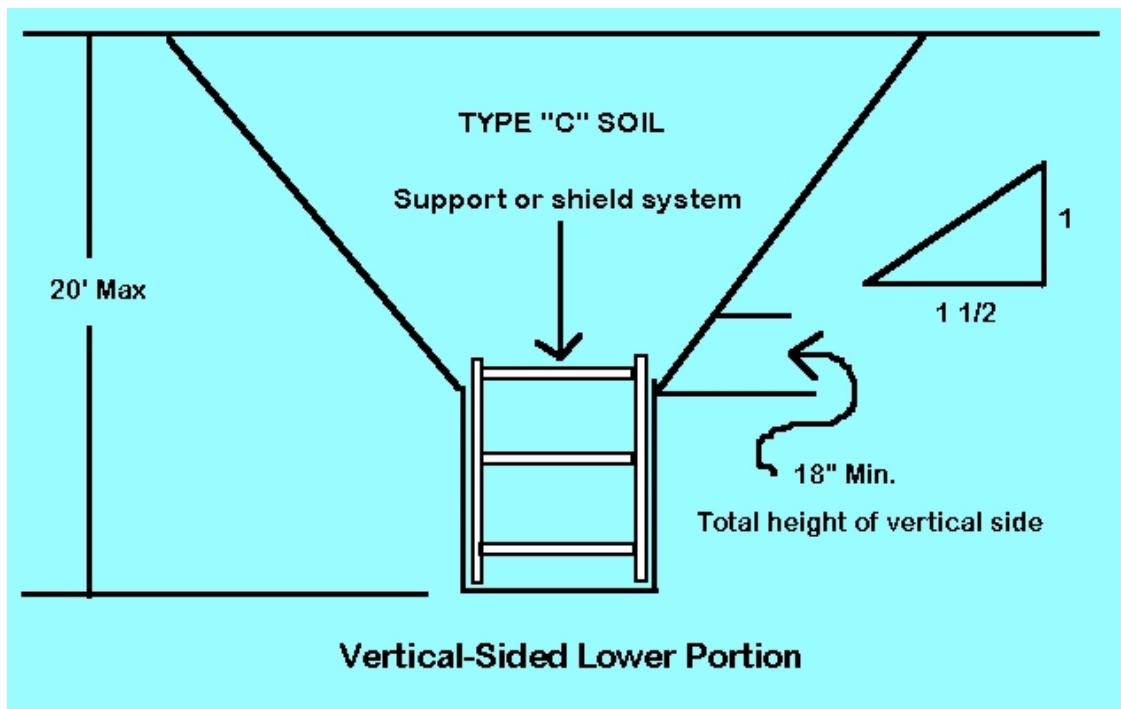
Shields may ride two feet above the bottom of an excavation, provided they are calculated to support the full depth of the excavation and there is no caving under or

behind the shield.

Workers must enter and leave the shield in a protected manner, such as by a ladder or ramp.

Workers may not remain in the shield while it is being moved.

Illustration of Shielding Systems in Type B and C Soils



T. DEFINITIONS

1. **Aluminum hydraulic shoring**

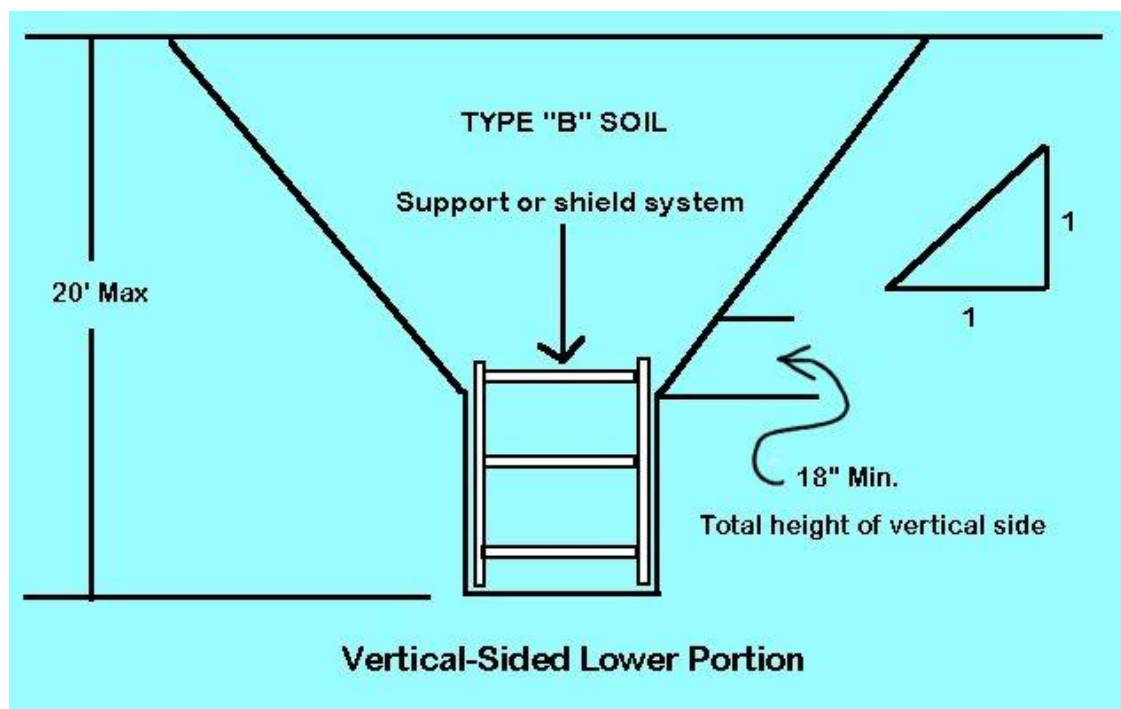
An engineered shoring system comprised of aluminum hydraulic cylinders (crossbraces), used in conjunction with vertical rails (uprights) or horizontal rails (walers). Such a system is designed specifically to support the sidewalls of an excavation and prevent cave-ins.

2. **Benching**

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.

3. **Cave-in**

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.

4. **Competent person**

One who is capable of identifying existing and predictable hazards in the surroundings, or working conditions that are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt

corrective measures to eliminate them. All competent persons must complete the trenching and shoring class, successfully pass the exam, and be certified for successful completion of the class. A competent person should have and be able to demonstrate the following:

Training, experience, and knowledge of:

- soil analysis,
- use of protective systems, and
- requirements of 29 CFR 1926 Subpart P.

Ability to detect:

- conditions that could result in cave-ins,
- failures in protective systems,
- hazardous atmospheres, and
- other hazards including those associated with confined spaces.

Authority to take prompt corrective measures to eliminate existing and predictable hazards and to stop work when required.

5. **Excavation**

Any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

6. **Registered professional engineer**

A person who is registered as a professional engineer.

7. **Shield (shield system)**

A structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees with the structure. Shields can be permanent structure or can be designed to be portable and moved along as work progresses. Also known as trench box or trench shield.

8. **Shoring (shoring system)**

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.

9. **Sloping (sloping system)**

A method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline varies with differences in such factors as the soil type, environmental conditions of exposure, and

application of surcharge loads.

10. **Trench (trench excavation)**

A narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than 15 feet. If forms or other structures are installed or constructed in an excavation as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet or less, the excavation is also considered to be a trench.

TRENCH INSPECTION AND ENTRY AUTHORIZATION FORM					
LOCATION:					DATE:
TIME OF INSPECTION(S)					
WEATHER CONDITIONS:					APPROX. TEMP.:
CREW LEADER:				SUPERVISOR:	
DIMENSIONS :	DEPTH =			Yes No	HAZARDOUS CONDITIONS
	TOP =	W	L	<input type="checkbox"/> <input type="checkbox"/>Saturated soil / standing or seeping water
	BOTTOM =	W	L	<input type="checkbox"/> <input type="checkbox"/>Cracked or fissured wall(s)
SOIL TYPE:		TESTED:		<input type="checkbox"/> <input type="checkbox"/>Bulging wall(s)
<input type="checkbox"/> Solid rock (most stable)		<input type="checkbox"/> Yes		<input type="checkbox"/> <input type="checkbox"/>Floor heaving
<input type="checkbox"/> Average soil		<input type="checkbox"/> No		<input type="checkbox"/> <input type="checkbox"/>Frozen soil
<input type="checkbox"/> Fill material				<input type="checkbox"/> <input type="checkbox"/>Super-imposed loads
<input type="checkbox"/> Loose sand				<input type="checkbox"/> <input type="checkbox"/>Vibration
				<input type="checkbox"/> <input type="checkbox"/>Depth greater than 10'
PROTECTION METHODS:				PLACEMENT OF SPOILS & EQUIPMENT	
(Walls MUST be vertical—NO voids)				<input type="checkbox"/> <input type="checkbox"/>Spoils at least 2 feet from edge of trench	
SHORING				<input type="checkbox"/> <input type="checkbox"/>Equipment at least 2 feet from edge	
<input type="checkbox"/> Timber				<input type="checkbox"/> <input type="checkbox"/>Backhoe at end of trench	
<input type="checkbox"/> Pneumatic				<input type="checkbox"/> <input type="checkbox"/>Compressor, etc. at remote location	
<input type="checkbox"/> Hydraulic				LADDER LOCATION	
<input type="checkbox"/> Screw Jacks				<input type="checkbox"/> <input type="checkbox"/>Located in protected area	
<input type="checkbox"/> Trench Shield				<input type="checkbox"/> <input type="checkbox"/>Within 25 feet of safe travel	
UNEVEN, IRREGULAR WALLS				<input type="checkbox"/> <input type="checkbox"/>Secured	
<input type="checkbox"/> Trench Box				<input type="checkbox"/> <input type="checkbox"/>Extends 36 inches above the landing	
Sloping: q 1:1 (45°) q 1 ½:1 (34°)				<input type="checkbox"/> <input type="checkbox"/>Leads to safe landing	
Yes No ENVIRONMENTAL CONDITIONS:				OTHER:	
<input type="checkbox"/> <input type="checkbox"/> Gas detector used?				<input type="checkbox"/> <input type="checkbox"/> Shoring equip. & matls inspected prior to use	
<input type="checkbox"/> <input type="checkbox"/> Confined space permit issued?				<input type="checkbox"/> <input type="checkbox"/> Is trench SAFE to enter?	
COMMENTS:					

		Work Order #
N O T E	All unsafe conditions must be corrected prior to trench entry. If any hazardous conditions are observed, the trench must be immediately evacuated and no one allowed to re-enter until corrective action has been taken.	TO BE FILLED OUT BY EHS PERSONNEL
		Excavation Entry Authorized By: _____ EHS Inspector