

Trenching and Shoring Guidelines

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Trenching and Shoring Guidelines

I. General

Excavating is recognized as one of the most hazardous operations. This standard shall provide guidance for University employees who perform excavations on property owned by the University of Northern Colorado (UNC).

II. Definitions

Aluminum hydraulic shoring: An engineered shoring system comprised of aluminum hydraulic cylinders (cross braces), 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.

Benching: A method used to protect 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.

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.

Competent Person: An individual who is capable of identifying existing and predictable hazards or working conditions that is 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: 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 occupancy.

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

Hazardous Atmosphere: An atmosphere that by reason of being explosive, flammable, corrosive, oxidizing, irritating, oxygen-deficient, toxic, or otherwise harmful may cause death, illness, or injury to persons exposed to it.

Ingress and Egress: means “Entry” or “Exit”. In trenching and excavation operations, it is referred to the provision of safe means for employees to enter or exit an excavation or trench.

III. Requirements

Excavations shall be made in accordance to the industrial standards set forth in 29CFR 1926.650, .651, .652.

A competent person shall be placed in charge of all excavations.

The competent person should have and be able to demonstrate the following:

Training, experience, and knowledge of:

- Soil analysis;
- Use of protective systems

Ability to detect:

- Conditions that could result in cave-ins
- Failures in protective systems
- Hazardous atmospheres
- Other hazards including those associated with confined spaces

Has the authority to take prompt corrective measures to eliminate existing and predictable hazards and to stop work when required.

- A. Underground utilities must be located and marked before excavations begin.
- B. Spoil piles shall be a minimum of two (2) feet from the edge of the dig area.
- C. Employees are not allowed in the excavation while heavy equipment is digging.
- D. A competent person shall conduct visual inspections:
 - Daily and before the start of each shift
 - As dictated by the work being done in the trench
 - After every rainstorm
 - After other events that could increase hazards, such as a 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.
- E. For trenches 4 feet or greater in depth a trench inspection form shall be filled out by a competent person.

IV. Soil Types

Soil and rock deposits are categorized into four types, A through D as follows:

Stable Rock: A natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed. This is usually identified by a rock name such as granite or sandstone.

Type A: Most stable: clay, silty clay, sandy clay, clay loam, 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 of a sloped, layered system where the layers dip into the excavation on a slope of 4 horizontal to 1 vertical or greater, or has seeping water.

Type B: Medium stability: angular gravel, silt, silt loam, medium clay, and unstable dry rock; previously disturbed soils unless classified as Type C; soils that meet the requirements of Type A if it is fissured or subject to vibration or dry unstable rock.

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

Layered geological Strata (where soils are configured in layers): the soil may 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 (ie, where a Type C soil rests on top of stable rock).

V. Test Methods and Evaluating Soil Type

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

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. If the soil remains in clumps, it is cohesive; if it appears to be coarse-granular sand or gravel, it is considered granular. The competent person 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 if so, what sort of backfill was used, and observe the open side of the excavation for indications of layered geologic structuring.

The competent 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.

Manual Tests

Thumb Penetration Test: 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 testing methods.

Dry Strength Test: Take a sample of dry soil. If it crumbles freely or with moderate pressure into individual grains it is considered granular (Type C). Dry soil that falls into clumps that subsequently break into smaller clumps (and the smaller clumps can be broken only with difficulty) is probably clay in combination with gravel, sand, or silt (Type B)

VI. Ingress and Egress

VIII. Warning Systems for Mobile Equipment

The following steps should be taken to prevent vehicles or people from accidentally falling into a 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

IX. Hazardous Atmospheres and Confined Spaces

Empl

X. Standing Water and Water Accumulation

Methods for controlling standing water and water accumulation must be provided and should consist of the following when 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

Surface water diverted away from the trench

Employees shall be removed from the trench during a rainstorm

Trenches carefully inspected by a competent person after each rain and before employees are permitted to re-enter the trench.

XI. Benching, Sloping, Shoring, and Shielding Requirements

All excavations or trenches 4 feet or greater in depth shall be appropriately benched, shored, or sloped.

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

Benching

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

In Type B soil, the bottom vertical height of the trench must not exceed 4 feet. Benches must be below the maximum allowable slope for that soil type. (For example, 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.

Sloping

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

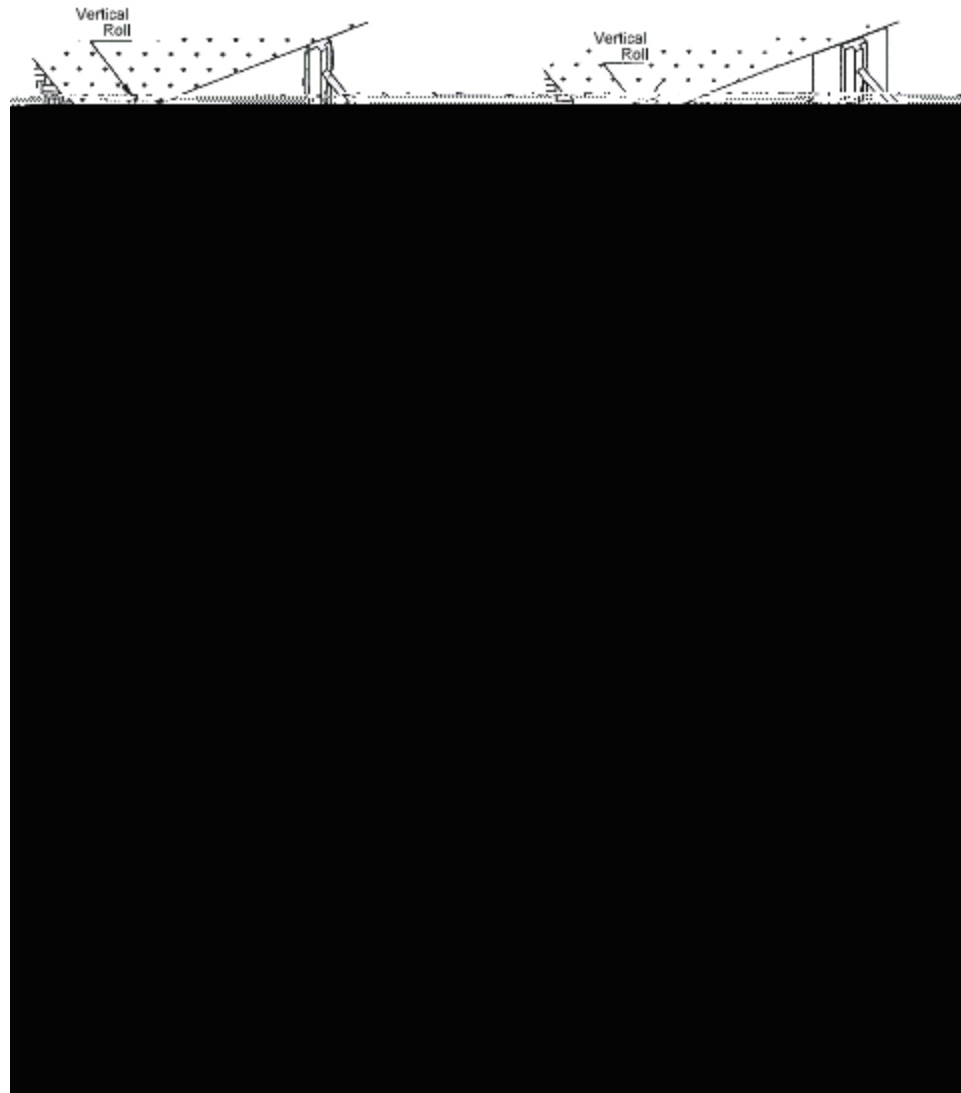
Soil Type	Height / Depth Ratio	Slope Angle
Type A	$\frac{3}{4}:1$	53 degrees
Type B	1:1	45 degrees
Type C	$1\frac{1}{2}:1$	34 degrees

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 three basic types of shoring; timber, aluminum hydraulic, and pneumatic.

Aluminum

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



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 the excavation site.

Shielding

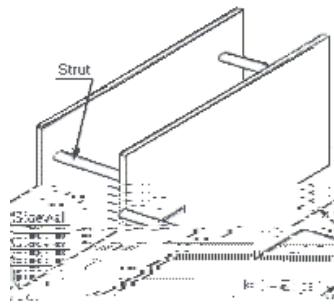
Trench boxes are different shoring because, instead of shoring up or otherwise supporting the trench face, they are intended primarily to protect from cave-ins and similar incidents.

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 the excavation, provided the shields 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 ladder or ramp. Workers may NOT remain in the shield while it is being moved.



XII. Training and Recordkeeping

It is the responsibility of each department to ensure that their employees receive the required training. Training can be provided by the Environmental Health and Safety department. Training records will be retained by the Environmental Health and Safety office.

**UNIVERSITY OF
NORTHERN COLORADO**

TRENCH INSPECTION AND ENTRY AUTHORIZATION FORM					
LOCATION:				DATE:	
INSPECTED BY:			TIME OF INSPECTION(S)		
WEATHER CONDITIONS:			APPROX. TEMP.:		
CREW LEADER:			WORK ORDER #:		
DIMENSIONS:	DEPTH =			Yes No	HAZARDOUS CONDITIONS
	TOP =	W	LSaturated soil / standing or seeping water	
	BOTTOM =	W	LCracked or fissured wall(s)	
SOIL TYPE:	TESTED:				
Solid rock (most stable)	Yes	Bulging wall(s)		
Average soil	No	Floor heaving		