WHITMAN COLLEGE

Excavation & Trenching

The Hazards of Excavation and Trenching and How to Control Them

Whitman College Department of Environmental Health & Safety and the Washington State Department of Labor & Industries

Course objective:

- **to provide a basic overview of the excavation, trenching and shoring regulations located in Part N, chapter 296-155 WAC.**

Topics covered

- HAZARDS OF TRENCHING & EXCAVATION
- SOIL CLASSIFICATION
- TRENCH PROTECTIVE SYSTEMS – SHORING & SLOPING
- OTHER HAZARD CONTROLS
- COMMON VIOLATIONS

WHAT IS AN EXCAVATION?

An excavation is any person-made cut, cavity, trench, or depression in the earth's surface.

A trench is an excavation

Employees must be protected from cave-in when the excavation is 4 feet or more in depth.

Cave-in protection is not required when:

- ***Excavations are made entirely in stable rock; or***
- ***They are less than 4 feet in depth and examination of the ground by a Competent Person provides no indication of a potential cave-in.***

15 Fatalities Related to Excavation Activities in Washington State

1998 – 2008

Types of Incidents

Soil collapse (cave-in) = 7

Struck by machinery = 4

Struck by motor vehicle = 1

Struck by falling object = 1

Electrocution = 1

Fall = 1

WHAT MAKES TRENCHES HAZARDOUS?

- ***The factors shown in this illustration can create deadly conditions for workers.***

- ***The spoils pile and the equipment being too close to the vertical walls of the trench are called "surcharge loads" which increase the likelihood of collapse.***

- ***Additionally, equipment vibration, adverse weather conditions and ground water can change the condition and classification of the soil.***

A "Competent Person" must take all of these factors into consideration and re-evaluate the jobsite periodically.

FALL PROTECTION

- ***Fall protection- guardrails shall be provided for walkways over the excavation. Employees at the edge of an excavation 4 feet or more in depth shall be protected from falling when the excavation is not readily seen due to plant growth or other visual barriers.***

EDGE PROTECTION

- ***Edge protection – when equipment approaches the edge of the excavation, and the operator does not have a clear and direct view of the edge, a warning system such as barricades, hand/mechanical signals or stop logs are to be used. The grade should be away from the excavation.***

HAZARDOUS ATMOSPHERE

Where a hazardous atmosphere could reasonably be expected to exist, the atmosphere shall be tested for oxygen, LEL and contaminates before employees enter an excavation of 4 feet or more. Confined space rules apply if the atmosphere presents a hazard to employees

WATER ACCUMULATION

- ***Water accumulation in a trench is hazardous because it erodes and changes soil; which means the stability of the soil is likely weakened.***
- ***Prevent water accumulation by using sump pumps, or create diversion ditches and dikes for natural drainage of streams interrupted by the excavation or in anticipation of heavy rainwater runoff, or consult with an RPE.***

Special supports or shield systems may be needed if water accumulates on the trench floor.

WATER ACCUMULATION CONTROL SYSTEM

- ***Water accumulation hazards should be prevented by either using a special support or shield systems designed for water drainage issues, or water removal to control the level of accumulating water, or use of a safety harness and lifeline by workers inside excavation.***
- ***Water controlled through the use of pumps and other equipment setups must be monitored by a Competent Person to ensure proper operation.***
- ***Diversion ditches, dikes, or other suitable means should be used to prevent surface water or rainwater from entering and accumulating in the excavation.***

STORAGE AT THE TOP OF THE TRENCH

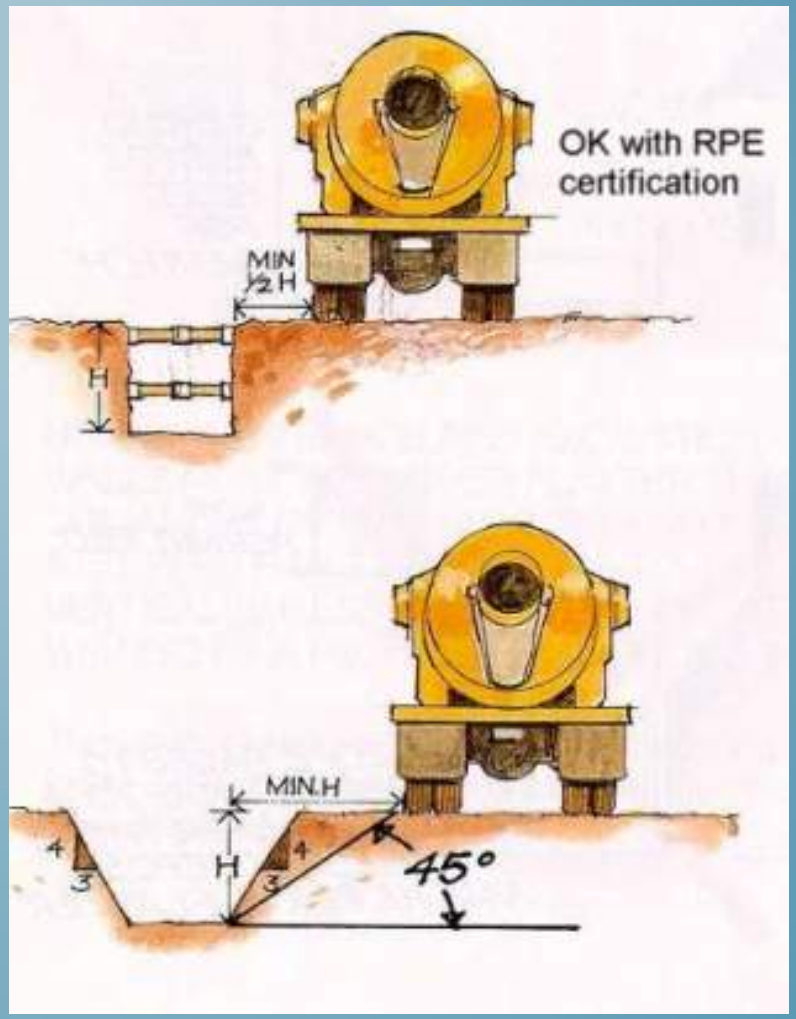
Materials and Equipment must be kept at least 2 feet from the edge of the trench unless restrained.

Soil or dirt is very heavy. A cubic foot can easily weigh 114 pounds and a cubic yard can be as heavy as a pick-up truck.

CONTROLLING HEAVY VEHICLE SURCHARGE LOADS

What does the 45-degree angle represent?

It represents the zone of influence or affected area. In other words, it represents the shear plane (weakest area), at which the excavation or trench wall will fail, and that is why it should always be kept clear of heavy equipment or machinery, and the spoils pile, unless the trench can be properly shored.



EXAMPLE OF A HAZARDOUS TRENCH

EXAMPLE OF A HAZARDOUS TRENCH

- ***This trench is well over 4' deep, cut into loose sand (class C soil), that is sloughing off the trench walls. The spoils pile is a surcharged load. The shear weight of the spoils not being set at least 2 feet back from the vertical face increases the likelihood of a cave-in and it adds to the depth of the trench. If the trench is 8' deep and the spoils pile is 8' high directly at the edge, the trench is now 16' deep! A trench that is 3' deep could easily become 5-6' deep if the spoils pile is on the edge.***

HAZARDOUS TRENCH EXAMPLE (CON'T.)

- ***The weight & vibration of the track-hoe also increases the probability of a collapse.***

- ***The employees working in the trench are exposed to:***

  - overhead hazards (no hardhats), and

  - trench collapse without a protective system

- ***It does not appear that safe access or egress has been provided.****

A stairway, ramp, ladder or other safe means of egress must be located so workers don't have to travel more than 25 feet laterally in the trench

ANOTHER HAZARDOUS TRENCH EXAMPLE

ANOTHER HAZARDOUS TRENCH EXAMPLE

- ***Nearby heavy equipment and the spoils pile directly on the right edge of the excavation both create a surcharge load. The protective system in this photo does not extend far enough up the trench to provide adequate protection for the two workers in the trench.***

PROCESS FOR SAFE TRENCH WORK

- ***Identify knowledgeable Competent Person – a Competent Person is one who is knowledgeable in the requirements of the rules, can identify existing or predictable hazards in the surroundings that are unsanitary, hazardous, or dangerous to employees and who also has the authorization or authority by the nature of their position to take prompt corrective measures to eliminate them.***

- ***Check and verify above and below ground utility locations, any adjacent structures or surface encumbrances, and water table***

- ***Determine soil classification through testing***

- ***Choose the correct protective system for soil type***

- ***Verify protective system installation and set-up***

- ***Provide safe access***

- ***Comply with requirements specified in the Excavation, Trenching, and Shoring regulations.***

- ***Conduct daily inspections prior to the start of work, after any weather event, if conditions change and as needed.***

FIRST: YOU MUST LOCATE UTILITIES BEFORE DIGGING!

www.callbeforeyoudig.org
or
Call 811
It's Free!

UNDERGROUND INSTALLATIONS (UTILITIES)

You are required to call for utility locates and once the locates have been identified onsite, the employer must do an exact locate as specified by:

WAC 296-155-655(2)(c)

"When excavation operations approach the location of underground installations, the exact location of the installations shall be determined by safe and acceptable means."

Why do you need to do exact utility locates?

Because they are rarely spot-on, and older installations may not show up on current utility maps.

CLASSIFYING SOILS

It is important to correctly classify soil type before selecting and using a protective system.

In order to classify soil, at least one visual test and one manual test are required to determine if the soil is Type A, Type B, or Type C.

Most engineers agree that less than 5% of the soil in Washington can be classified as Type A, and as soon as the Type A soil is disturbed, it must be down graded to a Type B.

NOTE: If you designate the soil as Type C, no testing is required.

SOIL CHARACTERISTICS

Type A: ***Good cohesive soil with a high compressive strength such as: clay, silty clay, sandy clay, clay loam and cemented soils such as caliche, duricrust and hardpan***

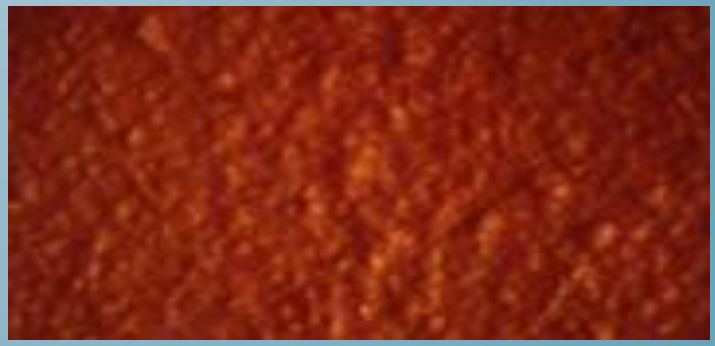
Type B: ***Cohesive soil with a moderate compressive strength such as: silt, silty clay, sandy clay, clay loam, silt loam, sandy loam, angular gravel (similar to crushed rock), any previously disturbed fissured or soil subject to vibration***

Type C: ***Cohesive soil with a low compressive strength such as: granular soils including gravel, sand, and loamy sand or submerged soil or rock that is not stable or soil from which water is freely seeping***

SOIL CLASSIFICATION

- ***Type "A"***
  - ***Fine grained***
  - ***Doesn't crumble***
  - ***Hard to break up when dry***
  - ***Examples:***
    - ***Clay***
    - ***Hardpan***
    - ***Silty or sandy clay, clay loam***

Clay Loam



Clay

As more organic matter, silt and sand (together known as loam) gets mixed in and as the grains get larger, the classification will be degraded to type B. As the mix has less and less clay and organic matter in it becoming closer to pure sand or gravel it is further degraded to Type C.

SOIL CLASSIFICATION

Type A

Even if soil has a high clay content and is plastic when moist, it cannot be classified as "type A" if it is:

- ***Fissured,***
- ***Has been previously disturbed, or***
- ***Subjected to vibration from heavy traffic, etc.***

This soil is fissured changing the classification from A to B

- ***As more organic matter, silt and sand (together known as loam) gets mixed in and as the grains get larger, the classification will be degraded to type B. As the mix has less and less clay and organic matter in it becoming closer to pure sand or gravel it is further degraded to Type C.***

SOIL CLASSIFICATION

Type B

- ***Granular: coarse grains***
- ***Little or no clay content***
- ***Crumbles easily when dry***
- ***Examples:***

  - **Silt**-***fine mineral particles in size between clay and sand***

  - **Loam**-***from fragments of rock deposits in water***

  - **Angular gravel**-***crushed rock- the angular nature of the individual rocks provides some resistance to movement***

Silty loam

Loam

Angular gravel

SOIL CLASSIFICATION

Type C *

- ***Granular soil: very coarse***
- ***Minimal cohesion***
- ***Examples:***

  - ***Sand***
  - ***Gravel***
  - ***Loamy sand***
  - ***Submerged soil or soil with freely seeping water***
  - ***Submerged rock that is not stable.***

Sand

Gravel

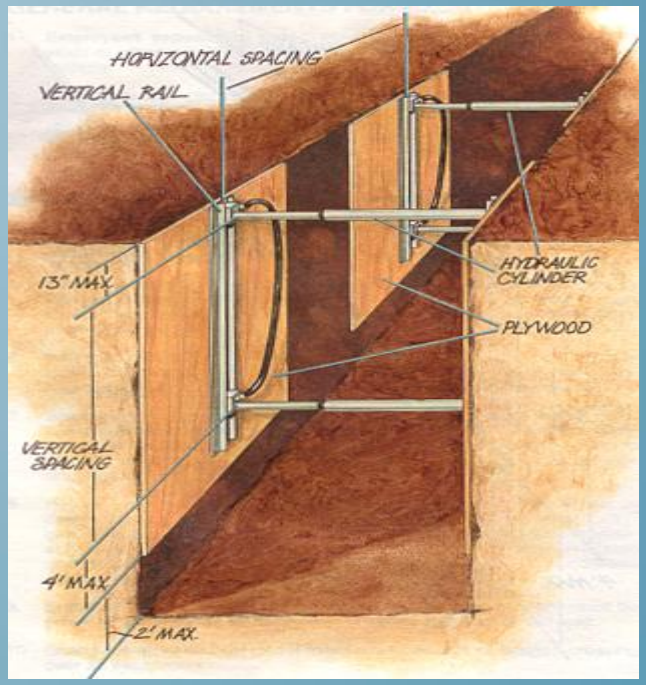
Loamy sand

*Type C is the most common soil classification in Washington

TYPES OF PROTECTIVE SYSTEMS

Your choices are:

Sloping and Benching



Shoring System timber, aluminum-hydraulic

Shield System steel shield box, aluminum

WHAT ARE THE PROTECTIVE SYSTEM REQUIREMENTS?

Use protective systems when there is potential for cave-in for Class A, B, and C soils:

- **Under 4'** ***deep if a potential for a cave-in exists***

- **4' to 20'** ***deep***
  - ***Sloping or Benching (benching is not an option in C soil)***
  - ***Shield or Shoring***

- **Over 20' deep** - ***protective system must be designed by Registered Professional Engineer or approved in manufacturer's tabulated data***

- ***Protective system is not required for stable rock***

SLOPING

Sloping is the process of removing soil to eliminate the chance of a cave in.

The required maximum allowable slope is determined by the class of soil.

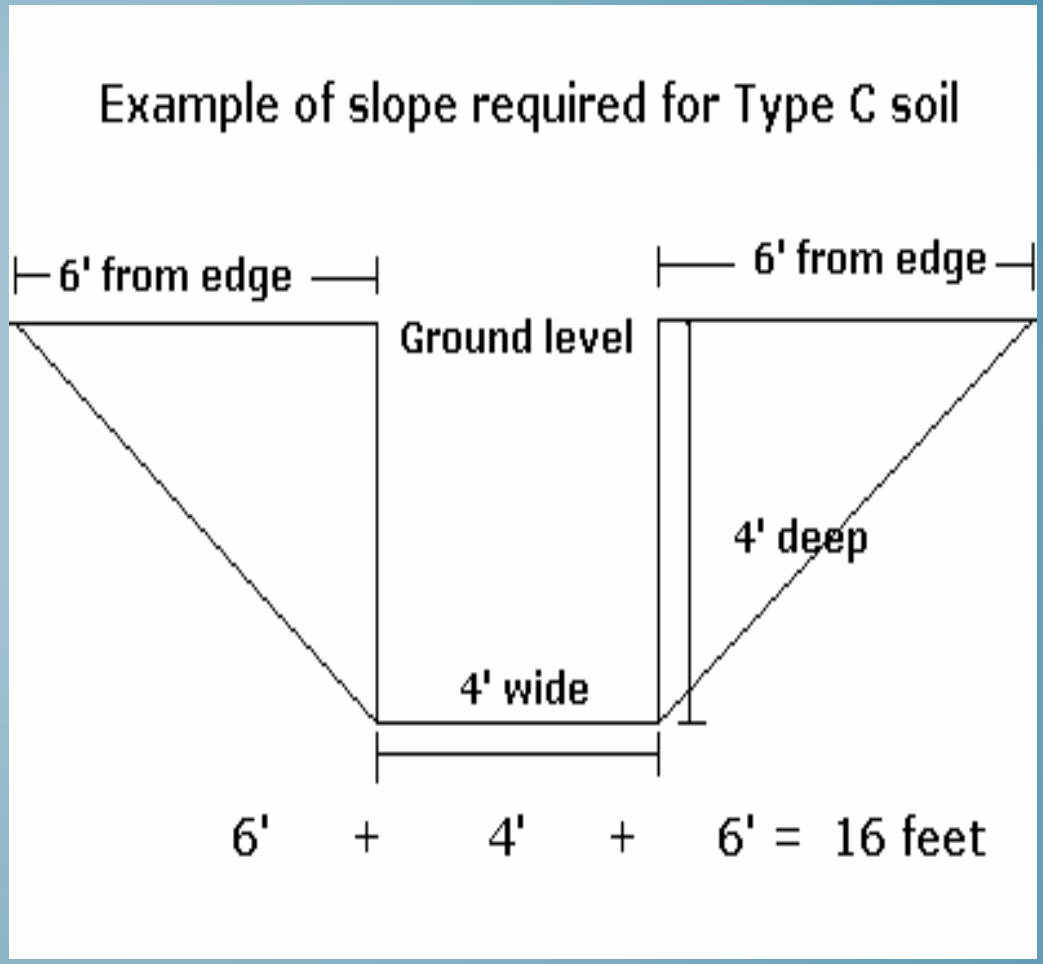
The requirements are as follows:

- For each foot of trench depth, the ratio of slope measured from the trench edge at ground height must be:

Soil Type A – ¾ to 1 (53°)

Soil Type B – 1 to 1 (45°)

Soil Type C – 1 ½ to 1 (34°)



SHORING

Shoring is one of the most common used methods of worker protection. It is light-weight, portable and easy to install.

The manufacturer provides tabulated data with the shoring that provides the limitations, precautions, required spacing and proper use.

This photo shows an example of aluminum hydraulic shoring.

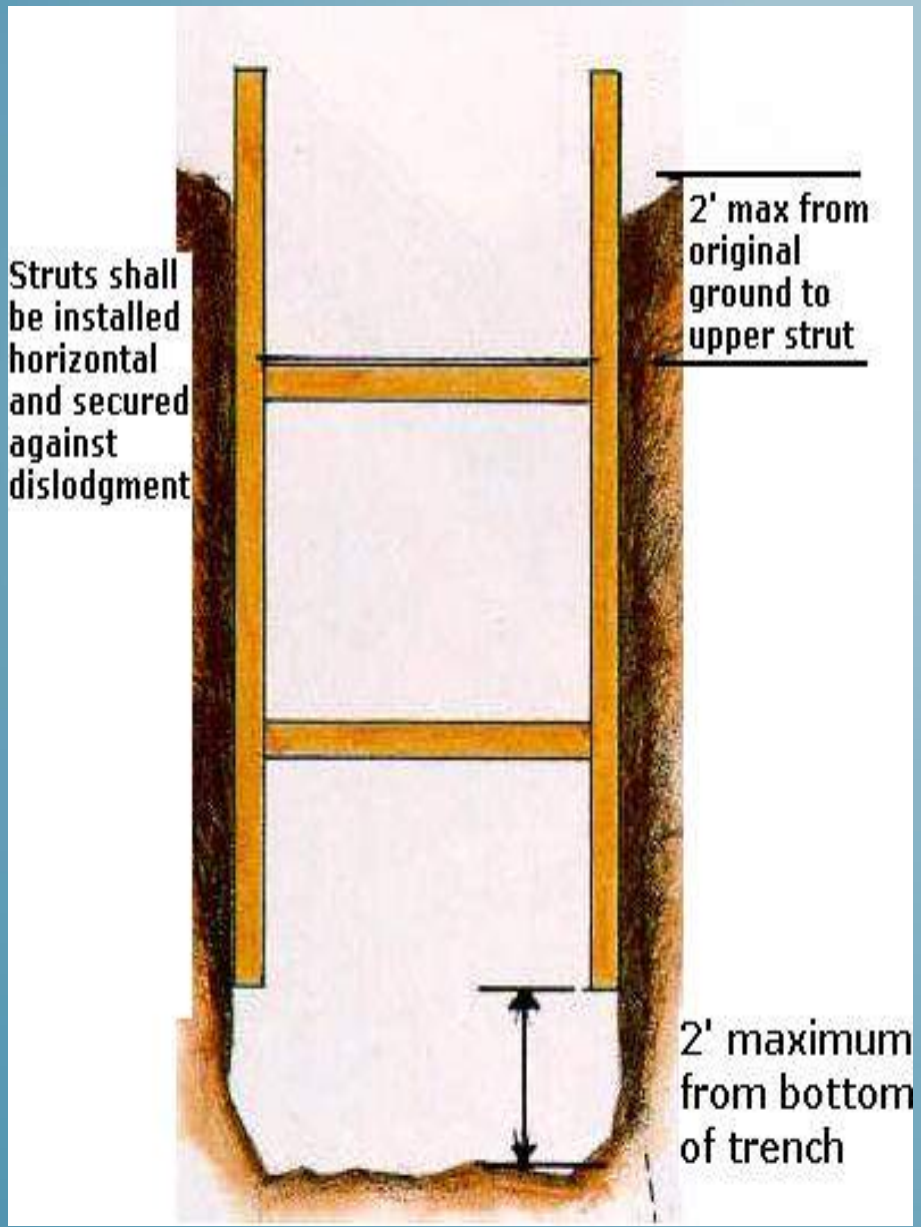
SHIELDS

Shields are manufactured by a number of companies and are designed to protect workers working within the confines of the shield.

Check tabulated data for the maximum allowable depth it can be used. The tabulated data must accompany the shield when it is being used.

Additionally, the shield must be designed by a Registered Professional Engineer, be in good condition, and used properly.

SHIELDS THAT DON'T GO ALL THE WAY TO THE BOTTOM



- ***Excavation of material to a level no deeper than 2 feet below the bottom of the members of a support system is permitted only if:***
  - ***- the system is designed to resist the forces calculated for the full depth of the trench,***
  - ***- there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the support system.***

RPE-DESIGNED PROTECTIVE SYSTEM

A Registered Professional Engineer can design a protection system for use on a specific project.

The RPE will consider the soil type and conditions as well as other concerns that might exist at the excavation site.

The system must be used as designed by the RPE.

Even with an RPE, the Competent Person must still perform daily inspections checking site conditions and any change.

PROVIDE SAFE ENTRY AND EXIT

- ***A trench that is 4' or more in depth must have a safe means for workers to get in and out of the trench.***
- ***A means of egress is required to be within 25' of lateral travel.***
- ***The most common method for access is a straight ladder or an extension ladder. If a ladder is used, it must extend a minimum of 3' above the landing. The use of step ladders is not permitted.***
- ***Other means could be a stairway or ramps or other means as designed by a RPE.***
- ***Locating the method of access/egress outside of the protective system is prohibited.***

PROVIDE SAFE ENTRY AND EXIT

Buckets of excavators, backhoes, etc.

are <u>not</u> to be used as a means of egress.

MOST COMMON TRENCHING VIOLATIONS

- ***No cave-in protective system being used when required by soil classification, depth, and code***
- ***Excessive surcharge load (spoils piles too close to excavation wall or equipment or traffic too close to excavation operations)***
- ***No access/egress for excavations 4 feet or more in depth***
- ***No <u>Competent Person</u>***

MORE INFORMATION AND TRAINING

- ***Online Training course:***
- ***NIOSH -Trench Safety Awareness***

- **OSHA e-Tool: OSHA Construction eTool: Trenching and Excavation**

- **Oregon OSHA : "ExcavationSafe Practices" publication: http://www.cbs.state.or.us/osha/pdf/pubs/2174.pdf**

- **DOSH excavation, Trenching and Shoring Rule:**

http://www.lni.wa.gov/wisha/rules/construction/HTML/296-155N_1.htm