Introduction

Excavation Safety

• Welcome! This module will cover:
  – The Federal OSHA excavation standard
  – CFR 1926 Subpart P, Excavations
• Course length: 30-40 minutes
• Refer to your local state laws for more information.
Introduction

Course Objectives

• Upon completion of this course, you should be familiar with the hazards of trenching and related OSHA safety standards, including those regarding:
  – Classification of soils
  – Air monitoring
  – Trench and excavation access
  – Spoils piles
  – Shoring and sloping
• Learn how to identify and mitigate excavation hazards
Learning Objectives

- Upon completion of this training session, the student will be able to:
  - 1: Identify major excavation hazards
  - 2: Describe types of excavation hazards
  - 3: Protect him/herself from excavation hazards
  - 4: Recognize employer requirements to protect workers from excavation hazards
TIP: Disclaimer: This Compliance Assistance product is not a standard or regulation, and it creates no new legal obligations. The Compliance Assistance product is advisory in nature, informational in content, and is intended to assist employers in providing a safe and healthful workplace. Pursuant to the Occupational Safety and Health Act, employers must comply with safety and health standards promulgated by OSHA or by a State with an OSHA-approved State Plan. In addition, pursuant to Section 5(a)(1), the General Duty Clause of the Act, employers must provide their employees with a workplace free from recognized hazards likely to cause death or serious physical harm. Employers can be cited for violating the General Duty Clause if there is a recognized hazard and they do not take reasonable steps to prevent or to abate the hazard. However, failure to implement these recommendations is not, in itself, a violation of the General Duty Clause. Citations can only be based on standards, regulations, and the General Duty Clause.
Introduction

Topic 1 Overview

• What is a excavation Hazard?
  – Definitions
  – Statistics
  – Examples

• ALL excavation related deaths are 100% PREVENTABLE!
Introduction

Topic 2 Overview

• What are the Major Types of excavation Hazards in Construction?
  A. Unprotected edges
  B. Fall hazards
  C. Improper sloping or benching
  D. Spoils mismanagement
  E. Not properly classifying soils
  F. Improper shoring systems
Introduction

Topic 3 Overview

• How can I protect myself from excavation Hazards?

A. Minimum Training Requirements
B. Safety Requirements for excavations
C. Shoring systems
D. Benching and Sloping
E. Evaluating soils
Introduction

Topic 4 Overview

• What is my employer required to do to protect workers from excavations?
  • Provide excavation Protection Training & Equipment
  • Proper Excavation Techniques
  • Excavation Inspections and Use
  • Competent Person
Introduction

OSHA’s Excavation Safety Standards

• In place since 1989
• 37% of all trenching incidents occur at depths less than 5 feet!
• Most fatalities occur in trenches 5-15 feet deep
• Employers & Employees are responsible to ensure excavations are safe before entering
• Safety Standards are designed to save your life!
Trench or Excavation?

• Trench: a cut in the earth that is deeper and longer than it is wide, but not wider than 15 feet

• Excavation: any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal

• Trenches and Excavations:
  – Similar characteristics
  – Equally dangerous
  – Require worker protection
What is an Excavation Hazard?

Review the Facts: Excavation Fatality #1

• Victim: 37-year-old laborer, 3 years of experience
• Task: installing a small diameter pipe in a trench
• Trench:
  – 3 feet wide, 12 – 15 feet deep, 90 feet long
  – Not shored or sloped
  – No box or shield
  – Evidence of a previous cave-in
• Results: Victim killed in a second cave-in
• How was this preventable?
What is an Excavation Hazard?

Excavation Fatality  Root Cause

• OSHA citations to management included failure to provide:
  – Sloping or shoring
  – Adequate PPE
  – Ladder, ramp, or runway access
  – Proper training

• This death was 100% Preventable!
What is an Excavation Hazard?

Review the Facts: Excavation Fatality 2

- Victims/task: employees replacing a concrete filter tank at a carwash
- Trench:
  - 9 feet deep, 14 feet long, 6 feet wide
  - No shoring or sloping provided
- Tragedy: a vertical face gave way, killing one employee, seriously injuring the other.
Excavation Fatality 2 (cont.)

- OSHA citations to management included failure to:
  - Shore unstable soils.
  - Train employees.
  - Provide PPE.
  - Enforce the use of PPE.
  - Protect against impalement.
Find and Fix
Recognize Any Hazard(s)?
Find and Fix
What is an Excavation Hazard?

Myths of Excavation

• “If the trench is not deeper than 5 feet, I don’t have to shore or protect the excavation.”
• “Air monitoring is only for confined spaces, not excavations.”
• “I can dig myself out if I am buried.”
• “Hitting utilities is simply part of the business!”
• “If the soil looks pretty good, it must be type A.”
What is an Excavation Hazard?

Myth 1: Under Five feet, Shoring Is Not Required

• The OSHA regulation actually says:
  - Each employee shall be protected . . . Except when excavations are less than 5 feet and examination of the ground by a competent person provides no indication of a potential cave-in.

• Therefore, based on the competent person’s examination, shoring may still be required.
What is an Excavation Hazard?

Myth 2: Air Monitoring Is Not Required in Trenches

• OSHA requires air monitoring in confined spaces.
  – Includes trenches deeper than 4 feet, which present hazards such as:
    • Methane gas (landfills)
    • Flammable vapors (old gas stations)
    • Carbon monoxide (your own equipment)
    • Various chemicals (welding tasks, etc.)

Safety Tip: Most of us don’t think of trenches as confined spaces, so the thought of air monitoring is not a primary issue when excavating.
What is an Excavation Hazard?

Myth 3: I Can Dig Myself Out

• Reality of a cave-in:
  – A cubic yard of soil can weigh as much as a small pickup truck.
  – Soil pressing on the chest can make it impossible to breathe.
  – Fine particles of dirt can clog your nose, mouth, and lungs.

Safety Tip: The first order of business is protecting workers in the trench, not planning on an impossible self rescue.
What is an Excavation Hazard?

Myth 4: Hitting Utilities Is Part of the Business

• Live electrical lines in the ground can kill workers and cause significant property damage.
  – A gas line hit can lead to an explosion.
  – A broken water line can fill a trench in seconds.
  – Contact with buried power cables can kill.

Safety Tip: Always call your local utility locating service such as 811 before you dig, and get the utilities marked. Hand dig to locate the lines safely.
What is an Excavation Hazard?

Myth 5: If the Soil Looks Good, It Must Be Type A

• To be classified as Type A, the soil can NOT be:
  – Previously disturbed
  – Cracked or fissured
  – Subject to vibration
  – Seeping water
  – Part of a mixed layered system

• To be classified as Type A, the soil MUST be:
  – Fully tested by a competent person, every time

Safety Tip: Type A soil is the best soil to be digging in. However, most soils that you will encounter will not be type A.
Types of Excavation Hazards

The Competent Person

- Capable of identifying existing and predictable hazards
- Authorized to take prompt corrective measures
- Specifically trained in:
  - Soils analysis
  - Protective systems & equipment
  - OSHA standard requirements

Safety Tip: Learn more about the definition and role of the competent person in the attached safety link.

Types of Excavation Hazards

What causes Cave-ins?

• Characteristics of soil:
  – Lateral pressure up to 800 pounds per square foot
  – Cubic yard can weigh 3000 pounds
  – Cave-ins happened quickly with little warning
  – Self-rescue nearly impossible due to the weight

  **Safety Tip:** Don’t be fooled thinking that you will be in a trench for only a few minutes. Never enter an unprotected trench or excavation.
Types of Excavation Hazards

Soil Failures

• Stress cracking near the edge of the excavation
  – Caused by Soil Pressures or Equipment Vibrations
  – Indicative of Impending Failure
  – Competent Person required to
    • Remove workers
    • Specify appropriate protective systems
    • Inspect daily for effectiveness

Safety Tip: Workers seeing problems should exit the trench and report these hazards to their supervisor or the competent person.
Types of Excavation Hazards

Spoil Piles
• Spoils too close to the edge of the trench can:
  – Slide in, on top of employees.
  – Put lateral pressure on side walls, causing failure.
• Piles must be kept at least 2 feet from the edge.
  – Essential for preventing a cave-in
• Water saturation increases the risk of cave-ins

Safety Tip: Clay soils saturated with water may fail in the case where a large soil section sheers off from the side wall and rolls to the opposite wall. An employee standing at the point opposite the failure could be trapped and pinned by the soil. A second failure of the wall above could bury him.
You are in an excavation and see a bulge beginning between shores. The excavation is equipped with aluminum hydraulic shoring protection. What is your immediate reaction?

- Leave the trench and remove any other employees immediately. <ans> Correct! Even with aluminum hydraulic shoring protection, your immediate reaction should be to leave the trench. Report the problem to the competent person for correction.

- Keep working and report the problem to the competent person at your first opportunity. <ans> Incorrect; even with shoring protection, your immediate reaction should be to leave the trench. Report the problem to the competent person for correction before continuing work. 
Soil and Soil Classification

Soil Types

• Four Classes of Soils
• OSHA assigns the following 4 classifications of soil:
  – Solid rock
  – Type A
  – Type B
  – Type C
Soil and Soil Classification

Soil Types

• **Solid Rock**
  – Natural solid mineral material
  – Can be excavated with vertical sides
  – Will remain intact while exposed
  – Identification often requires the help of a geologist

• If unsure, take the time to ask for a second opinion, lives may depend on it!
Safety Tip: Some solid mineral materials which might appear to an excavator as solid rock display characteristics of failure that makes an unprotected trench a potential death trap.

Soil and Soil Classification

Type A Soils

- Type A Soils include:
  - Various clays: silty clay, sandy clay, clay loam and others
  - Cemented soils: caliche and hardpan

- No soil is Type A if:
  - The soil is fissured
  - The soil is subject to vibration
  - The soil has been previously disturbed
  - Other factors exist that would classify it as a less stable material
Safety Tip: Caliche is a sedimentary rock, a hardened deposit of calcium carbonate. This calcium carbonate cements together other materials, including gravel, sand, clay, and silt. Caliche occurs worldwide, generally in arid or semi-arid regions, including the High Plains of the western USA, and in the Sonoran Desert.
Soil and Soil Classification

Type B Soils

• Type B Soils include most granular soils that include:
  – Angular gravel, silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.
  – Previously disturbed soils, except those which would otherwise be classified as type C
  – Soil that would meet the requirements for type A, but is in some way unstable
Soil and Soil Classification

Type C Soils

• Type C
  – Typically granular
  – Gravel, sand, and loamy sand
  – Submerged soil
  – Soil from which water is freely seeping
  – Submerged rock that is not stable

• High potential for instability and cave-ins
Soil and Soil Classification

Classifying Soils

Required Soil Tests

• One visual and one manual test, by a competent person, on fresh soil unaffected by weather

• Common tests
  – Ribbon
  – Thread
  – Thumb
  – Dry strength
  – Sedimentation
Classifying Soils

Critical to be “Correct”

- No matter what type of process the competent person uses:
  - Soil must be classified before a protective system decision can be made.
  - Results must be correct; lives will depend upon it.

**Safety Tip:** For more information and training, refer to other details on soil classification and analysis.
Protection from Excavation Hazards

Learning Objective # 2: Protective Systems

Protecting Yourself from Harm:

• Employees in a trench or excavation must be protected by a protective system.

• Only two exceptions:
  – Entirely stable rock
  – Less than 5 feet without sign of potential cave-in

**Safety Tip:** Protective System means a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or 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.
Protection from Excavation Hazards

Types of Protective Systems

• Sloping
• Benching
• Wood shoring
• Aluminum hydraulic shoring
• Waler systems
• Trench boxes
• Screw jacks
• Engineered systems

Safety Tip: Information on protective systems can be found in the OSHA standards at Subpart P of 1926 the Construction Safety Standards
Protection from Excavation Hazards

Sloping and Benching

• The requirements of sloping and benching are detailed in link. Click on the link and review:
  – Important information
  – Charts and diagrams

• Shoring and sloping are a preferred method for creating a safe excavation.

Protection from Excavation Hazards

Find the Excavation Hazards!

• Identify hazards
Protection from Excavation Hazards

Protective Systems
Sloping – Type A
• Type A soils
  – Strongest and most cohesive
  – The most sloping and benching options
  – Simple slope of \( \frac{3}{4} \) to 1: every 1 foot down, soil must be excavated \( \frac{3}{4} \) of a foot out from the toe

**Safety Tip:** The slope of an excavation is measured from the toe of the slope to the top edge. The toe is where the slope meets the bottom.
Protection from Excavation Hazards

Protective Systems

Sloping & Benching – Type B Soils

• Type B soils
  – Most common soil encountered
  – Four options for protecting workers
  – In a simple slope, 45-degree angle of repose
  – Rise and run of each bench will be equal
Protection from Excavation Hazards

Protective Systems
Sloping – Type C
• Type C soils
  – Poorest quality
  – Sloping is still possible
  – Angle of repose is very low (34 degrees)

**Safety Tip:** In type C soil, for every foot down, the slope must extend 1.5 feet from the toe.
Protection from Excavation Hazards

Protective Systems

Aluminum Hydraulic Shoring

- Light weight aluminum frames
  - Patents first issued in Late 60’s and early 70’s
  - Sliding cylinders, hydraulic fluids
  - May be installed and removed by one person
  - Entering the trench not required
Protection from Excavation Hazards

Protective Systems

Aluminum Hydraulic Shoring

• Aluminum hydraulic shores: vertical, bearing fully on the side vertical walls of the trench.

• Cylinders: maximum spacing of 4 feet vertically, bottom cylinder no more than 4 feet up.

• Side rails: must extend to within 2 feet of the bottom to prevent kickout.

Safety Tip: Well, first, there should be a solid pad under the outrigger plate to spread the load. Secondly, the influence of the crane loading on the trench must be considered when setting up the crane.
Protection from Excavation Hazards

Protective Systems
Aluminum Hydraulic Shoring

• Shores pumped to a minimum of 750 pounds of pressure (1000 pounds is best practice)
• 1000 pounds of pressure translates to 3000 psi against side rails and into the soil
Protection from Excavation Hazards

Protective Systems

Waler Systems (cont.)

• Type C soil:
  – Walers must be used.
  – Typically requires timber backing;
    • Street plates or sheet pile can also be used

Safety Tip: Follow OSHA tables covering the use of waler systems in types B and C soil.
Protection from Excavation Hazards

Protective Systems

- Many systems for protecting workers (Appendix E)
  - Trench boxes
  - Trench shields
  - Slide rail systems
  - Sheet pile
  - Screw jack systems

Safety Tip: All systems have one item in common and that is a set of manufacturer’s tabulated data to be used for proper design and installation of the equipment.
Protection from Excavation Hazards

Trench Boxes

- Trench shields or boxes:
  - Protect against collapsing soil
  - Do not prevent cave-ins
  - Available in a variety of dimensions
  - Usually aluminum or steel
  - May be custom-built from tabulated data
  - Installed such that hazardous movement of the shield is restricted in sudden lateral pressures

**Safety Tip:** Workers must not be allowed in shields when shields are being installed, removed, or moved vertically.
Protection from Excavation Hazards

Screw Jacks

• Screw jack systems:
  – Struts adjusted manually
  – Worker must be in the trench for adjustment
  – No uniform preloading
  – Weight creates handling difficulties
Protection from Excavation Hazards

Excavations Deeper than 20 feet

- **Engineered Design**
  - Requires a Registered Professional Engineer
  - Allows deviations from OSHA standard
  - Allows greater flexibility in use
  - Required whenever using shores in a manner that differs from OSHA requirements

**Safety Tip:** Tabulated Data means tables and charts approved by a registered professional engineer and used to design and construct a protective system.
Engineered Systems

- Registered professional engineer: person who is registered as a professional engineer in the state in which the work is to be performed;

- However, any state is acceptable within the meaning of this standard when approving designs for manufactured protective systems or tabulated data to be used in interstate commerce.
New Employer Requirements

Employers Must Provide Protection

• Protection for employees entering trenches or excavations is required at all times.
  – Employers Responsibility to provide you training, safe work procedures and the right tools to get the job done safely
  – Its YOUR responsibility to follow procedures and NEVER put your life at risk on the job!
Employer Requirements

Safe Planning of Work

- Proper planning and preparation required for anything that could create a hazard within the Zone of Influence, such as:
  - Trees, spoil piles
  - Curbs, gutters, sidewalks
  - Buildings, foundations, utility poles
  - Excavating equipment, dump trucks
  - People
Employer Requirements

Provide Location of Underground Installations

• Underground utilities must be located and marked.
• Contact utility companies and owners in advance.
• After the allotted time, proceed with caution.
  – Hand digging, potholing, equipment for detection
• Once cut is open, all underground installations must be protected, supported, or removed.
• Each company (subcontractors) must receive a permit from the one-call organization.

Safety Tip: Be careful of overhead utility hazards as excavation equipment can strike power lines, and make sure that your equipment is at least 10 feet away from all above-ground power sources.
Employer Requirements

Provide Safe Access and Egress

• Cuts over 4 feet deep: safe access and egress required within 25 feet of lateral travel.

• When using ladders:
  – Must extend at least 3 feet over solid ground
  – Secure at 4 to 1 angle to prevent movement

**Safety Tip:** If you are not using a structural ramp then you must use a ladder or other safe means of entry and exit.
Protection from Vehicular Traffic

• In the presence of vehicular traffic:
  – Highly visible clothing with reflective material
  – Adequate signage, markings, and traffic control
  – Lights at night
  – Plan approved by local government
Employer Requirements

Exposure to Falling Loads

• To avoid being struck:
  – No work under overhead loads being transported by lifting or digging equipment
  – Employees must stand away from vehicles being loaded or unloaded
  – Stand clear of loads being lowered into the trench

Employees should be wearing hardhats, safety glasses and high visibility vests to protect against obvious hazards.
Employer Requirements

Warning Systems for Mobile Equipment

• Equipment presents many hazards
  – Falling into the trench
  – Unexpected equipment failures or movements

• Warning system required when there is not a clear view of the ditch: barricades, spotters with established hand signals, stop logs

Safety Tip: Workers must be aware of the working radius of equipment, make their presence known, establish eye contact with the operator, and maintain a safe distance.
Employer Requirements

Evaluating for Hazardous Atmospheres

• If you suspect a hazard, test the area with a direct-reading calibrated instrument or gas monitor.

• The atmosphere must be declared safe before workers are allowed into the excavation.

• See Confined Spaces Entry module for a more detailed discussion of identifying, controlling, and testing confined spaces.

Safety Tip: Other courses in Hazardous Materials, Asbestos, and Confined Spaces that will discuss in depth potentially lethal environments, such as lack of oxygen, volatile combustibles or explosive fuels, poisons, and asbestos containing rock.
Employer Requirements

Protection from Water Accumulation Hazards

• Do not work in excavations where there are signs of accumulating water.
  – May weaken the side walls

• Protection requirements may include:
  – Special support or shield systems
  – Water removal (monitored by competent person)

Safety Tip: Keep in mind that any water being discharged may be subject to your local storm water discharge regulations.
Employer Requirements

Stability of Adjacent Structures

• Buildings, parallel utilities, utility poles, or sidewalks commonly exist near the excavation.
  – Threat of failure when exposed or undercut
  – Should be underpinned or cribbed
  – Enlist a registered professional engineer
Employer Requirements

Competent Person Inspections

- Prior to work and as needed (e.g., after a change in conditions), competent person must inspect the site
  - Existing or predictable hazards
  - Indications of impending failure of protective systems (shoring, shielding, sloping)
  - Other potentially hazardous atmospheres

**Safety Tip:** Workers and the job supervisor should also be trained to recognize hazards. A checklist should be devised to assist you or your team in identifying hazards.
Employer Requirements

Perimeter Access/Walkways
• Bridges or walkways must always be used when
  – Crossing an open cut
  – Accessing a structure from the edge of the trench
• Walkways 6 feet up and more require handrails.
• Always use the walkway provided.
• Never jump across the trench as a shortcut.

Safety Tip: California has added the special requirement that the trench must be 30 inches across or wider to require the bridge crossing.
Summary

We have now completed our discussion of the hazards of trenching and related OSHA safety standards, including those regarding:

- Classification of soils
- Air monitoring
- Trench and excavation access
- Spoils piles
- Shoring and sloping
- Subpart P - Excavations