SC Budget and Control Board

Safety Program

Excavations

OSHA Construction Standard:
1926 Subpart P
1926.650 - 652 with Appendices A - F

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10930

Excavation: Definitions

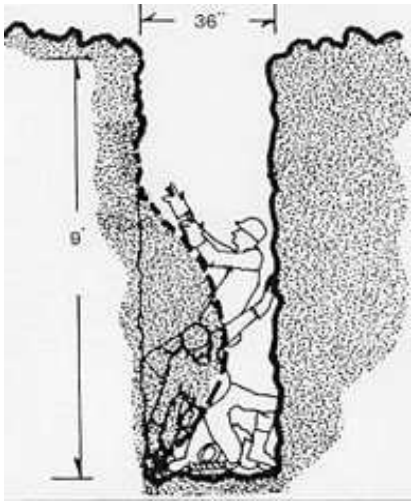
Excavation – a man-made cut, cavity, trench, or depression formed by earth removal

Trench – a narrow excavation where the depth is greater than the width; bottom not wider than 15 feet

Excavation: **Hazards**

Cave-ins from:

- **Soil Conditions**
- **Vibration From Nearby Machinery / Vehicles**



Falling Objects from:

- **Spoil Pile**
- **Stored Supplies**

Underground Utility Lines (accidentally cut gas, water, electrical, telephone)

- **Asphyxiation** (lack of oxygen)
- **Drowning**
- **Electrocution**
- **Inhale Toxic Materials**

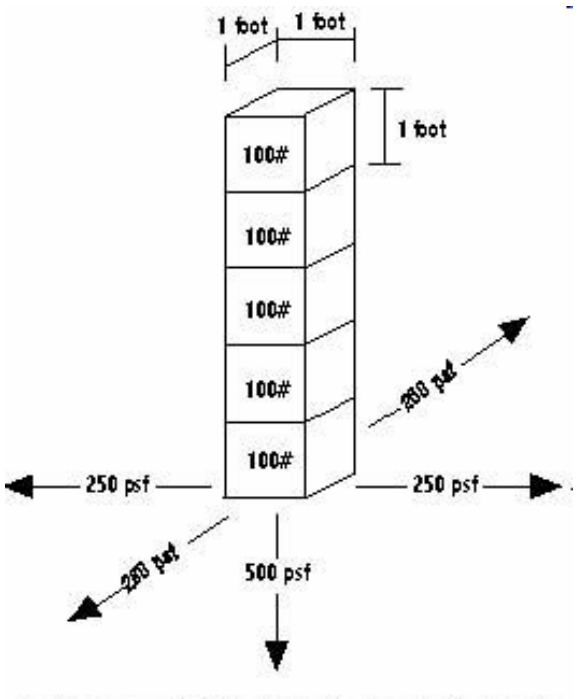
Photo courtesy of OSHA

Any Excavation is Dangerous

Excavation: **Hazards**

Is It Really That **Dangerous**?

- ***Every* Trench Will Fail**
- One Cubic Yard of Soil = 100 Pounds per Cubic Foot (145 lbs wet)
- Even Partial Burial Can Be Fatal
  - Crush / Blunt Force Trauma
  - Suffocation



Excavation: **Hazards**

Person Buried to Knees Can't Escape By Self

Person Buried Above Waist Can Suffocate (Die)

Excavation: **Hazards**

Crane: Weight & Vibrations

= Danger for Trench Collapse

No Sloping, Shoring or Shield

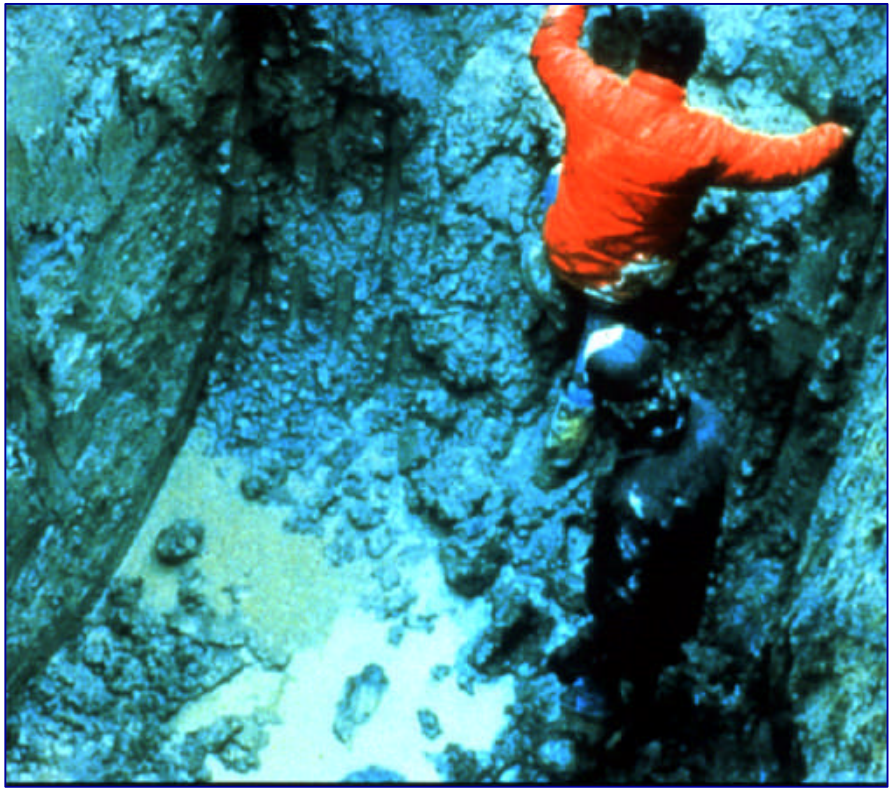
= No Protection from Cave-In

No Ladder or Ramp

= No Emergency Escape

Workers should not be in this trench

Excavation: **Hazards**



WATER =

- Unstable Soil / Cave-In
- Drowning Hazard
- Hinders Egress

Never work in a trench during a rainstorm

Excavation: **Hazards**

Atmosphere

Treat an Excavation > 4’

as a

Confined Space

Test for:

- **Oxygen Deficiency**
- **Combustible Gas**
- **Toxic & Other Hazardous Substances**

Excavation: **Hazards**

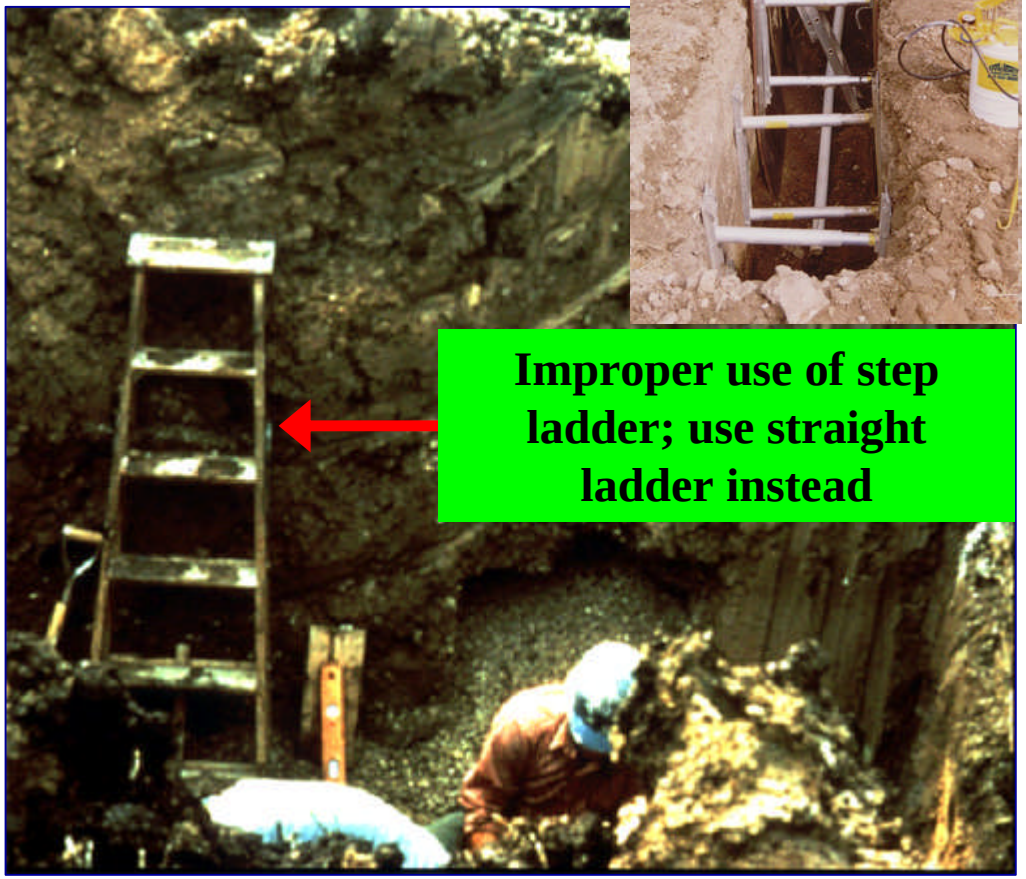
Emergency Egress

4’ or Over Requires:

- **Stairway**
- **Ladder or**
- **Ramp**

Within 25’ of Entrant

Top of straight ladder to be 3’ above excavation



Improper use of step ladder; use straight ladder instead

Excavations

Competent Person

Trained and Knowledgeable About:

- **OSHA Standards**
  - **Excavations, Fall Protection, Confined Space Entry, Personal Protection Equipment, Ladders, Lockout-Tagout, etc.**
- **Hazard Identification**
- **Locating Underground Utilities**
- **Soil Typing and Analysis**
- **Constructing Protective Systems**
- **Determining Needed Safety Equipment**
- **Providing Safe Access & Emergency Egress**
- **Site Inspection**

Authorized to Immediately Eliminate Hazards / Stop Work

Soil Classifications - Definitions

Soil is Categorized by **Type A, B or C** which depends on:

- **Grain Size** (the bigger the grain, the less stable the soil)
  - Gravel (larger than pencil lead)
  - Sand (smaller than gravel)
  - Silt or Clay (microscopic)
- **Cohesion** (how well soil holds together)
- **Unconfined Compressive Strength**
  (weight per square foot for wall shear, spall and collapse)
- **Saturation** (degree of water in soil
  - Too wet (voids full of water) = unstable
  - Too dry (voids air-filled) = unstable

Soil Classifications - Definitions

Type A Soil : Most Stable

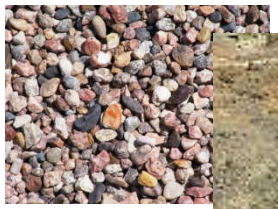
- Dense, Heavy and Hard to Break Apart when Dry
- Holds Together when Wet
- Examples: Clay, Silty Clay, Hardpan

Type B Soil: Unstable

- Examples: Sandy Loam, Medium Clay, Unstable Dry Rock Angular Gravel

Type C Soil: Least Stable

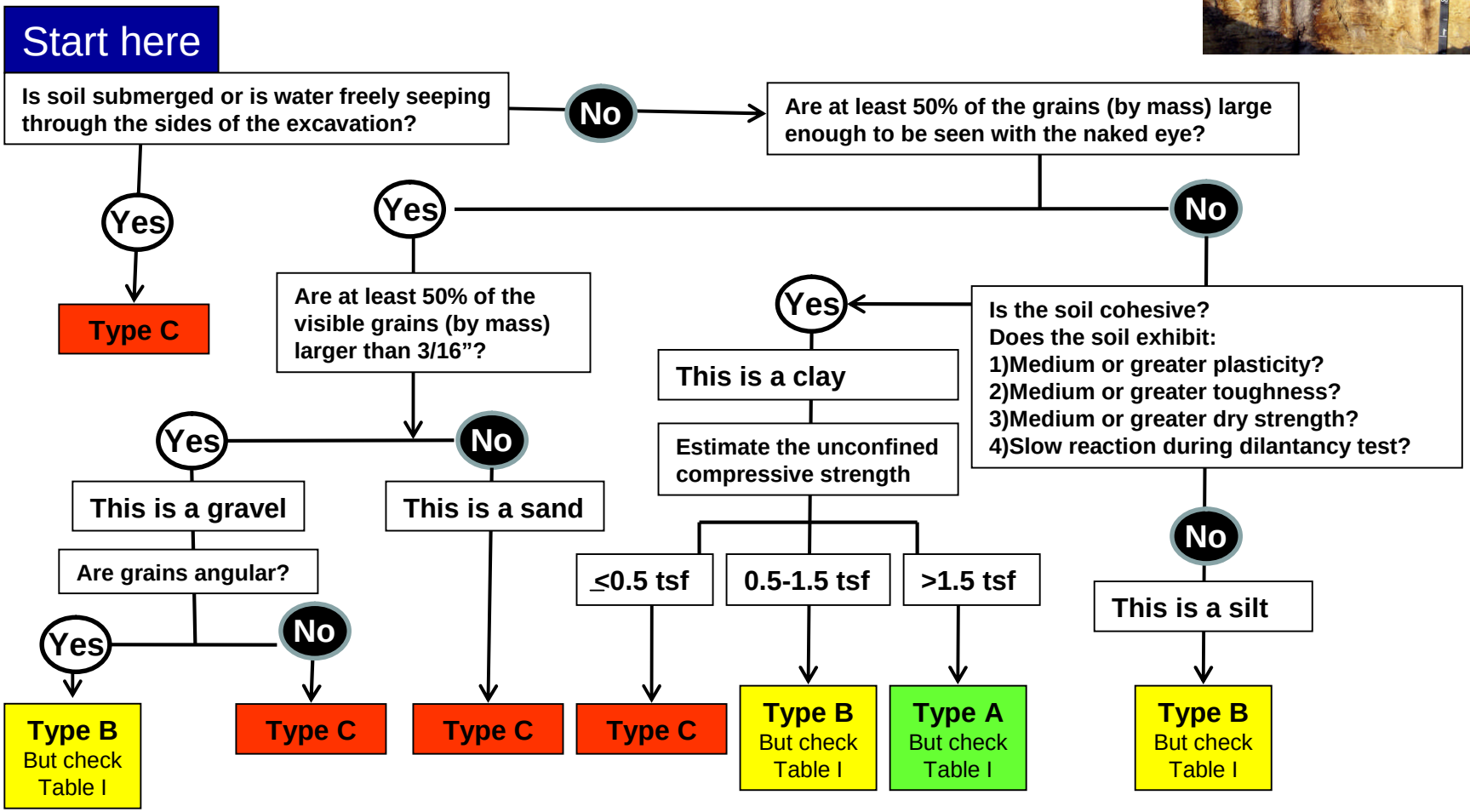
- Least Stable Soil
- Examples: Rounded Gravel, Sand, Soft Clay, Submerged Silt, Heavy and Unstable Rock



If Excavation Has Layers of Different Types of Soil Overall Classification Is Based on the *Weakest* Soil

Excavations: **Competent Person**

Soil Classification



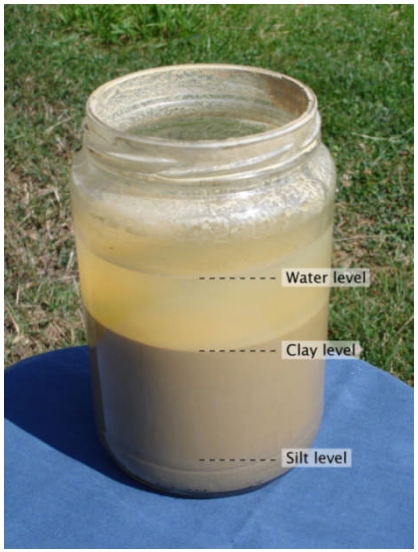
See 29 CFR 1926 Subpart P – App A: **Soil Classification, Illustration 5**

Soil Classification

Manual Soils Tests:

- **From Drill Sample** (Before Dig) or **Spoil Pile** (After Dig)
- **Sedimentation Test** (how much silt & clay in sandy soil)
- **Wet Shake Test** (amount of sand versus silt & clay)

Drill sample

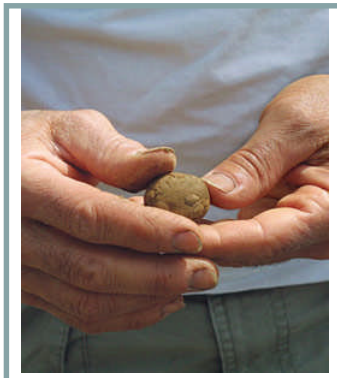


Sedimentation / Wet Shake Test

Soil Classification

Manual Soils Tests:

- **Dry Strength Test** (squeeze soil to see if clumps, breaks apart or granular)
- **Manual Thread Test** (pick up soil rolled to 1/8” to see how well holds together)
- **Ribbon Test** (roll sample to ¾”, flatten to 1/8 -1/4” to see how well holds together)



Ribbon Test

1) Add water to a small amount of dry soil, and form it into a ball if you can
2) Knead the soil between your fingers to form a flat ribbon

- If you are unable to form a ribbon of soil, your soil is at least 50% sand and has little clay
- If your soil makes a medium ribbon (1”-2” long) before breaking, your soil is roughly 25% clay
- If the soil ribbon is 2”-3½” long before breaking, you have about 40% clay in your soil
- If the soil ribbon is longer than 3½” then your soil is made up of at least 50% clay

Soil Classification

Manual Soils Tests:

- **Pocket Pentrometer** (field instrument to test unconfined compressive strength / how well reacts under pressure)
- **Vane Shear Device** (field instrument to test shear strength)

Pentrometer

Vane Sheer Test

Excavations: **Competent Person**

Excavation > 4' Deep Requires Protective System

Factors In Designing a Protective System

- **Soil Classification**
- **Depth of Cut**
- **Water Content of Soil**
- **Changes Due to Weather and Climate**
- **Other Operations in the Vicinity**

Excavations: **Competent Person**

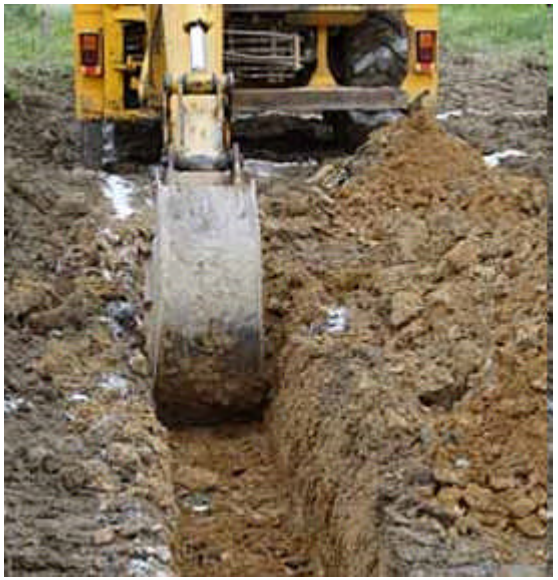
Underground Utilities

South Carolina State Law: Any activity that results in the movement or removal of earth, rock or other materials in or on the ground requires the excavator to contact the Utility Company or One Call Center with adequate information regarding the dig. Each excavator is required to wait 72-hours or 3 business days before starting the digging work.

A Palmetto Utility Protection System (PUPS) representative will record the location of the digging site and notify member utility companies of the intent to dig. Utility companies will then send out a professional locator to your site to mark the approximate location of utility lines. Once your lines have been marked, you may begin to carefully excavate around the marked lines.

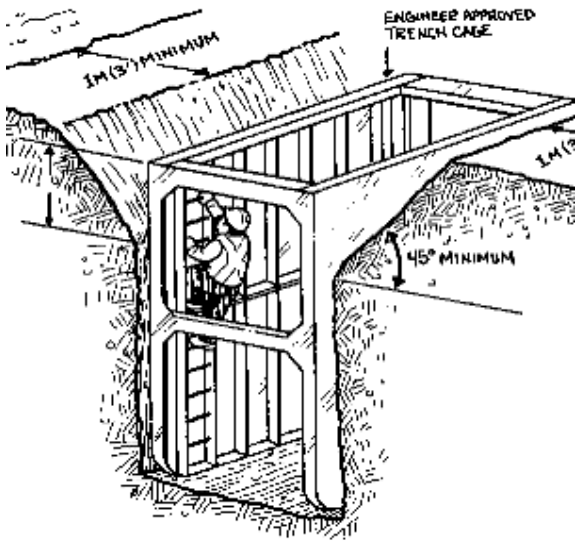
Identify Utility Locations Before Digging

- **Utilities May Need to Be Supported, Removed or Protected**



Cave-In Protection

A well-designed protective system
+
correct installation / removal
+
Appropriate materials handling



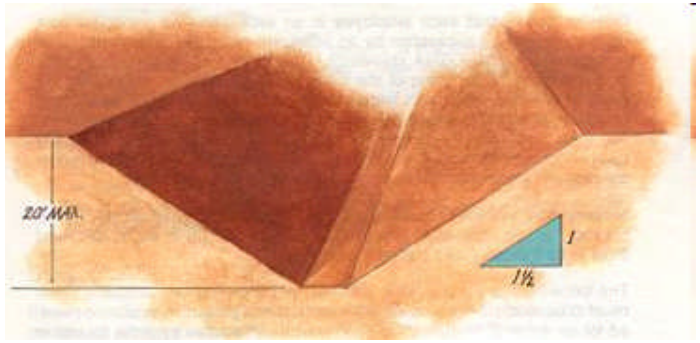
See 29 CFR 1926.652 Requirements for Protective Systems

Proper Protection

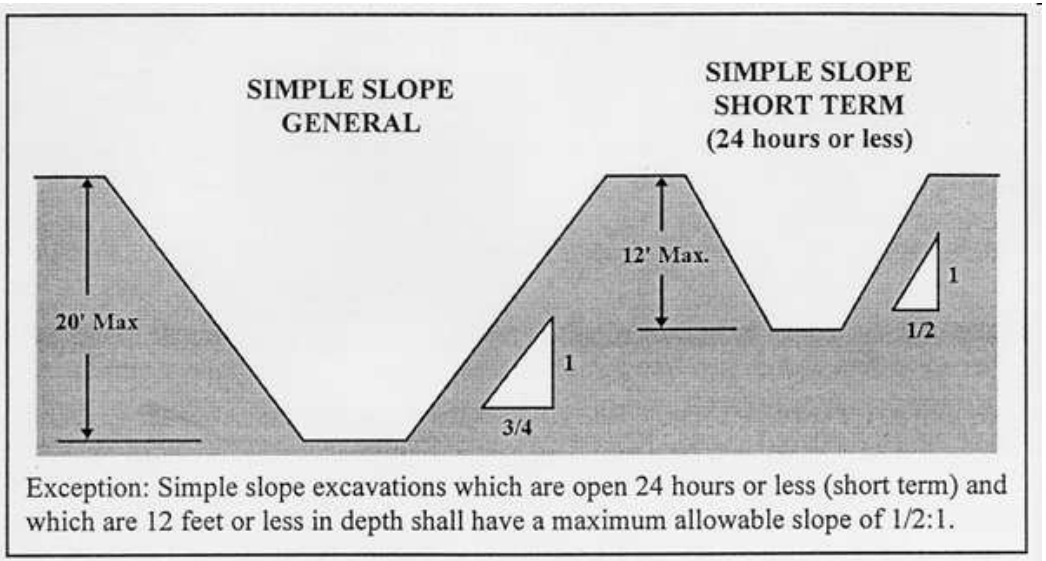
Inadequate Protection

Cave-In Protection

Sloping - angling the sides of an excavation according to factors such as soil type



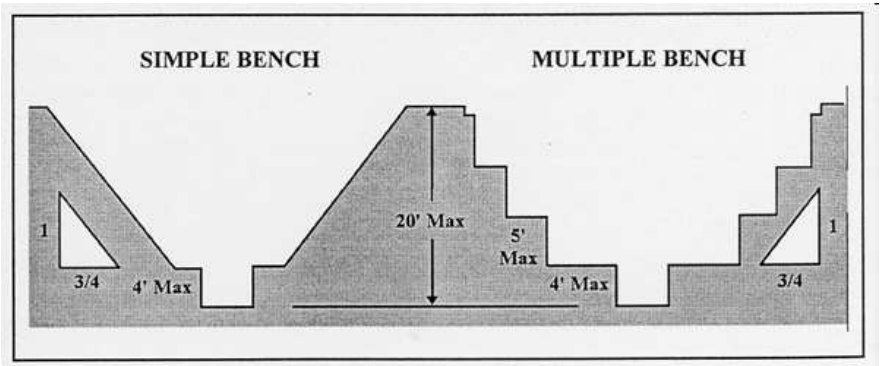
Slope Angle & Depth Depends on Soil Type

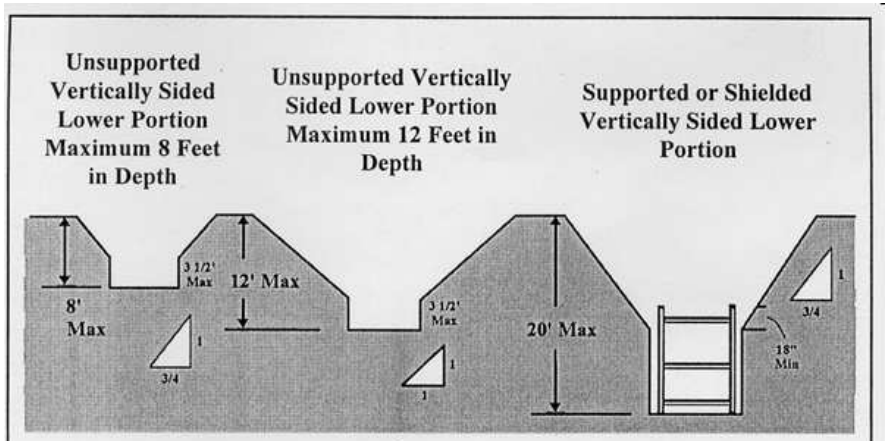


See 29 CFR Subpart P
App B: Sloping and Benching

Cave-In Protection

Benching – a stepped form of sloping





All excavations more than 8 feet but not more than 12 feet in depth with unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3 1/2 feet.

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of 3/4:1. The support or shield system must extend at least 18 inches above the top of the vertical side.

See 29 CFR Subpart P
App B: Sloping and Benching

Cave-In Protection

Shield / Shoring - a structure or box that supports the sides of an excavation; used when space is limited (not enough room for sloping)

Timber Shoring

Trench Box Shield

Hydraulic Aluminum Shoring

See 29 CFR Subpart P
App C: Timber Shoring for Trenches
App D: Aluminum Shoring for Trenches

Cave-In Protection

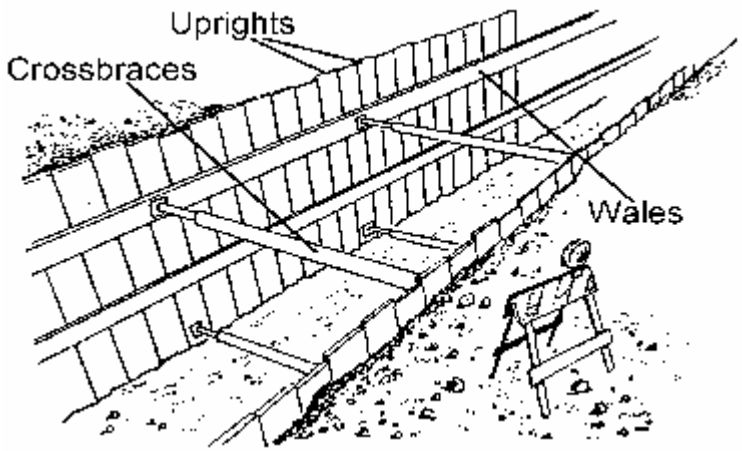
Shielding

- **Protects workers from cave-ins, but doesn't prevent them**
- **Top of Shield 18" above top of soil**
- **Don't extend with sheeting**
- **Fill in gaps**
- **Use care when stacking**
- **Evacuate before moving**

Cave-In Protection

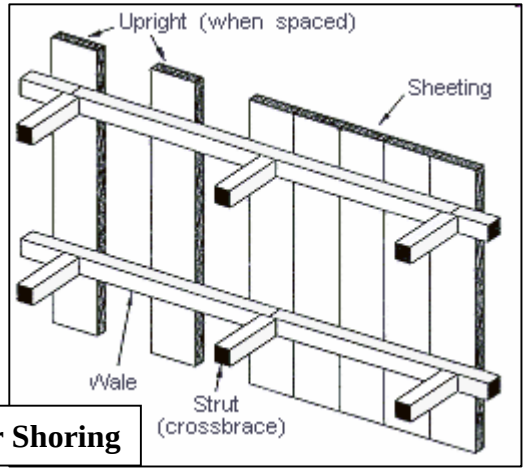
Shoring

- **Provides a Framework to Work In**
  - **Uses Wales, Cross Braces and Uprights**
  - **Supports Excavation Walls**
- **To Use OSHA Tables Must Know:**
  - **Soil Type**
  - **Depth and Width**

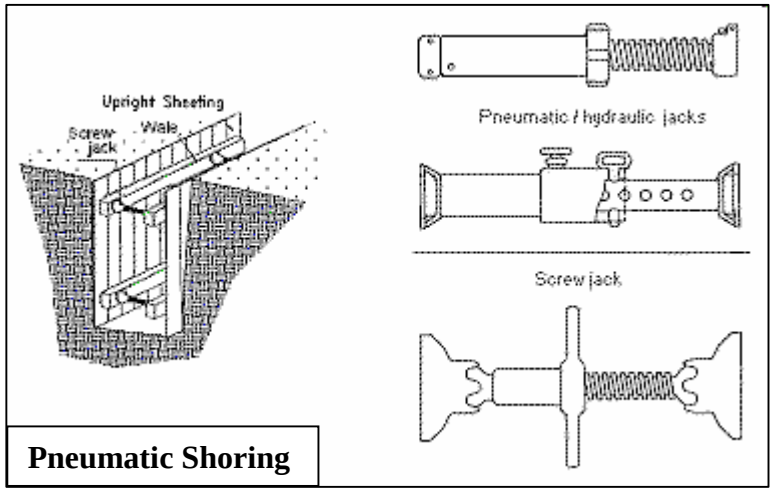


Cave-In Protection

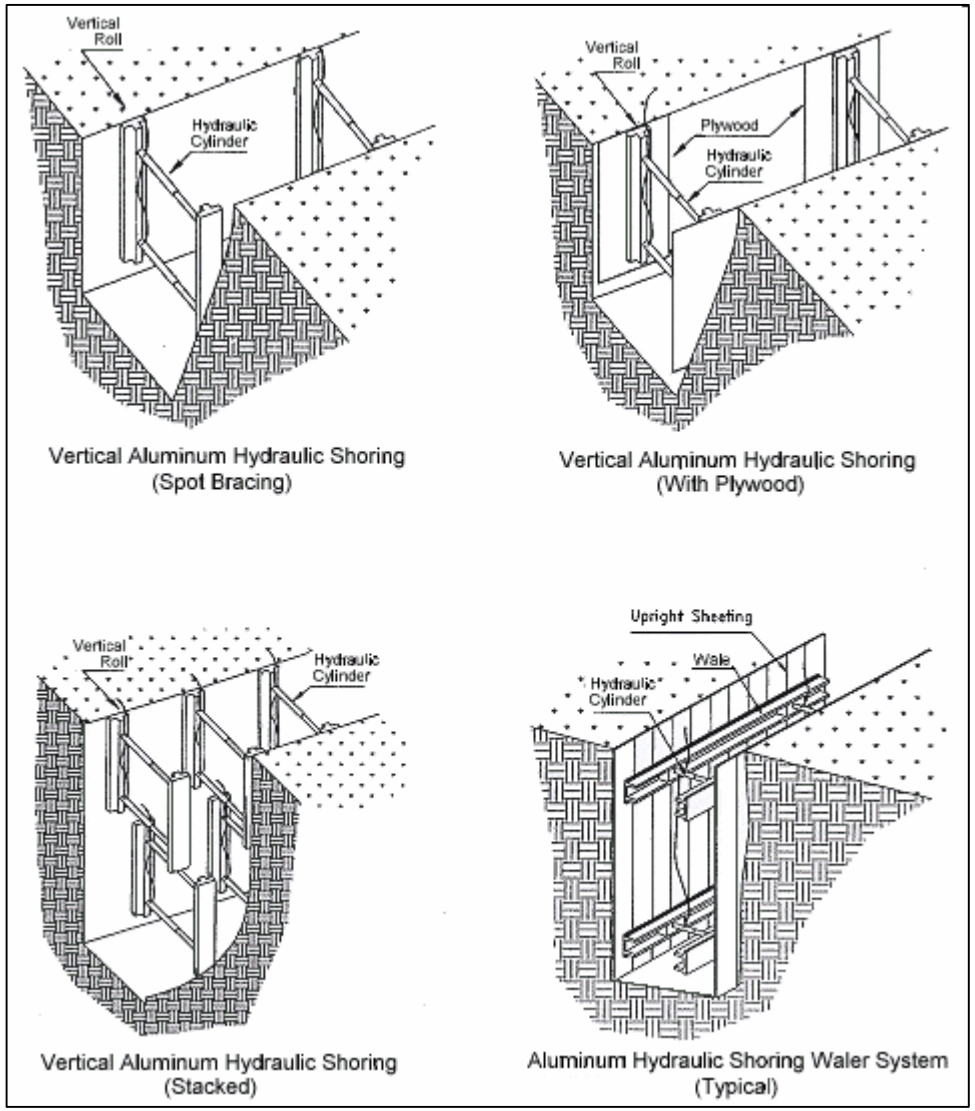
Shoring



Timber Shoring



Pneumatic Shoring



Inspections

Daily (*Before* Work Starts):

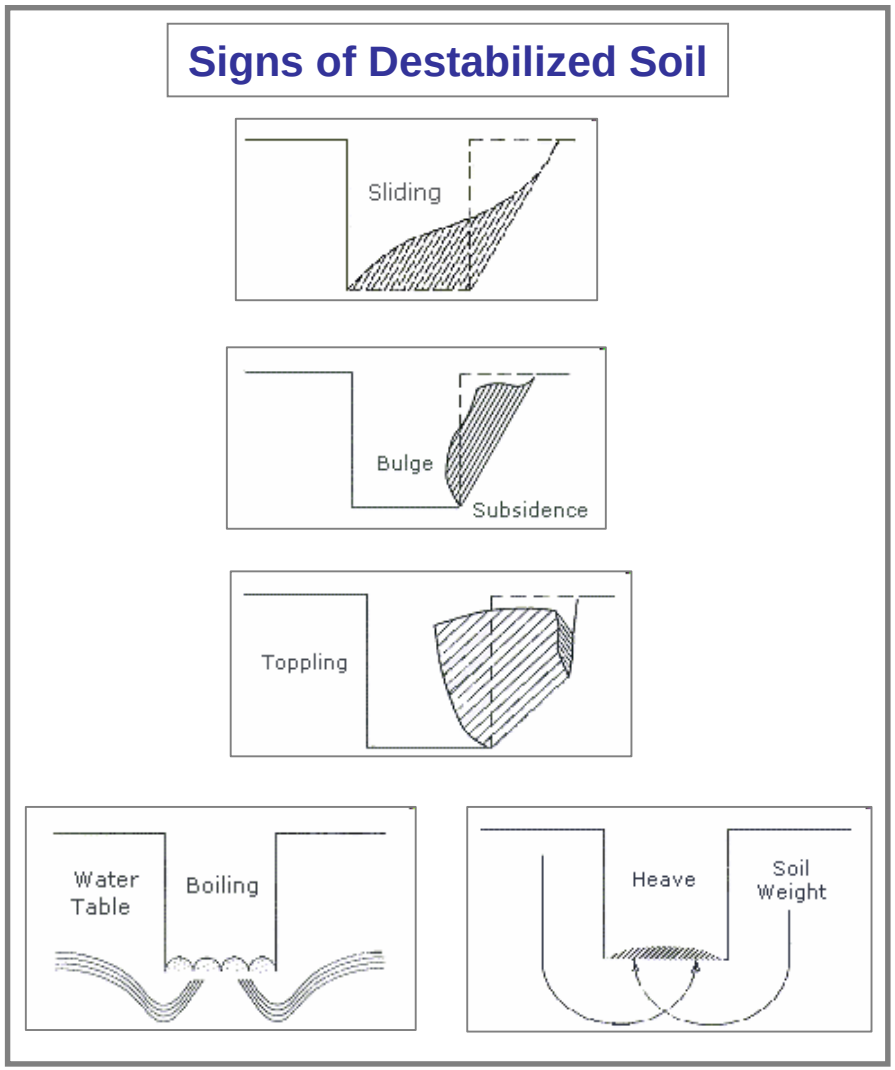
OSHA Technical Manual – Hazard Recognition in Trenching and Shoring
http://www.osha.gov/dts/osta/otm/otm_v/otm_v_2.html

- **Excavations**
  - **Continuous Testing for Low Oxygen, Flammable Gases, Toxic Gases**
  - **Signs of Impending Collapse**
- **Protective systems**
  - **Proper Installation**
  - **Damage**
- **Egress**
- **Surrounding Area:**
  - **Spoil Pile**
  - **Stored Equipment & Supplies**
  - **Vehicles**

Inspections

Inspect Before a Job Begins and as Job Progresses
(to determine if conditions deteriorated)

- **Soil Can Destabilize Quickly**
- **Stay Alert for:**
  - **Cracks, bulging or heaving**
  - **Sinking along the edges**
  - **Seeping or running water**
  - **Trickling gravel or pebbles**



Inspections

Conditions that Affect Rock/Soil Slope Stability

CONDITION	REQUIREMENT
Soil is fractured/unstable dry rock	Downgrade to Type B
Soil is fractured/unstable submerged rock	Downgrade to Type C
Soil is cemented (caliche, hardpan, etc.)	Classify as Type A
Soil is fissured	Downgrade from Type A to Type B
Soil is subject to vibration	Downgrade from Type A to Type B
Soil has been previously disturbed	Downgrade from Type A to Type B
Soil is submerged or water is freely seeping through the sides of the excavation	Downgrade from Type A to Type C Downgrade from Type B to Type C
Soil profile is layered with the layers dipping into the excavation on a slope of four horizontal to one vertical or steeper	Downgrade from Type A to Type C Downgrade from Type B to Type C

See 29 CFR 1926 Subpart P – App A: Soil Classification, Table I

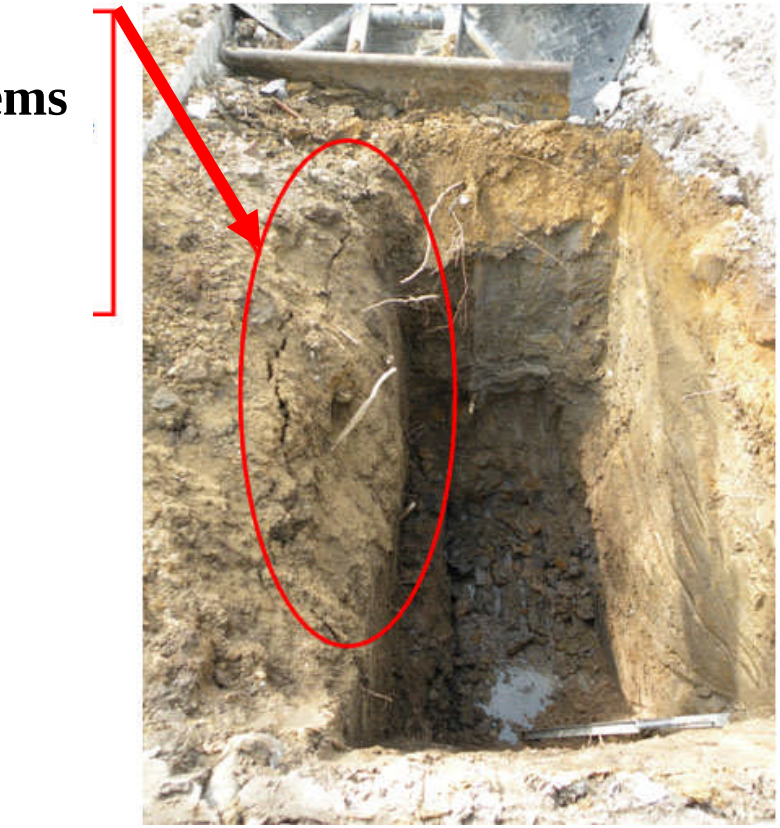
Inspections

If the Competent Person Finds:

- **Evidence of a Possible Cave-In**
- **Indications of Failed Protective Systems**
- **Hazardous Atmosphere**
- **Other Hazardous Conditions**

Then Exposed Employees:

- **Must Evacuate the Excavation**
- **May Not Return Until the Necessary Precautions Have Been Taken**



Inspections

General Rules

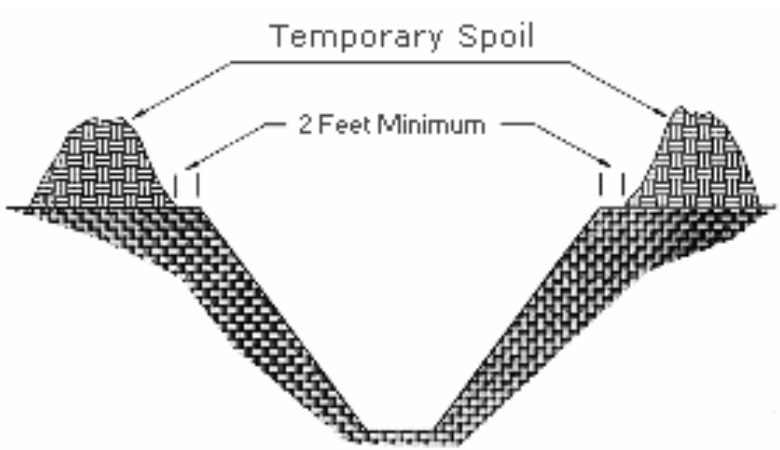
- **Barricades, Fencing & Signs (To Warn & Keep Away From Open Hole)**
- **Have Spotter Use Hand/Mechanical Signals for Vehicle Operators**
- **Wear PPE (Hard Hat, Safety Footwear & Eye Protection, etc.)**
- **Never stand or work under a load**
- **Exit immediately when told (by Attendant)**

Trench collapsed when vehicle got too close to edge

Inspections

Spoil Piles

- **Place Excavated Materials 2' or More From Edge of Excavation**
  - **Recommended Distance Back is Half of the Depth**
- **Grade Spoil Pile so Drainage Runs Away from the Excavation**



Inspections

Water Accumulation

- **Employees Are Not to Work In Excavation With Standing Water**
  - **Water Removal Equipment Can Be Used To Prevent Accumulation**
- **Surface Water Must Be Prevented From Entering By:**
  - **Diversion Ditches, Dikes, etc.**

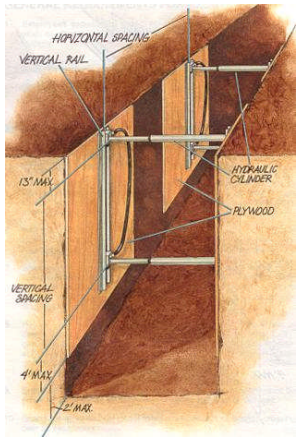
Inspections

As Needed, such as After:

- **Every Rain**
- **Other Occurrences that Increases Hazards such as:**
  - **Nearby Blasting**
  - **Welding**

Dismantling

- **Remove Cross Bracing**
  - **From Bottom Up**
  - **Release Strain Slowly**
  - **Pull Braces Out With Lifting Equipment**
- **Backfill As the Shoring is Dismantled**
- **Inspect and Discard Damaged Shoring**

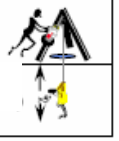


Excavations **Rescue**

Permit Required Confined Spaces

Employees Must Be Trained in Confined Space Entry

See Supervisor for Permit



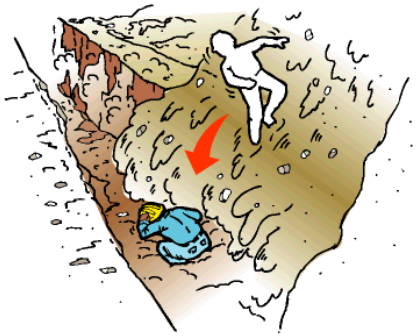
Excavation Over 4' Deep = Permit Required Confined Space

- **Minimum Number in Excavation to Do Work**
  - **1 Attendant per Each Entrant (1:1)**
- **Test Atmosphere Using Multi-Gas Monitor**
- **Consider *External Extraction Rescue* Equipment**
  - **Each Entrant Wears Full Body Harness Attached to:**
    - **Rescue Tripod With Personnel Winch**
    - **or Rescue Rope**
- **Notify Columbia Fire Dept./Hazmat 1 of Excavation Entry**
  - **Call 9-1-1 For Excavation Emergency Rescue**

Safety Program

Excavations

- **Greatest Risk is a Cave-In**
  - **Other Hazards** (water, oxygen deficiency, toxic fumes, falls and mobile equipment)
- **Employees Can Be Protected Through**
  - **Sloping**
  - **Shielding and/or Shoring**



- **Competent Person is Responsible to Keep Workers Safe by:**
  - **Selecting Appropriate Protection**
  - **Inspecting the Excavation**

Questions: Contact BCB Safety, 737-2315