Trenching, Shoring and Excavation Safety for the End User

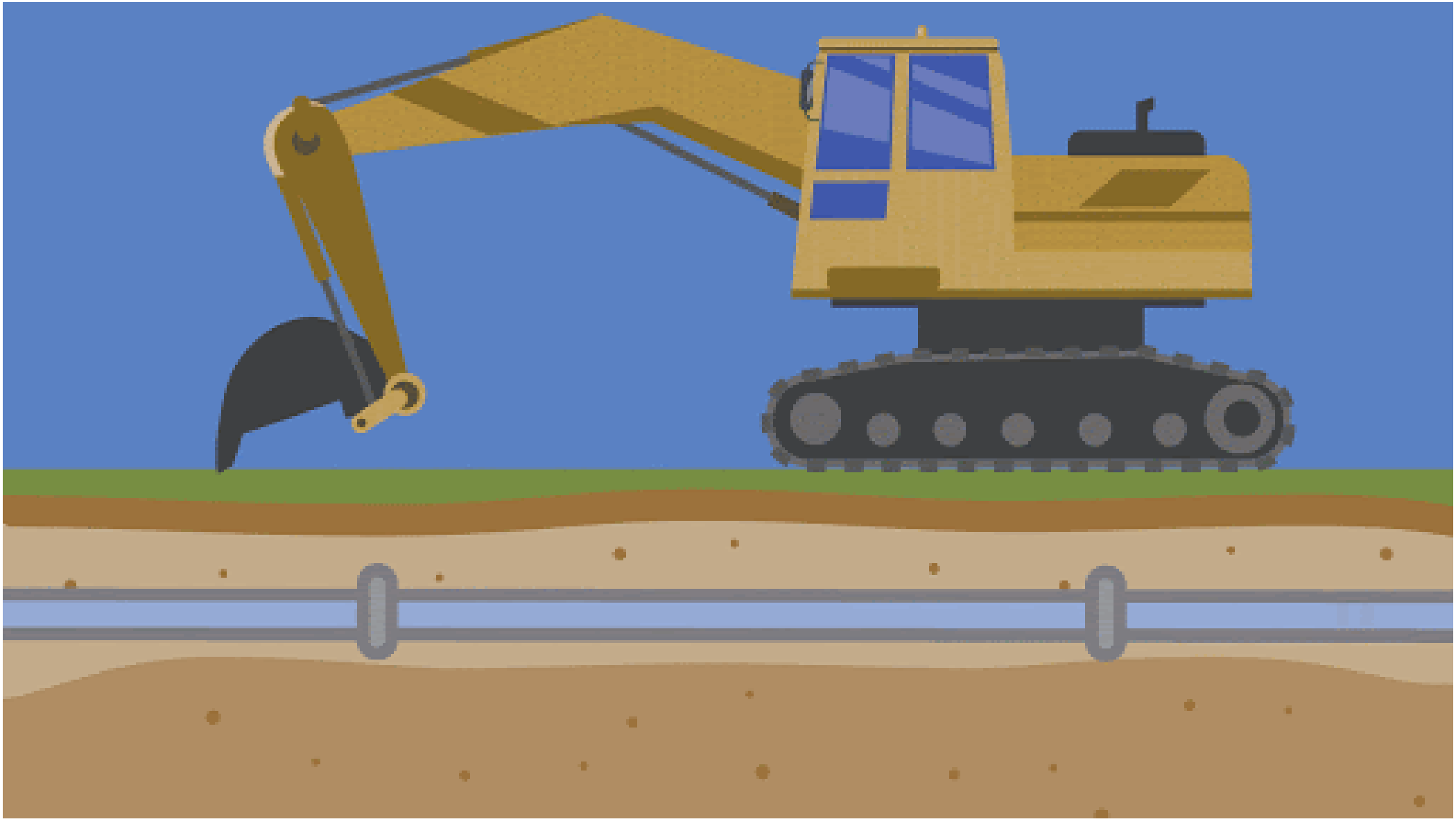
Instructor: Henry Fockler

SLOPE IT

800-321-OSHA (6742)

SHORE IT SHIELD IT

DU-ALL SAFETY



Objectives

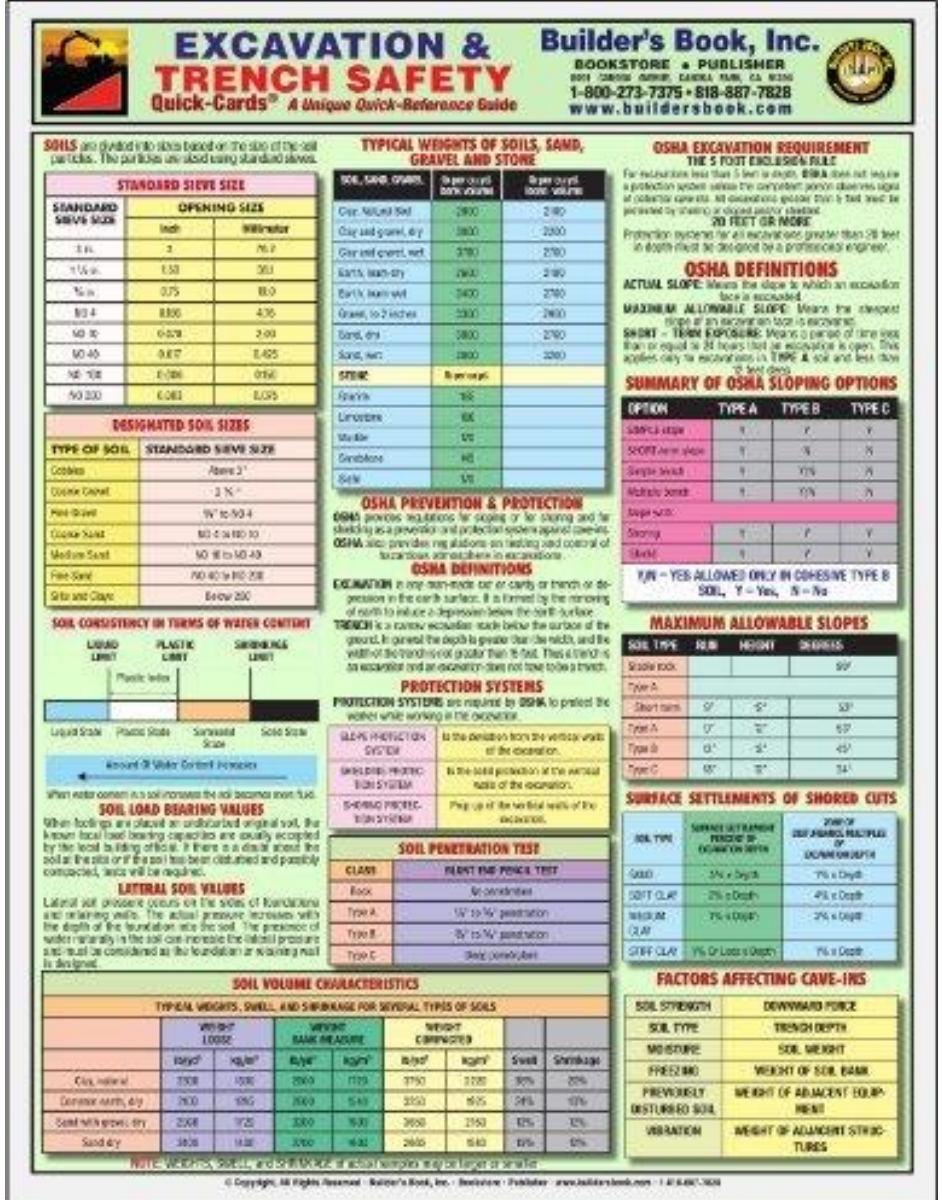
Couse Objective is to help you:

- Identify and apply CalOSHA standards and City Code of Safe Practice for trenching, shoring and excavation safety
- Understand the roles and responsibilities of a competent person
- Coordinate with contractors for their excavations
- Recognize excavation/trenching hazards
- Explain basics of soil mechanics/classification and perform a soil evaluation
- Establish proper use of various protection systems
- Perform inspection using the checklist

It is the Law!

- Use all the resources available to you.
- Educate yourselves.
- Follow the Law, Regulations, Policies and Best Management Practices.

Quick Card



EXCAVATION & TRENCH SAFETY
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SOILS are divided into sizes based on the size of the soil particles. The particles are sized using standard sieves.

STANDARD SIEVE SIZE

STANDARD SIEVE SIZE	OPENING SIZE	
	Inch	Millimeter
3 in.	3	76.2
1½ in.	1.50	38.1
¾ in.	0.75	19.0
NO 4	0.187	4.75
NO 10	0.078	2.00
NO 40	0.017	0.425
NO 100	0.006	0.150
NO 200	0.003	0.075

DESIGNATED SOIL SIZES

TYPE OF SOIL	STANDARD SIEVE SIZE
Cobbles	Above 3"
Coarse Gravel	3" to ¾"
Fine Gravel	¾" to NO 4
Coarse Sand	NO 4 to NO 10
Medium Sand	NO 10 to NO 40
Fine Sand	NO 40 to NO 200
Silts and Clays	Below 200

SOIL CONSISTENCY IN TERMS OF WATER CONTENT

When water content in a soil increases the soil becomes more fluid.

SOIL LOAD BEARING VALUES

When footings are placed on undisturbed original soil, the known local load bearing capacities are usually accepted by the local building official. If there is a doubt about the soil at the site or if the soil has been disturbed and possibly compacted, tests will be required.

LATERAL SOIL VALUES

Lateral soil pressure occurs on the sides of foundations and retaining walls. The actual pressure increases with the depth of the foundation into the soil. The presence of water naturally in the soil can increase the lateral pressure and must be considered as the foundation or retaining wall is designed.

TYPICAL WEIGHTS OF SOILS, SAND, GRAVEL AND STONE

SOIL, SAND, GRAVEL	Weight per cu yd, bank volume	Weight per cu yd, loose volume
Clay, Natural Bed	2800	2160
Clay and gravel, dry	3000	2200
Clay and gravel, wet	3780	2780
Earth, loam dry	2800	2160
Earth, loam wet	3400	2780
Gravel, to 2 inches	3300	2800
Sand, dry	3000	2780
Sand, wet	3800	3200
STONE	Weight per cu yd.	
Granite	165	
Limestone	155	
Marble	170	
Sandstone	145	
Slate	170	

OSHA PREVENTION & PROTECTION

OSHA provides regulations for sloping or for shoring and for shielding as a preventive and protective system against cave-ins.
OSHA also provides regulations on testing and control of hazardous atmospheres in excavations.

OSHA DEFINITIONS

EXCAVATION is any man-made cut or cavity or trench or depression in the earth surface. It is formed by the removing of earth to induce a depression below the earth surface.
TRENCH is a narrow excavation made below the surface of the ground. In general the depth is greater than the width, and the width of the trench is not greater than 15 feet. Thus a trench is an excavation and an excavation does not have to be a trench.

PROTECTION SYSTEMS

PROTECTION SYSTEMS are required by OSHA to protect the worker while working in the excavation.

SLOPE PROTECTION SYSTEM	is the deviation from the vertical walls of the excavation.
SHIELDING PROTECTION SYSTEM	is the solid protection of the vertical walls of the excavation.
SHORING PROTECTION SYSTEM	Prop up of the vertical walls of the excavation.

SOIL PENETRATION TEST

CLASS	HAND PAN PENCIL TEST
Rock	No penetration
Type A	¼" to ¾" penetration
Type B	¾" to ¾" penetration
Type C	Deep penetration

SOIL VOLUME CHARACTERISTICS

TYPICAL WEIGHTS, SWELL, AND SHRINKAGE FOR SEVERAL TYPES OF SOILS

	WEIGHT LOOSE		WEIGHT BANK MEASURE		WEIGHT COMPACTED			
	lb/yd³	kg/m³	lb/yd³	kg/m³	lb/yd³	kg/m³	Swell	Shrinkage
Clay, natural	2300	1500	2800	1725	3150	2200	30%	20%
Common earth, dry	2600	1595	3000	1840	3350	2505	24%	12%
Sand with gravel, dry	2500	1725	3200	1930	3650	2350	12%	12%
Sand dry	2600	1600	3200	1930	3600	2340	12%	12%

NOTE: WEIGHTS, SWELL, and SHRINKAGE of actual samples may be larger or smaller

OSHA EXCAVATION REQUIREMENT
THE 5 FOOT EXCLUSION RULE

For excavations less than 5 feet in depth, OSHA does not require a protection system unless the competent person observes signs of potential cave-ins. All excavations greater than 5 feet must be protected by sloping or stepped and/or shielded.

20 FEET OR MORE

Protection systems for all excavations greater than 20 feet in depth must be designed by a professional engineer.

OSHA DEFINITIONS

ACTUAL SLOPE: Means the slope to which an excavation face is excavated.
MAXIMUM ALLOWABLE SLOPE: Means the steepest slope of an excavation face is excavated.
SHORT – TERM EXPOSURE: Means a period of time less than or equal to 24 hours that an excavation is open. This applies only to excavations in TYPE A soil and less than 12 feet deep.

SUMMARY OF OSHA SLOPING OPTIONS

OPTION	TYPE A	TYPE B	TYPE C
Simple slope	Y	Y	Y
Short term slope	Y	N	N
Simple bench	Y	Y/N	N
Multiple bench	Y	Y/N	N
Slope w/ ss			
Shoring	Y	Y	Y
Shield	Y	Y	Y

Y/N – YES ALLOWED ONLY IN COHESIVE TYPE B SOIL, Y – Yes, N – No

MAXIMUM ALLOWABLE SLOPES

SOIL TYPE	RUN	HEIGHT	SLOPE/ANGLE
Stable rock			90°
Type A			
Short term	0"	0"	53°
Type A	0"	12"	53°
Type B	0"	0"	45°
Type C	0"	0"	34°

SURFACE SETTLEMENTS OF SHORED CUTS

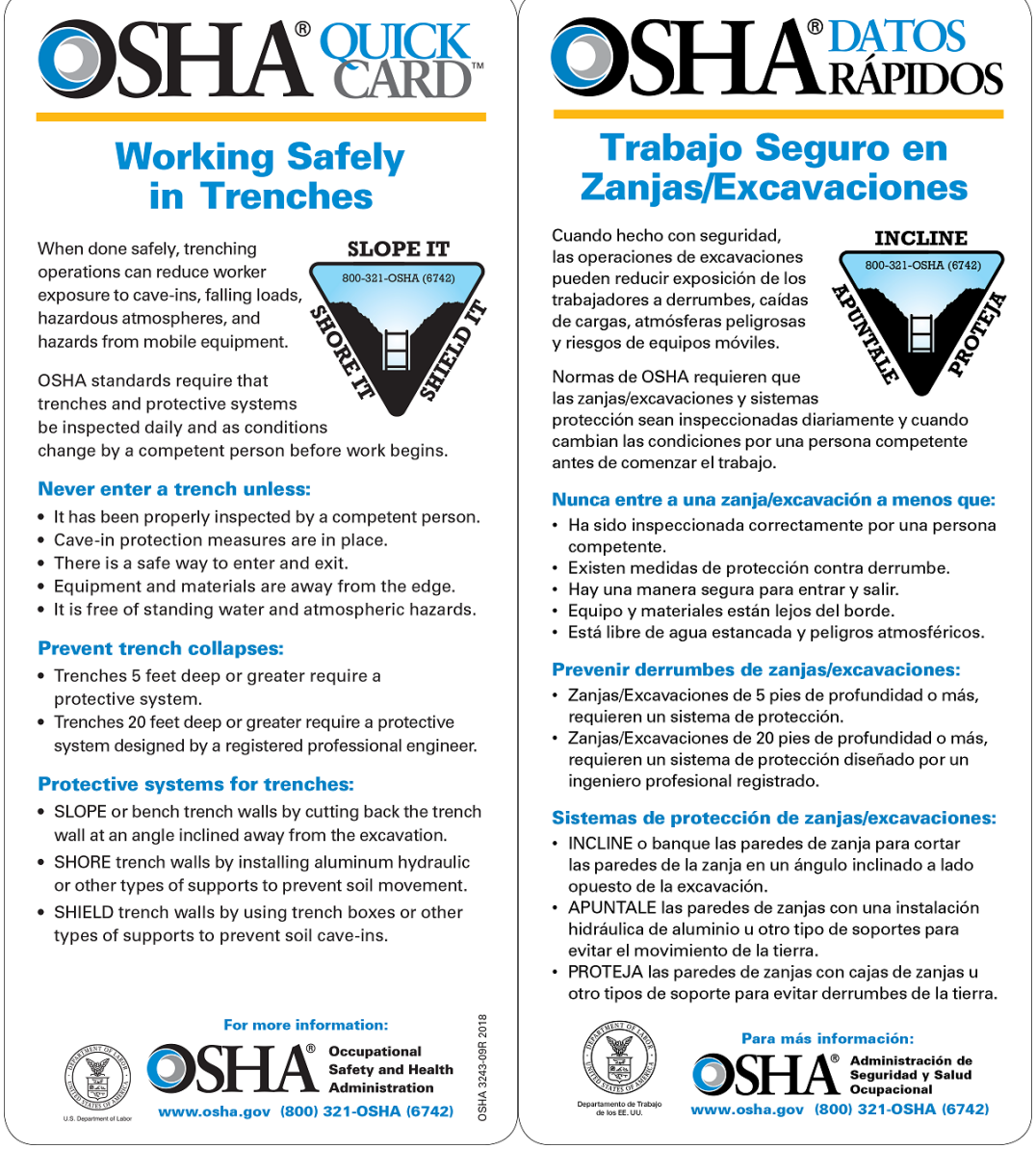
SOIL TYPE	SURFACE SETTLEMENT PERCENT OF EXCAVATION DEPTH	ZONE OF SIGNIFICANT SETTLEMENT PERCENT OF EXCAVATION DEPTH
Sand	3% x Depth	1% x Depth
SOFT CLAY	2% x Depth	4% x Depth
MEDIUM CLAY	1% x Depth	2% x Depth
STIFF CLAY	1% Or Less x Depth	1% x Depth

FACTORS AFFECTING CAVE-INS

SOIL STRENGTH	DOWNWARD FORCE
SOIL TYPE	TRENCH DEPTH
MOISTURE	SOIL WEIGHT
FREEZING	WEIGHT OF SOIL BANK
PREVIOUSLY DISTURBED SOIL	WEIGHT OF ADJACENT EQUIPMENT
VIBRATION	WEIGHT OF ADJACENT STRUCTURES

OSHA QUICK CARD

- Another source of reference
- You can print this off the OSHA website and laminate it for employees



OSHA® QUICK CARD™

Working Safely in Trenches

When done safely, trenching operations can reduce worker exposure to cave-ins, falling loads, hazardous atmospheres, and hazards from mobile equipment.

SLOPE IT
800-321-OSHA (6742)
SHORE IT
SHIELD IT

OSHA standards require that trenches and protective systems be inspected daily and as conditions change by a competent person before work begins.

Never enter a trench unless:

- It has been properly inspected by a competent person.
- Cave-in protection measures are in place.
- There is a safe way to enter and exit.
- Equipment and materials are away from the edge.
- It is free of standing water and atmospheric hazards.

Prevent trench collapses:

- Trenches 5 feet deep or greater require a protective system.
- Trenches 20 feet deep or greater require a protective system designed by a registered professional engineer.

Protective systems for trenches:

- SLOPE or bench trench walls by cutting back the trench wall at an angle inclined away from the excavation.
- SHORE trench walls by installing aluminum hydraulic or other types of supports to prevent soil movement.
- SHIELD trench walls by using trench boxes or other types of supports to prevent soil cave-ins.

For more information:
U.S. Department of Labor
OSHA® Occupational Safety and Health Administration
www.osha.gov (800) 321-OSHA (6742)

OSHA 3243-09R 2018

OSHA® DATOS RÁPIDOS

Trabajo Seguro en Zanjas/Excavaciones

Cuando hecho con seguridad, las operaciones de excavaciones pueden reducir exposición de los trabajadores a derrumbes, caídas de cargas, atmósferas peligrosas y riesgos de equipos móviles.

INCLINE
800-321-OSHA (6742)
APUNTALE
PROTEJA

Normas de OSHA requieren que las zanjas/excavaciones y sistemas protección sean inspeccionadas diariamente y cuando cambian las condiciones por una persona competente antes de comenzar el trabajo.

Nunca entre a una zanja/excavación a menos que:

- Ha sido inspeccionada correctamente por una persona competente.
- Existen medidas de protección contra derrumbe.
- Hay una manera segura para entrar y salir.
- Equipo y materiales están lejos del borde.
- Está libre de agua estancada y peligros atmosféricos.

Prevenir derrumbes de zanjas/excavaciones:

- Zanjas/Excavaciones de 5 pies de profundidad o más, requieren un sistema de protección.
- Zanjas/Excavaciones de 20 pies de profundidad o más, requieren un sistema de protección diseñado por un ingeniero profesional registrado.

Sistemas de protección de zanjas/excavaciones:

- INCLINE o banque las paredes de zanja para cortar las paredes de la zanja en un ángulo inclinado a lado opuesto de la excavación.
- APUNTALE las paredes de zanjas con una instalación hidráulica de aluminio u otro tipo de soportes para evitar el movimiento de la tierra.
- PROTEJA las paredes de zanjas con cajas de zanjas u otro tipos de soporte para evitar derrumbes de la tierra.

Para más información:
Departamento de Trabajo de los EE. UU.
OSHA® Administración de Seguridad y Salud Ocupacional
www.osha.gov (800) 321-OSHA (6742)

OSHA Quick Card

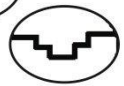
OSHA® QUICK CARD™

Working Safely in Trenches

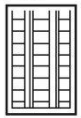
Two workers are killed every month in trench collapses. Each worker in a trench shall be protected from a cave-in by an adequate protective system. Some of the protective systems for trenches are:

- Sloped for stability; or

- Cut to create stepped benched grades (Type A or B soil only); or



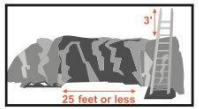
- Supported by a system made with materials such as posts, beams, shores or planking and hydraulic jacks; or



- Shielded by a trench box to protect workers in a trench.

Excavated or other materials and equipment must be at least 2 feet back from the edge of a trench; and

A safe way to exit must be provided within 25 feet of workers in a trench.



A competent person must inspect trenches daily and when conditions change. An unprotected trench is an early grave. Do not enter an unprotected trench.

For more information:

OSHA® Occupational Safety and Health Administration
U.S. Department of Labor
www.osha.gov (800) 321-OSHA (6742)
TTY (887) 889-5627

OSHA 3243-09R 11

Any issues?

Any issues?

Any issues?

CalOSHA Standard

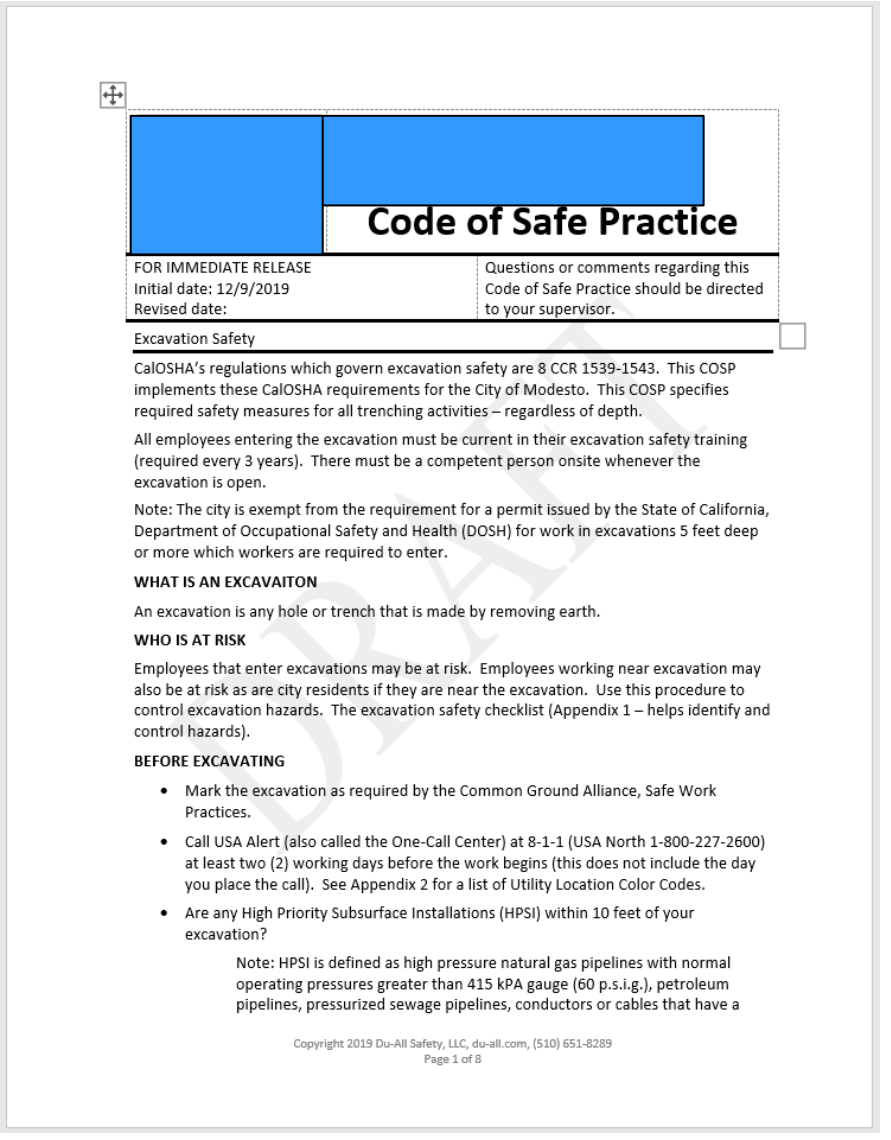
- Excavation and trenching operations are considered to be among the most hazardous types of construction work

8 CCR 1539-1543 Excavations

- Covers CalOSHA's requirements for excavation and trenching work
- CalOSHA standards are the *minimum* safety requirements

COSP

- Addresses areas of safety associated with excavations
- Specifies controls to be used during excavations
- Includes an inspection checklist – use is required under some circumstances



Code of Safe Practice

FOR IMMEDIATE RELEASE Initial date: 12/9/2019 Revised date:	Questions or comments regarding this Code of Safe Practice should be directed to your supervisor.

Excavation Safety

CalOSHA's regulations which govern excavation safety are 8 CCR 1539-1543. This COSP implements these CalOSHA requirements for the City of Modesto. This COSP specifies required safety measures for all trenching activities – regardless of depth.

All employees entering the excavation must be current in their excavation safety training (required every 3 years). There must be a competent person onsite whenever the excavation is open.

Note: The city is exempt from the requirement for a permit issued by the State of California, Department of Occupational Safety and Health (DOSH) for work in excavations 5 feet deep or more which workers are required to enter.

WHAT IS AN EXCAVAITON

An excavation is any hole or trench that is made by removing earth.

WHO IS AT RISK

Employees that enter excavations may be at risk. Employees working near excavation may also be at risk as are city residents if they are near the excavation. Use this procedure to control excavation hazards. The excavation safety checklist (Appendix 1 – helps identify and control hazards).

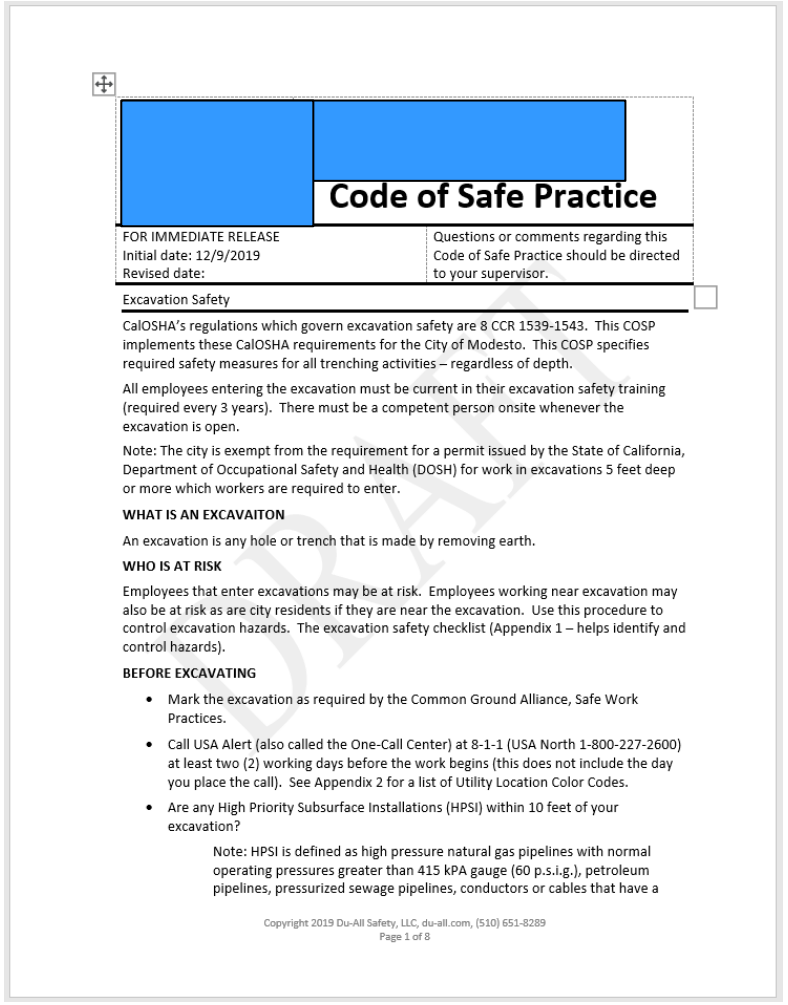
BEFORE EXCAVATING

- Mark the excavation as required by the Common Ground Alliance, Safe Work Practices.
- Call USA Alert (also called the One-Call Center) at 8-1-1 (USA North 1-800-227-2600) at least two (2) working days before the work begins (this does not include the day you place the call). See Appendix 2 for a list of Utility Location Color Codes.
- Are any High Priority Subsurface Installations (HPSI) within 10 feet of your excavation?

  Note: HPSI is defined as high pressure natural gas pipelines with normal operating pressures greater than 415 kPA gauge (60 p.s.i.g.), petroleum pipelines, pressurized sewage pipelines, conductors or cables that have a

Code of Safe Practice

- What is an excavation
- Who is at risk
- Before excavating
- What are the hazards
- What can be done to protect employees
- Competent person inspections
- Checklist



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Appendix 1 – [redacted] Excavation Inspection Checklist

Daily Excavation Safety Inspection Checklist

Competent Person: Date:

Site Location:

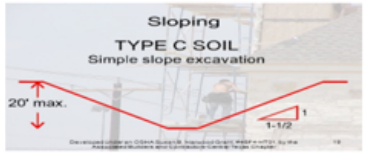
Soil Type: Excavation Depth: Excavation Width:

Type of Protective System Used:

Indicate for each item: Yes – No – or N/A for not applicable. Corrective Actions documented on bottom of last page

1. General Information:	Yes	No	N/A
A. Is there a potential for a cave-in? ***IF YES, excavation must be sloped, shored, or shielded.**			
B. Is excavation deeper than five feet in depth? *** IF YES, excavation must be sloped, shored, or shielded.**			
C. Is the excavation less than five feet in depth, but workers are exposed to hazardous cave in because of work position?			
D. Is sloping going to be used for protective system – if yes, see illustration below:			

Slope information to keep in mind



OSHA Sloping Requirements		
Soil Type	Slope	Angle (Degrees)
A	3/4H:1V	53°
B	1H:1V	45°
C	1½H:1V	34°

2. Inspection of Job-site:	Yes	No	N/A
A. Surface encumbrances removed or supported.			
B. Employees protected from loose rock or soil that could pose a hazard by falling or rolling into the excavation.			
C. Hard hats, safety shoes/boots and safety glasses worn by all employees.			
D. Spoils, materials, and equipment set back at least two feet from the edge of the excavation.			
E. Adequate barriers provided at all excavations, wells, pits, shafts, etc.			
F. Warning vests or other highly visible clothing provided and worn by all employees exposed to vehicular traffic.			
G. Warning system established and utilized when mobile equipment is operating near the edge of the excavation.			
H. Walkways and bridges over excavations 6 feet or more in depth where people are expected to cross the trench are equipped with standard guard rails			
I. Fall Protection Harness, lifeline and anchor (or barrier to prevent falls) used when working at the edge of excavations deeper than 6 feet			
Notes:			

3. Utilities:	Yes	No	N/A
A. Location of utilities marked			
B. Prior to mechanical excavation, underground utilities have been located by hand digging and potholing (note: hand digging required within 2 feet of utility)			
C. Underground utilities are protected, supported, or removed when excavation is open			
Notes:			

Daily Excavation Checklist Continued:

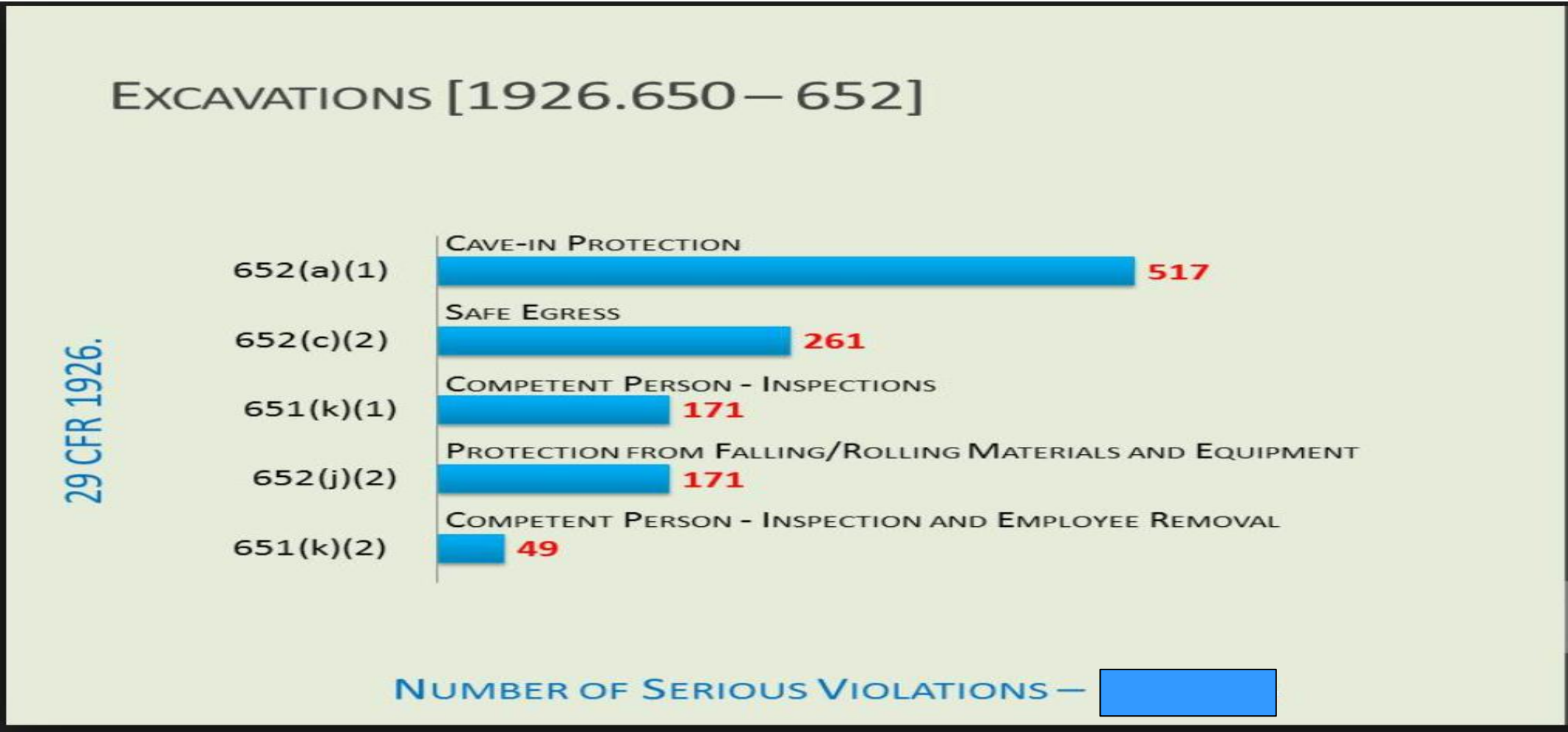
4. Means of Access and Egress:	Yes	No	N/A
A. Travel distance to means of egress no greater than 25 feet in excavations four feet or more in depth.			
B. Straight ladders used in excavations extend at least three feet above the edge of the trench.			
C. Employees protected from cave-ins when entering or exiting the excavation.			
Notes:			

5. Wet Conditions:	Yes	No	N/A
A. Precautions have been taken to protect employees from the accumulation of water.			
B. Water removal equipment monitored by a competent person.			
C. Surface water or runoff diverted or controlled to prevent accumulation in the excavation.			
D. Inspections have been made after every rainstorm or other hazard-increasing occurrence.			
Notes:			

6. Hazardous Atmosphere: **The atmosphere within the excavation must be tested where there is a reasonable possibility of an oxygen deficiency, combustible or other harmful contaminant exposing employees to a hazard or if the excavation is more than 4 feet in depth.**	Yes	No	N/A
A. Are there exposed sewer or natural gas lines in excavation?			
B. Is excavation near a landfill area, or are hazardous substances being stored close to the excavation?			
Notes:			

7. Support Systems:	Yes	No	N/A
A. Materials and/or equipment for support systems selected based on soil analysis, trench depth (5 feet), and expected loads.			
B. Materials and equipment used for protective systems inspected and in good condition.			
C. Materials and equipment not in good condition has been removed from service.			
D. Support systems provided to ensure stability of adjacent structures, buildings, roadways, sidewalks, walls, etc.			
E. Removal of support systems progresses from the bottom and members are released slowly so you can note any indication of possible failure.			
F. Top shore hydraulic cylinder is no more than 18 inches from the top of the trench wall.			
G. Bottom shore hydraulic cylinder is no more than 4 feet from bottom of trench and bottom of vertical shoring is no more than 2 feet from bottom of trench.			
Notes:			
Corrective Actions, if any			

Common OSHA Citations



Why You Should Care

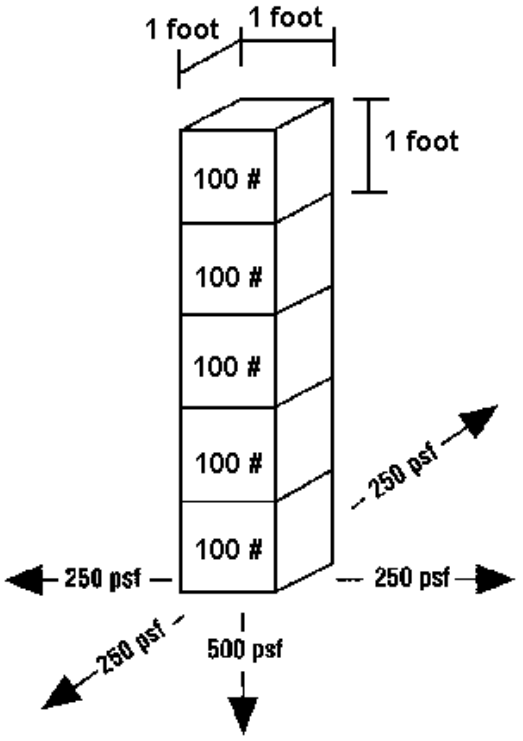
- Because you don’t want this to be you!
- Accidents in excavations tend to be more serious – more fatalities than normal work!

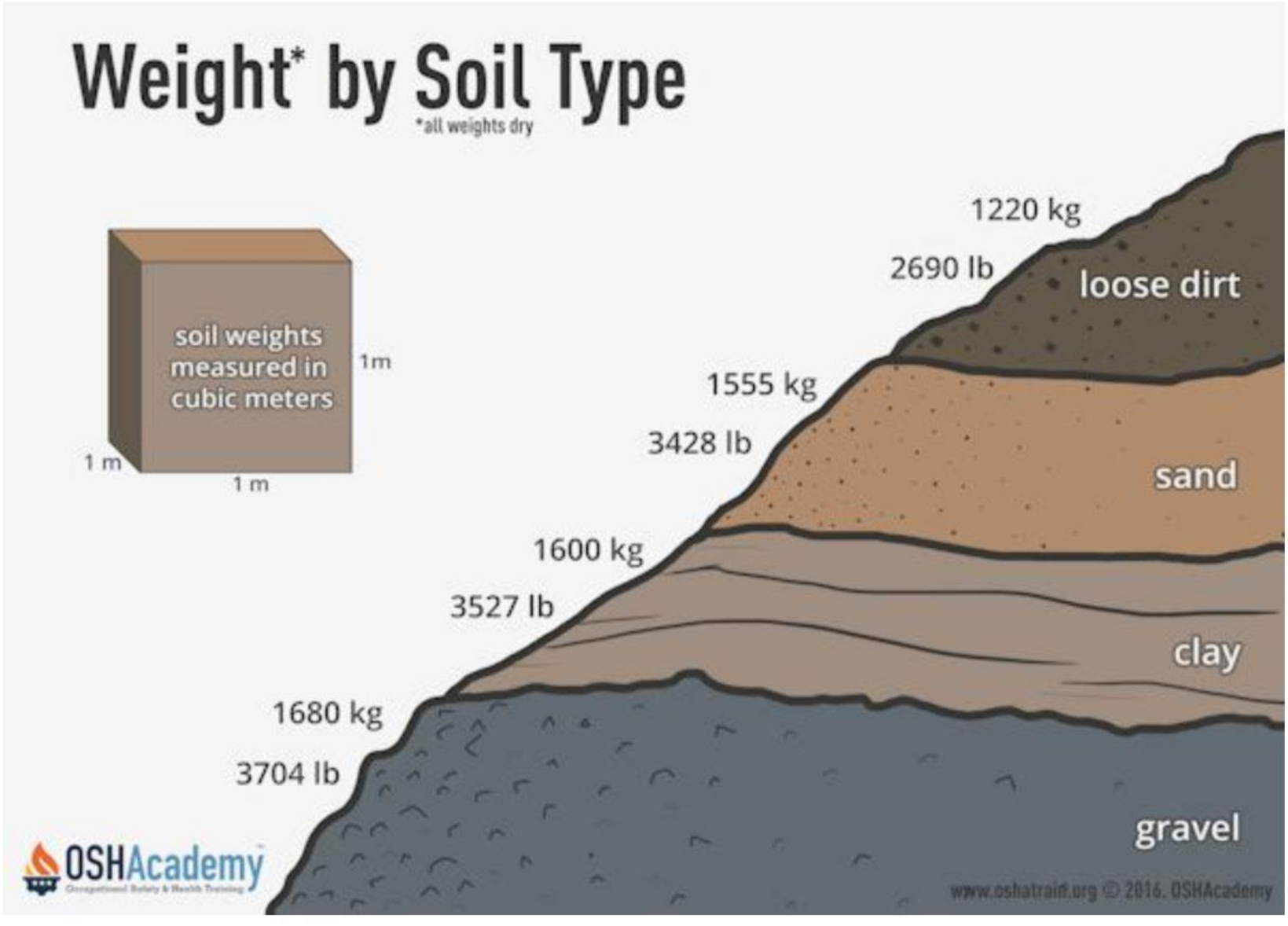
Why You Should Care

- Approximately 100 workers die annually in excavations
- Thousands of workers are injured annually
- Cave-in accidents are most prominent
- Fatality rate for trenching is TWICE the construction rate!
- The cost of excavation failures accounts for around 8% of the construction cost – that can add up quickly.

The Weight of Soil

- One cubic yard weighs 3,000lbs – or more than a Honda Civic!
- An excavation 6 feet deep could be a lot of cubic yards!
- The dirt shifts with the body, filling in around the worker




Weight* by Soil Type
*all weights dry
soil weights measured in cubic meters
1m
1 m
1 m
1220 kg
2690 lb
loose dirt
1555 kg
3428 lb
sand
1600 kg
3527 lb
clay
1680 kg
3704 lb
gravel
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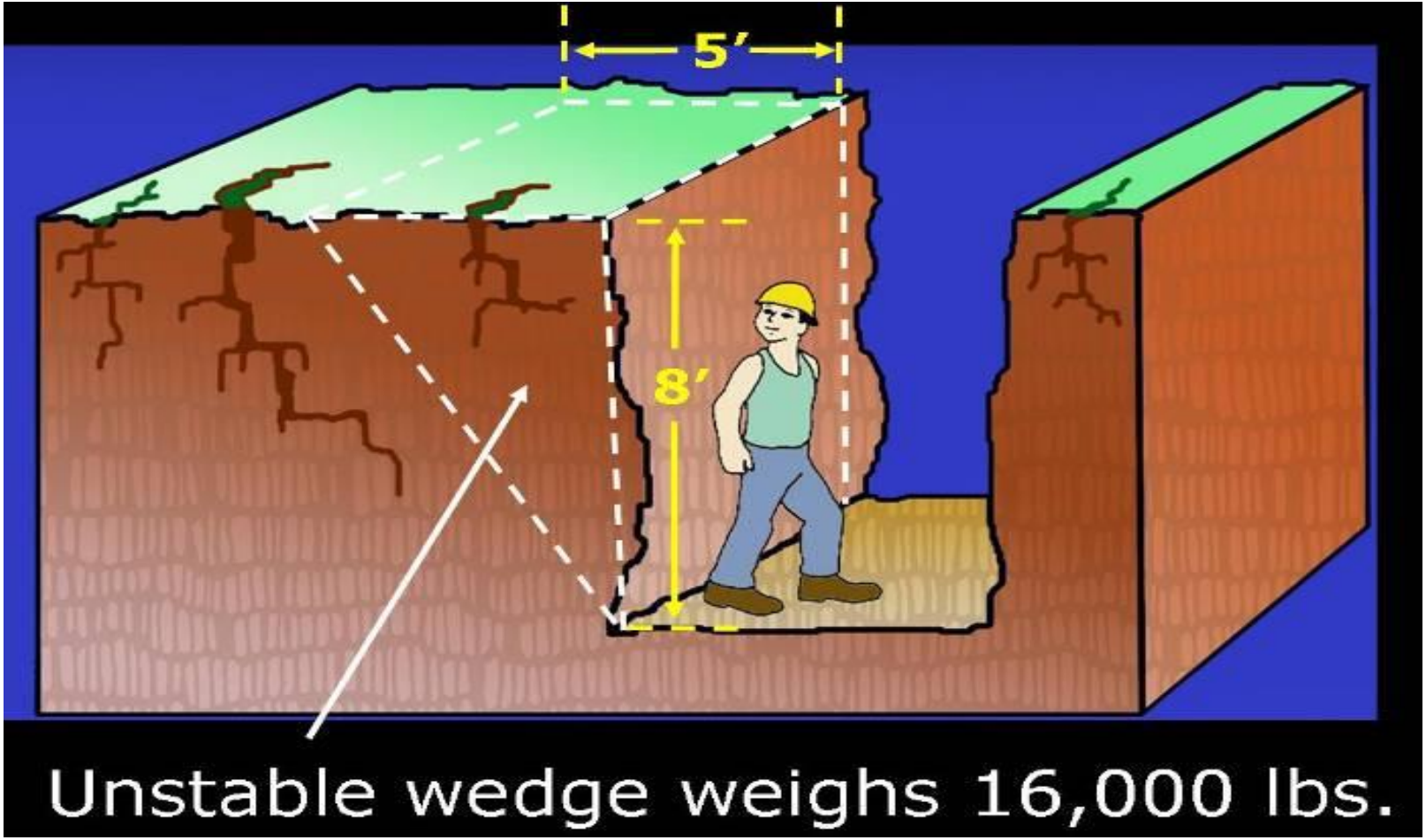
The Weight of Soil



What Causes Cave-Ins?

- Vibrations
- Freezing and thawing
- Adjacent structures
- The weight of the soil itself
- Addition/removal of water
- Capacities of soil
- Wind

What's in the Regulations?

- 8 CCR 1540 Definitions
- 8 CCR 1541 General Requirements
- 8 CCR 1541.1 Requirements for Protective Systems
- Appendix A Soil Classification
- Appendix B Sloping and Benching
- Appendix C Timber Shoring
- Appendix D Hydraulic Shoring

General Requirements (8 CCR 1541)

Subsurface installations

- High Priority Subsurface Installations
  - High pressure gas lines >60 psig, high voltage 60 kilovolts or greater) lines or hazmat
  - Utility owner will notify you
  - Documented meeting with all contractors
- Only qualified persons shall perform utility locations
- Protection of surface and subsurface installations

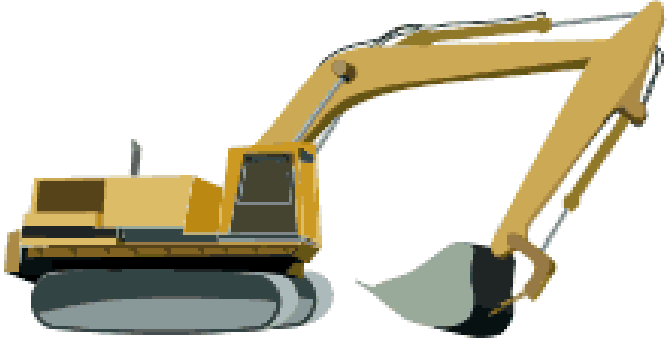
General Requirements 8 CCR 1541

Access and Egress

Exposure to Vehicle Traffic and equipment

Exposure to Falling Loads

Hazardous Atmospheres



At Risk?

- Workers in a trench with no protective system
  - Slope
  - Bench
  - Shore
  - Shield
- No means of egress
- Suspended loads
- Equipment
- Fall Hazard

General Requirements (8 CCR 1541)

- Protection from Water Accumulation
- Stability of Adjacent Structures
- Protection from Loose Rock and Soil (spoil)
- Inspections
- Fall Protection

Definitions of Roles

Authorized Worker

- Person approved or assigned by the employer to work in an excavation
- Must be trained
  - 8CCR1541 “Employees that are involved in excavation operations and exposed to excavation operation hazards shall be trained in the excavation notification and excavation practices required by this section.

Definitions of Roles

Qualified Person

- Person who has the skills needed to accomplish the task – whether from a degree, certificate, training, or extensive experience.
- Registered Professional Engineer (RPE)
- Utility Locator

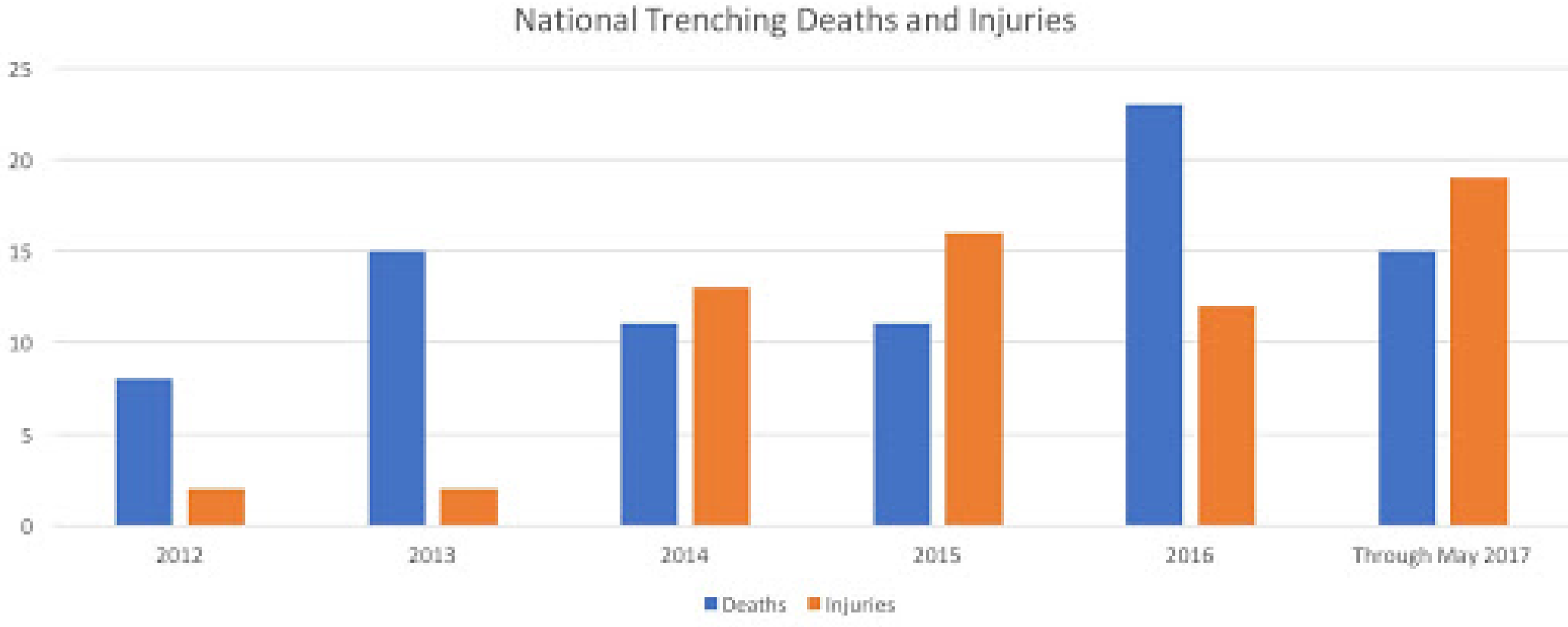
Definitions of Roles

Competent Person

- Must have specific training and be expert about soil analysis, use of protective systems, and OSHA requirements, and employer procedures.
- Person is required to be able to identify and PREDICT hazards in excavations.
- Has the authority to remove workers from a site when he/she feels the site is not safe.
- Must be qualified, authorized, and must be on an excavation site!

Competent Person Duties

- Inspect the excavation daily or as conditions change
  - Inspection must be documented if any hazard exists (Should document as a BMP)
  - Performs soil analysis and classification
  - Evaluates hazardous atmosphere or directs the evaluation
- Must be at the job site when work is performed
- Must select/approve proper protective system
- Must inspect shoring systems


National Trenching Deaths and Injuries
25
20
15
10
5
0
2012
2013
2014
2015
2016
Through May 2017
Deaths
Injuries

Excavation Safety Guidelines

Before and during excavation:

1. Identify potential hazards (hazard requires documented inspection)
2. Reduce or eliminate known hazards
3. Establish emergency procedures
4. Determine periodic inspection intervals
5. Protect the excavation and the surface and subsurface installations
    - Identify and mark utility locations
6. Provide safe entrance and exit from and walkways over trenches

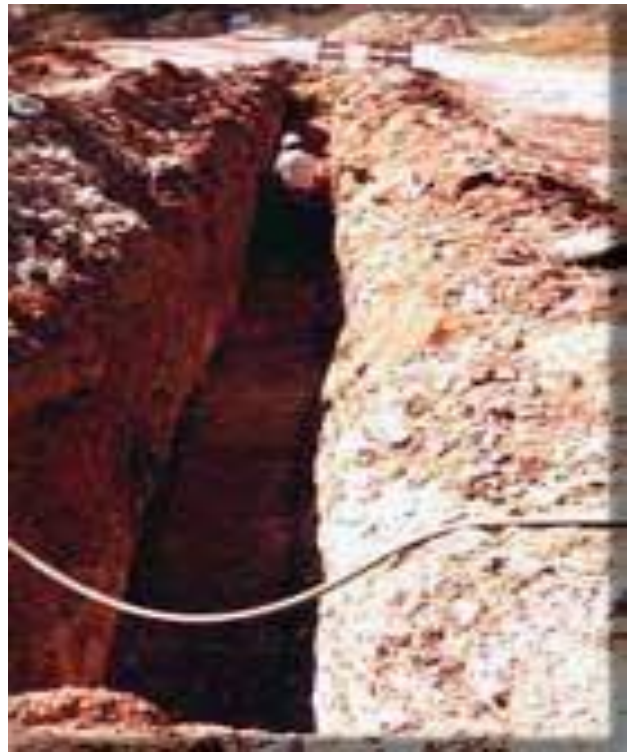
Potential Excavation Hazards

- Cave in
- Surface Crossing of Trenches
- Exposure to Falling Loads
- Exposure to Vehicles
- Warning Systems for Mobile Equipment
- Hazardous Atmospheres/Confined Spaces
- Emergency Rescue
- Standing Water and Water Accumulation
- Inspections

Hazard #1
Soil

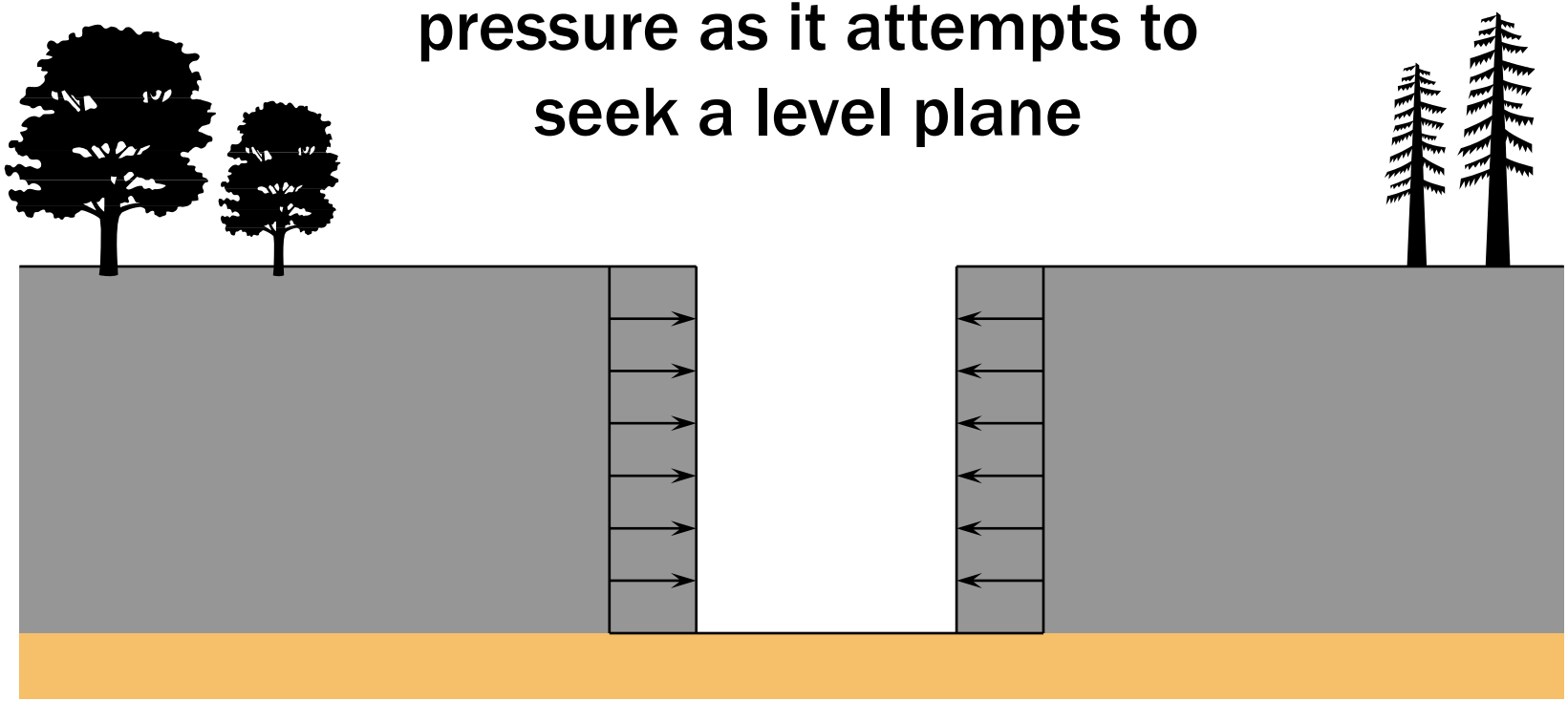
Soil Instability

- Understand the amount of time soil will stand up under its own weight
- Consider:
  - Cohesive strength of soil
  - Unit weight of soil
  - Depth of trench
  - Slope of wall
  - Surface vibration
  - Depth of water table
  - Adjacent structures



Soil Instability

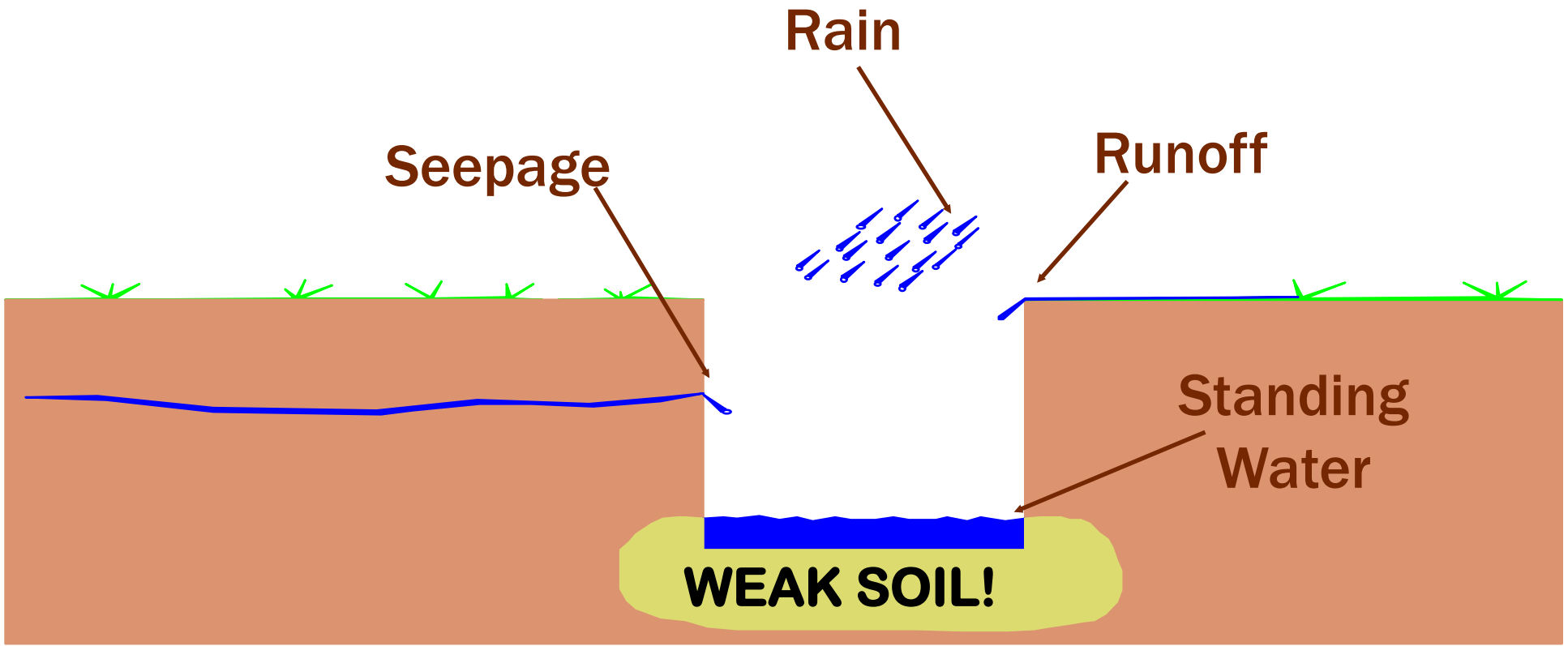
Soil exerts horizontal pressure as it attempts to seek a level plane




WORK SAFE BC

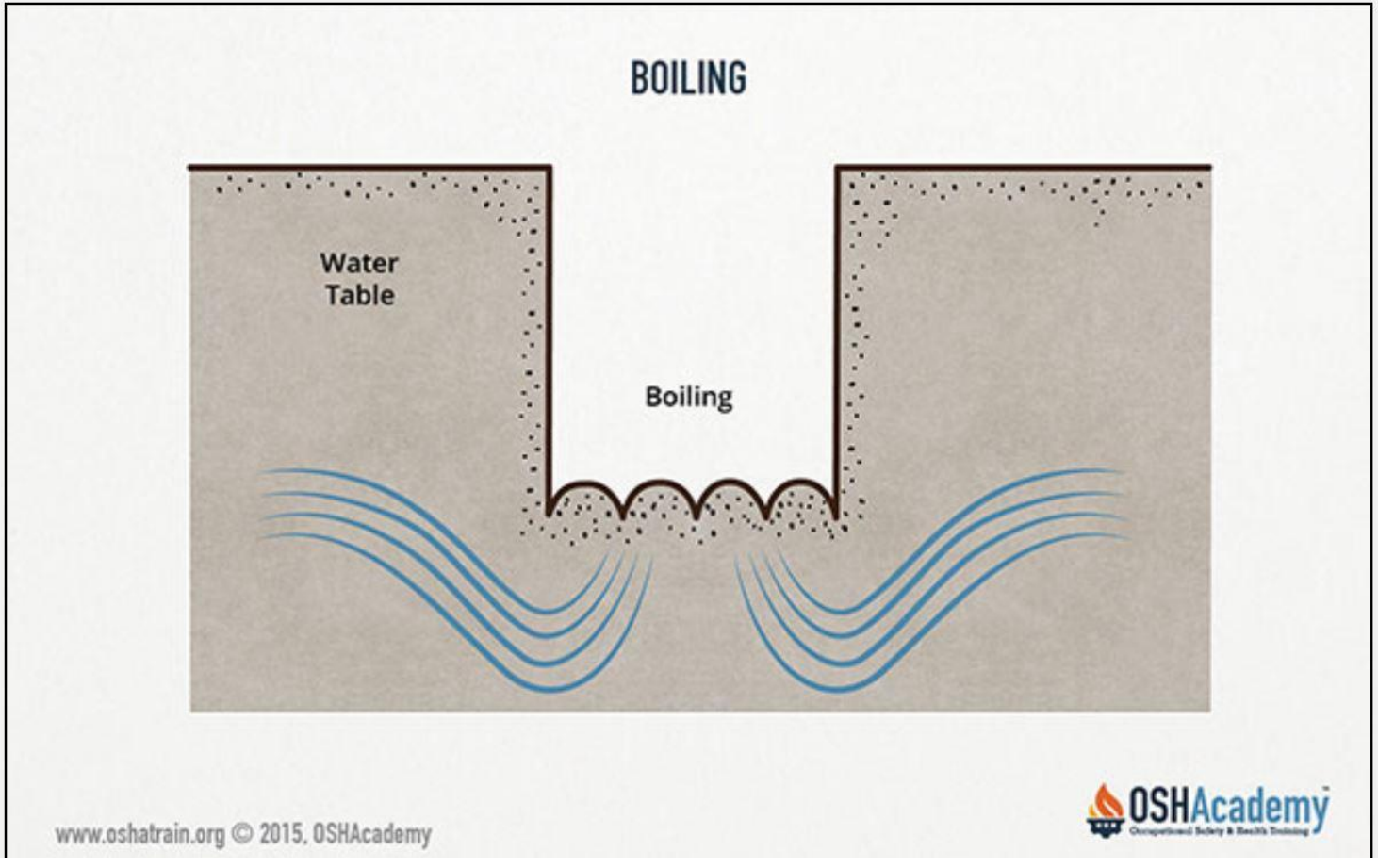
Mechanics of a Cave-In

Water enters trenches, causing the soil to weaken



Boiling

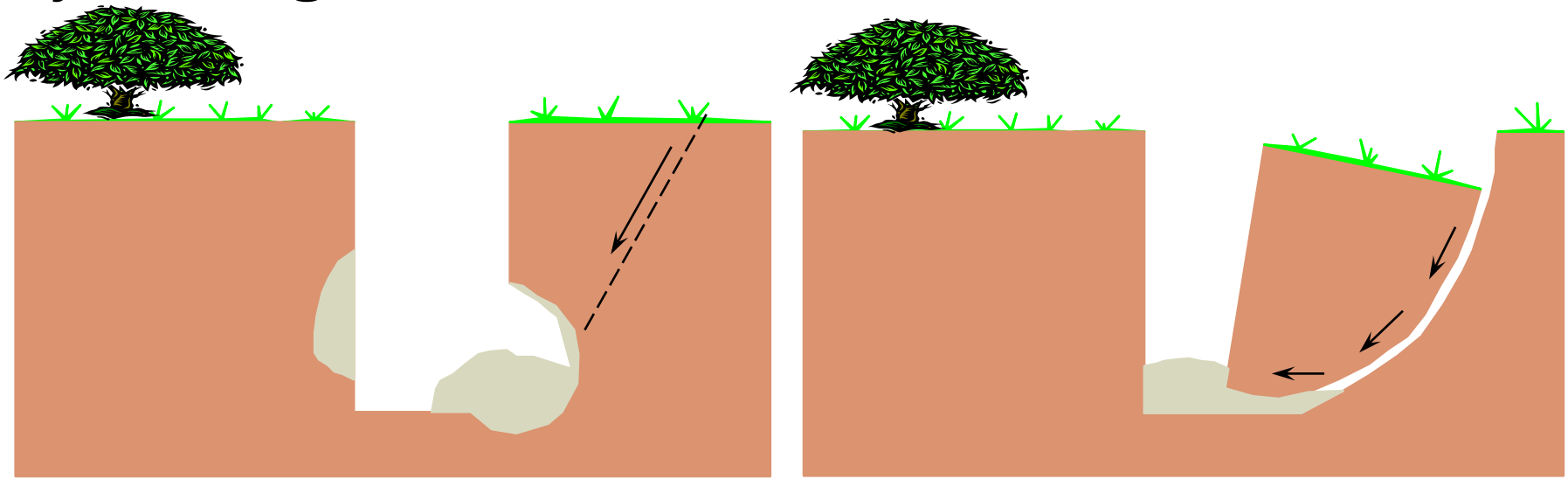
Boiling is evidenced by an upward water flow into the bottom of the cut. A high water table is one of the causes of boiling. Boiling produces a “quick” condition in the bottom of the cut and can occur even when shoring or trench boxes are used.



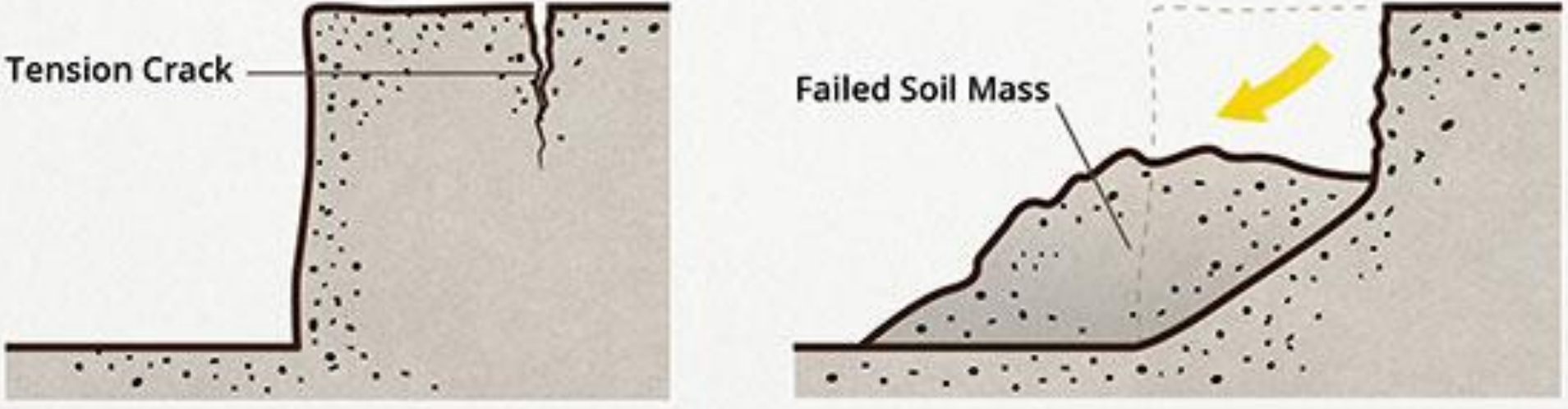
Mechanics of a Cave-In

If water gets into the bottom of the trench and erodes the soil under the dirt, you may lose support you thought was there.

The unsupported soil eventually will collapse and fill in the void.



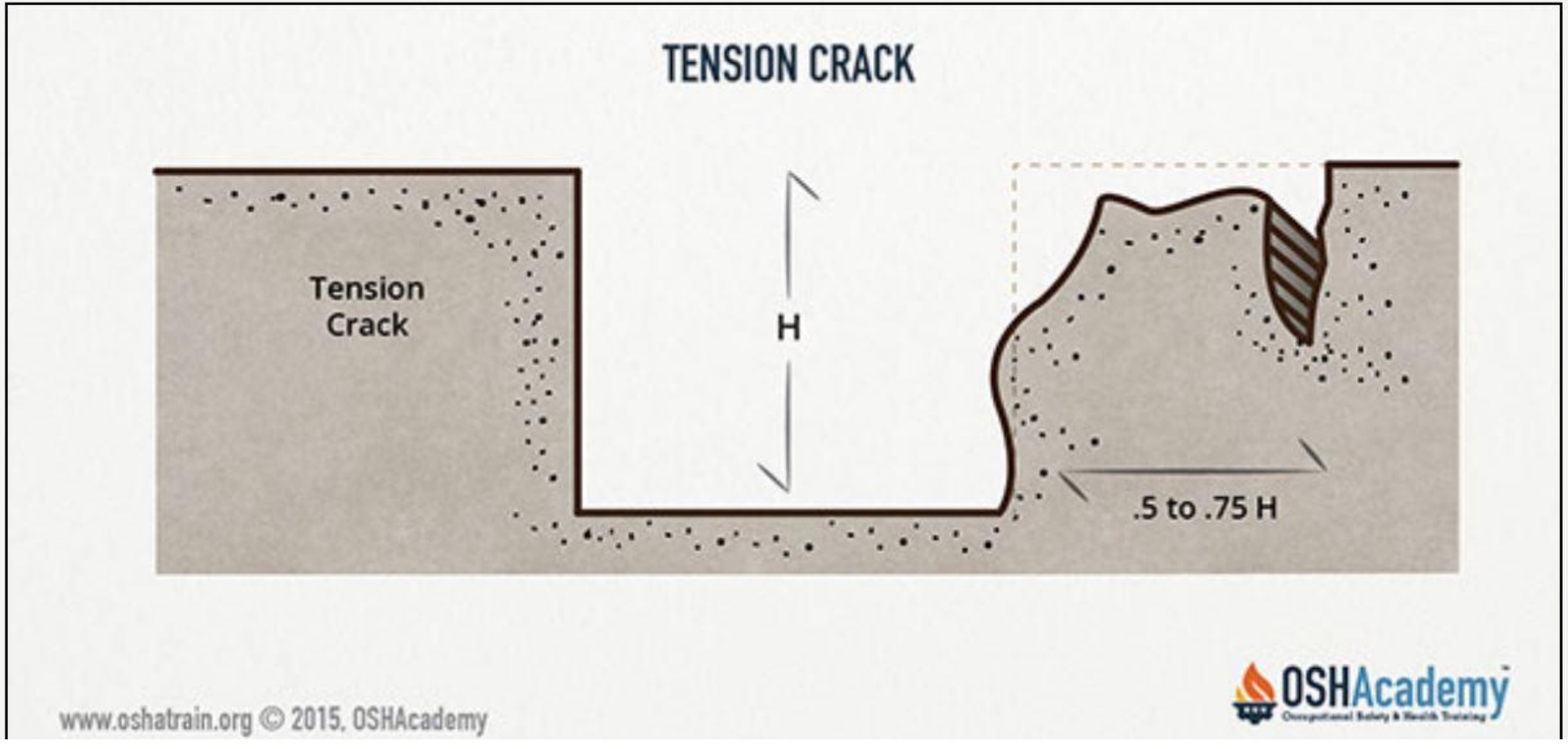
SLIDING FAILURE



OSHAcademy
Occupational Safety & Health Training

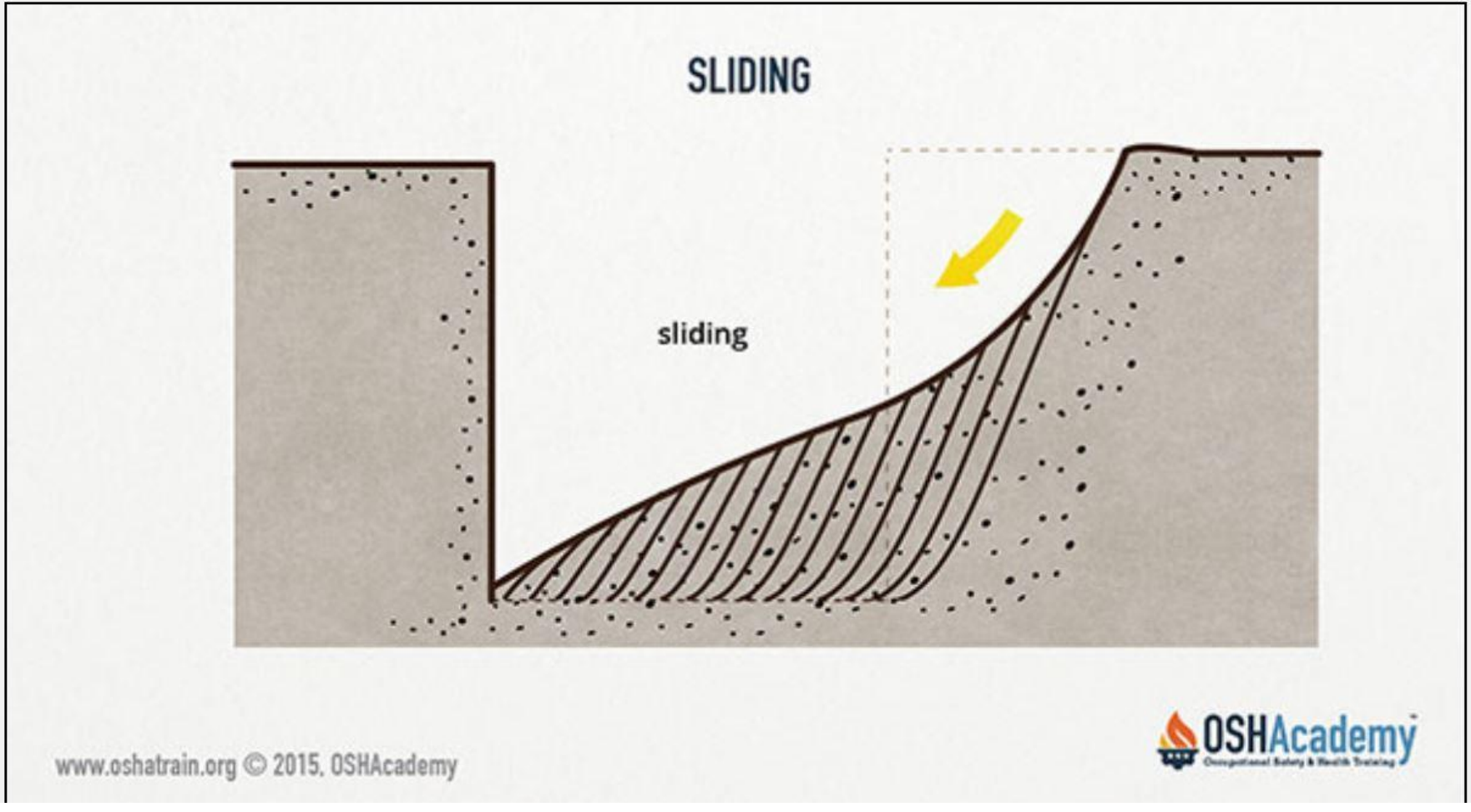
Tension Cracks

Tension cracks usually form at a horizontal distance of one-half to three-quarters times the depth of the trench, measured from the top of the vertical face of the trench.



Sliding or Sluffing

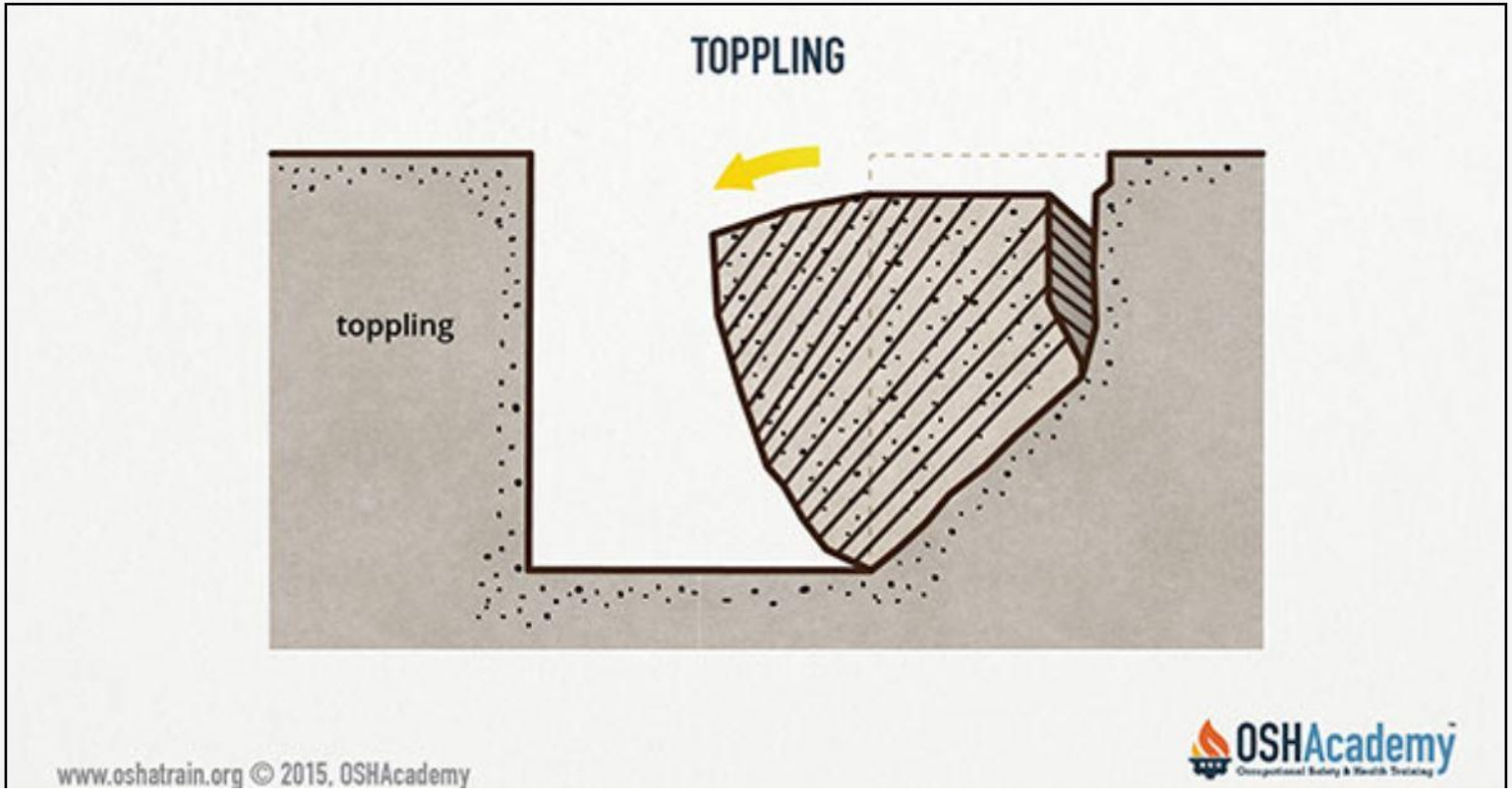
This may occur as a result of tension cracks.



Soil Mechanics (Continued)

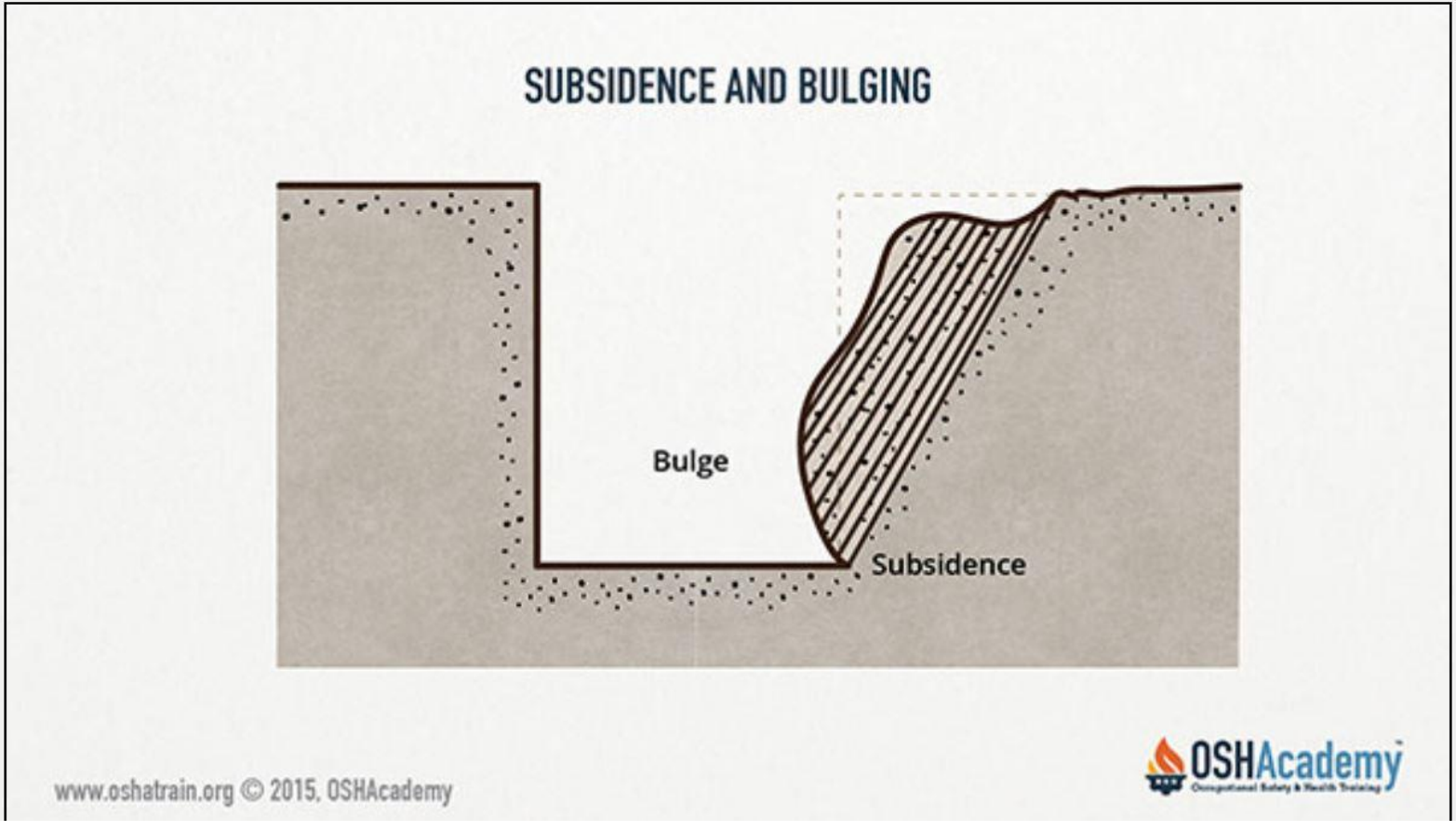
Toppling

In addition to sliding, tension cracks can cause toppling. Toppling occurs when the trench's vertical face shears along the tension crack line and topples into the excavation.



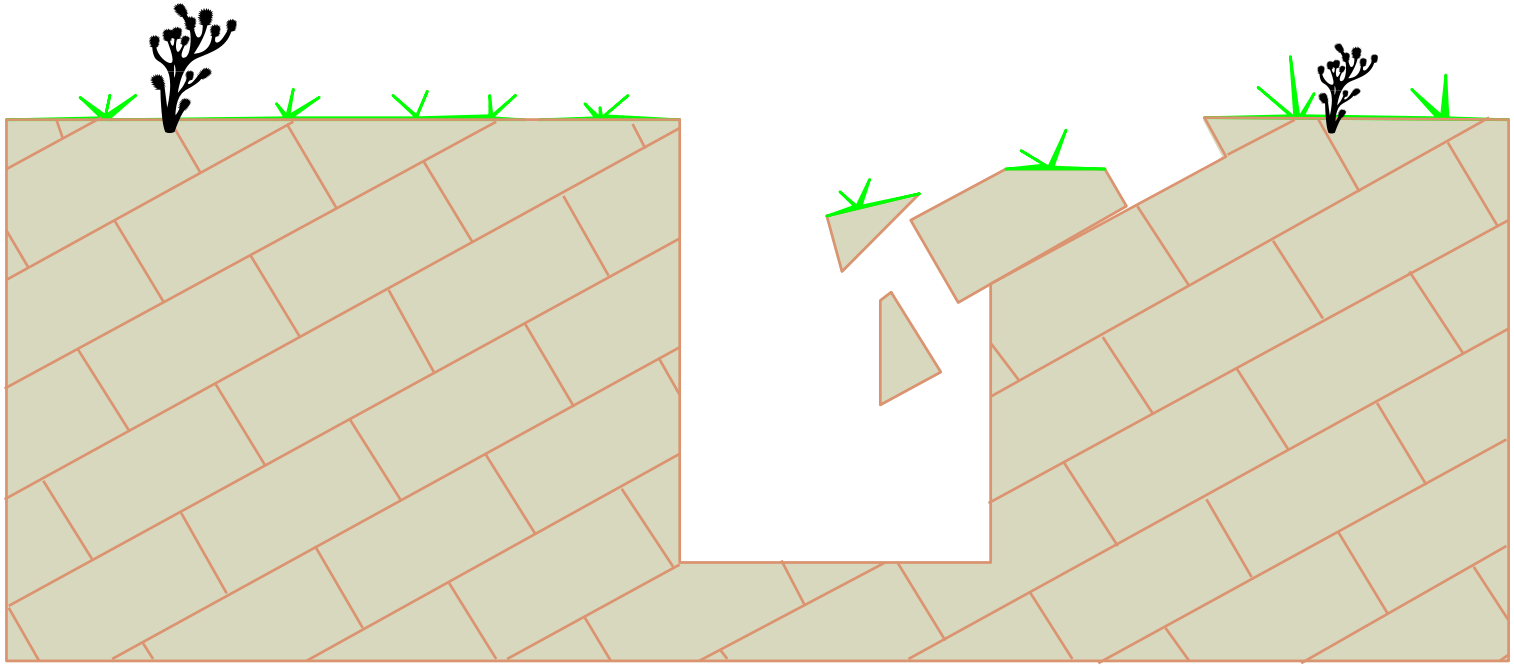
Subsidence and Bulging

An unsupported excavation can create an unbalanced stress in the soil, which, in turn, causes subsidence at the surface and bulging of the vertical face of the trench. If uncorrected, this condition can cause face failure and entrapment of workers in the trench.



Mechanics of A Cave-In

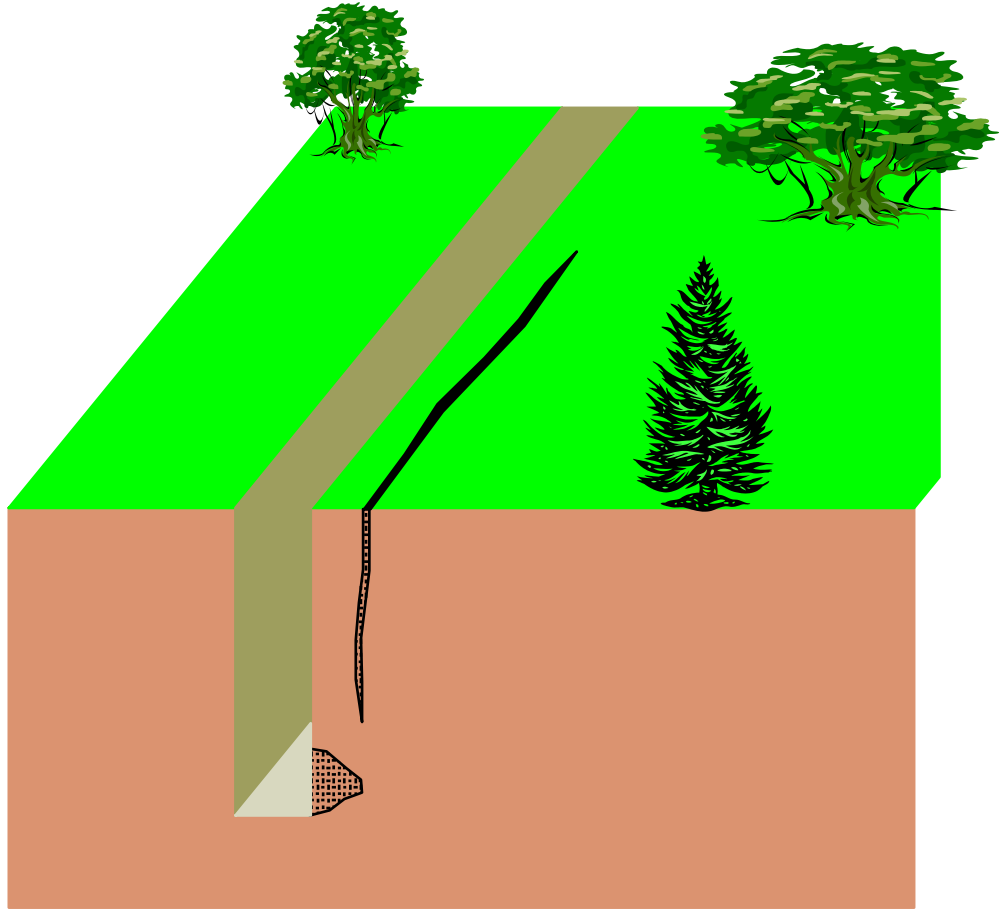
Rocky soil in layers tends to react to disturbances by sliding in on your excavation. When you make a cut into the earth, you remove one of the supporting levels and the soil wants to collapse into the trench as well.



Mechanics of a Cave-In

What do fissures mean?

Even in dry soil, fissures can develop as soil dries and begins to crack on its own. These cracks can become deep very quickly, affecting the soil around the trench.



Fissures Are Dangerous

Fissure identified by Compliance Officer. Entire area around fissure collapsed into trench within minutes of initiating the inspection.

Water Accumulation

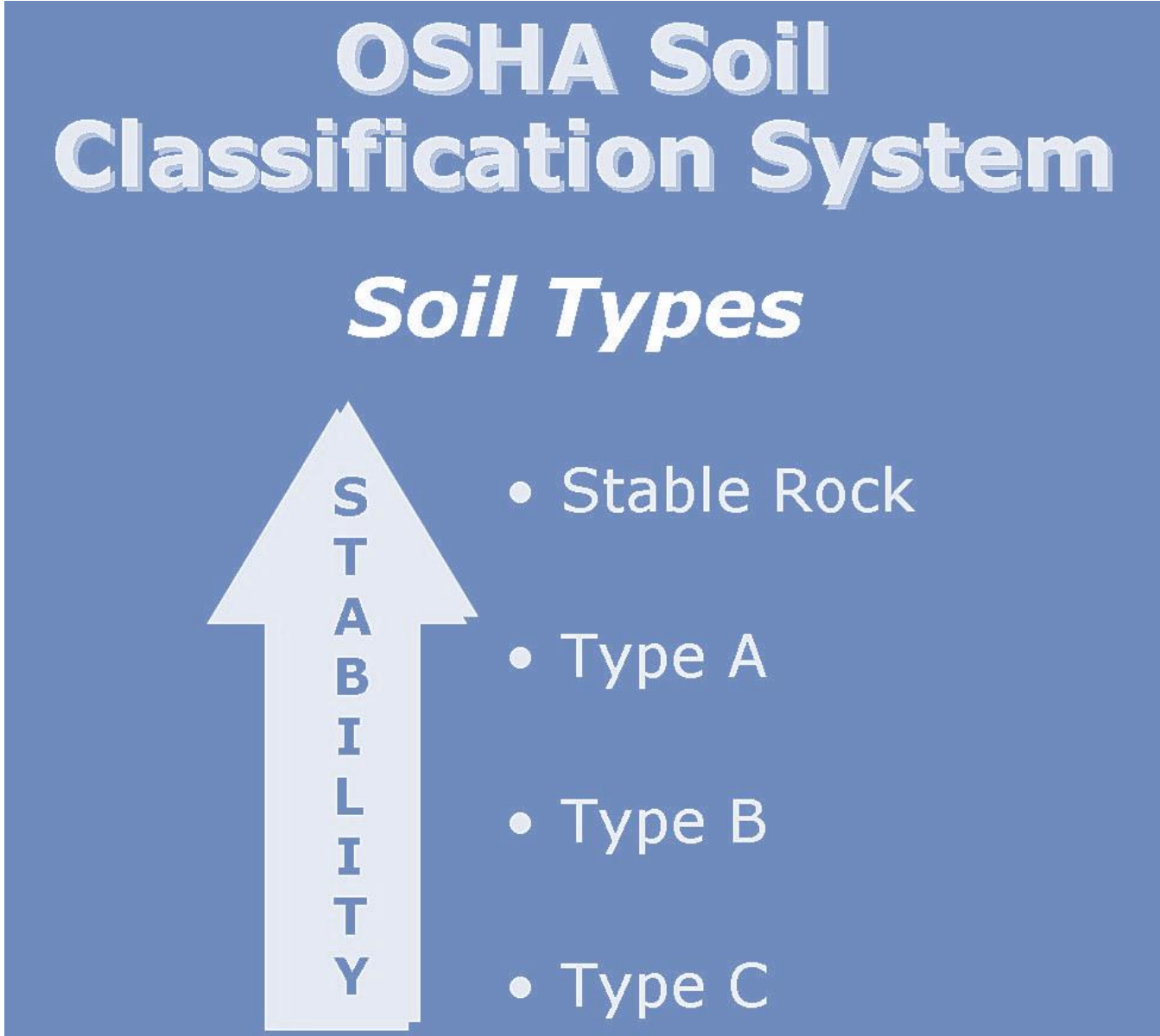
Adequate precautions must be taken when working in accumulated water:

- Controlling water and water removal must be monitored constantly by a Competent Person
- Use ditches, dikes, or comparable means to keep surface water from entering excavations
- Use water pumps

Soil Classification

Competent person will observe the trenching operation during work to anticipate changes in the excavation

Soil Classification



Soil Classification

TYPE A:

- Clay, Silty Clay, Sandy Clay
- Cohesive soil
- 1.5 TSF or >
- It can NOT be Type A if the soil is:
  - Fissured
  - Subject to vibration
  - Previously disturbed
  - Part of a sloped, layered system
  - Subject to other factors requiring it to be classified as a less than stable material

Soil Classification

TYPE B:

- Crushed rock, silt, sandy loam
- > than .5 TSF but < 1.5 TSF
- Previously disturbed soils, except those which would be classified as Type C
- Dry rock that is not stable

Soil Classification

TYPE C:

- Gravel, sand, loamy sand
- .5 TSF or <
- Submerged soil or soil from which water is seeping
- Submerged rock that is not stable
- Normally previously disturbed soil

Soil Classification

Some things to remember:

- Soil that stays in clumps is cohesive (closer to Type A)
- Soil that breaks up easily or does not stay in clumps is granular (closer to Type C)

Soil Classifications

- Cal OSHA 1541.1 Appendix A
  - Conducted by a competent person to determine qualitative information regarding the soil
    - Visual Test
    - Manual Test
      - Thumb penetration Test
        - » Type A – very little penetration
        - » Type B – penetration to base of thumbnail
        - » Type C – Penetration of the entire thumb
      - Use of a pocket penetrometer

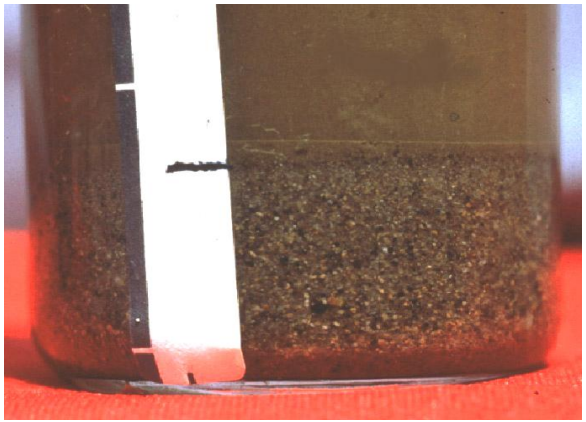
Instructor Demo

Visual Evaluation

- A visual test is a qualitative evaluation of conditions around the site.
- 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-grained sand or gravel that does not clump, it is considered granular.
- The evaluator also checks for any signs of vibration.

Manual Testing Methods

- Thumb test
- Plasticity
- Pocket Penetrometer
- Torvane shear
- Sedimentation



Thumb Penetration

- This test can be used to estimate the unconfirmed compressive strength of cohesive soils.

Thumb Penetration Test

- ***Type A***: These soils can be indented by the thumb, but penetration takes great effort.
- ***Type B***: Easily indented, can be penetrated with somewhat less effort than type A.
- ***Type C***: This type of soil can be easily penetrated up to several inches by the thumb and can be molded with light finger pressure.

Manual tests

Manual testing involves evaluating a sample of soil from the excavation to determine qualities such as cohesiveness, granularity, and unconfined compressive strength. Soil can be tested either on site or off site but should be tested as soon as possible to preserve its natural moisture. Examples of manual tests:

Plasticity test. Shape a sample of moist soil into a ball and try to roll it into threads about $^1/_8$-inch in diameter. Cohesive soil will roll into $^1/_8$-inch threads without crumbling.

Dry strength test. Hold a dry soil sample in your hand. If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it's granular. If the soil breaks into clumps that are hard to break into smaller clumps, it may be clay combined with gravel, sand, or silt.

Thumb penetration test. This test roughly estimates the unconfined compressive strength of a sample. Press your thumb into the soil sample. If the sample resists hard pressure it may be Type A soil. If it's easy to penetrate, the sample may be type C.

Pocket penetrometers offer more accurate estimates of unconfined compressive strength. These instruments estimate the unconfined compressive strength of saturated cohesive soils. When pushed into the sample, an indicator sleeve displays an estimate in tons per square foot or kilograms per square centimeter.

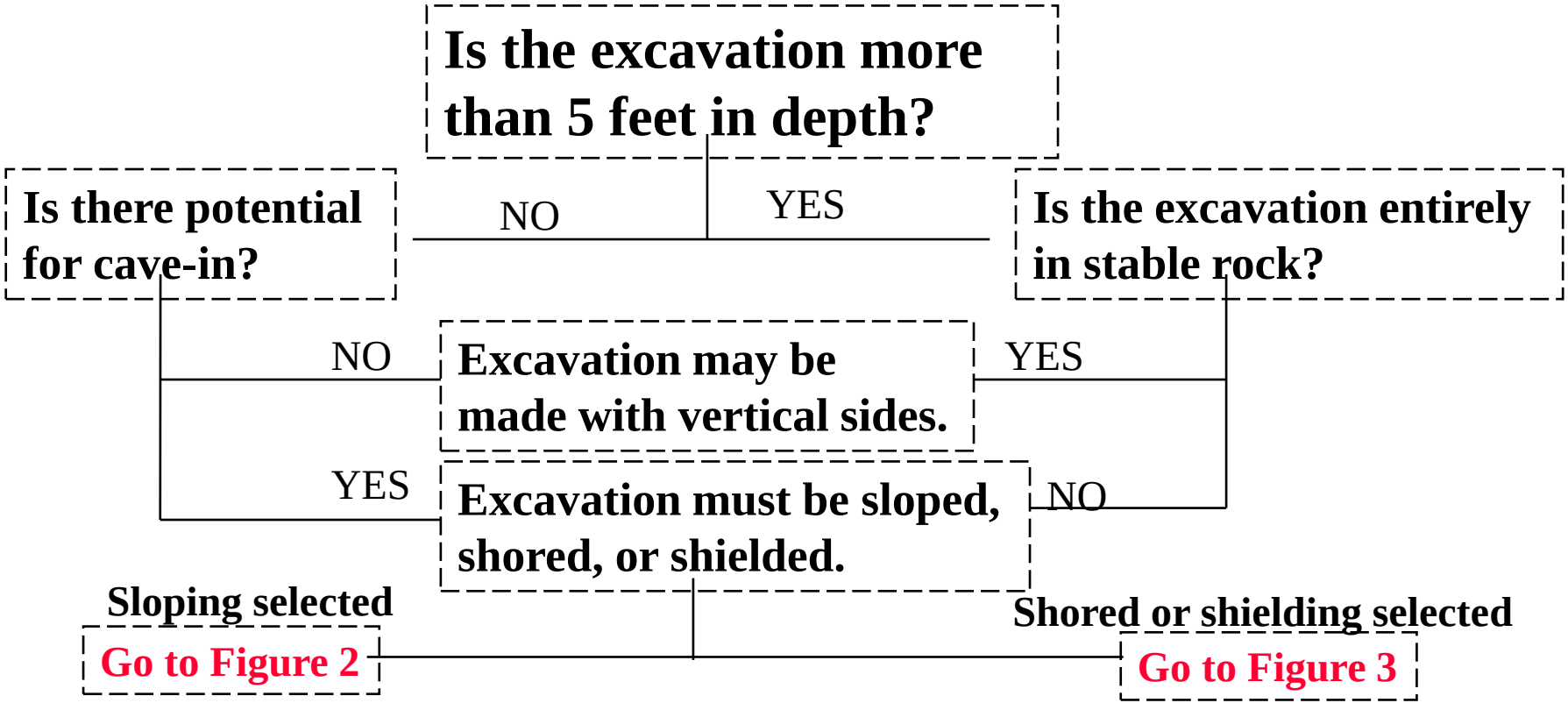
SELECTING AND USING PROTECTIVE SYSTEMS

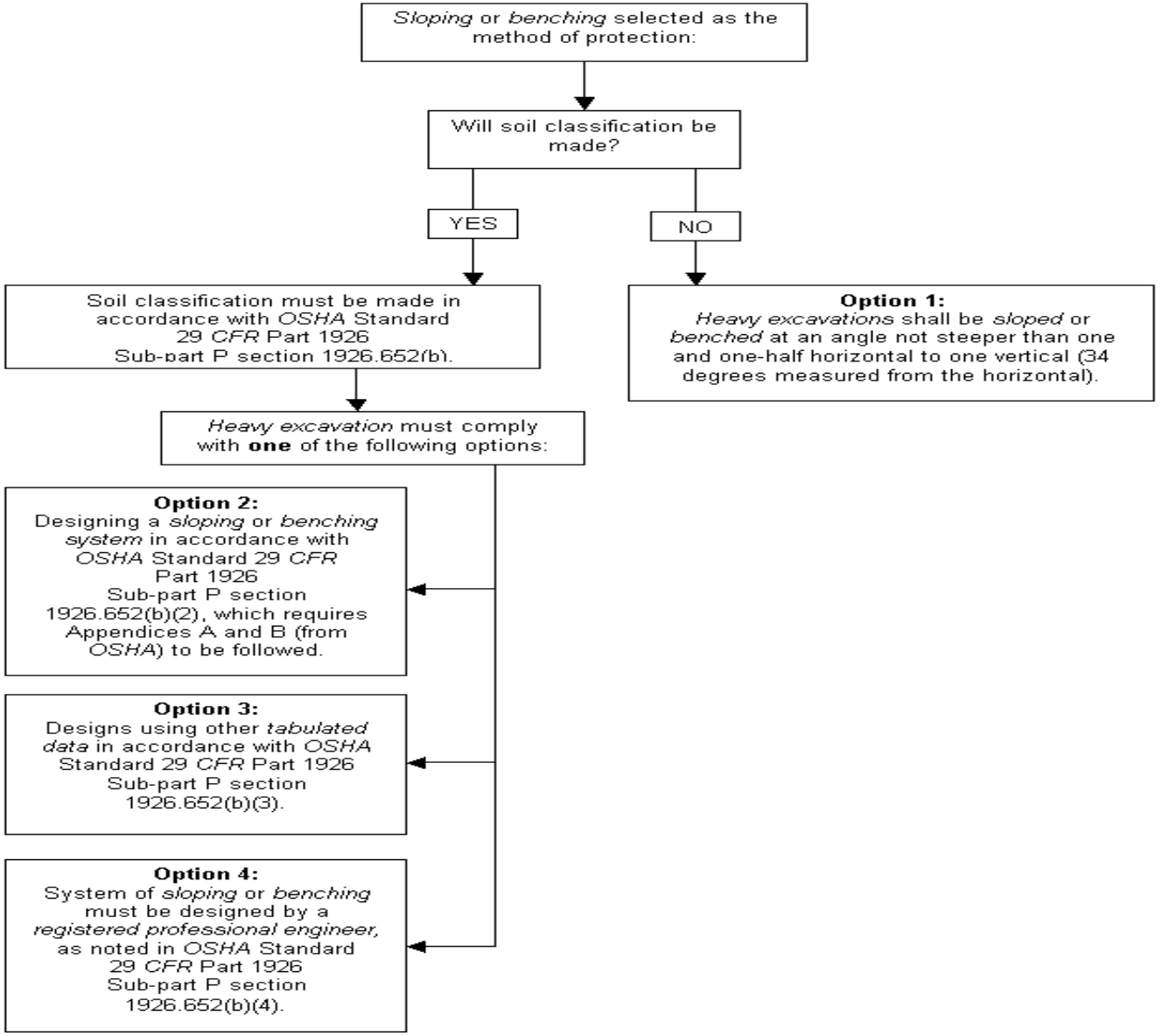
Protective Systems

Sloping **Shoring** **Shielding**

Trenching Flow Chart

Use this basic flowchart to increase your knowledge of excavation





Trenching Flow Chart

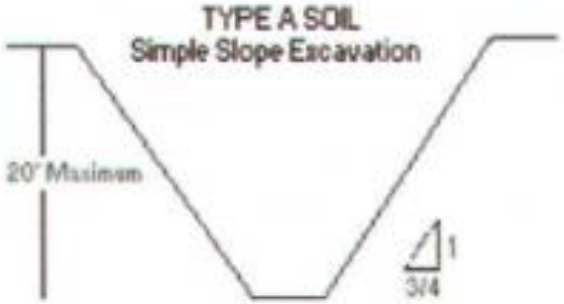
Sloping and Benching Systems

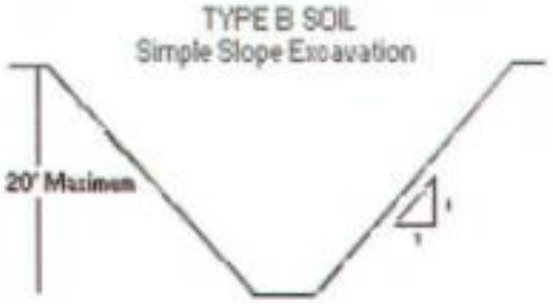
- Employees may not work on the faces of sloped or benched excavations

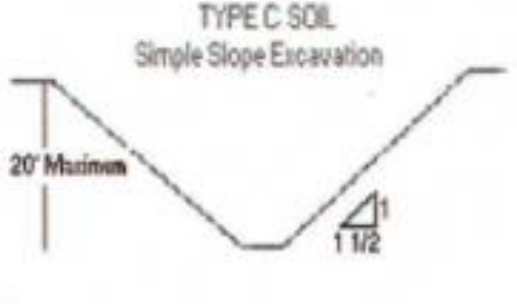
Employees may not work at levels above other employees, except when employees at the lower levels are adequately protected from the hazard of falling, rolling, or sliding material or equipment

Sloping Maximum Allowable Slopes

Soil Type	Height/Depth ratio	Slope Angle
Stable Rock	Vertical	90 deg.
Type A	¾ : 1	53 deg.
Type B	1 : 1	45 deg.
Type C	1½ : 1	34 deg.





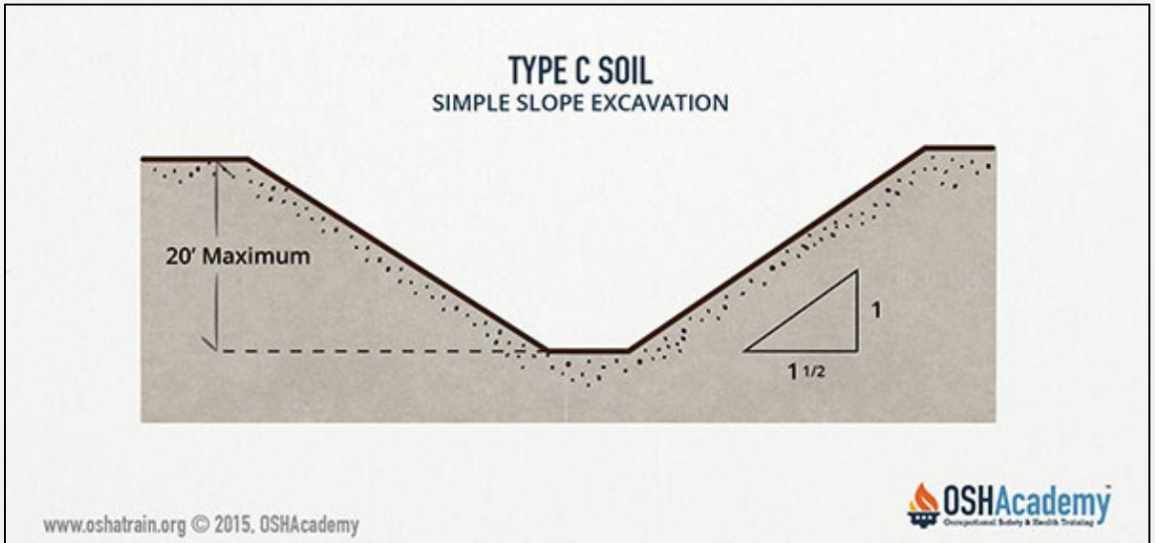


Designing a protective system can be complex because of the number of factors involved:

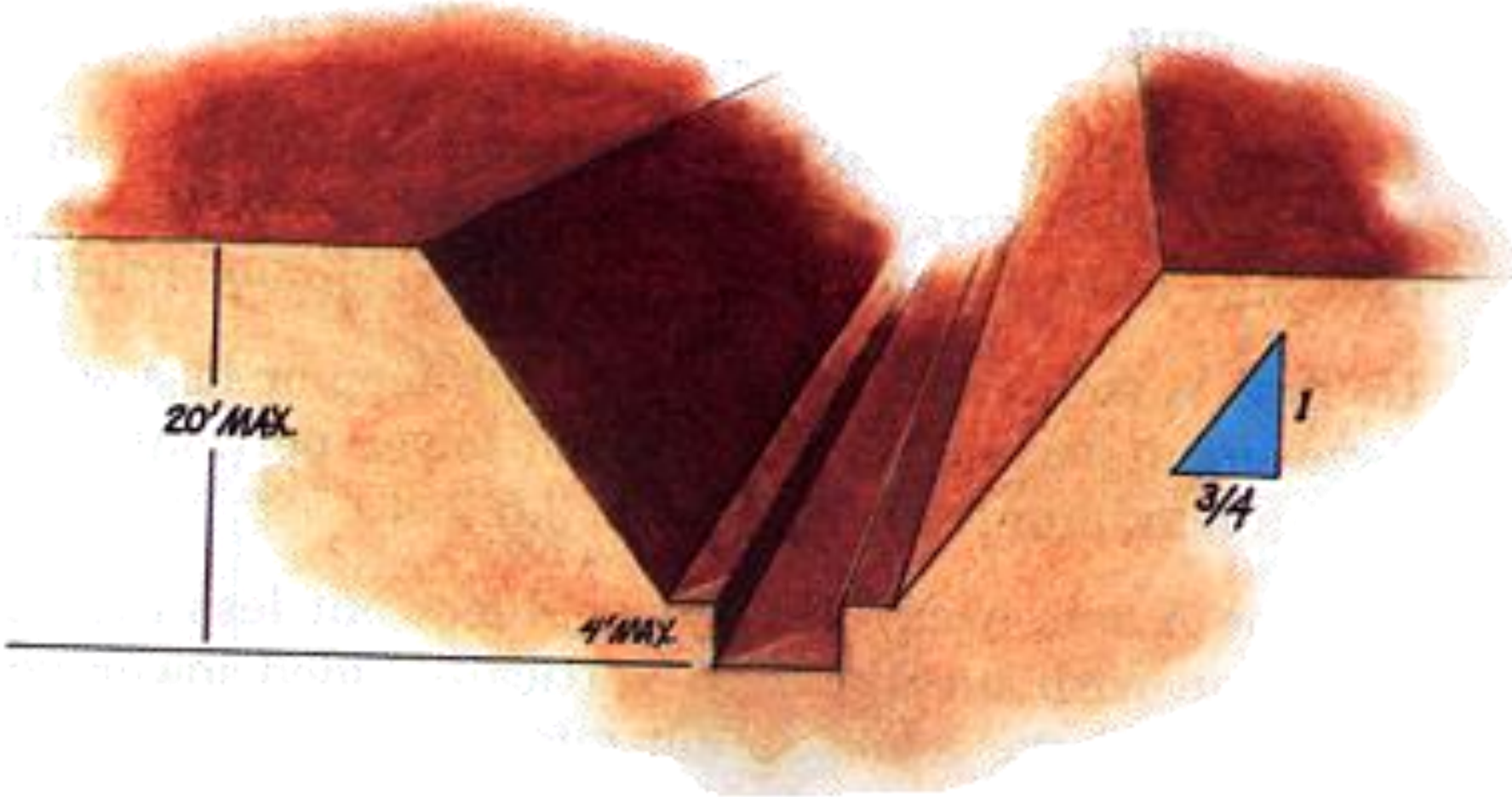
- Soil classification
- Depth of cut
- Water content of soil
- Changes due to weather and climate
- Other operations in the vicinity

The standard, however, provides several different methods and approaches (four for sloping and four for shoring, including the use of shields) for designing protective systems that can be used to provide the required level of protection against cave-ins.

One method of ensuring the safety and health of workers in an excavation is to slope the sides to an angle not steeper than 1½ horizontal to 1 vertical (34 degrees measured from the horizontal). These slopes must be excavated to form configurations that are in accordance with those for Type C soil found in Appendix B of the standard. A slope of this gradation or less is considered safe for any type of soil.

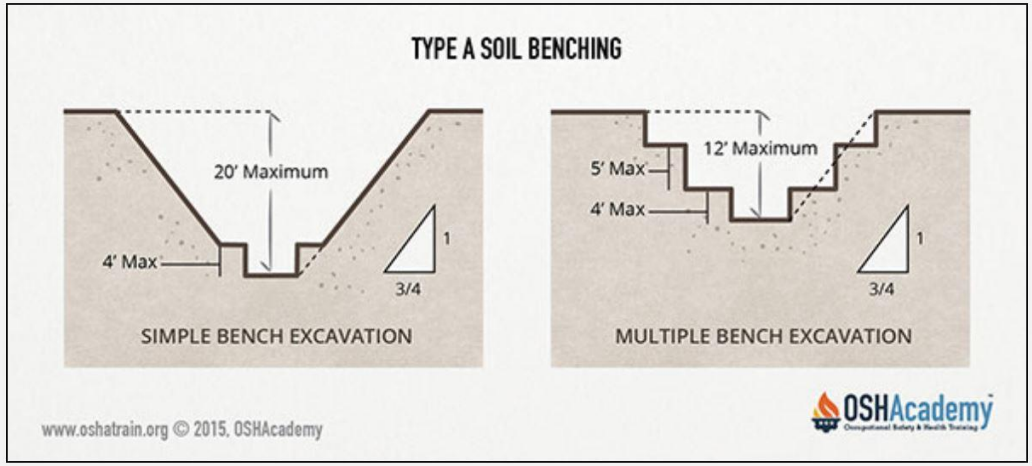


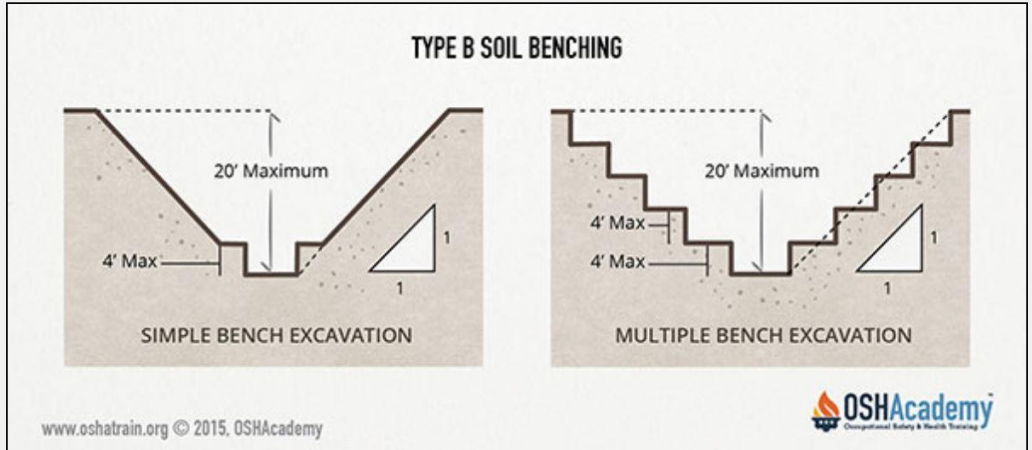
Single Benching Systems



Benching

There are two basic types of benching: simple and multiple. The type of soil determines the horizontal to vertical ratio of the benched side. As a general rule, the bottom vertical height of the trench must not exceed 4 feet. However, subsequent benches may be up to a maximum of 5 feet vertical in Type A soil and 4 feet in Type B soil. All subsequent benches must be below the maximum slope allowed for that soil type. Also, in Type B soil, the trench excavation is permitted only in cohesive soil.



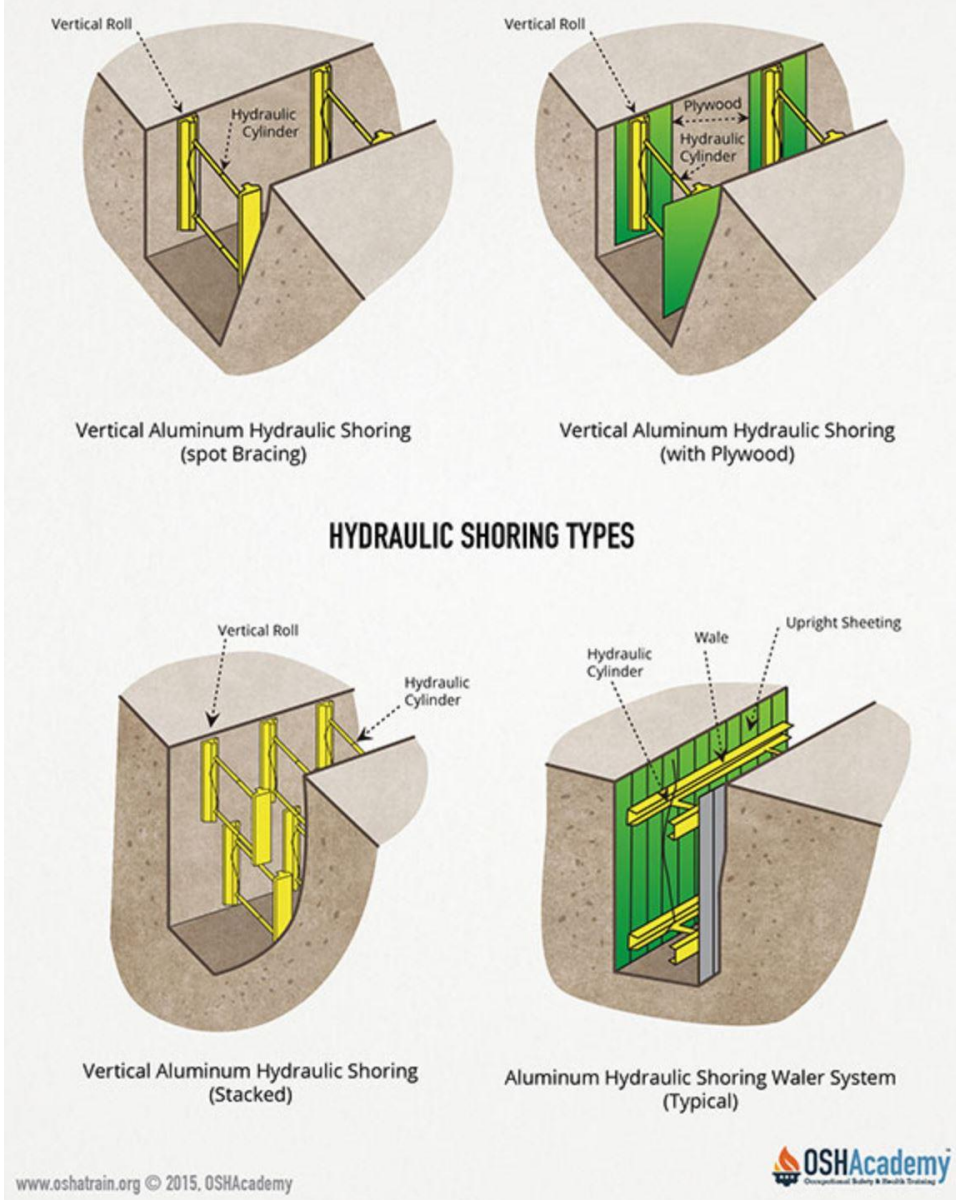


Trench Shoring

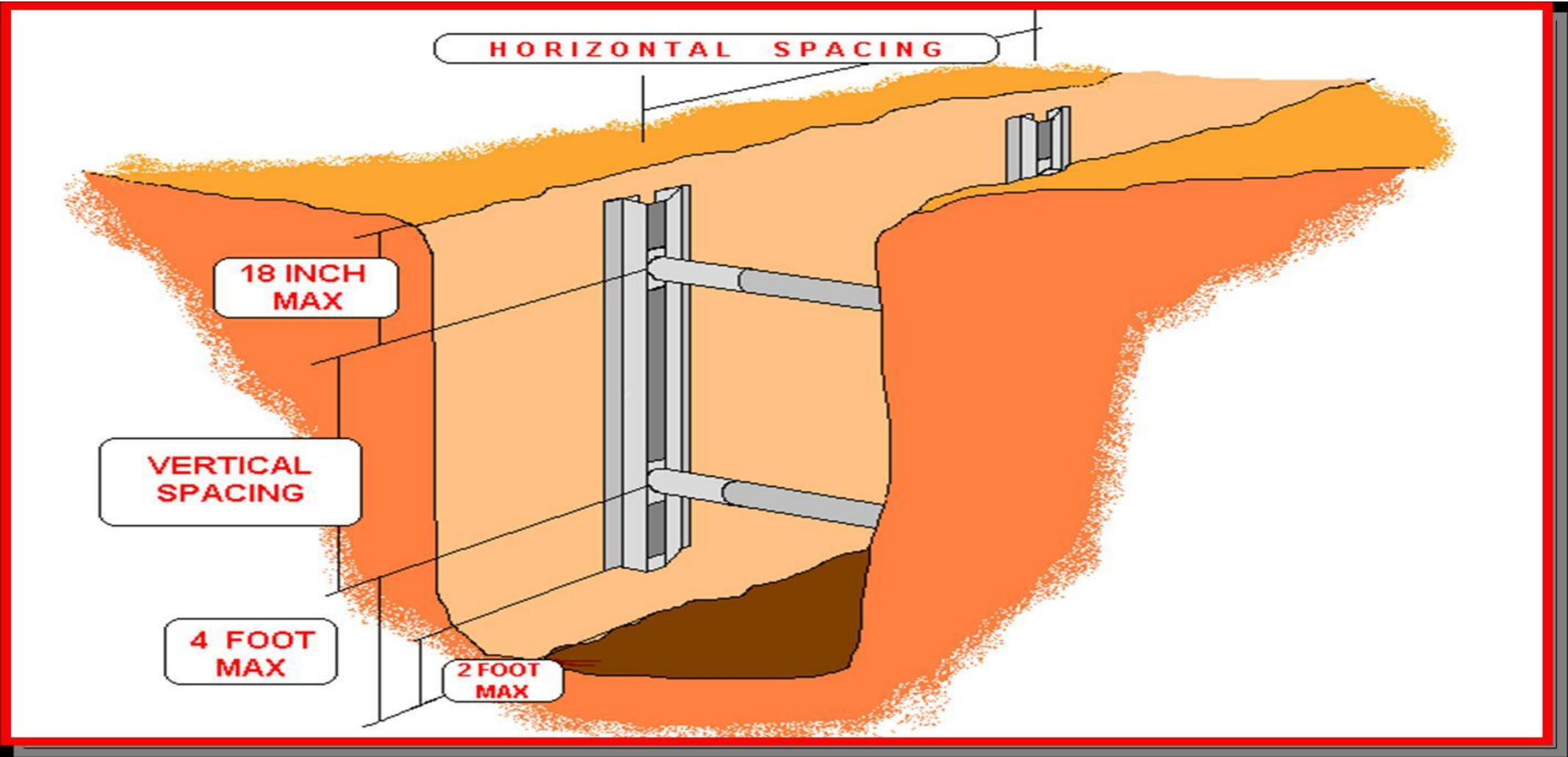
- Require shoring or must have a stabilized slope
- Trenches under five feet need protection if there is a potential for cave in – Workers bend over to work
- Use tabulated data from equipment manufacturer to determine the spacing

Hydraulic Shoring

- Hydraulic shoring, a pre-fabricated strut and/or wale system made from aluminum or steel. Hydraulic shoring provides a critical safety advantage over timber shoring because **workers do NOT have to enter the trench to install or remove hydraulic shoring.**
- Other advantages to most hydraulic systems include:
- **Light enough to be installed by one worker**
- Gauge-regulated to ensure even distribution of pressure along the trench line
- Can have their trench faces “pre-loaded” to use the soil’s natural cohesion to prevent movement
- **Can be adapted easily to various trench depths and widths**
- All shoring should be **installed from the top down and removed from the bottom up. Hydraulic shoring should be checked at least once per shift for leaking hoses and/or cylinders, broken connections, cracked nipples, bent bases, and other damaged or defective parts.**



Shoring Installation



How to Install

TABLE D - 1.2
Aluminum Hydraulic Shoring
Vertical Shores for Soil Type B

DEPTH OF TRENCH (feet)	HYDRAULIC CYLINDERS				
	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)	WIDTH OF TRENCH (feet)		
			UP TO 8	OVER 8 UP TO 12	OVER 12 UP TO 15
OVER 5 UP TO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER *Note (2)*	3 INCH DIAMETER
OVER 10 UP TO 15	6.5	4	2 INCH DIAMETER	2 INCH DIAMETER *Note (2)*	3 INCH DIAMETER
OVER 15 UP TO 20	5.5	4	2 INCH DIAMETER	2 INCH DIAMETER *Note (2)*	3 INCH DIAMETER
OVER 20	*Note (1)*				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Note (1): See Appendix D, Item (g)(1)
Note (2): See Appendix D, Item (g)(2)

How to Install

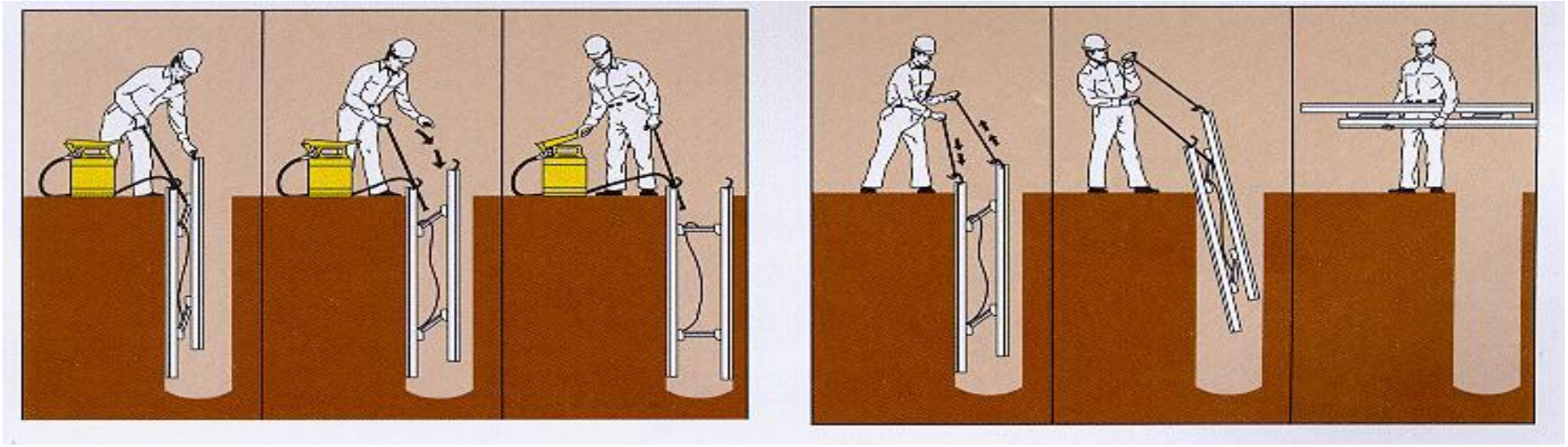
Type C Soils

TABLE D - 1.4
Aluminum Hydraulic Shoring
Waler Systems for Soil Type C

DEPTH OF TRENCH (feet)	WALES		HYDRAULIC CYLINDERS						TIMBER UPRIGHTS		
			WIDTH OF TRENCHES (feet)						MAX. HORZ. SPACING (on center)		
			UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO 15				
	VERTICAL SPACING (feet)	SECTION* MODULUS (in^3)	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	SOLID SHEET	2 ft.	3 ft.
OVER 5 UP TO 10	4	3.5	6.0	2 in.	6.0	2 in. Note (2)	6.0	3 in.	3 x 12	--	--
		7.0	6.5	2 in.	6.5	2 in. Note (2)	6.5	3 in.			
		14.0	10.0	3 in.	10.0	3 in.	10.0	3 in.			
OVER 10 UP TO 15	4	3.5	4.0	2 in.	4.0	2 in. Note (2)	4.0	3 in.	3 x 12	--	--
		7.0	5.5	3 in.	5.5	3 in.	5.5	3 in.			
		14.0	8.0	3 in.	8.0	3 in.	8.0	3 in.			
OVER 15 UP TO 20	4	3.5	3.5	2 in.	3.5	2 in. Note (2)	3.5	3 in.	3 x 12	--	--
		7.0	5.6	3 in.	6.0	3 in.	5.0	3 in.			
		14.0	6.8	3 in.	6.0	3 in.	6.0	3 in.			
OVER 20	*Note (1)*										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g).
Notes (1): See Appendix D, Item (g)(1)
Notes (2): See Appendix D, Item (g)(2)
*Consult product manufacturer and/or qualified engineer for Section Modulus of available walers.

Hydraulic Shoring System – Have Your Trench Release Hook And Pump Hooked Up



Installation of a Vertical Shore







Removing a Vertical Shore



NAXSA
North American
Excavation Shoring Association

Installing a Hydraulic Vertical Shore

Types of Shoring

Trench box shoring

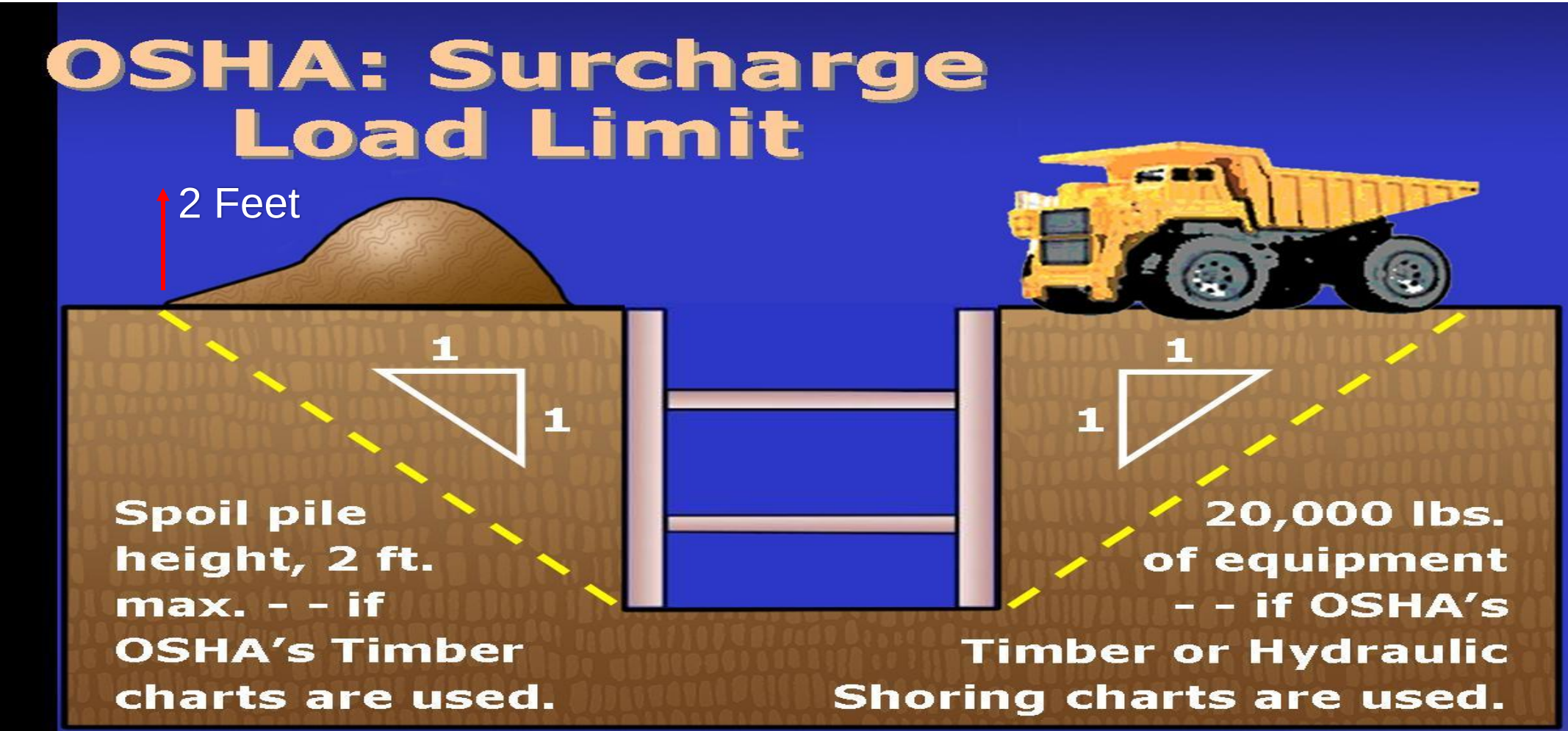
- Walls of the box must extend 18 inches over the walls of the trench
- Boxes do not support trench walls, they are to protect workers from cave-ins
- Always backfill the space between the box and the trench wall

Types of Shoring

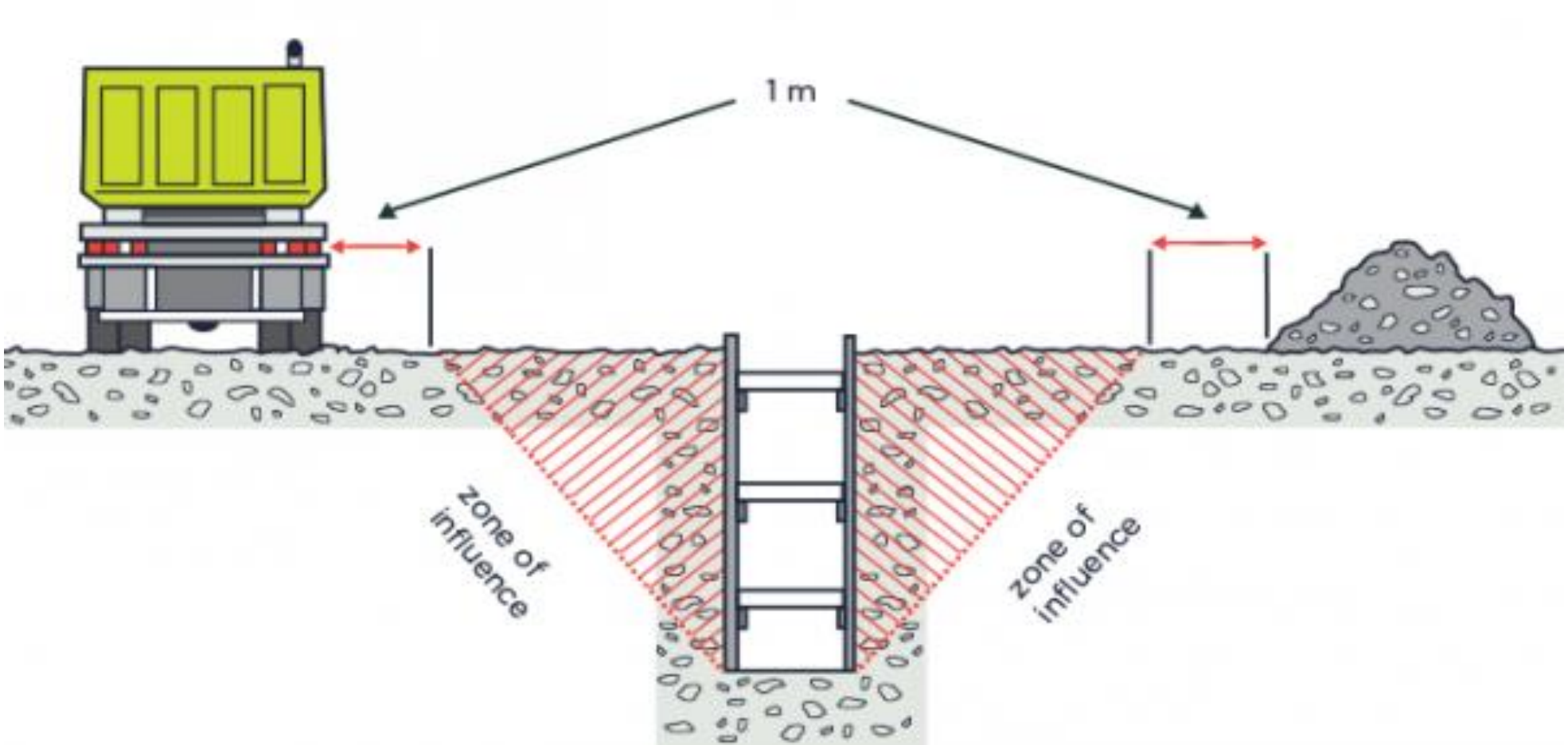
Shield System

- Limited by weight limit of the load
- Install to restrict hazardous movement
- Do not allow employees in shields when they are being installed
- Check condition of shield prior to installation

Protect the Excavation – 8 Foot trench, 8 Foot Zone of Influence

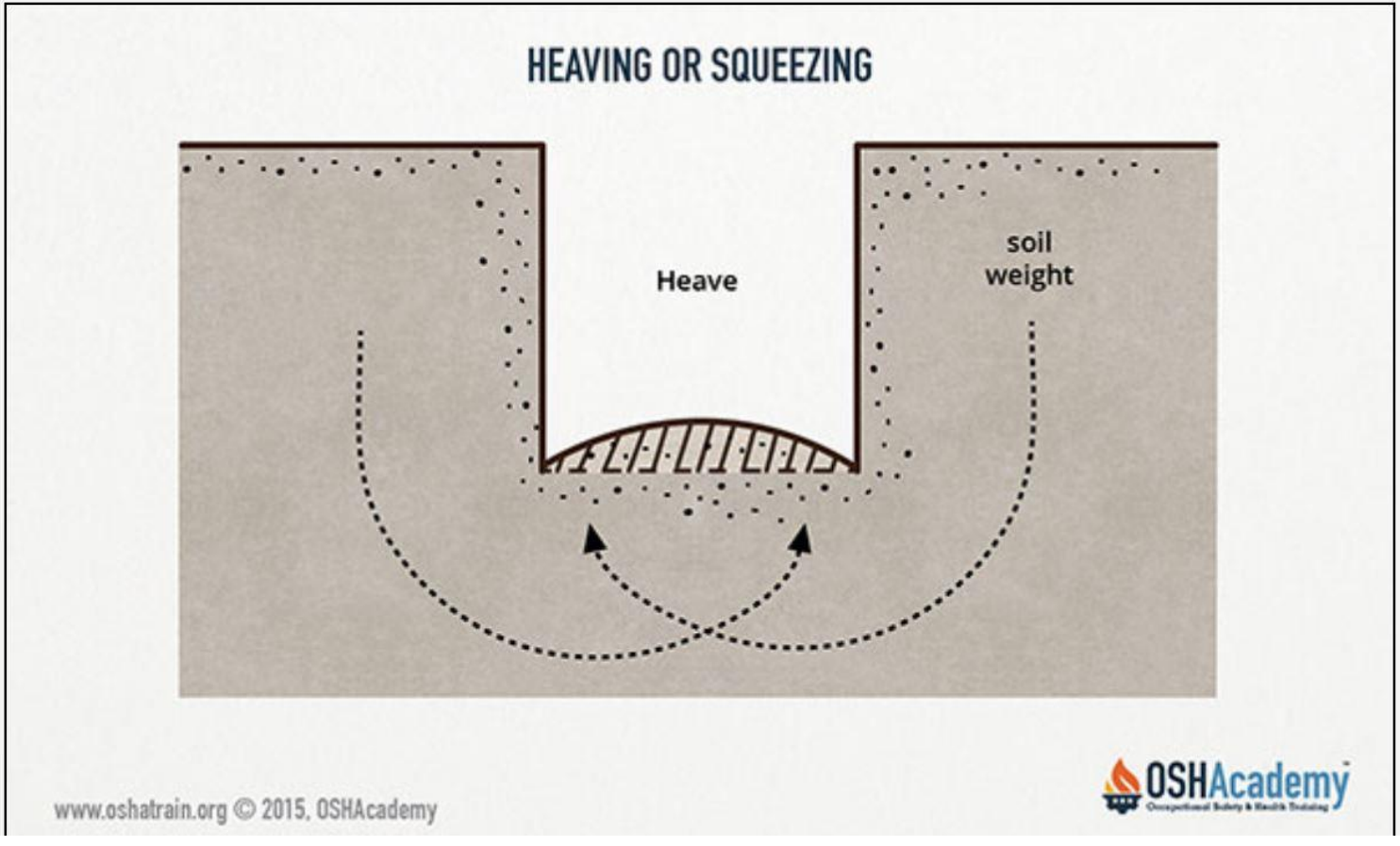


Surcharge Load Limit – Another Example



Heaving or Squeezing

Bottom heaving or squeezing is caused by the downward pressure created by the weight of adjoining soil. This pressure causes a bulge in the bottom of the cut, as illustrated below. Heaving and squeezing can occur even when shoring or shielding has been properly installed.



Getting in and Out of A Trench

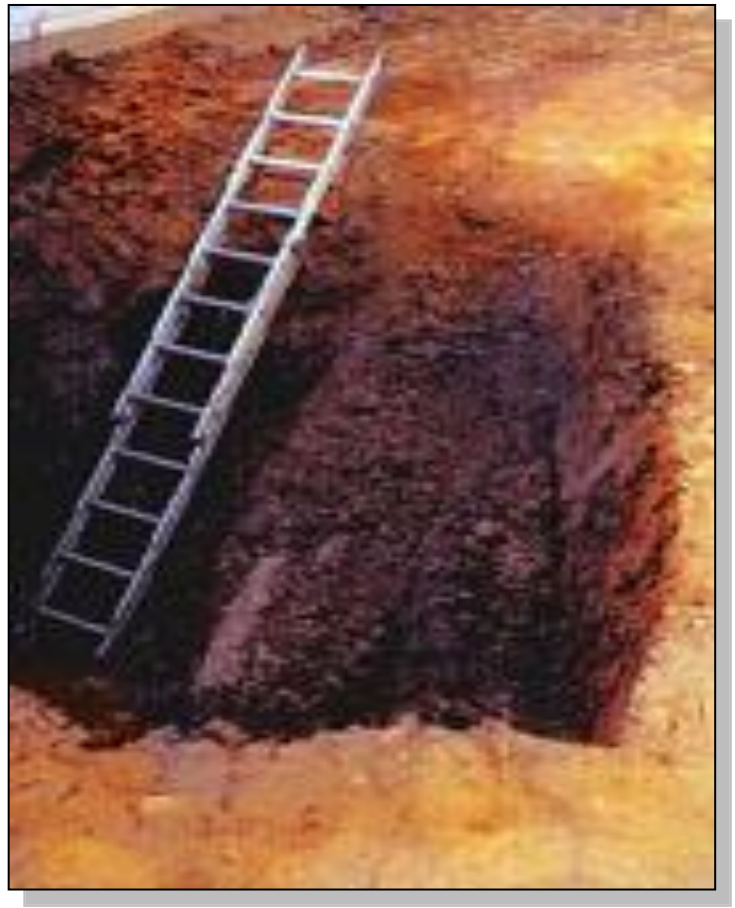
Plan the egress from your trench, <u>BEFORE</u> you enter that trench!

- Trenches 4 feet deep, consider:
  - Ladder
  - Ramp
  - Stairway
- Trenches more than 4 feet deep must have a fixed means of egress

Getting in and Out of A Trench

Ladders

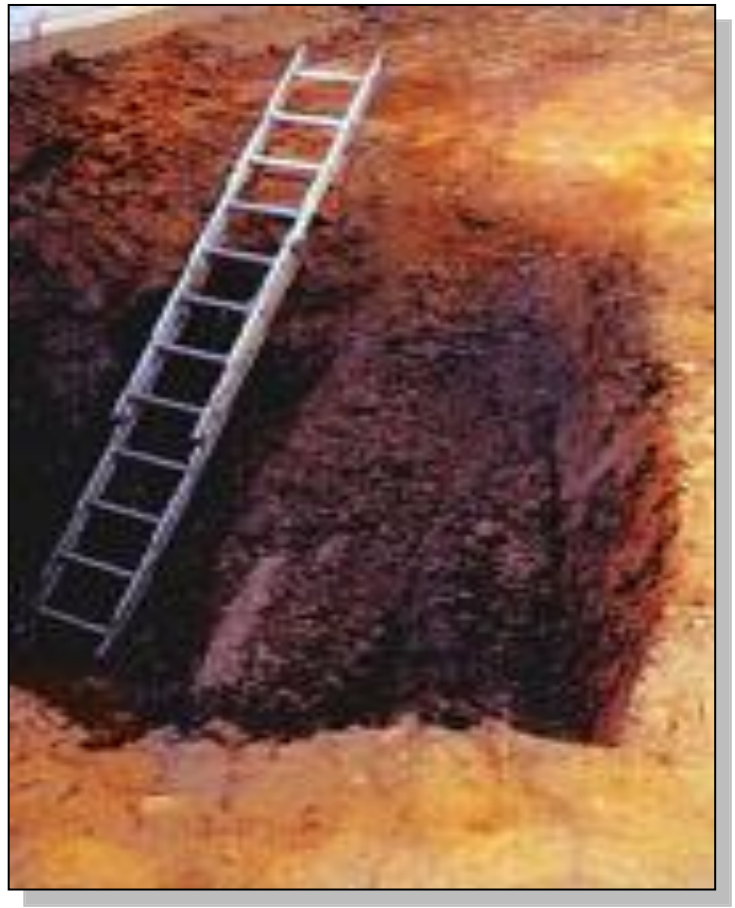
- Must extend three feet past the top of the excavation
- Move the ladder to where the workers are so they can get out quickly during a collapse (rescuers normally start digging at the site of the ladder)



Getting in and Out of A Trench

Ladders

- Ladder must extend 36 inches above the landing
- Ladder must be secured from movement
- In trenches over 4 feet deep, place ladders so workers need only travel 25 feet or less to get out



Preventative Measures

Support Systems

- Must begin at the bottom of the excavation

- Precautions must be taken to ensure safety before temporary removal begins
- Backfilling must progress together with the removal of support systems from excavations

Preventative Measures

Spoil Piles

Temporary spoil piles must be kept two feet from the edge of the excavation and no more than two feet high

Water Accumulation

- Methods for controlling standing water and water accumulation
  - Use of special support or shield systems approved by a registered professional engineer.
  - Water removal equipment used and monitored by a competent person.
  - Surface water diverted away from the trench.
  - 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.

Water Accumulation

Surface Encumbrances

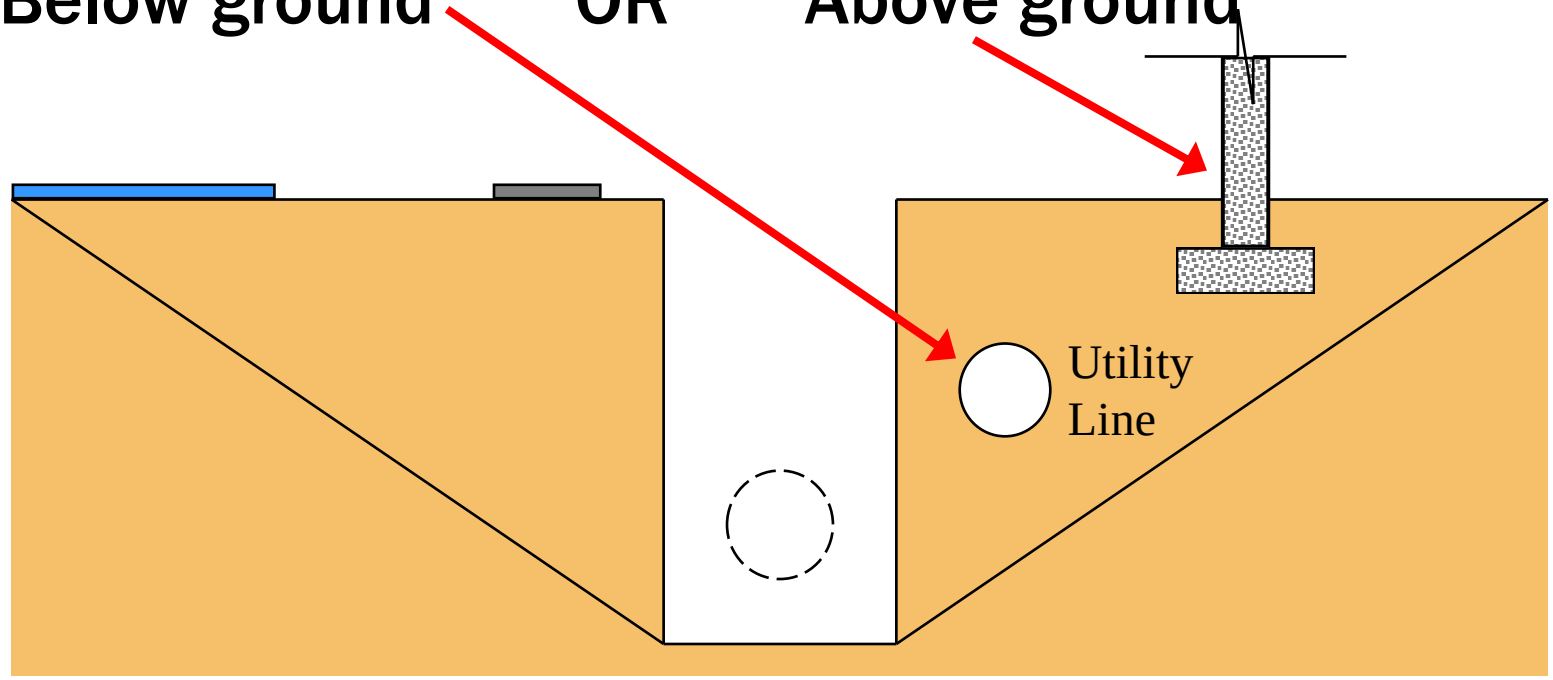
- Fencing
- Posts
- Telephone Poles
- Cable Boxes
- Electrical Access Boxes

When excavating, these objects tend to fall over, you must remove, relocate, or support them for protection and safety.

Surface Encumbrances

Utility lines can be:

Below ground **OR** **Above ground**



BOTH must be supported!

Land Down Under

Utility lines are EVERYWHERE – Call BEFORE you dig!

- Utility lines must be located before excavation begins
- When utility companies or owners must be contacted:
  - Consider response times
  - Advise of proposed work
  - Get answers to all underground questions

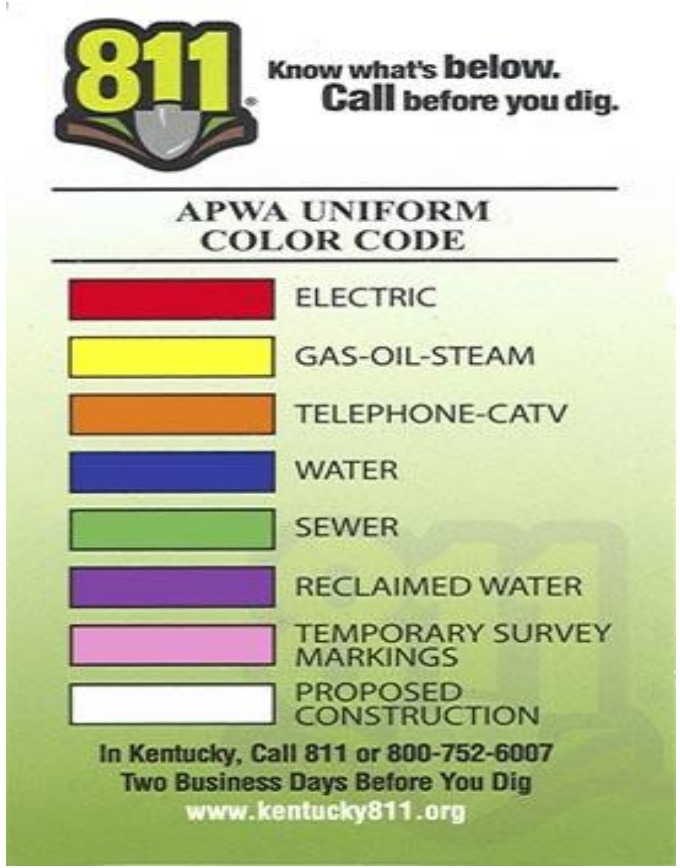
Utilities Everywhere

Underground Utility Hazards

Five Steps to a Safe Excavation

1. Mark and Survey
2. Call before you dig
3. Wait the required time
4. Respect the marks
5. Dig with care

   Hand excavate if within 24 inches of utility mark



1-800-227-2600


2017 DIRT Report
Hand Tools
Can Damage Unmarked Gas Lines
More than 80 percent of "no call" damages involving hand tools damaged natural gas facilities.
CommonGroundAlliance.com/DIRT
811

More Details on USA North

- Outline your excavation area in white
- A 2 working-day up to 14 calendar-day (legal) notice is required before digging
- USA North will notify its members of your excavation
- The USA North members will mark or stake the horizontal path of their facilities, provide in-formation about the location of their facility, or advise the excavator of clearance
- Expose the underground facilities by hand before using power equipment
- Keep the USA North ticket number to validate your excavation permit
- The USA North ticket number is valid for 28 calendar days. You must have an active USA North ticket number for the entire duration of your excavation

OTHER HAZARDS

Foot and Vehicle Traffic

- Warn and reroute public traffic
- Use reflective vests
- Warn site traffic with signs
- Install protective support systems
- Post signs, barricades, and flagger

Fall Protection

Don't make your employees walk the plank!

- Employees required to cross over excavations over 6 feet in depth and wider than 30 inches, walkways or bridges with guardrails shall be provided

Fall Protection

Guardrails must be provided for crossing over excavations

Barriers must be provided for remotely located excavations to keep people out of the area

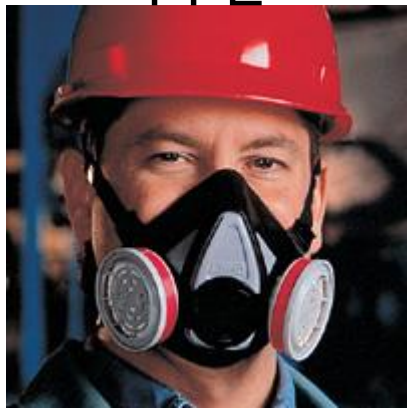
Falling Loads

- Hard hats required (hmmm, what's our worker missing in this picture?)
- No work beneath raised loads
- Stand away from equipment being loaded or unloaded

Hazardous Atmospheres

Monitor atmosphere

PPE



Ventilate

Rescue

Confined Spaces in Excavations & Trenches

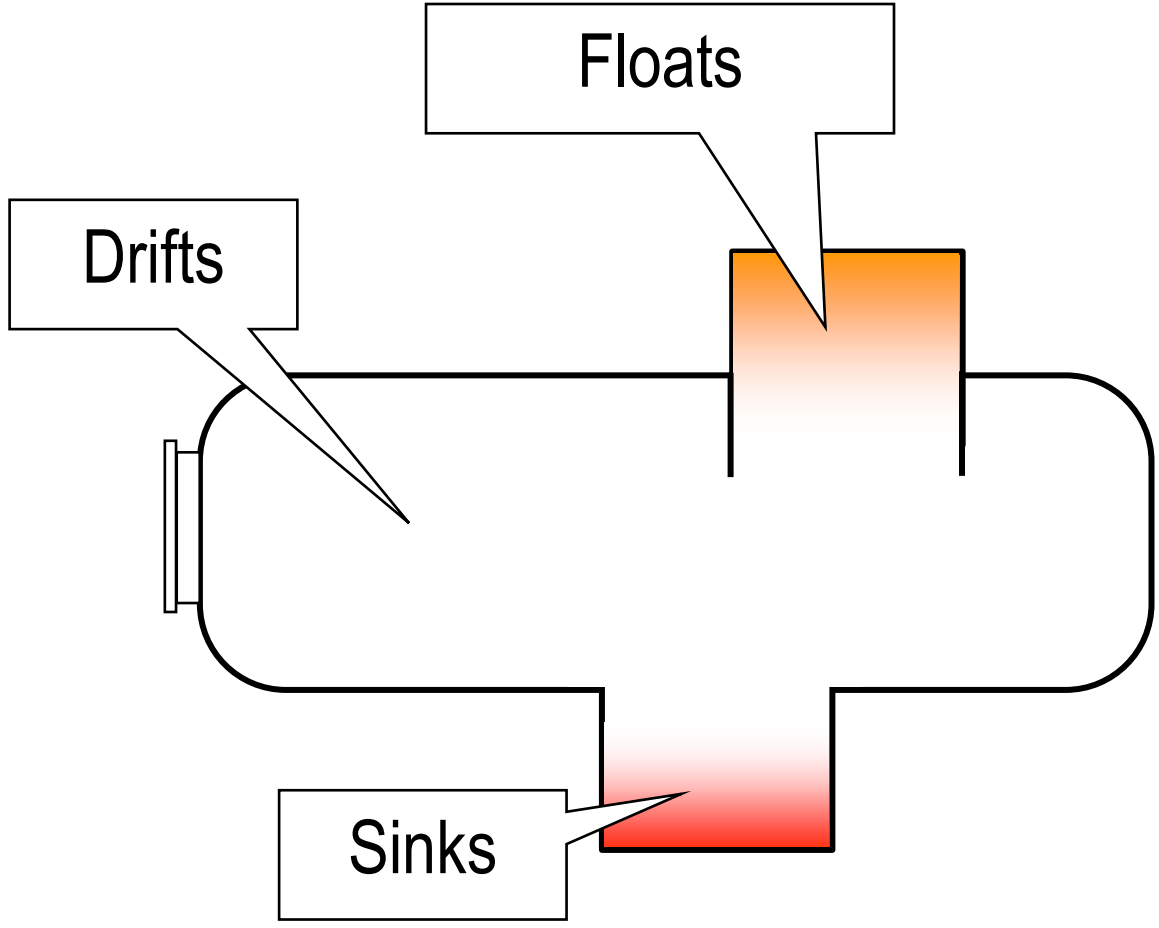
- Atmospheric testing is required when an oxygen deficient, explosive/flammable, and/or toxic atmosphere exists or could reasonably be expected to exist

Hazardous Atmospheres

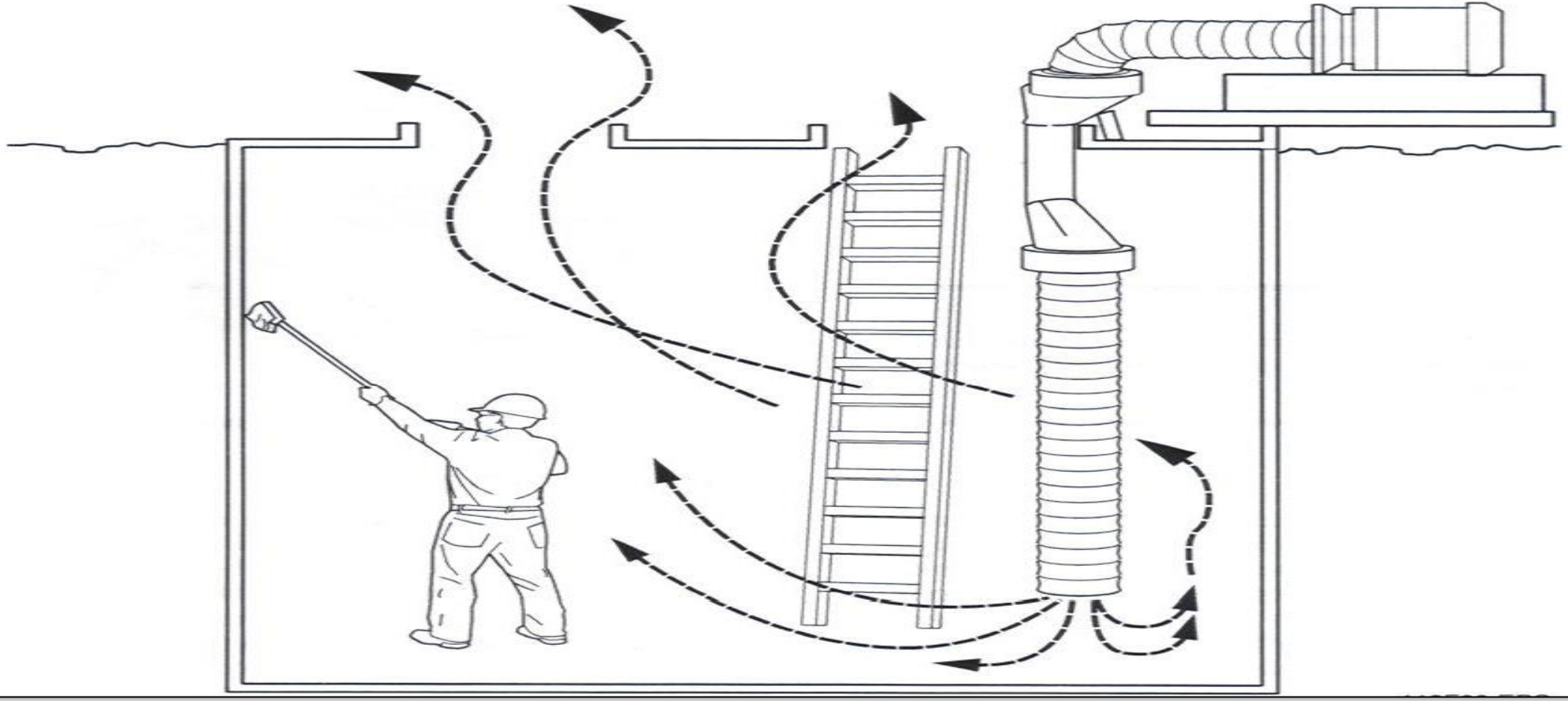
- At excavations near sewers, landfills, and other potentially hazardous atmospheres
  - Test atmosphere when deeper than 4 feet
  - Ventilate or use appropriate PPE
  - Maintain rescue and emergency equipment on site

Gas Behavior in Trenches

- Stratification
- Pocketing
- Floating



Ventilation



Inspection Requirements

- **Daily inspections must be made by a competent person if a hazard to personnel exists and include :**
  - Situations that could result in a cave in
  - Protective systems (shoring)
  - Means of escape (ladders)
  - Hazardous atmospheres
  - Other hazardous conditions

- Exposed employees shall be removed from the hazard areas until the hazard is corrected
- Documentation of the inspection Is not required (but what will you show to prove you did it?)

Appendix 1 – [redacted] Excavation Inspection Checklist

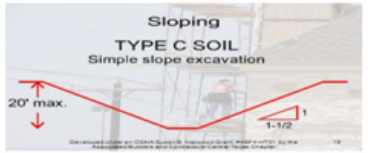
Daily Excavation Safety Inspection Checklist

Competent Person:	Date:	
Site Location:		
Soil Type:	Excavation Depth:	Excavation Width:
Type of Protective System Used:		

Indicate for each item: Yes – No – or N/A for not applicable. Corrective Actions documented on bottom of last page

1. General Information:	Yes	No	N/A
A. Is there a potential for a cave-in? ***IF YES, excavation must be sloped, shored, or shielded.**			
B. Is excavation deeper than five feet in depth? *** IF YES, excavation must be sloped, shored, or shielded.**			
C. Is the excavation less than five feet in depth, but workers are exposed to hazardous cave in because of work position?			
D. Is sloping going to be used for protective system – if yes, see illustration below:			

Slope information to keep in mind



OSHA Sloping Requirements		
Soil Type	Slope	Angle (Degrees)
A	3/4H:1V	53°
B	1H:1V	45°
C	1½H:1V	34°

2. Inspection of Job-site:	Yes	No	N/A
A. Surface encumbrances removed or supported.			
B. Employees protected from loose rock or soil that could pose a hazard by falling or rolling into the excavation.			
C. Hard hats, safety shoes/boots and safety glasses worn by all employees.			
D. Spoils, materials, and equipment set back at least two feet from the edge of the excavation.			
E. Adequate barriers provided at all excavations, wells, pits, shafts, etc.			
F. Warning vests or other highly visible clothing provided and worn by all employees exposed to vehicular traffic.			
G. Warning system established and utilized when mobile equipment is operating near the edge of the excavation.			
H. Walkways and bridges over excavations 6 feet or more in depth where people are expected to cross the trench are equipped with standard guard rails			
I. Fall Protection Harness, lifeline and anchor (or barrier to prevent falls) used when working at the edge of excavations deeper than 6 feet			
Notes:			

3. Utilities:	Yes	No	N/A
A. Location of utilities marked			
B. Prior to mechanical excavation, underground utilities have been located by hand digging and potholing (note: hand digging required within 2 feet of utility)			
C. Underground utilities are protected, supported, or removed when excavation is open			
Notes:			

Daily Excavation Checklist Continued:

4. Means of Access and Egress:	Yes	No	N/A
A. Travel distance to means of egress no greater than 25 feet in excavations four feet or more in depth.			
B. Straight ladders used in excavations extend at least three feet above the edge of the trench.			
C. Employees protected from cave-ins when entering or exiting the excavation.			
Notes:			

5. Wet Conditions:	Yes	No	N/A
A. Precautions have been taken to protect employees from the accumulation of water.			
B. Water removal equipment monitored by a competent person.			
C. Surface water or runoff diverted or controlled to prevent accumulation in the excavation.			
D. Inspections have been made after every rainstorm or other hazard-increasing occurrence.			
Notes:			

6. Hazardous Atmosphere: **The atmosphere within the excavation must be tested where there is a reasonable possibility of an oxygen deficiency, combustible or other harmful contaminant exposing employees to a hazard or if the excavation is more than 4 feet in depth.**	Yes	No	N/A
A. Are there exposed sewer or natural gas lines in excavation?			
B. Is excavation near a landfill area, or are hazardous substances being stored close to the excavation?			
Notes:			

7. Support Systems:	Yes	No	N/A
A. Materials and/or equipment for support systems selected based on soil analysis, trench depth (5 feet), and expected loads.			
B. Materials and equipment used for protective systems inspected and in good condition.			
C. Materials and equipment not in good condition has been removed from service.			
D. Support systems provided to ensure stability of adjacent structures, buildings, roadways, sidewalks, walls, etc.			
E. Removal of support systems progresses from the bottom and members are released slowly so you can note any indication of possible failure.			
F. Top shore hydraulic cylinder is no more than 18 inches from the top of the trench wall.			
G. Bottom shore hydraulic cylinder is no more than 4 feet from bottom of trench and bottom of vertical shoring is no more than 2 feet from bottom of trench.			
Notes:			
Corrective Actions, if any			

TRENCHING SAFETY CHECKLIST

BEFORE YOU BEGIN THE WORKDAY

- ☐ Competent person inspected excavation and adjacent areas
- ☐ Hard hats, safety vests, and visible clothing are worn by all employees
- ☐ Warning systems are established and put into place
- ☐ All utility lines are located and obviously labeled
- ☐ Protective systems are inspected and working as intended
- ☐ Nothing is near the excavation that shouldn't or doesn't have to be there

BIG RENTZ

Excavation Safety Guidelines

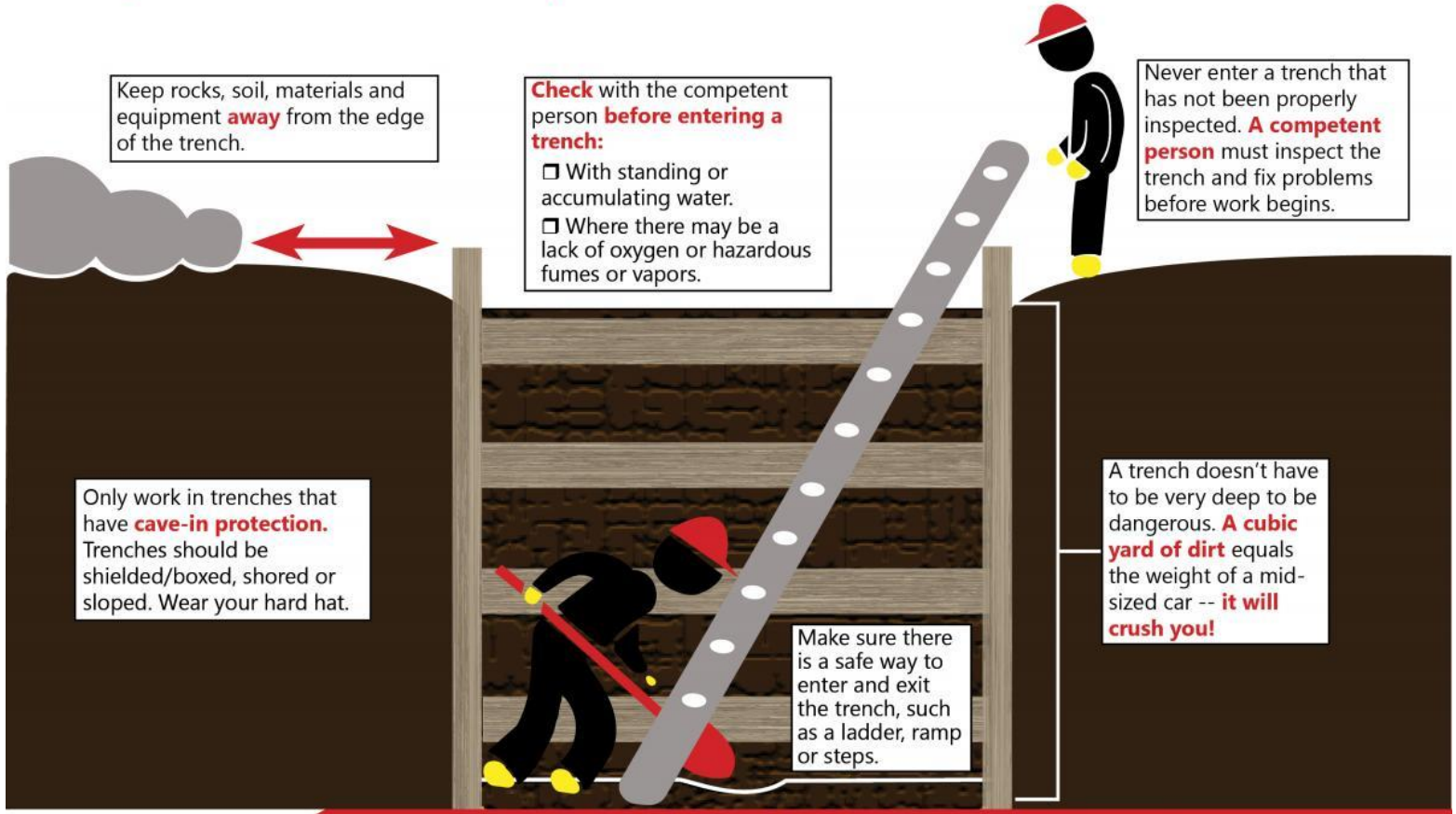
Before and during excavation:

1. Identify potential hazards
2. Reduce or eliminate known hazards
3. Establish emergency procedures
4. Determine periodic inspection intervals
5. Protect the excavation and the surface and subsurface installations
    - Identify and mark utility locations
6. Provide safe entrance and exit from and walkways over trenches

Practice Trench Safety. It Saves Lives.

Trench collapses cause fatalities and injuries.

It only takes a second for a trench to collapse. Take the following precautions to protect workers in trenches.



alliance An OSHA Cooperative Program CPWR THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING

Inspection Exercises


Rags

Trench Rescue Considerations


DECIDER

Thank You – Protect Yourself

OSHA QUICK CARD™

Protect Yourself

Trench Safety

- **Do not enter an unprotected trench!**
- Trench collapses cause dozens of fatalities and hundreds of injuries each year.