



FPST 2023 Industrial and Occupational Safety

Excavation & Trenching
29 CFR 1926.650
29 CFR 1926.651
29 CFR 1926.652

1



Incidents



- Excavation collapse
- Trench 1
- Watch video: Excavator Accidents

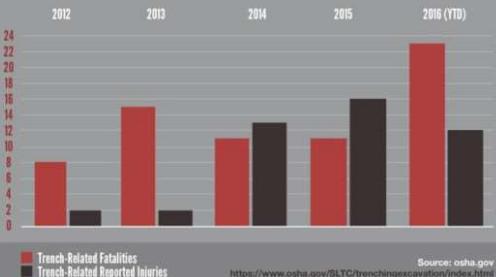
2



Excavation Fatalities



TRENCHING INJURIES & DEATHS



3



Frequently Cited

The chart displays the following data:

Regulation	Citations
652(a)(1) Employee protection in excavations - Protective system use	755
651(c)(2) Egress from trench excavations	351
651(k)(1) Inspections by competent person	345
651(j)(2) Protection from falling/rolling materials/equipment	263
651(k)(2) Competent person inspection - Employees removed from hazard	83

4

Top Five Excavation Hazards

The chart displays the following data:

1. Cave – ins
2. Overhead Electric Line Contact
3. Falls into Excavations
4. Equipment Falling into Excavations
5. Explosion / Fire / Electrocution

5

What are the top five causes of Excavation Accidents?

The chart displays the following data:

- Poor Planning
- Misjudgment of soil type
- Inadequate, or incorrect installation of protective devices
- Defective protective devices
- Failure to adjust for changing conditions

6



Definitions

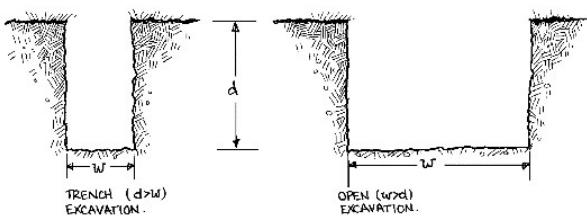


- Excavation
 - Any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.
- Trench (Trench excavation)
 - Means a narrow excavation (in relation to its length) made below the surface of the ground.
 - In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m).
 - If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

7



Excavation vs. Trench



8



CAVE-INS

9



Types of Soils



- Stable rock
 - Natural solid mineral
 - Vertical sides of excavation will remain intact
- Type A
 - Compressive strength of 1.5 tons per square foot
 - Clay
- Type B
 - Compressive strength and greater than .5 tons per square foot but less than 1.5 tons per square foot
 - Crushed rock
 - Silt
- Type C
 - Compressive strength of .5 tons per square foot or less
 - Gravel
 - Sand
- Laboratory testing process and comprehensive strength calculations require direction of a registered PE
- Video: Soil Classification

10



Soil



- One ft³ – 110 -140 pounds

$$1.0 \text{ m}^3 = 3552 \text{ pounds}$$

Weight of Volkswagen



2,785 pounds

Weight of 1 Cubic Yard Soil



2,700 pounds

11



Sliding Soil



- Most common
 - Occurs in soils that are not densely compacted
 - Tension crack – usually $\frac{1}{2}$ to $\frac{3}{4}$ trench depth
 - Increases or decreases in moisture content adversely affect trench stability



12



Soil Toppling



- Videos
 - Soil Toppling1
 - Soil Toppling2

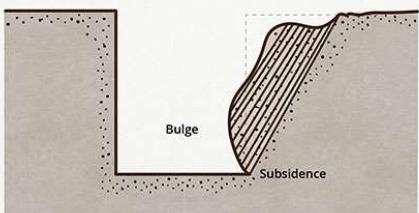
13



Soil Subsidence and Bulging



SUBSIDENCE AND BULGING



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14

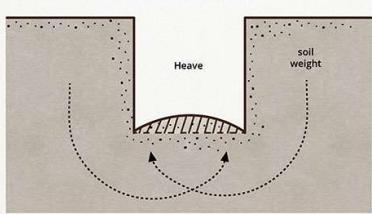


Soil Heaving or Squeezing



- Can occur even with shoring and shielding

HEAVING OR SQUEEZING



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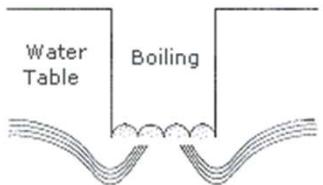
15



Soil Boiling



- Low water table
- Makes a “quick” bottom



16



What is a Competent Person?



- For excavations:
 - Training, experience, and knowledge of:
 - soil analysis;
 - use of protective systems; and
 - requirements of 29 CFR Part 1926 Subpart P
 - Ability to detect:
 - conditions that could result in cave-ins;
 - failures in protective systems;
 - hazardous atmospheres; and
 - other hazards including those associated with confined spaces.
 - Authority to take prompt corrective measures to eliminate existing and predictable hazards and to stop work when required
 - Video: OR-OSHA trench Collapse

17



Inspection



- Daily by Competent Person
- Required after natural events such as heavy rain or man-made events
- Materials and equipment free from damage or defects
- Manufactured materials maintain per manufacturer's instructions

18



Training



- Excavating hazards
- Soil identification
- Safe slopes
- Stress patterns caused by equipment or traffic
- Effects of nearby buried utilities or building foundations
- Effects on trench from severe weather
- Recognition of buried items such as drums, tanks, etc.

19



TRENCH ENTRY

20



Protective Systems



- Must account for:
 - Soil classification
 - Depth of cut
 - Water content of soil
 - Changes due to weather
 - Other operations and area of excavation
- Not required:
 - When the excavation is made entirely of stable rock; or
 - Depth is less than 5'

21



What are the allowable protective systems?

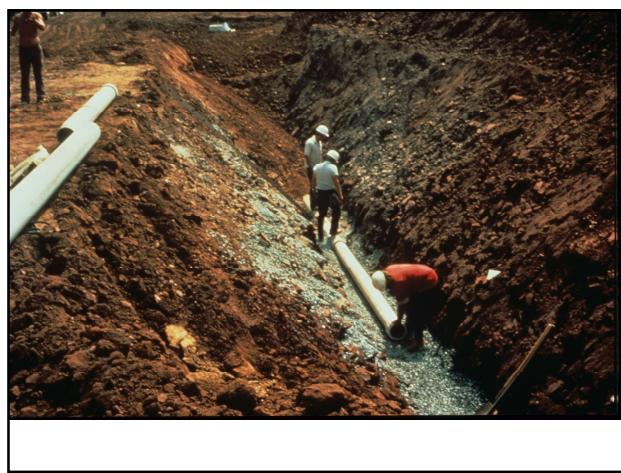
Sloping Shoring Benching Shielding

22

Sloping

- Safe slope
 - Defined as the maximum angle of the edge wall at which sliding will not occur unique soil mixtures necessitate different safe slopes
- 20 feet maximum depth
- 1.5:1 ratio
 - A slope of this ratio or less is safe for any type of soil

23



24

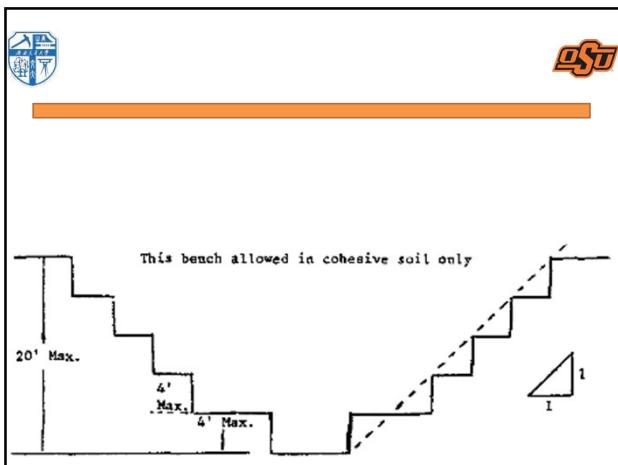


25

Benching

- Two types
 - Simple
 - Multiple
- The type of soil determines the horizontal to vertical ratio
- General rule
 - Bottom vertical height of trench not to exceed 4'
 - Subsequent benches maybe up to 5' vertical

26



27



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28



29



30



Shoring/Shielding



- Shoring used where the location or depth of cut makes sloping impractical. Consists of:
 - Posts
 - Struts
 - Sheeting
- Two types
 - Timber
 - Aluminum hydraulic
 - is the trend
 - Provides critical safety advantage over timber because worker does not have to enter trench to install or remove
 - Light enough to be installed by one worker

31



Shoring/Shielding



- Pneumatic shoring jacks
 - Popular since they are cleaner than hydraulic jacks
 - No danger of leaking fluid
- Installed from top down
- Excavation of 2' or less below the bottom members of support system is allowed
- Removed from bottom up
- Back fill as removed

32



33



34



35

Trench Box

- Must be approved by registered PE
- Watch video:
 - Trench box Installation



36



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37



38



39



40

Trench Entry

- Access and egress
 - Ladders
 - Steps
 - Ramps
 - Excavations of 4' or deeper
 - Travel distance no more than 25'
- Atmospheric testing required before entry on excavation is greater than 4'

41

Additional Protection

- Call before you dig
- Prevent falling or rolling materials into excavation
- Provide warning system or barricades
- Trench crossings
 - Should be discouraged
 - Must be designed and installed under supervision of registered PE
- Walkways
 - 20" Minimum width
 - Standard rails
 - Extend 24 inches past trench edge

42



Additional Protection



- Standard prohibits workers from entering excavation where water has accumulated
 - Special precautions include
 - Support or shield
 - Water removal system to control water depth
 - Safety harness and lifeline
 - Diversion ditches to prevent surface water from entering excavation
- Excavations under sidewalks and pavements are prohibited unless appropriately design support system is provided

43



Are there any exceptions to the Excavation requirements in 1926 Subpart P (650-652)?



- House foundations/excavations if:
 - Less than 7-1/2 feet deep or is benched for at least 2 feet horizontally for every 5 feet of depth
 - Horizontal width at bottom of trench is at least 2 feet
 - No adverse environmental conditions present
 - No heavy equipment operating in area
 - No excessive vibration source
 - All surcharge loads at least as far away from excavation as excavation is deep
 - Minimum number of employees and amount of time in excavation



44



Case Study – Excavation Fatality



- Fall 2012
- 40 yr old Male Sprinkler Pipe Fitter
- Struck by water tank
- Trench Wall Collapse
- Water Saturated Clay
- 2 ft of fill sand atop clay
- 40 ft x 14 ft x 14 ft



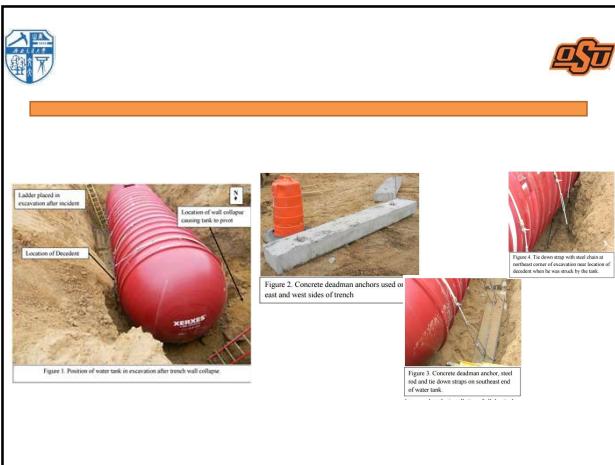
Figure 5. Collapsed soil in northwest corner causing tank to pivot to the east trench wall

Vertical Walls
Type C Soil
No Protective Systems

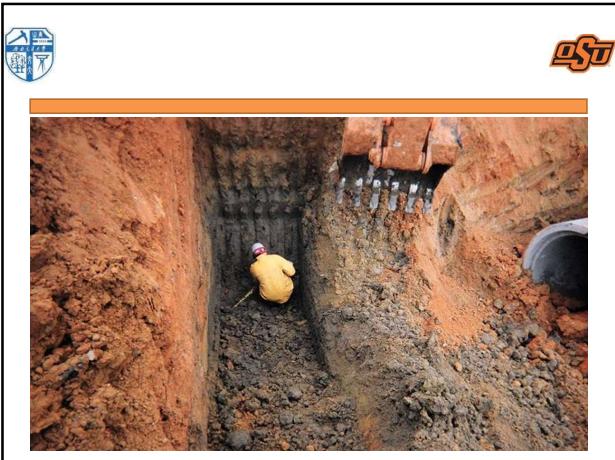
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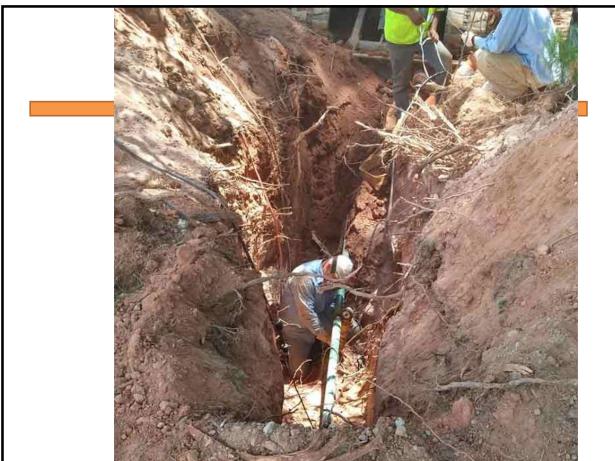
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46



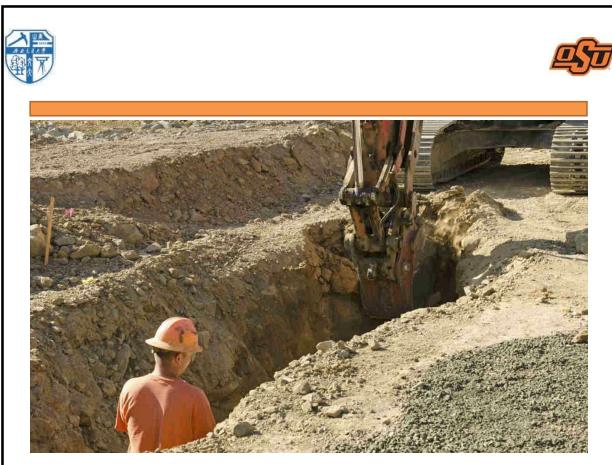
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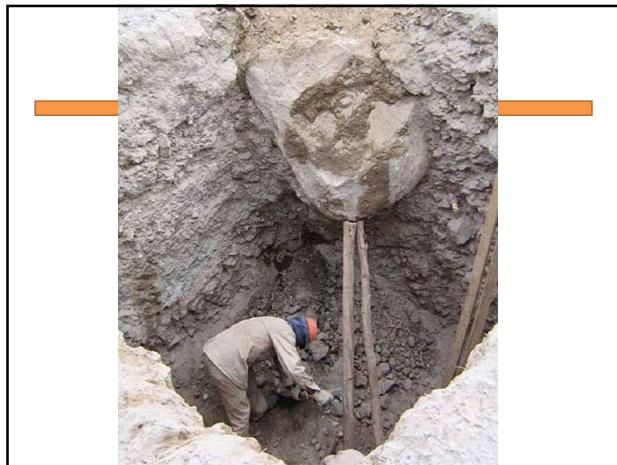
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49



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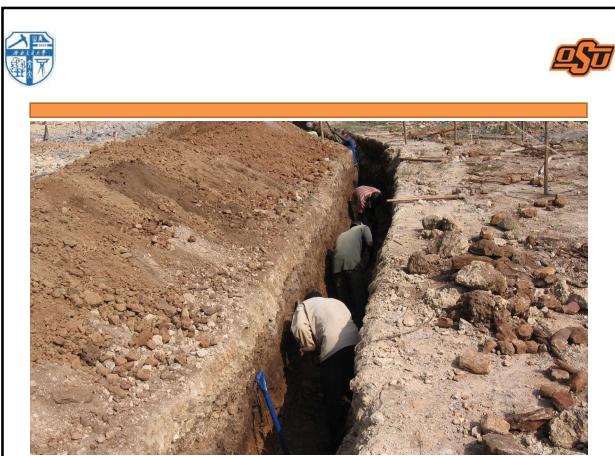
51



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52



53



54



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Watch video: excavation safety