Construction Inspector Safety

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What We'll Cover Today

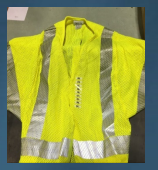
- Before you go
- Traffic and equipment awareness
- Jobsite electrical hazards
- Excavations

Before You Go

- Anticipate, think about where you're going, potential hazards
  - Type of work
  - Type of area
  - Time of day
  - Time of year
- Be prepared
  - Apparel
  - PPE
  - Water
  - Other equipment – lights, bug repellant, communications
  - Traffic cones
- Be ready for changes in conditions during the work
  - Time of day – could it get dark while you're there?
  - Changes in weather
  - Changes in traffic flow patterns

PPE

- The basics
  - Hardhat
  - Safety glasses – shaded and clear
  - Safety-toed boots
  - Traffic vest
- Others, based on the work and conditions
  - Hearing protection
  - Gloves
  - Raingear



When You Arrive

- Assess the traffic patterns, traffic control, parking options
  - Where is the best place to park?
  - Will you be joining a crew's traffic control?
  - Will you need to provide your own?
  - Don't be afraid to drive by to assess, then circle back
- If a crew is there, asked to be briefed on the job
  - They should cover the hazards you may be exposed to
  - Don't just sign the form, ask to be briefed on what may affect you
  - Do your own hazard analysis: walking surfaces, traffic, power lines, etc.

Traffic and Equipment

The Risk

- In 2010, there were 87,606 crashes in work zones across the U.S., resulting in 37,476 injuries.
- In 2010, there were 576 fatalities in work zones. 106 of those fatalities involved workers.
- There are approximately 20,000 workers injured annually.
- Construction equipment accidents accounted for as many "worker on foot" deaths as traffic vehicles

Causes of Worker Fatalities

- Rollover/backover incidents (48%)
- Collisions between vehicles/mobile equipment (14%)
- Caught in between/struck by construction equipment (14%)

High-Visibility Apparel

- OSHA requires protection whenever workers are exposed to hazards of traffic or moving equipment
- ANSI/ISEA 107
  - Class 1, 2, or 3, based on level of risk – traffic speed, traffic patterns, complexity of work environment
  - Orange or yellow-green hi-vis fabric, reflective striping
  - A yellow shirt with no striping doesn't meet ANSI standards, and a blue shirt with stripes doesn't meet it
- Most work requires at least Class 2, Class 3 for nighttime flagging

General Principles of Traffic Control

- Wear high-visibility apparel
- If working ANYWHERE in a roadway right-of-way, SOME form of traffic control is required
- Level of traffic control depends on
  - Type and duration of the work
  - Proximity to ramps or intersections
  - Road width and condition
  - Volume, speed, and proximity of traffic
- Lane closures – may need to get additional resources

Be Aware Of…

- Distance to traffic – work as far away as possible
- Barriers – keep barriers between you and traffic whenever possible, such as barriers, guardrails, equipment, heavy posts, etc.
- Escape route – always have one planned
- Drivers – never assume they're looking out for, or even at, you!
- Environmental factors that may impact drivers' ability to see you or that may distract them, such as light, glare, rain, wind, haze, hill, curves, trees
- Watch each others' backs, especially if a co-worker needs to be watching something else

Vehicle Blind Spots

Truck drivers and equipment operators sit high above the ground and cannot see pedestrian workers crossing close in front of them.

Driver's field of view inside of a tanker truck. Can you see the workers in front of and directly to the right of bug shield? (circle)

Obstructions in a driver's LINE of SIGHT might be:

- Mirrors
- Cab arrangements
- Door and window post
- Stacks and air cleaners

Jobsite Electrical Hazards

Types of Jobsite Electrical Risks

- Job equipment and tools
- Energized meters and pipes
- Overhead electric utilities
- Subsurface power lines

Dangers of Electricity

- It takes very little electricity to cause injury
- Main types of electrical injuries:
  - Electrical shock – may stop the heart
  - Burns from contact, arc flash, or burning materials
- Indirect – Falls
- Significant cause of fires

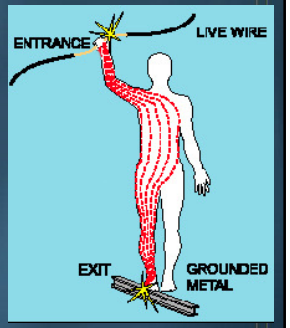
Dalziel's Table

- Low voltage or current does NOT mean no hazard!
- 110V circuits can deliver 10 to 20 amps (10,000 to 20,000 mA)

Body Effect	Threshold @ 110V AC
Slight sensation at point(s) of contact	0.3 - 0.4 mA
Threshold of bodily perception	0.7 - 1.1 mA
Pain with voluntary muscle control maintained	6 - 9 mA
Pain with loss of voluntary muscle control	10 - 16 mA
Severe pain and breathing difficulty	15 - 23 mA
Possible heart fibrillation after 3 seconds	100 mA

Electrical Shock Potential

- Is there a path to ground?
- Voltage
- Amount of current flowing through the body (amps)
- Moisture, which affects conductivity
- Insulation between you and the electrical source or the ground



Touch and Step Potential

- Touch Potential
  - The voltage potential difference between an energized structure or object and the ground
  - Trace the potential path to ground
- Step Potential
  - The voltage potential difference between two points on the earths surface, caused by a flow of current through the earth or through standing water

Energized Meters and Pipes

- Look for wires bonded to the gas line
- Consider induced voltage from overhead high-voltage lines
- Test with a reliable voltmeter before touching

Overhead Powerlines

- OSHA requirements are based on
  - Type of work (general industry vs. construction, work on scaffolds vs. work using heavy equipment),
  - The type of equipment (backhoe vs. crane)
  - The type of worker (qualified vs. non-qualified)
- The minimum distance for heavy equipment when working on jobsites is 10 feet around lines with voltages up to 50 kv

Crane Cable Contact with Overhead Line

Underground Utilities

- Follow One-Call guidelines for all subsurface work
- Locates are not foolproof
- If digging within tolerance zone, must use hand digging or vacuum excavator
- Consider if, or how, you can become the path to ground, and protect from it
- Use electrically rated tools and PPE

Conduit cut – Location was right, depth was wrong.

Trenching

- Operator
  - If underground strike, stay on the machine unless it starts to burn, then hop off without touching equipment, and hop/shuffle away
- Other personnel
  - Stay away from machine while digging – do not touch
  - Stay away from area to prevent step potential
- Dielectric boots for step potential

Underground Boring

- Path to ground: most current should go directly to ground from the bore head, some may travel back to machine
- Other personnel: do not touch equipment while advancing
- Operator: if underground strike, stay on the machine unless it starts to burn, then hop off without touching equipment, and hop/shuffle away
- Equipment grounding: required for strike alert to function
- Dielectric boots for step potential

Hand Work

- *1926.416(a)(2): In work areas where the exact location of underground electric powerlines is unknown, employees using jack-hammers, bars, or other hand tools which may contact a line shall be provided with insulated protective gloves.*
- Path to ground: most current should go directly to ground, but workers could directly contact lines with tools and become part of the path
- How to protect
  - Non-conductive tools
  - Rubber insulating gloves
  - Dielectric boots

Example

Electrically-Protective Boots

- Ratings
  - EH (Electrical Hazard): ASTM F2413 standard for safety footwear, for secondary electrical shock resistance from incidental contact
  - DI (Dielectric): ASTM F1117 standard, for "supplementary protection" only, because there is no "in-use standard for re-testing. Not to be relied on as primary protection.
- Visual inspection for defects only, not re-tested

Excavations

Definition of Excavation

OSHA: 29 CFR 1926.650(a):

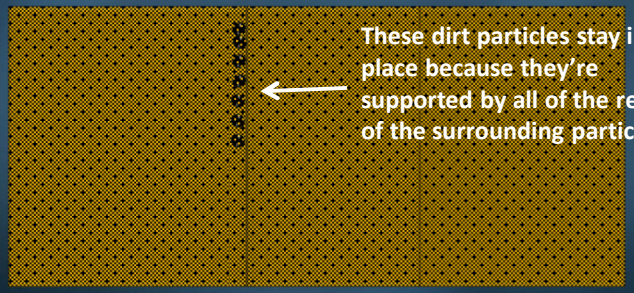
"Any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal."

Why is "earth removal" significant?

Why Does Dirt Stay in Place?

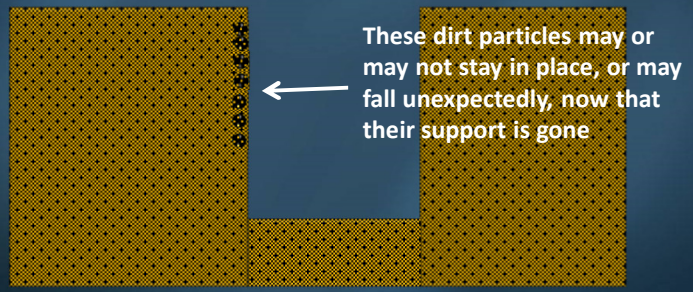
Start with flat ground.

Why doesn't it cave in? (ok, this is obvious)



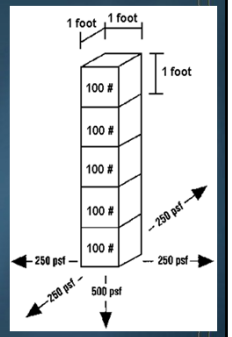
Why Does Dirt Fall Down?

Next, remove some of the dirt. Why does what remains stay up, and what can cause it to fall down? (not necessarily as obvious)



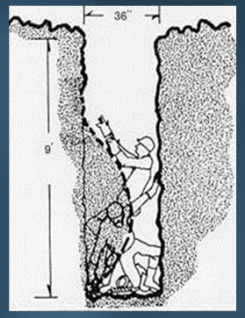
Excavation Collapse Factors

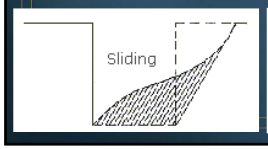
- Soil type, cohesion, strength
- Water!
  - Soil water content
  - Seeping or flowing water
  - Water table
- Pressure, based on
  - Depth – pressure increases with depth
  - Surface surcharge loads (encumbrances)
- Layers and their configuration
- Previous disturbance
- Underground utilities and structures
- Vibration – equipment, traffic, etc.

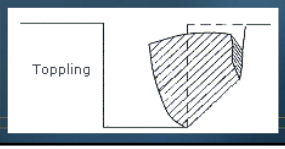


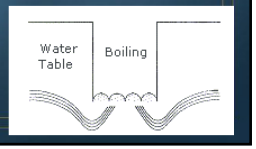
What Happens When Dirt Falls?

- Dirt moves surprisingly quickly, and with little or no warning
- Failures can take a number of forms, including sliding, toppling, and boiling



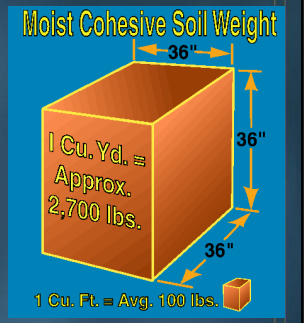






What Happens if Dirt Falls on You?

- Dirt is heavy: a cubic yard (about the size of a stove) weighs more than a ton
- If even a relatively small chunk of soil falls on you, would you be able to breathe?



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Trench Rescue

- If dirt falls on or around you, and you can't breathe, you have 4 minutes until brain damage starts
- What are your options?
  - Hand digging: how fast can your co-workers dig a ton of soil?
  - Mechanical equipment: obvious risks
  - Fire department heavy rescue: response time will be much more than 4 minutes (they won't go into a trench until it is made safe)

Going into Excavations

- So, you're thinking about entering an area where there is an incredible weight (many tons) hanging above you, and…
- The strength of whatever is holding it back is unknown, so you don't know if it will fall while you are in there, and….
- If it does fall while you are in there, it will probably happen so quickly that you won't have time to react or get out, and….
- If it falls on you, it will mean that you won't be able to breathe, and….
- It is so heavy that people around you won't be able to remove it quickly (before you are asphyxiated), then…..

One Question….

If you're thinking about entering an excavation that may not be safe, you should ask yourself one question:

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Are Cave-Ins Truly Accidents?

- Cave-ins are:
  - Predictable
    - All soil walls will eventually fail, return to their "angle of repose"
    - We know what factors determine how and why they fail, even if we don't generally know exactly when
  - Preventable
    - There are MEANS (equipment) and METHODS (work processes) available which will protect workers
    - It's just a matter of taking the time to implement those protective means
- That means cave-ins are NOT accidents
- You must decide if you will take the appropriate precautions before you enter an excavation

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Lots of Examples

- There are an average of more than 50 excavation-related deaths in the US each year
- There are likely hundreds, if not thousands, of cave-ins and entrapments each year, resulting in serious injuries
- The death rate for a trench related incident is 2 ½ times greater than for any other construction related event
- Entrapments also hurt and kill would-be rescuers

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OSHA'S Key Rules for Excavations

- Regular inspections by a competent person, including soils analysis
- Protection from cave-in by sloping, benching, and/or shoring, based on the soil type
- Spoils piles located at least 2 feet back, protection from material rolling in
- Means of egress
- Protection from falling loads (pipe, etc.)
- Protection from hazardous atmospheres
- Protection from water

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Excavation Competent Person

- OSHA definition: one who is able to identify hazards, and has authority to take corrective actions
- Must have had specific training in, and be knowledgeable about:
  - Excavation hazards
  - Soils classification
  - The use of protective systems
  - The requirements of the standard
- Different excavations have different degrees of hazards, require different levels of "competency"

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Duties of the Competent Person

- Review the excavation area for potential hazards
- Perform soil classification by visual and manual tests
- Determine if a hazardous atmosphere could exist
- Determine what means will be used to protect from cave-in, if any
- Oversee the construction of the protective system.
- Inspect the site daily to identify any new hazards, including water, and make sure protective measures are all being done properly.

Other's Excavations

- If you enter an excavation dug by another company, you must still assess the safety of the excavation for yourself
- Essentially, you are acting as a Competent Person for yourself
- If it's not safe, don't enter! This is your "corrective action"

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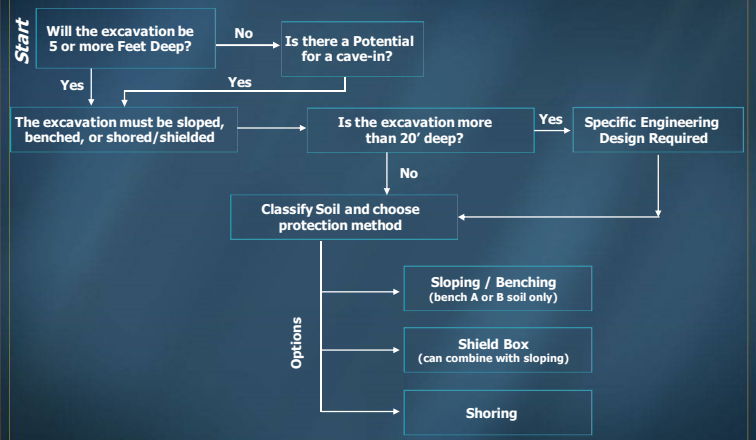
Cave-In Protection Requirements



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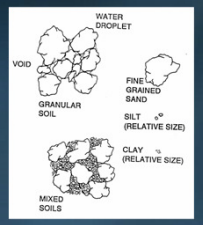
Soil Classification

- Soils must be classified by the competent person according to the soil types
- Classification must be made using <u>both</u> visual and manual tests



Soil Type	Characteristics
Stable Rock	
A	<u>Most stable.</u> Cohesive, very strong, **not previously disturbed**, no sloped layers, no seeping water
B	Most common. Cohesive, medium strength, may be slightly sloped layers
C	<u>Least stable.</u> Cohesive, low strength, seeping water, sloped layers
Non-cohesive	Pea gravel, sand, etc.

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Visual "Analysis" for Risk Factors

- What is the **depth** of the excavation? Pressure increases with depth.
- Is excavated soil **cohesive**, remain in clumps, granular, etc.?
- Are there **cracks running parallel** to the edge?
- Are there signs of **bulging, boiling, or sluffing**?
- Are there **layers** in the side wall? Are they sloped?
- Has the soil been **previously disturbed** and backfilled?
- Are there exposed **utilities**?
- Is there **water seeping or flowing** into the excavation?
- Is the **water table** above the bottom of the excavation?
- Observe the area for **vibration** sources: traffic, heavy equipment, compactors, etc.
- Check for **surcharge loads** from buildings, traffic, equipment, or the spoils pile.
- Are sidewalks, structures, poles or trees **undermined**?

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Water

- Increases cave-in risk
- Silty and sandy soils are particularly sensitive to moisture changes, can start to flow
- Employees shall not work in excavations where there is accumulated water or in excavations where it is accumulating unless:
  - The employees have been protected from the effects of the accumulated water
  - The water is removed from the excavation
  - The water is diverted around the excavation

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Manual Tests

- Thumb penetration - depth of penetration indicates softness of soil, soil type
- Dry strength – tests how easily soil crumbles
- Plasticity or wet thread test – cohesive soils can be rolled easily into thin "dirt snakes"
- Pocket penetrometer
- Shearvane

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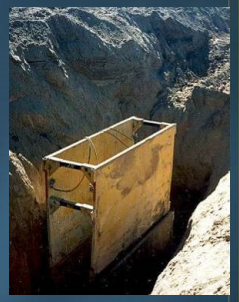
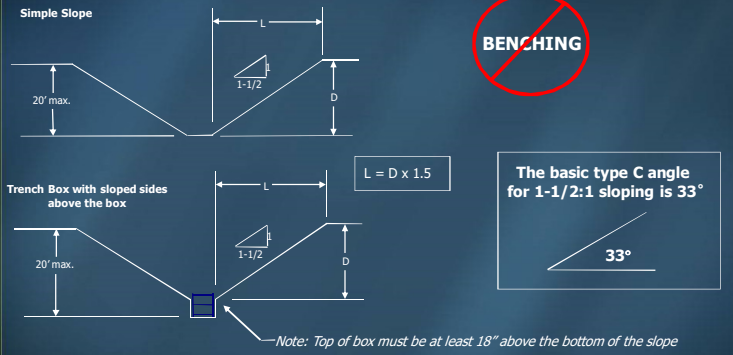
Protection from Cave-In

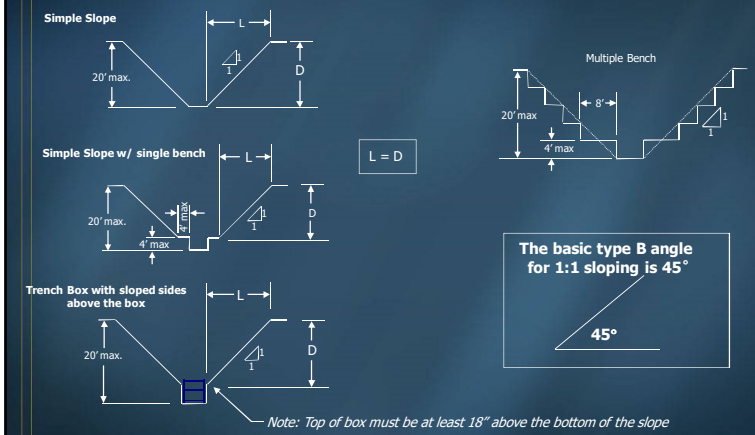
- Protective systems must be able to resist all expected loads to the system
- Sloping, based on
  - Soil types
  - Maximum allowable slope
- Benching considerations
  - Overall slope
  - Bench configuration, including first bench
- Shields, shoring
- Combination systems
- Excavations deeper than 20’ must be designed by registered professional engineer
- Spoils piles locations
- Water removal
- Minimize vibration
- Sidewall protection



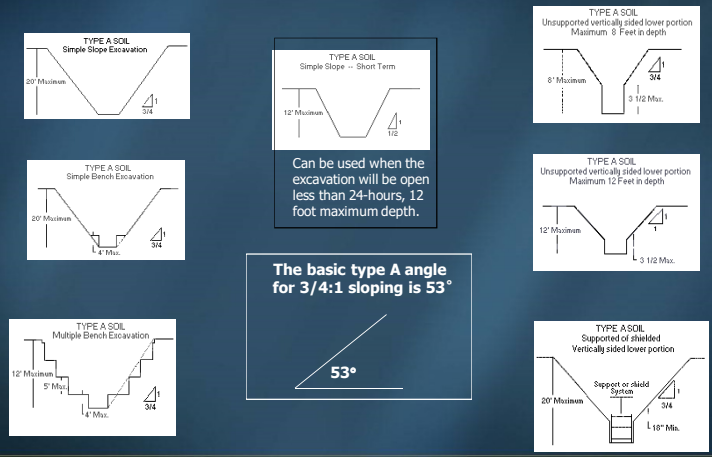
Type C Soil - Sloping Options



Type B Soil – Sloping/ Benching



Type A Soil – Sloping/ Benching

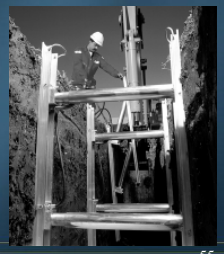


Sloping

Benching

Shielding and Shoring

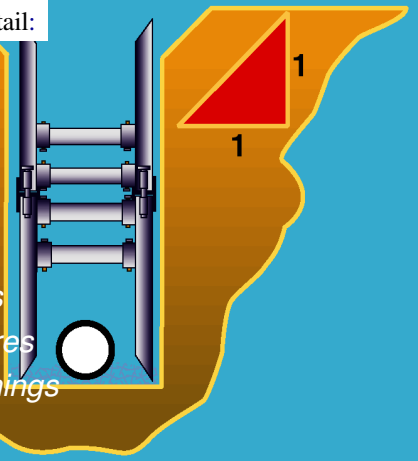
- Shielding
  - Simply resists against a cave-in
  - Includes trench boxes
- Shoring
  - Pushes back against the sides
  - Includes Speedshore
- Both
  - Must be certified by an engineer to withstand forces
  - Must keep tabulated data provided by the manufacturer on site



Tabulated Data

Tabulated Data Should Detail:

- *Engineer*
- *Manufacturer*
- *Type of soil*
- *Limitations of use*
- *Identifier on system*
- *Safe working depths*
- *Installation procedures*
- *Special hazard warnings*



Example Tabulated Data Sheet

HS-6x8

MODEL NO.

M05092354

SERIAL NO.

09/30/05

DATE SHIPPED

DEPTH/CAPACITY CHART

SOIL TYPE	EFP	MAXIMUM DEPTH Hydraulic	
A	25	25	
B	45	25	
C	60	25	
C	80	16	

Capacity Hydraulic	Static
1700	

WARNING!
Use of this equipment n
in accordance with
Manufacturers Tabulated
may lead to injury or dea

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Trench Box and Shoring Notes

- Trench boxes
  - Backfill between the sides to prevent lateral movement.
  - Top must extend 18" above the bottom of a slope above to prevent material sliding in.
  - May be set maximum of 2 feet above the bottom of the trench, but material must not slough off below.
  - The ends of the box must be either enclosed or sloped.
- Shoring
  - May be used with or without sheeting, unless material sloughs in between, then sheeting must be used
  - Cylinder spacing must meet many requirements

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The Reason Protection Is Installed

What's wrong with these pictures? Would you go in?

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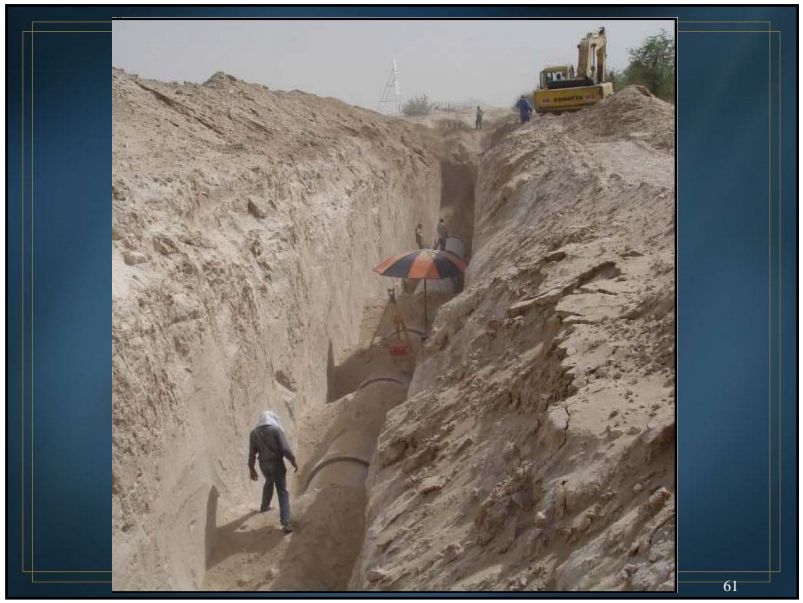

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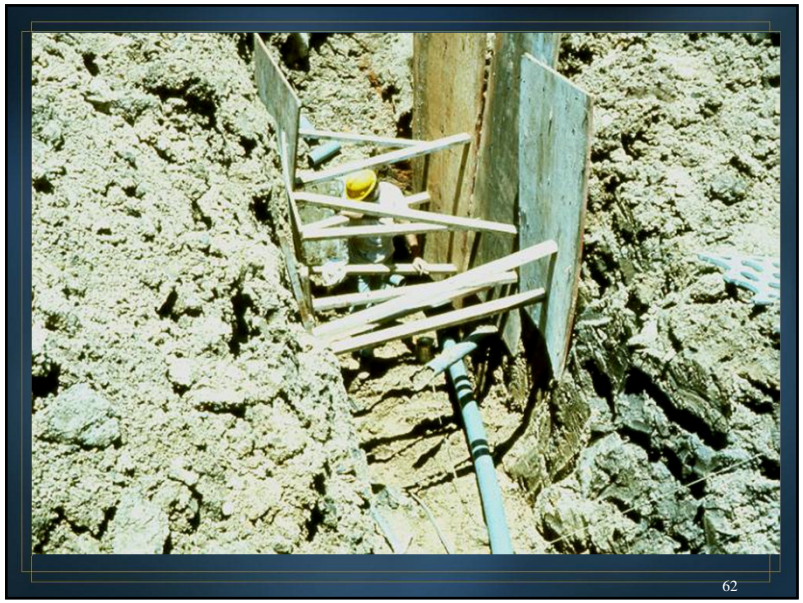

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