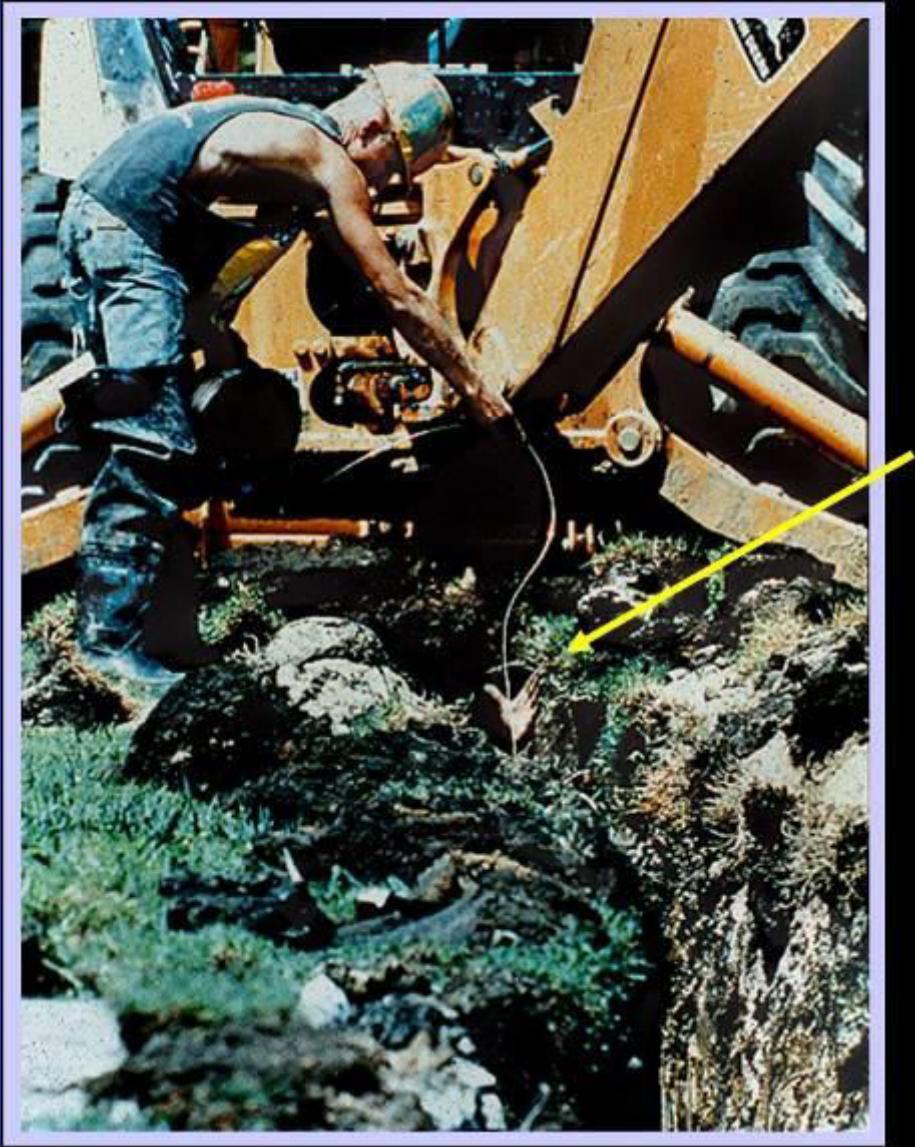




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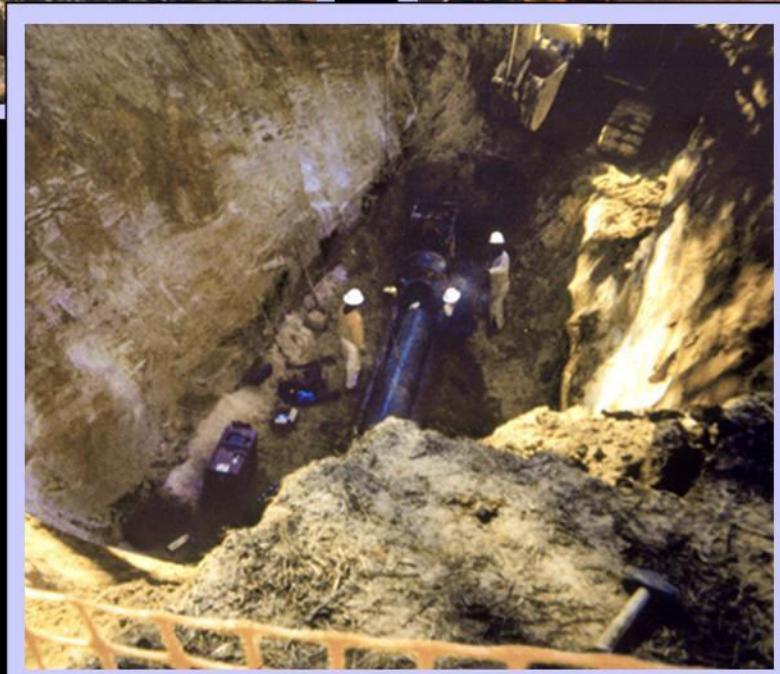
Susan Harwood Program Grant – The University of Texas at Arlington





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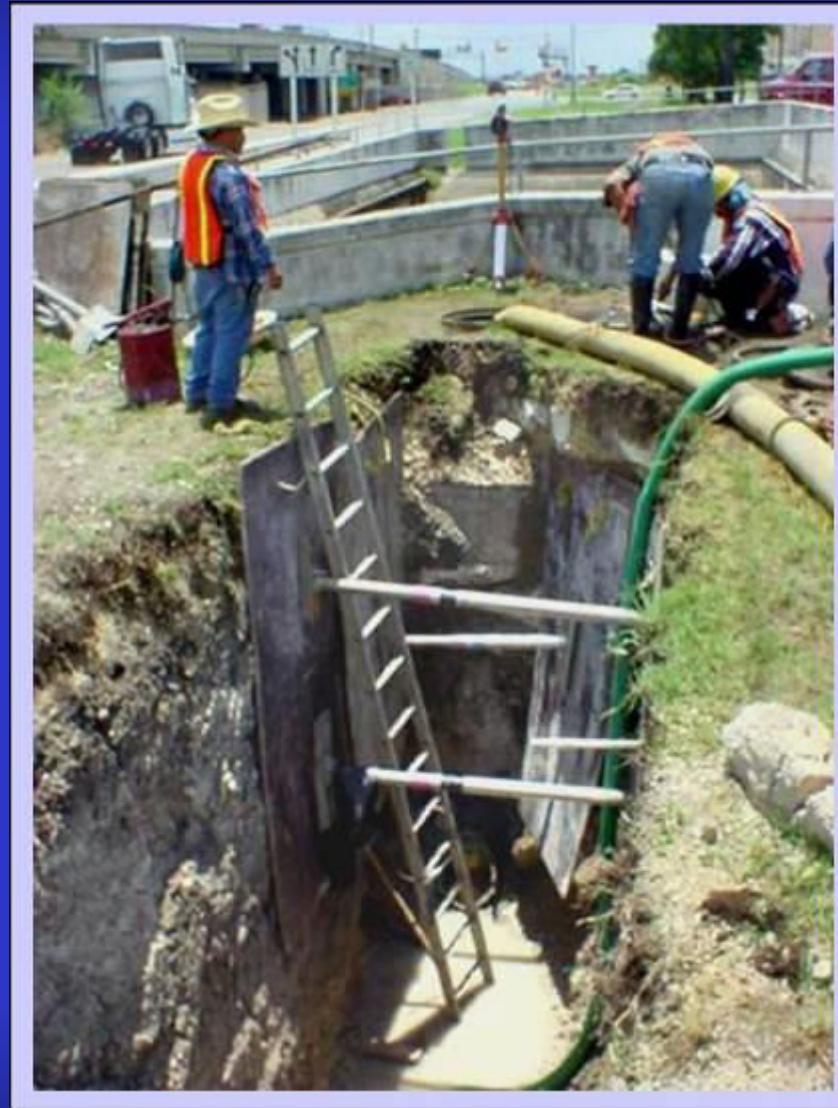
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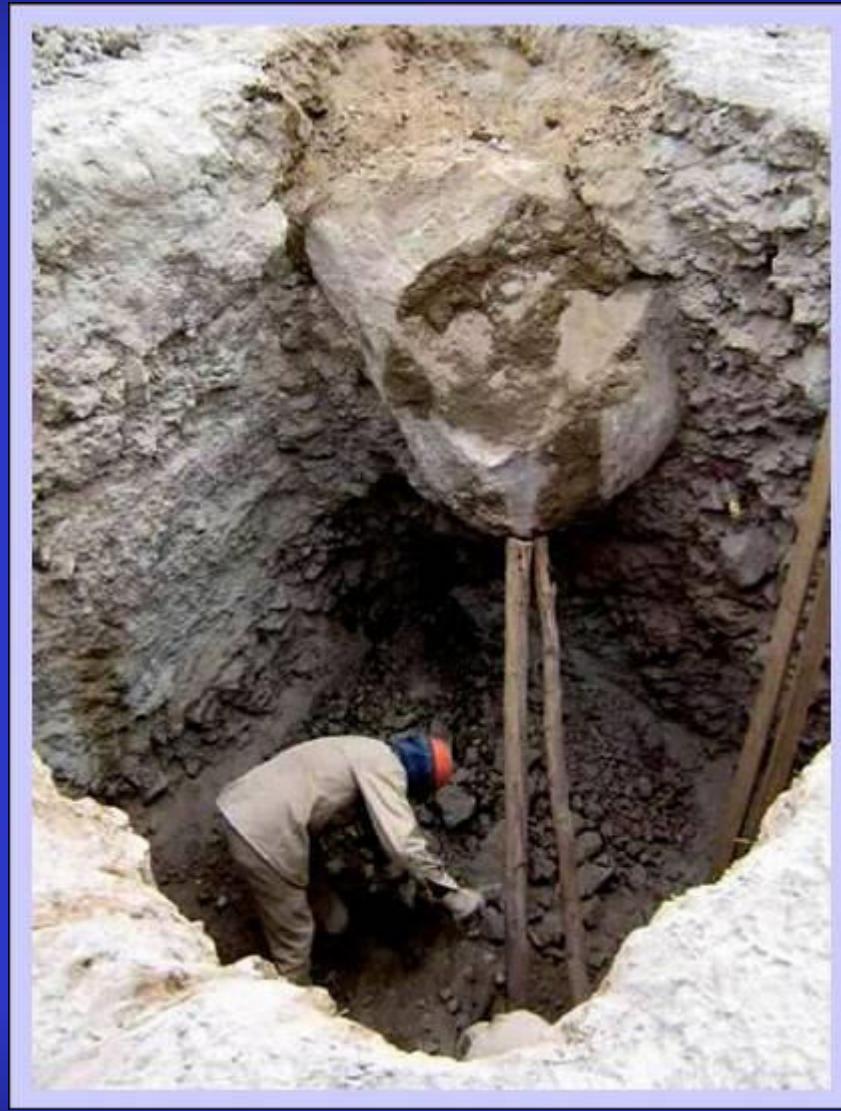
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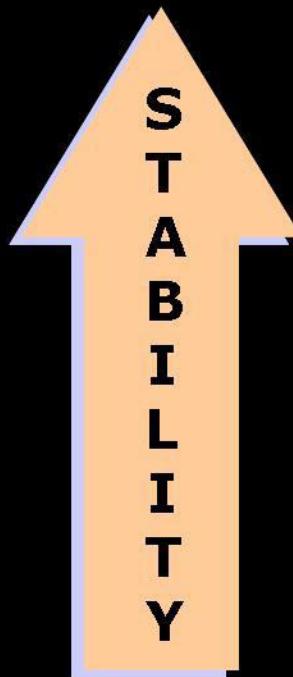


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OSHA Soil Classification System

Soil Types



- Stable Rock
- Type A
- Type B
- Type C

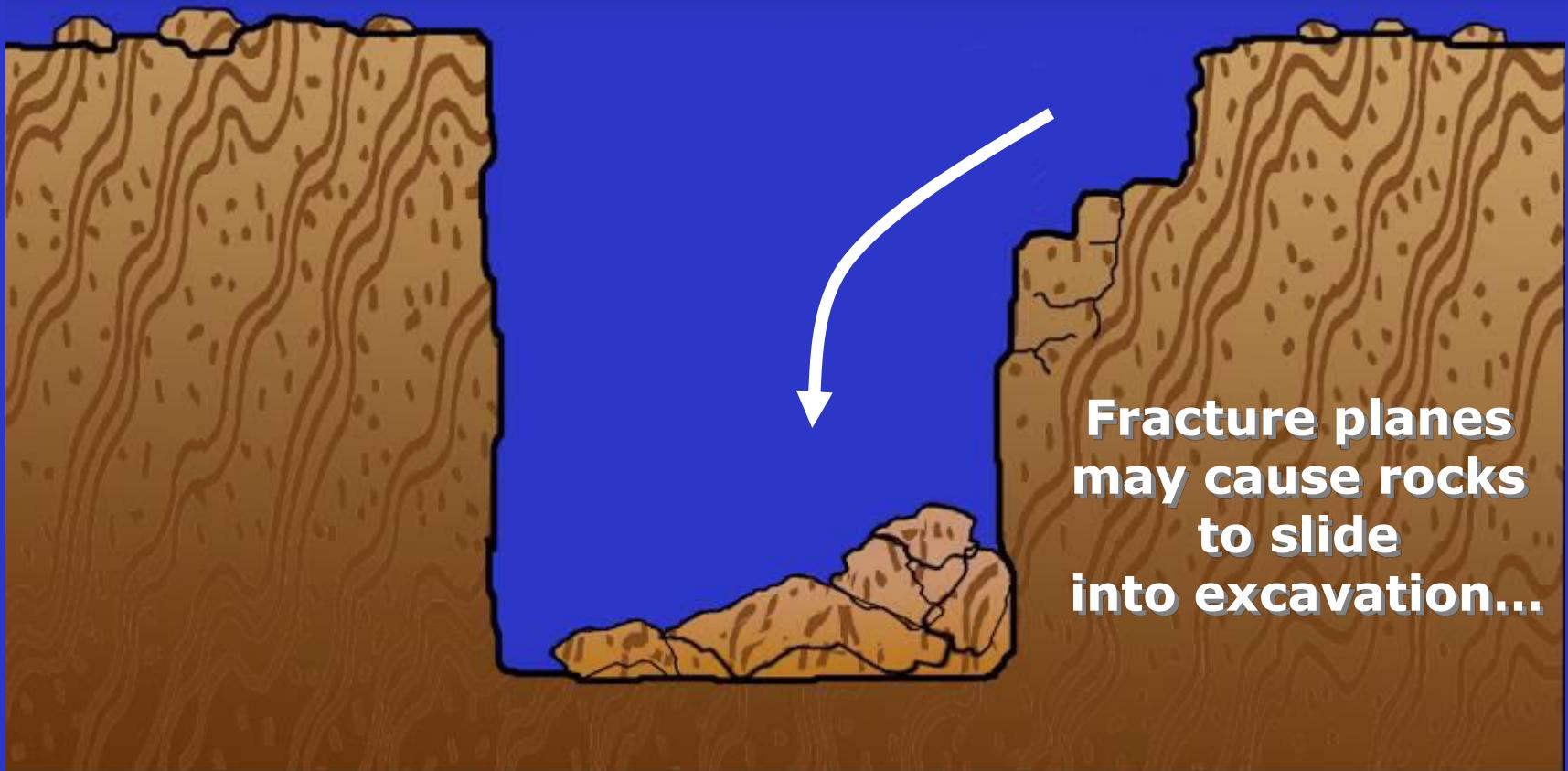


Stable Rock Means

Natural solid mineral matter
that can be excavated with
vertical sides and remain
intact while exposed.



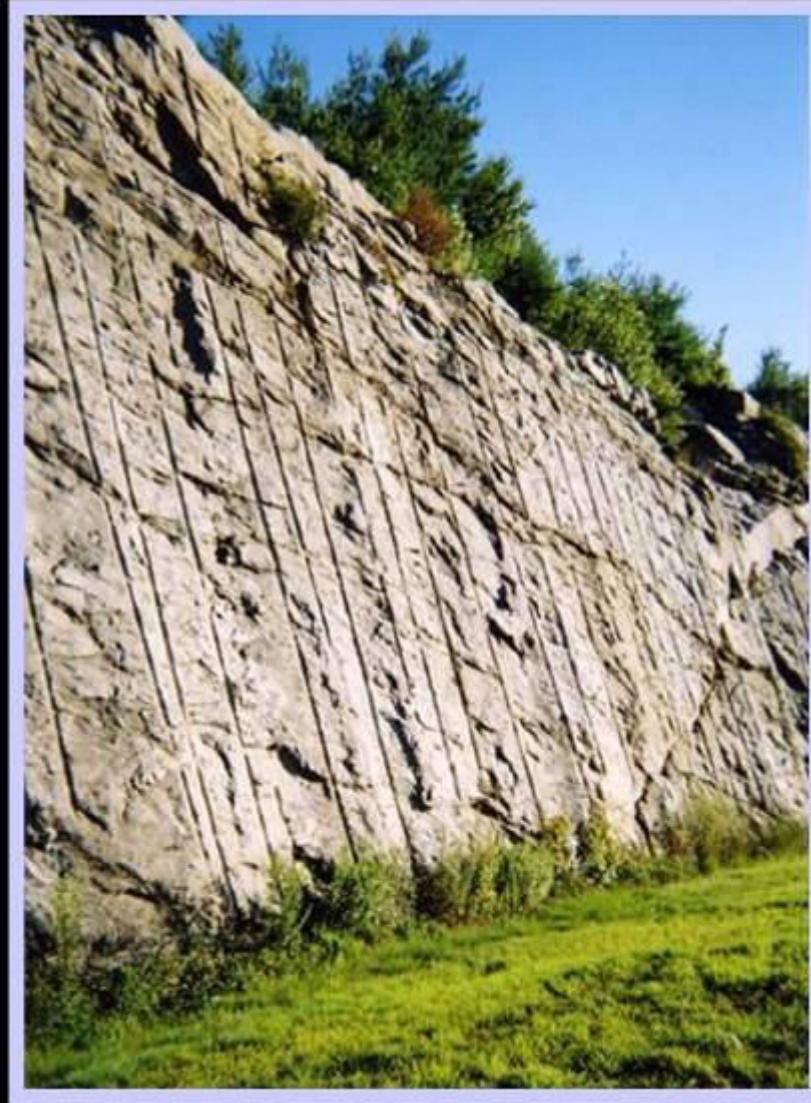
“Fallout” Effect of Fractured Rock





Inclined bedding planes can also cause rock to slide into the excavation.

Drilling
and
blasting
further
fractures
rock.



Rock
sawing
further
fractures
rock.



CAUTION!

**FALLING
ROCKS**





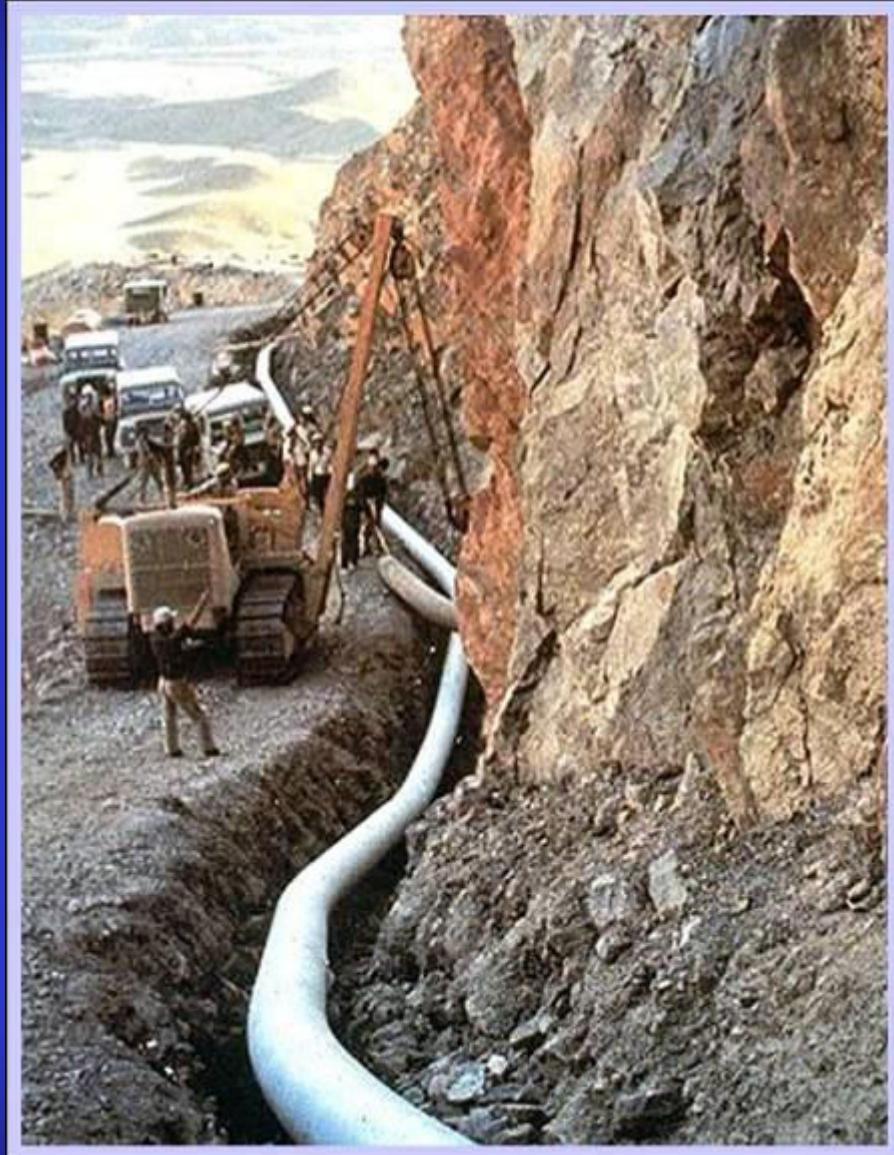
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**Fence used as
“shield” system**



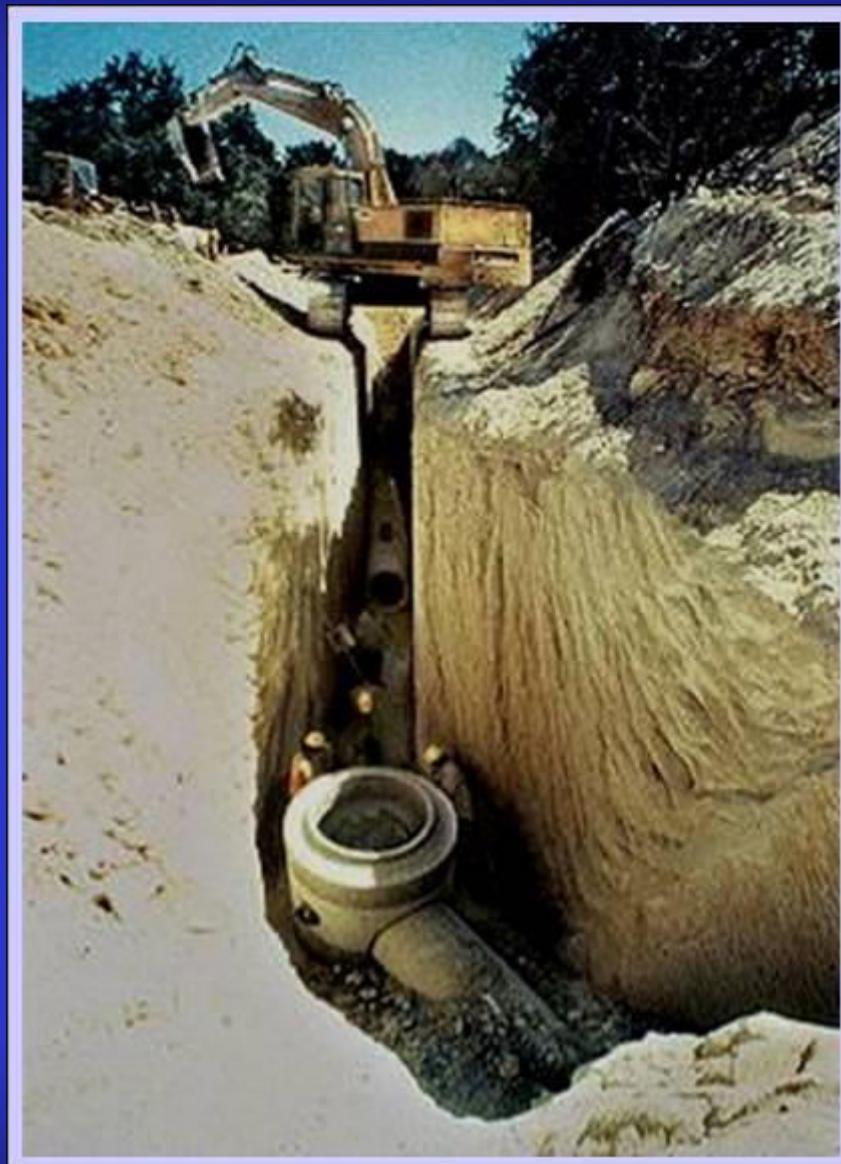


Rock fractured by blasting
will fail during excavation.



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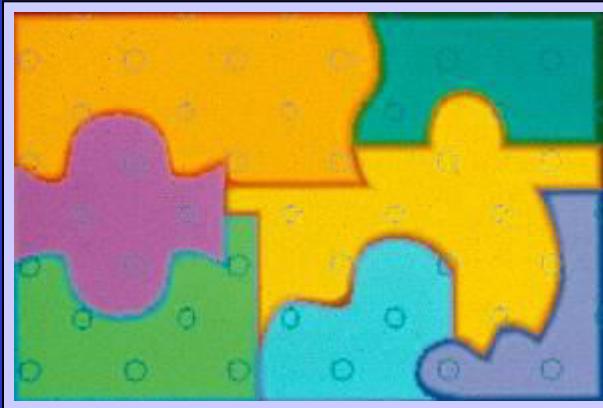


Type A Soil

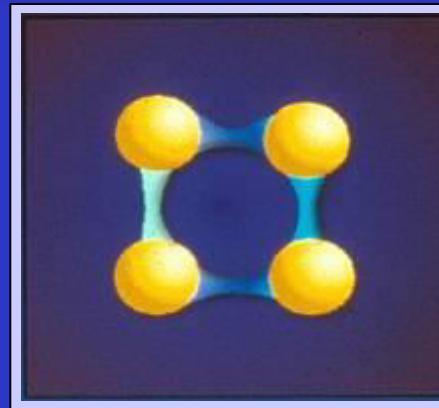
Cohesive soil with an unconfined compressive strength of 1.5 ton per square foot (TSF) (144kPa) or greater.



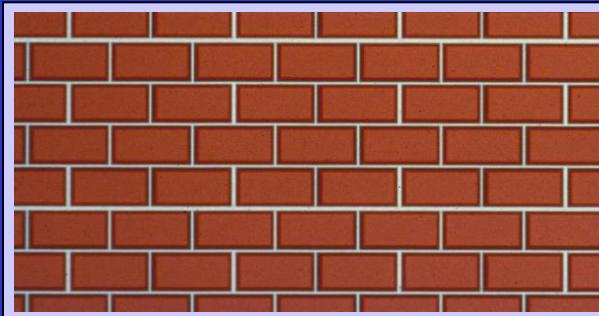
Cohesion



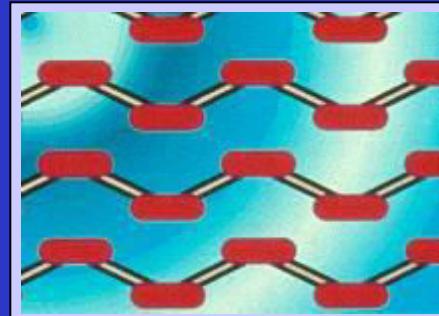
Friction



Liquid Bonding



Cementation



Chemical Bonding

Examples of Cohesive Soils are:

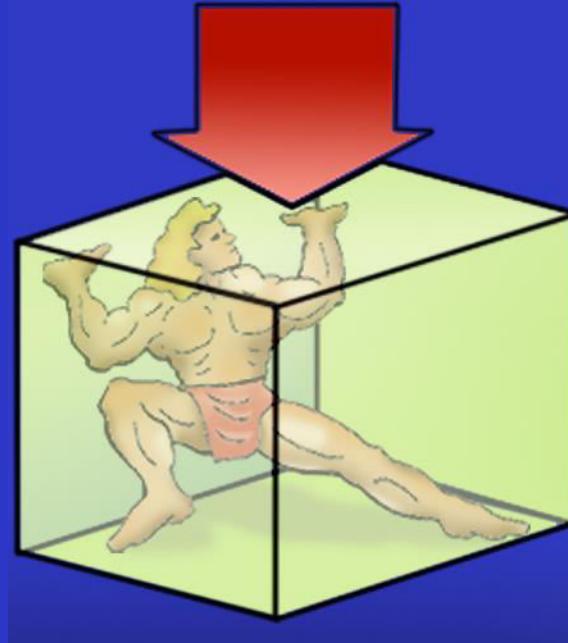
- **Clay**
- **Silty Clay**
- **Sandy Clay**
- **Clay Loam**
- **Silty Clay Loam** (in some cases)
- **Sandy Clay Loam** (in some cases)



Cohesive = Clay



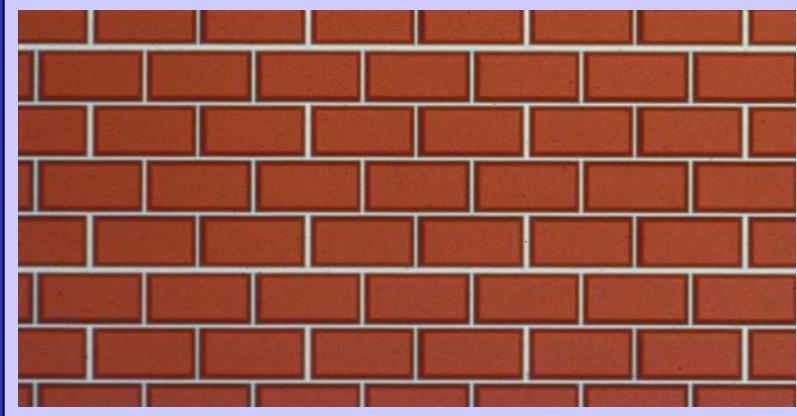
Unconfined Compressive Strength



$$\frac{C}{.5} \underline{B} \frac{A}{1.5}$$

T.S.F.

**Cemented Soils Such as
Caliche and Hard Pan are
also Considered Type A**



However, No Soil is Type A if:

1. The soil is fissured.
2. The soil is subject to vibration from heavy traffic, pile driving, or similar effects.
3. The soil has been previously disturbed.



However, No Soil is Type A if:

1. The soil is fissured.
2. The soil is subject to vibration from heavy traffic, pile driving, or similar effects.
3. The soil has been previously disturbed.

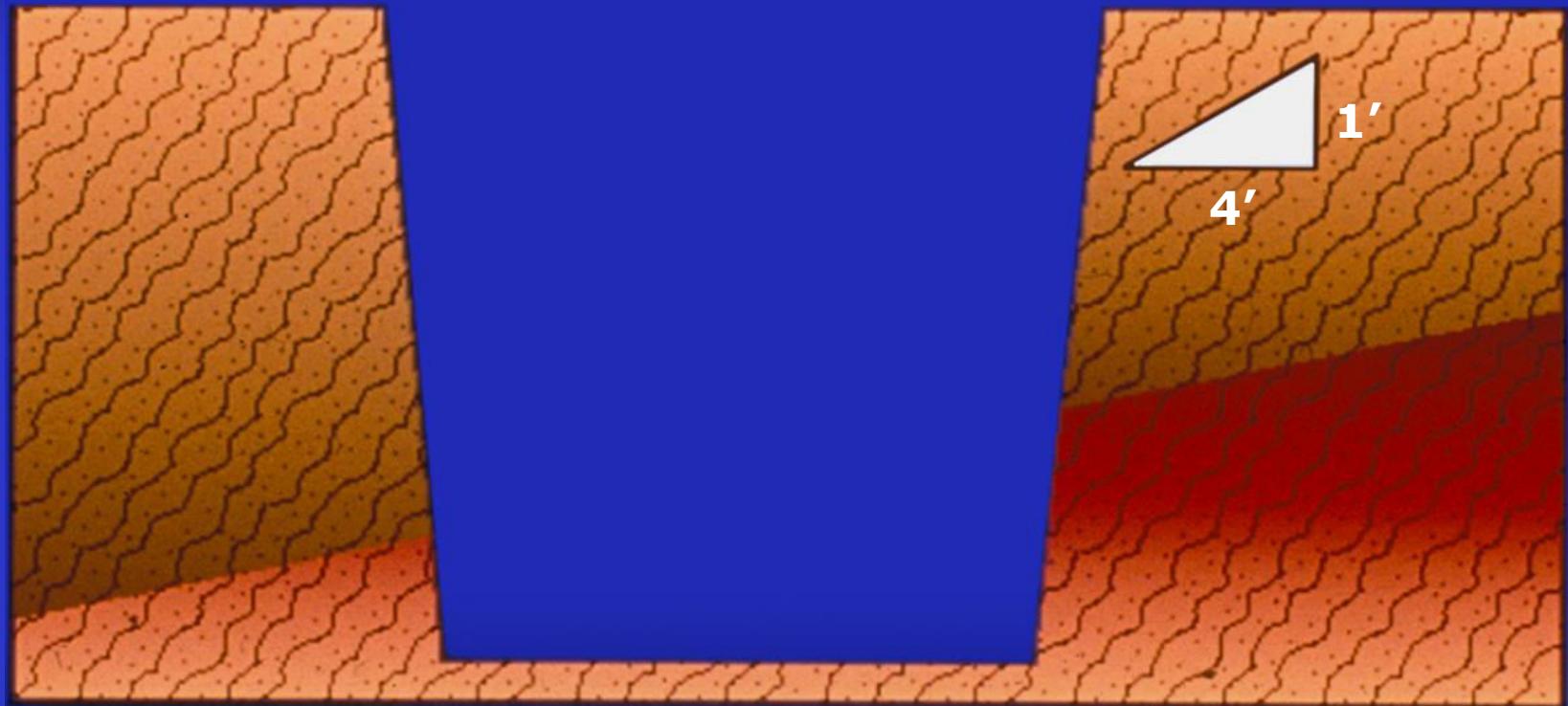


However, No Soil is Type A if:

1. The soil is fissured.
2. The soil is subject to vibration from heavy traffic, pile driving, or similar effects.
3. The soil has been previously disturbed.



Type A (*cont.*)



4. No soil is **Type A** if the soil is part of a sloped, layered system when the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater.

Type A *(cont.)*

5. No soil is **Type A** if the soil is subject to other (unspecified) factors that would require it to be classified as a less stable material.

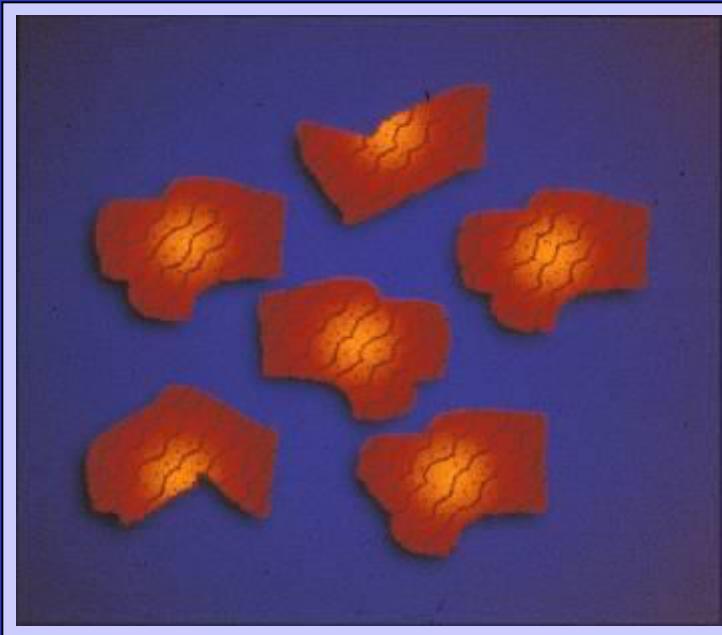


Type B Soil

1. Cohesive soil with an unconfined compressive strength greater than .5 TSF, but less than 1.5 TSF.

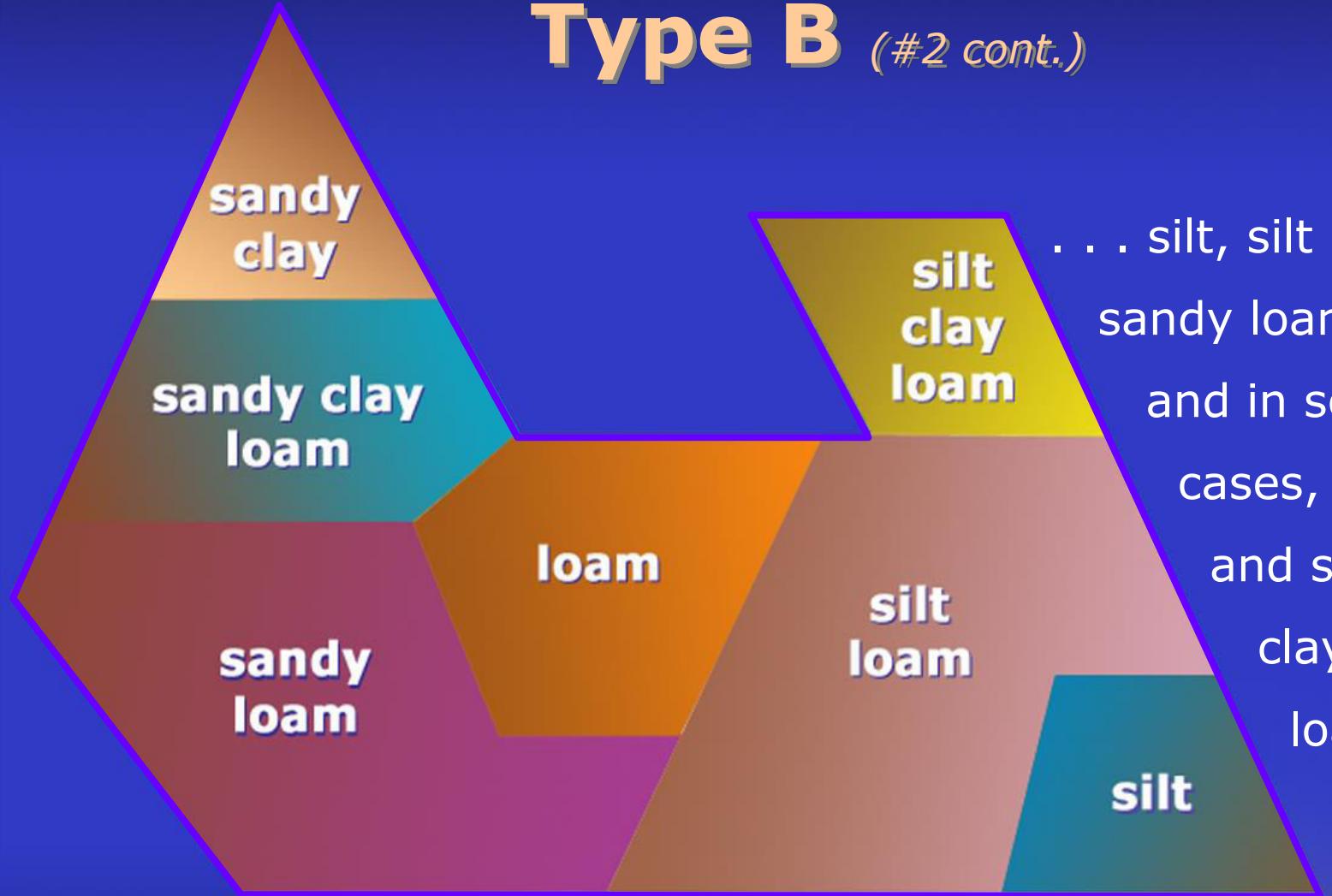


Type B *(cont.)*



2. Granular cohesionless soils including angular gravel, . . .

Type B (#2 cont.)



. . . silt, silt loam,
sandy loam,
and in some
cases, silty
and sandy
clay
loam.



Editorial Note:

While OSHA provides this single definition for a Type B granular soil, we suggest that the competent person treat all granular soil as **Type C**.



Type B *(cont.)*

3. Previously disturbed soils except those that would be classified as Type C soil.
4. Soil that meets the unconfined compressive strength or cementation requirements of Type A, but is fissured or subject to vibration.
5. Dry rock that is not stable.
6. Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.



Type B *(cont.)*

3. Previously disturbed soils except those that would be classified as Type C soil.
4. Soil that meets the unconfined compressive strength or cementation requirements of Type A, but is fissured or subject to vibration.
5. Dry rock that is not stable.
6. Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.



Type B *(cont.)*

3. Previously disturbed soils except those that would be classified as Type C soil.
4. Soil that meets the unconfined compressive strength or cementation requirements of Type A, but is fissured or subject to vibration.
5. Dry rock that is not stable.
6. Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.



Type B *(cont.)*

3. Previously disturbed soils except those that would be classified as Type C soil.
4. Soil that meets the unconfined compressive strength or cementation requirements of Type A, but is fissured or subject to vibration.
5. Dry rock that is not stable.
6. Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.



Type C Soil

1. Cohesive soil with an unconfined compressive strength of .5 TSF (48kPa) or less.
2. Granular soils including gravel, sand, and loamy sand.
3. Submerged soil or soil from which water is freely seeping.
4. Submerged rock that is not stable.
5. Material in a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or steeper.



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5. Material in a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or steeper.



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In Cooperation With

SPEED **SHORE®**
PIONEERING TRENCH SAFETY

Presents the . . .

Excavation Safety

Competent Person Training Program

Part 2



Protective Systems



Sloping



Shoring



Shielding

Sloping



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Sloping Options

1. Sloping sides $1\frac{1}{2}$ h to 1 v (34^0) - - as though it were **Type C** soil.
2. Use **Appendix A** to classify the soil and **Appendix B** to determine the correct slope.

OR

Have a registered professional engineer provide:

- Tabulated data for sloping or
- A site-specific sloping profile.



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- A site-specific sloping profile.



Angle of Repose

The term “angle of repose” which comes from stockpiling is no longer used by OSHA.

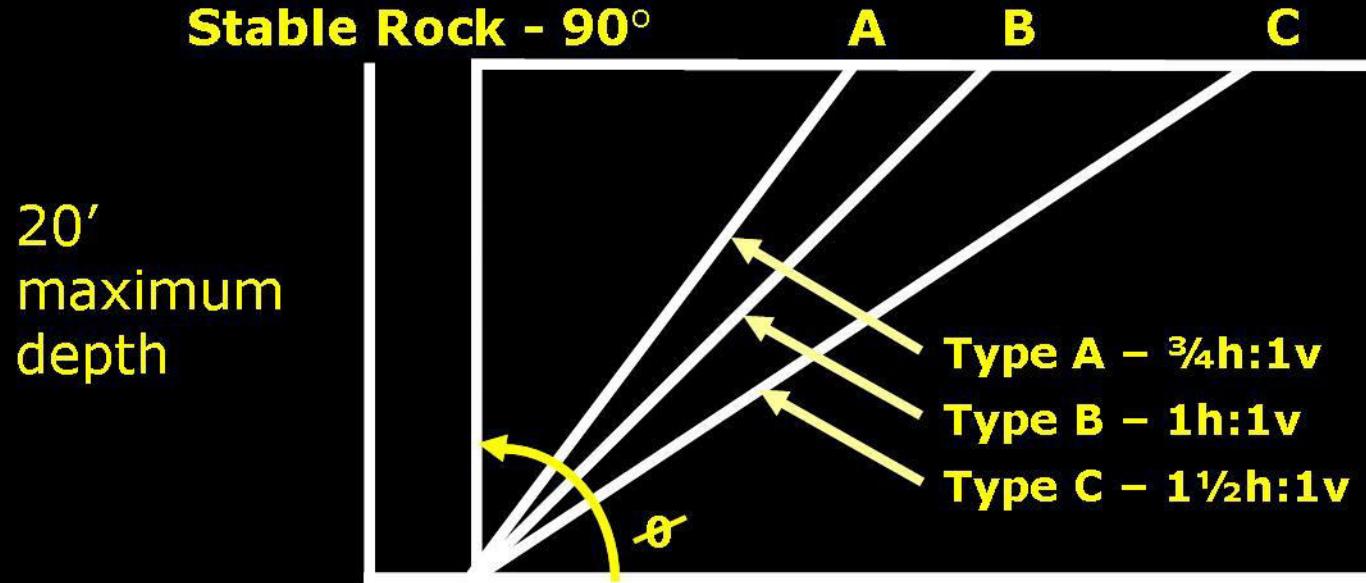


Terms Currently Used by OSHA

- **Safe angle**
- **Maximum allowable slope**
- **Actual slope**
- **~~Angle of repose~~**



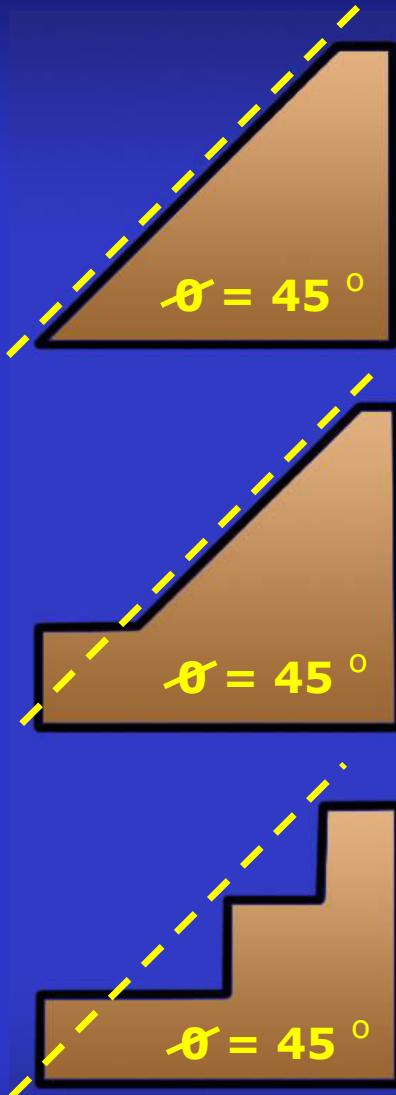
Sloping Chart



Stable Rock	$\theta = 90^\circ$
Type A	$\theta = 53^\circ$
Type B	$\theta = 45^\circ$
Type C	$\theta = 34^\circ$

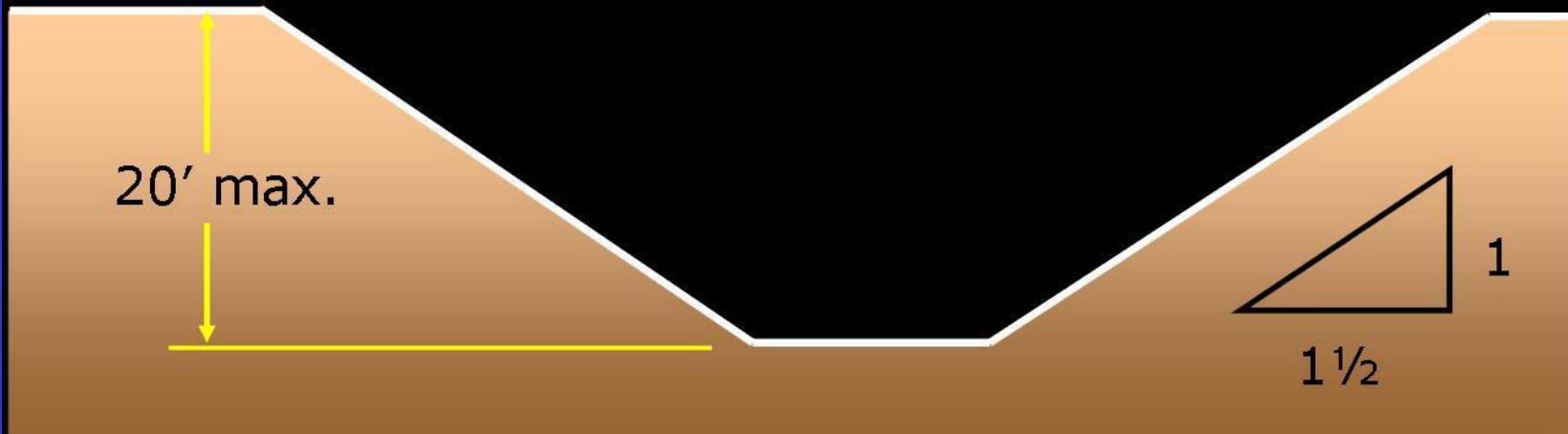


Type B



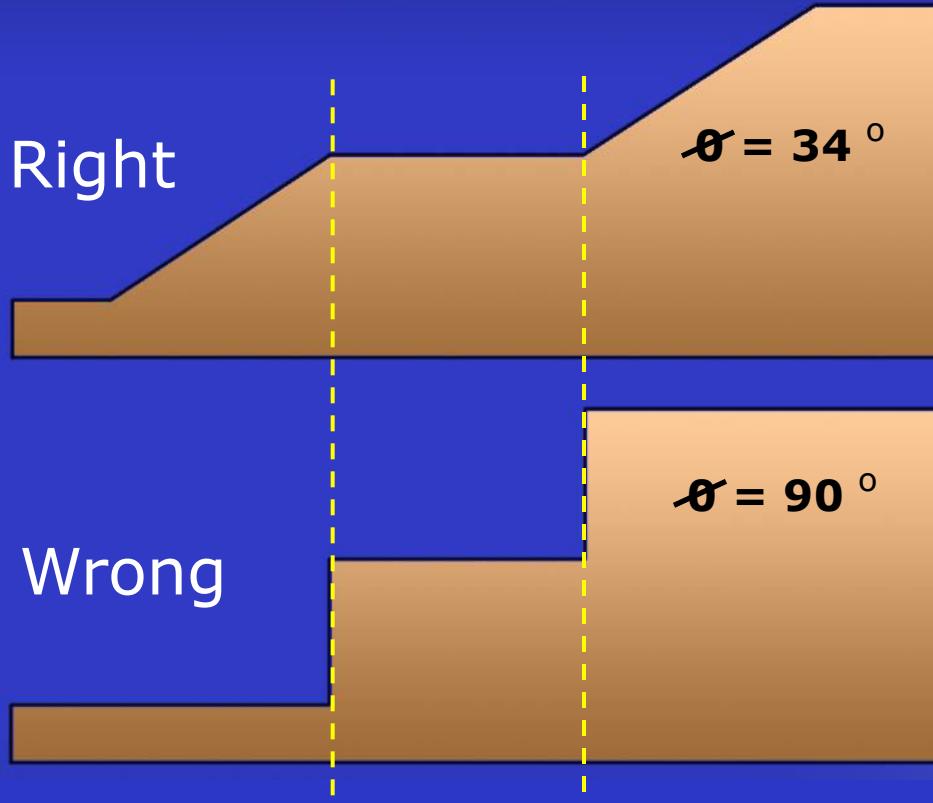
Excavation in Type C Soil

Type C Simple Slope



All simple-slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.





Benching is not allowed in Type C Soil.

Simple Sloping



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Sloping and Benching



Benching



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Benching

Do not put people or materials on steps above working level.



Shoring



Shoring braces the unstable wedges
so that they cannot fail.

Shoring Options

Use the timber or aluminum hydraulic shoring charts from the OSHA Standard

- - or - -

Have a registered professional engineer provide:

- Tabulated data
- Manufacturer's tabulated data
- Site-specific design



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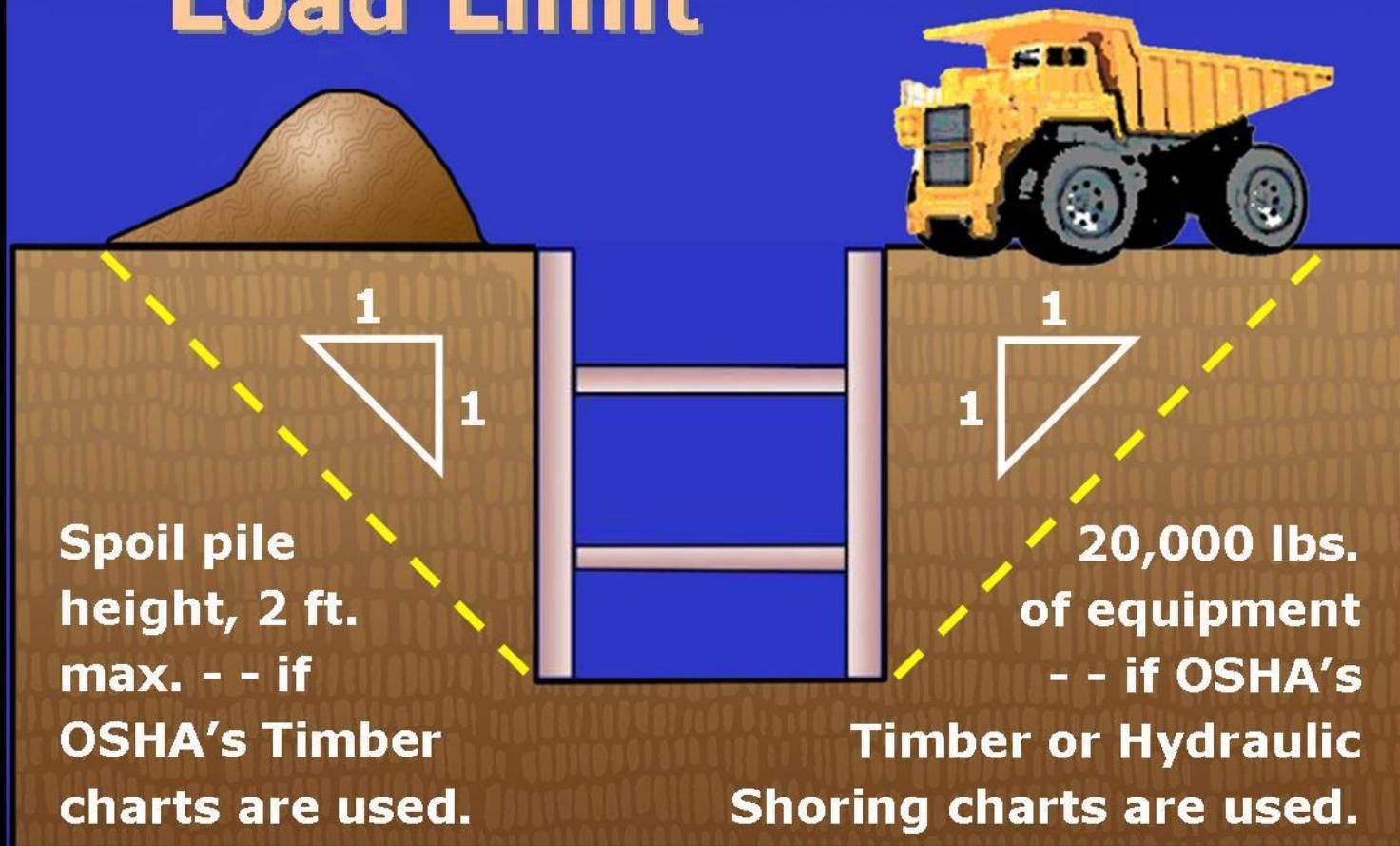


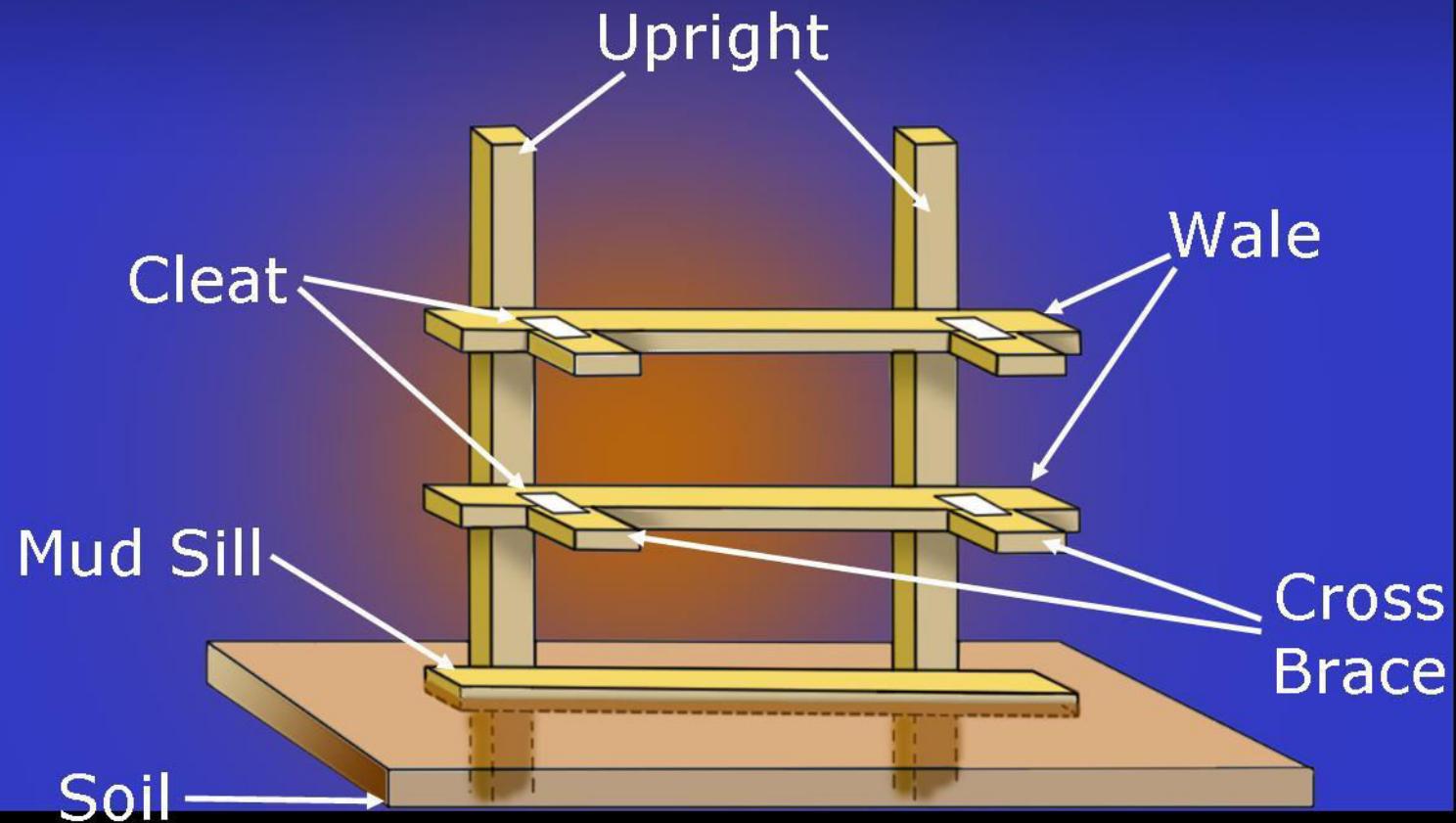
Overloading



Do not exceed allowable surcharge loads.

OSHA: Surcharge Load Limit





Timber Shoring

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Inadequate shoring constructed from
2" x 6" pine from the local lumber yard.



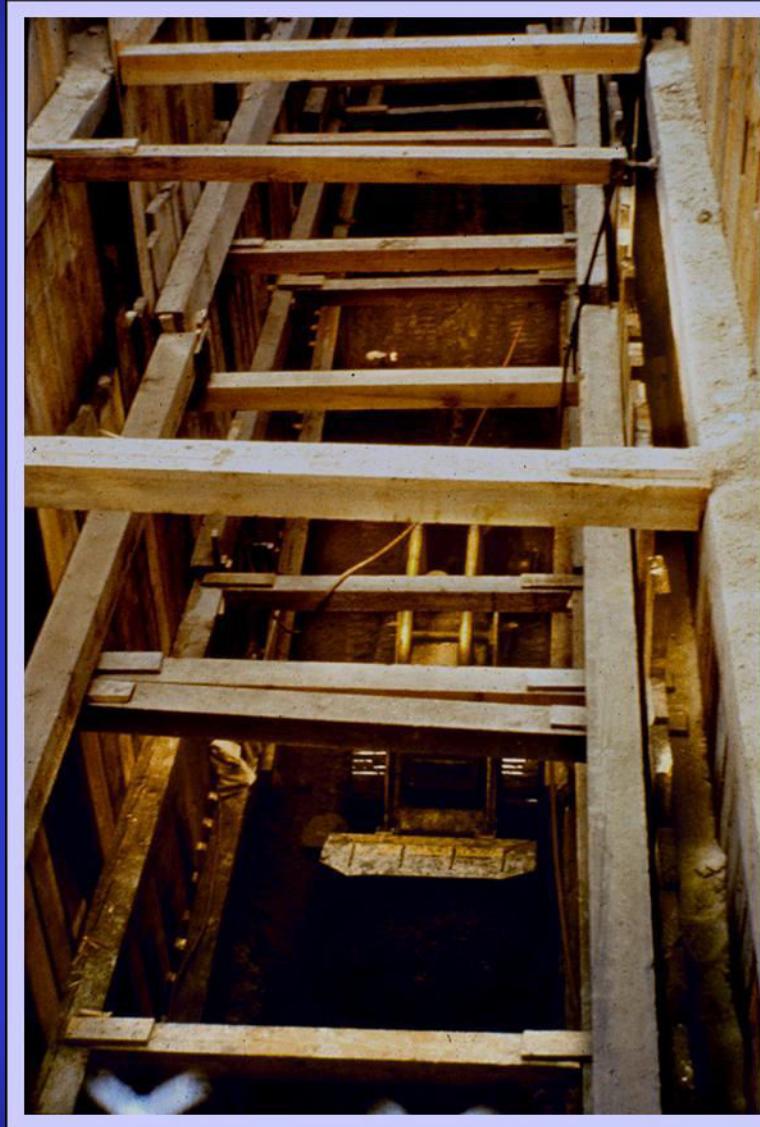
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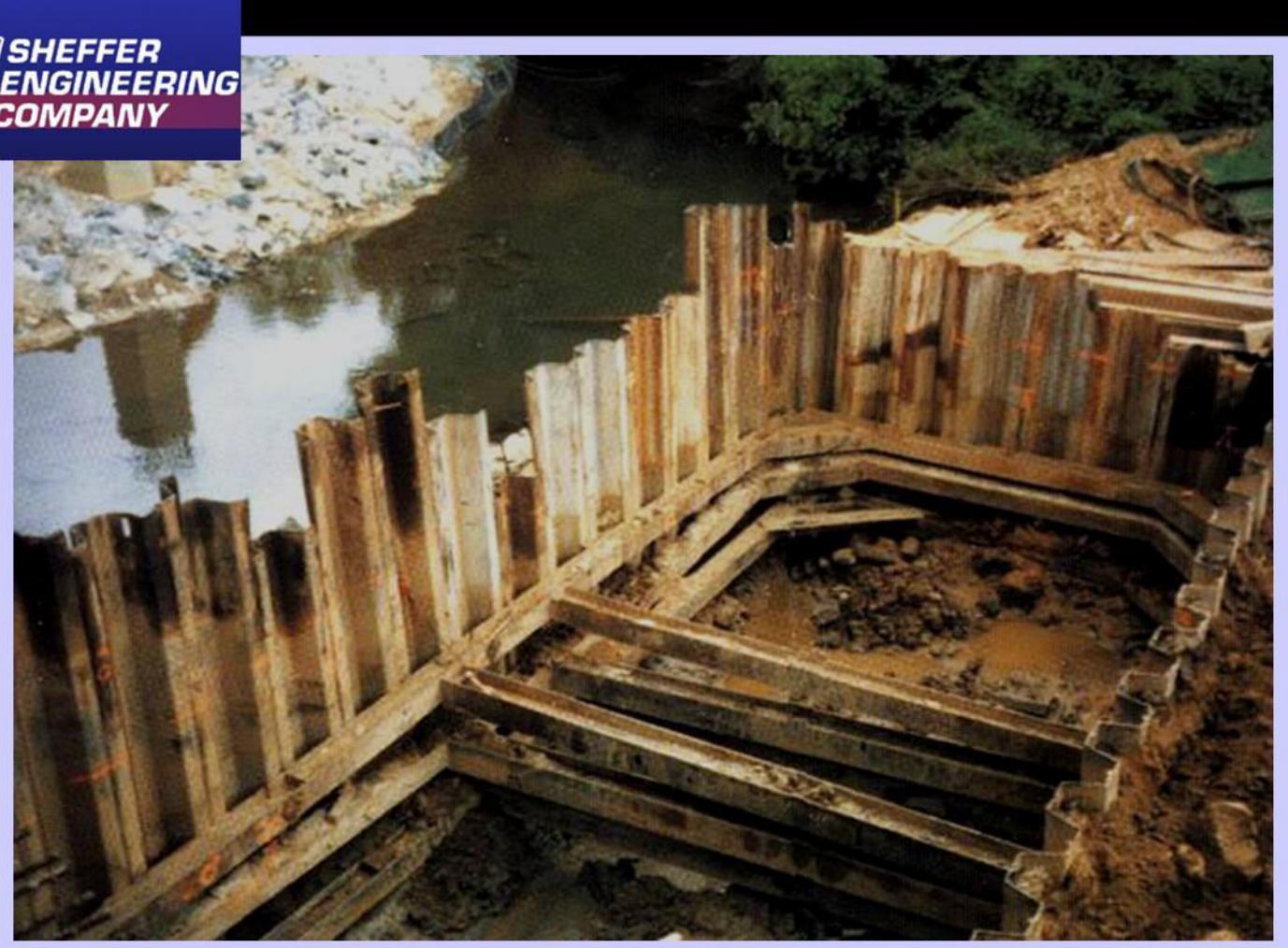
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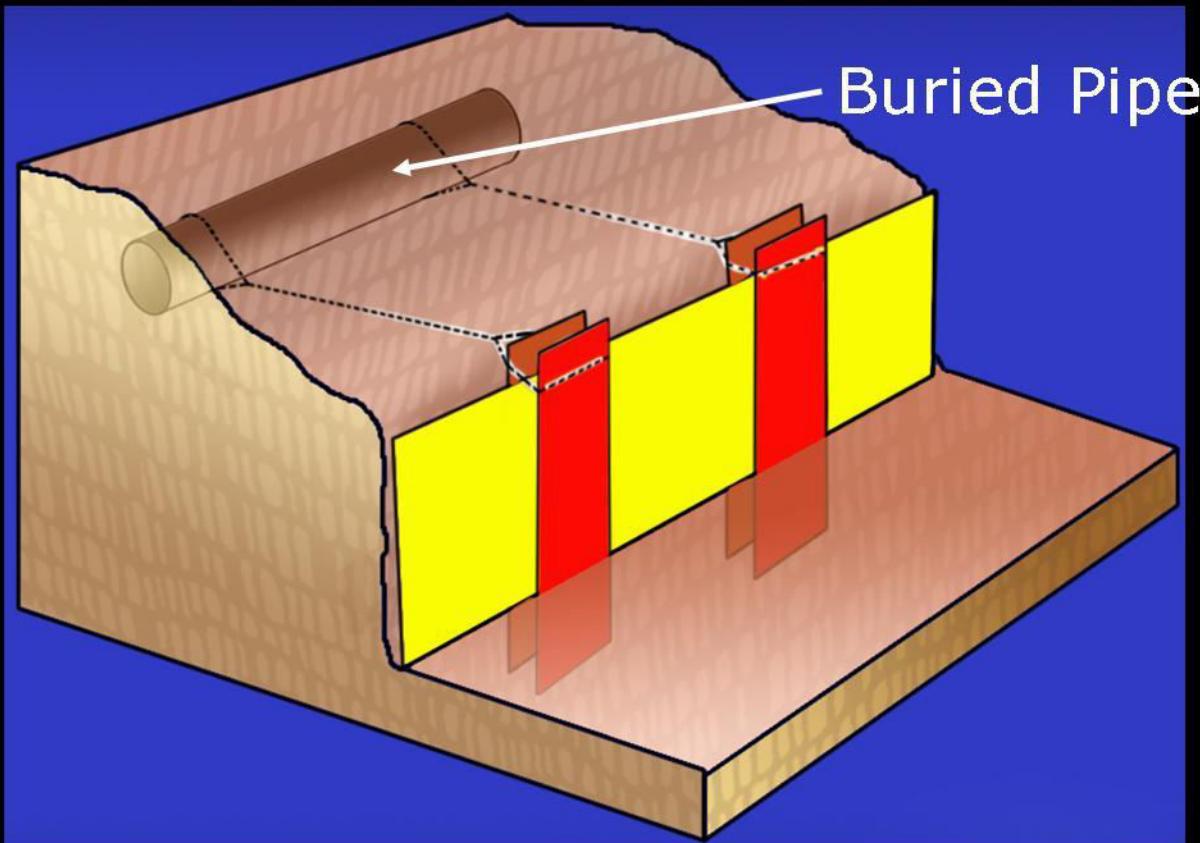
Steel sheet piling in “tight sheeting” application.



Soldier Piling



Tieback System

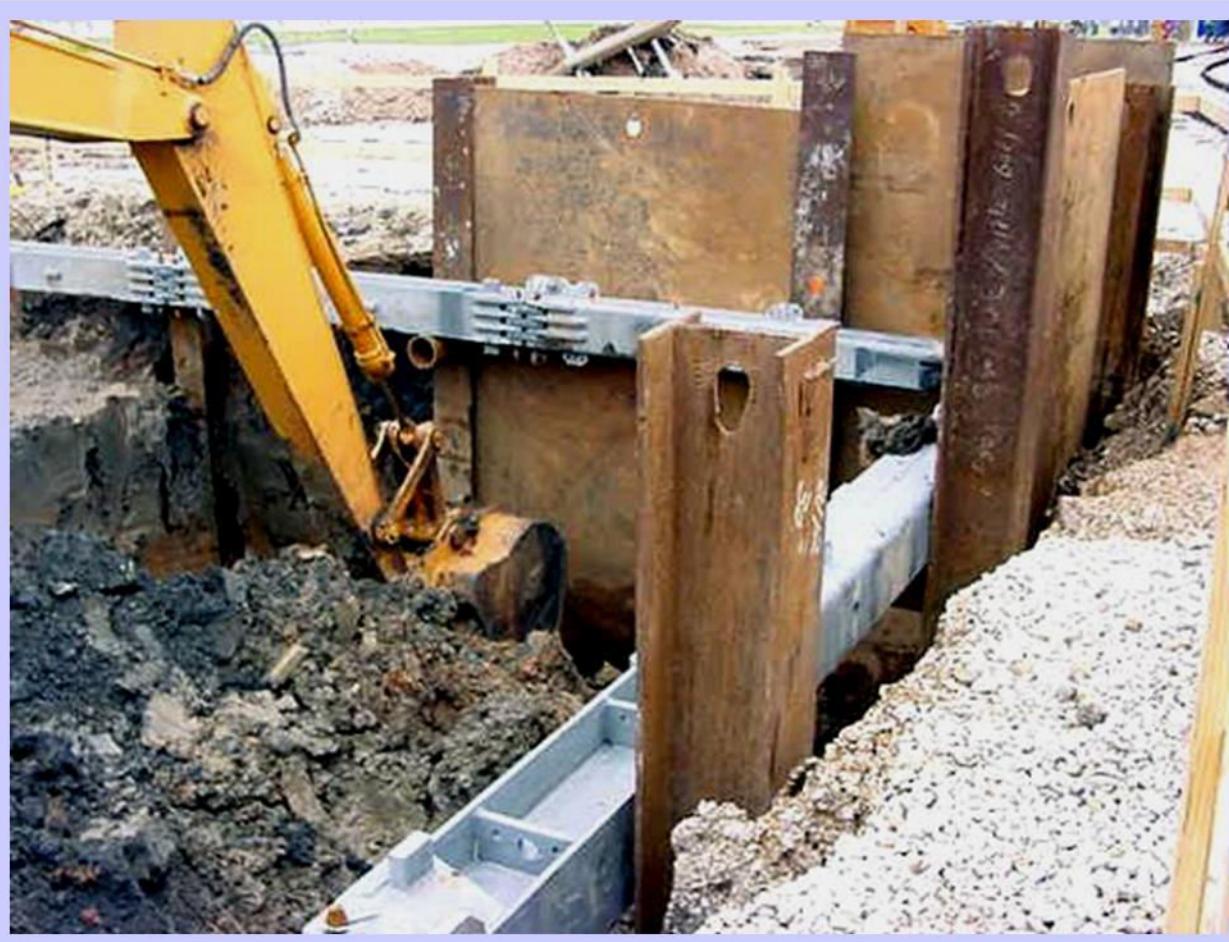


A Tieback System is often used with Soldier Piling or Plate & Beam Systems.



“Joe Pickup” Tieback System --
AKA, the fly swatter.

Plate & Beam System



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Soldier Piers



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Soil Nailing



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Slide Rail System



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Slide Rail System



Slide Rail & Steel Plate



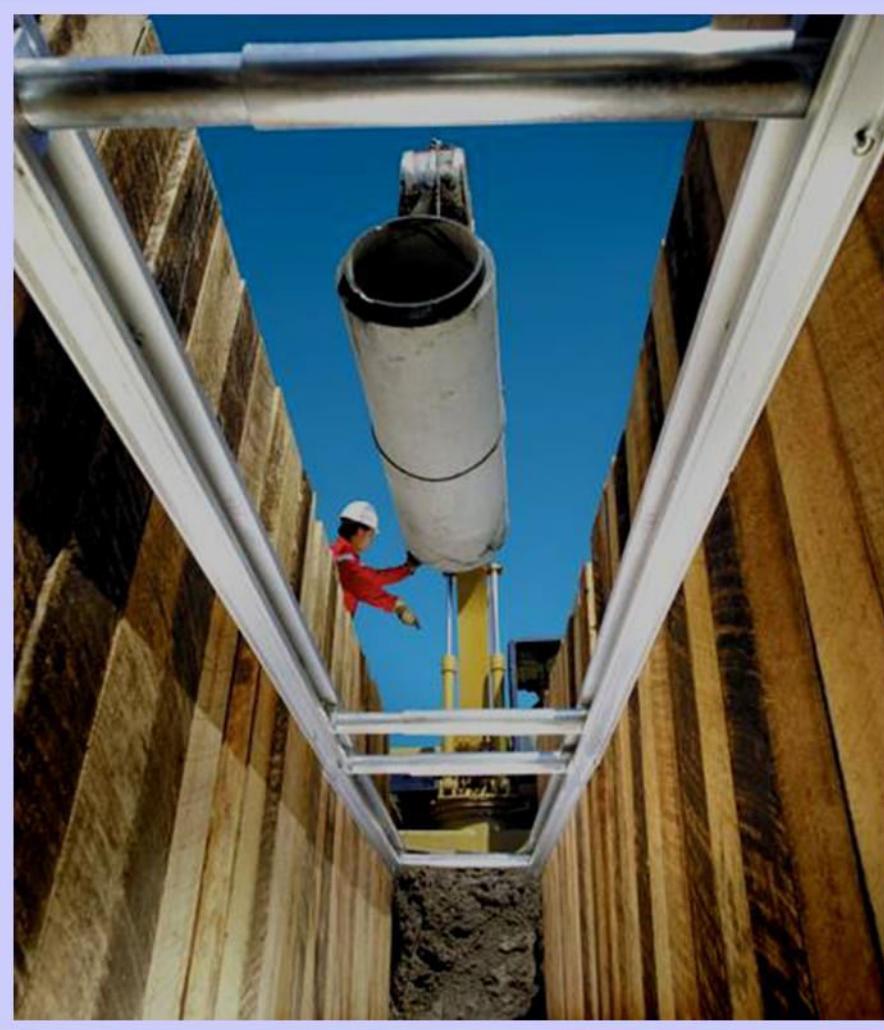
Aluminum Hydraulic Shoring



Vertical Shores



Waler Systems



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Single Shore



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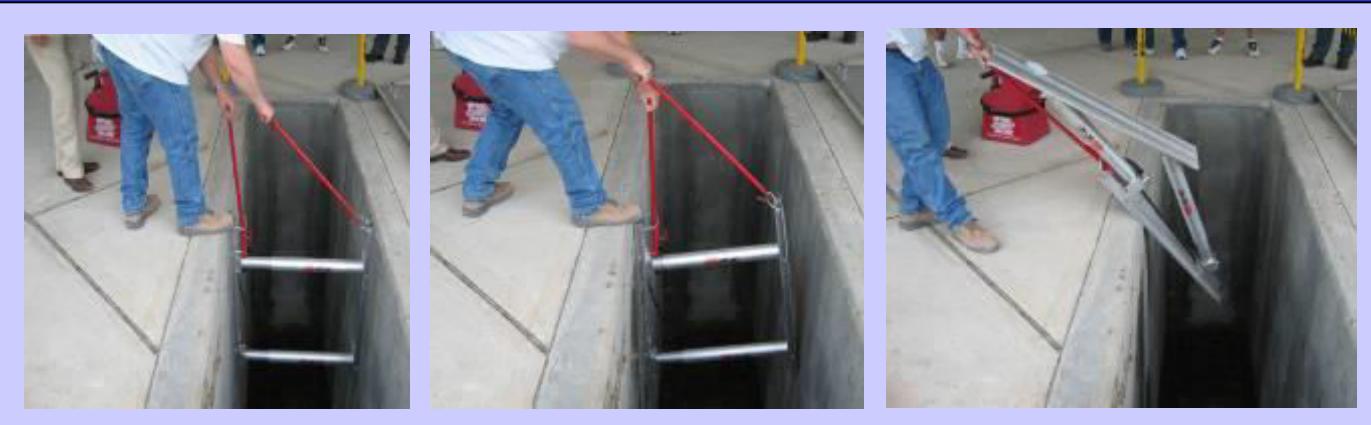
Installation of a Vertical Shore



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Removing a Vertical Shore



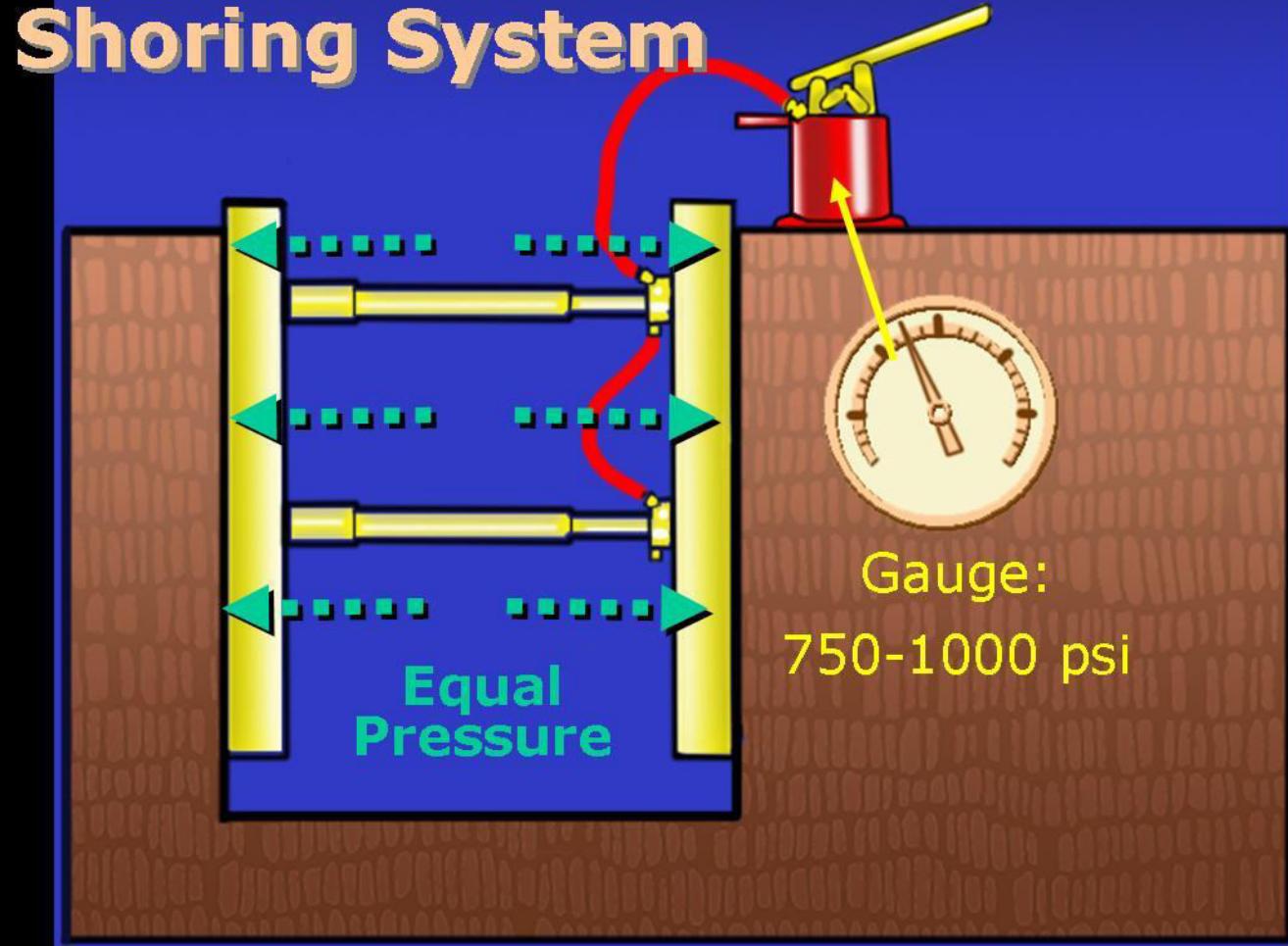


Environmentally Friendly Shoring Fluid

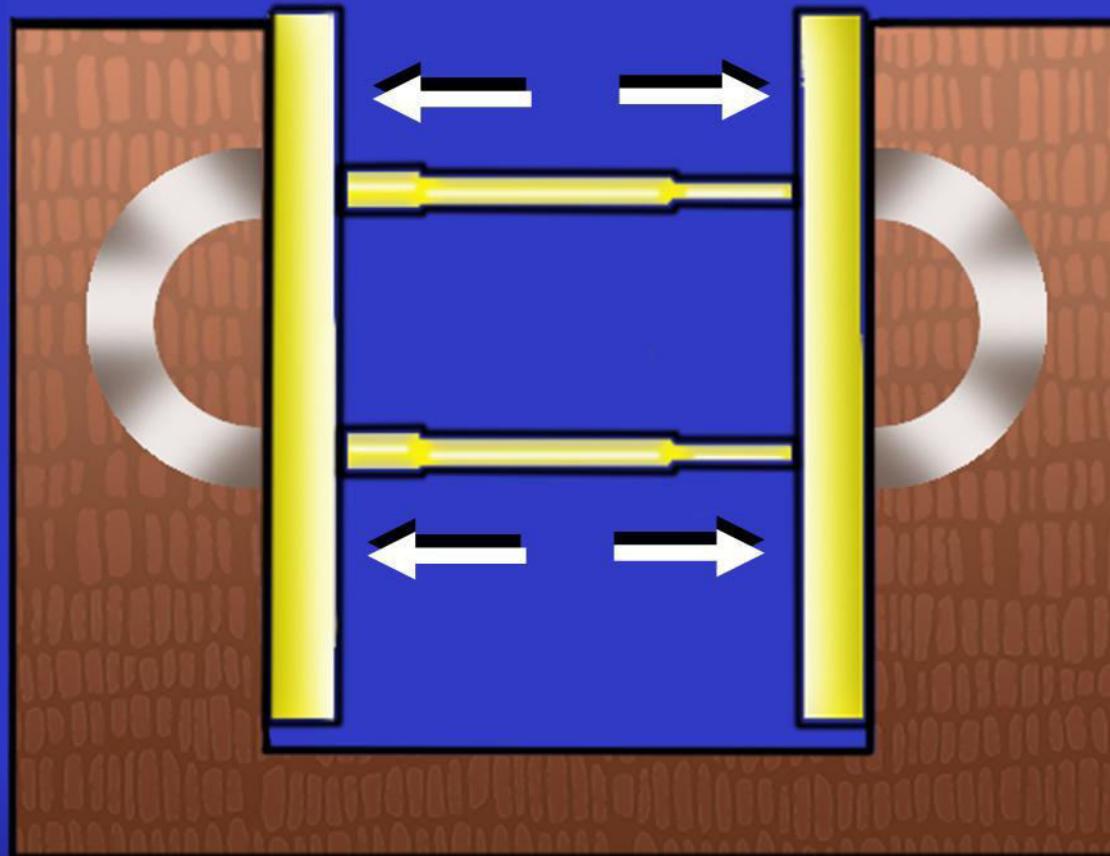
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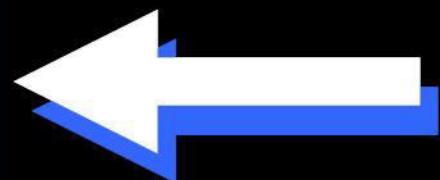
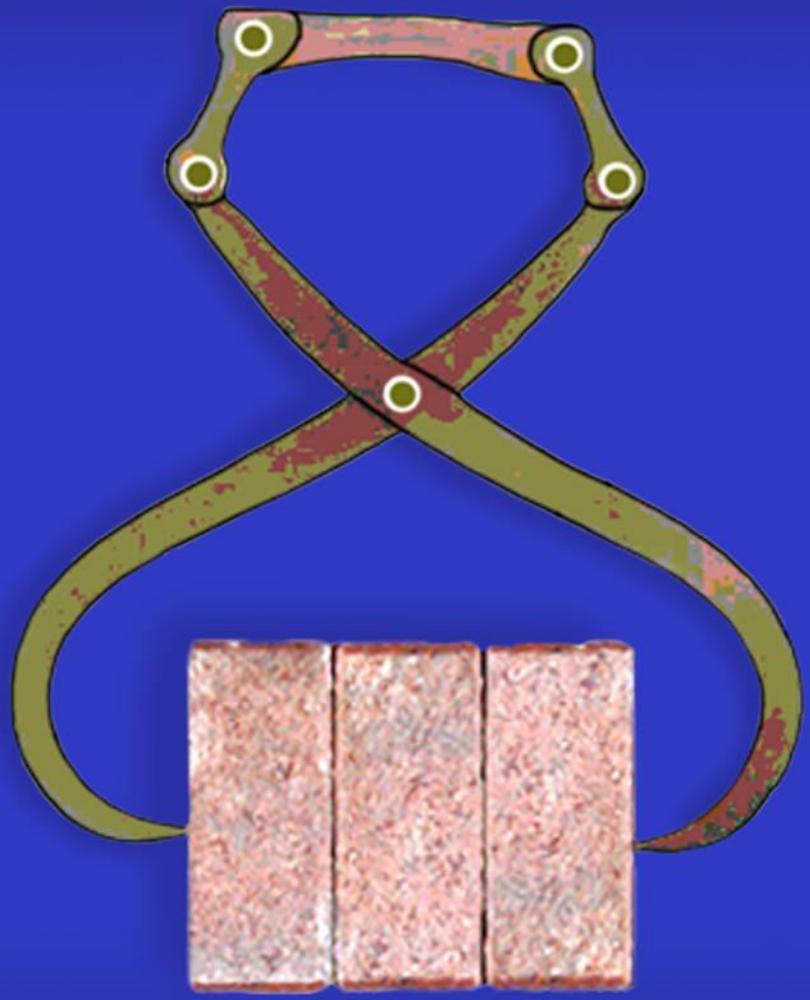


Hydraulic Shoring is an Active Shoring System



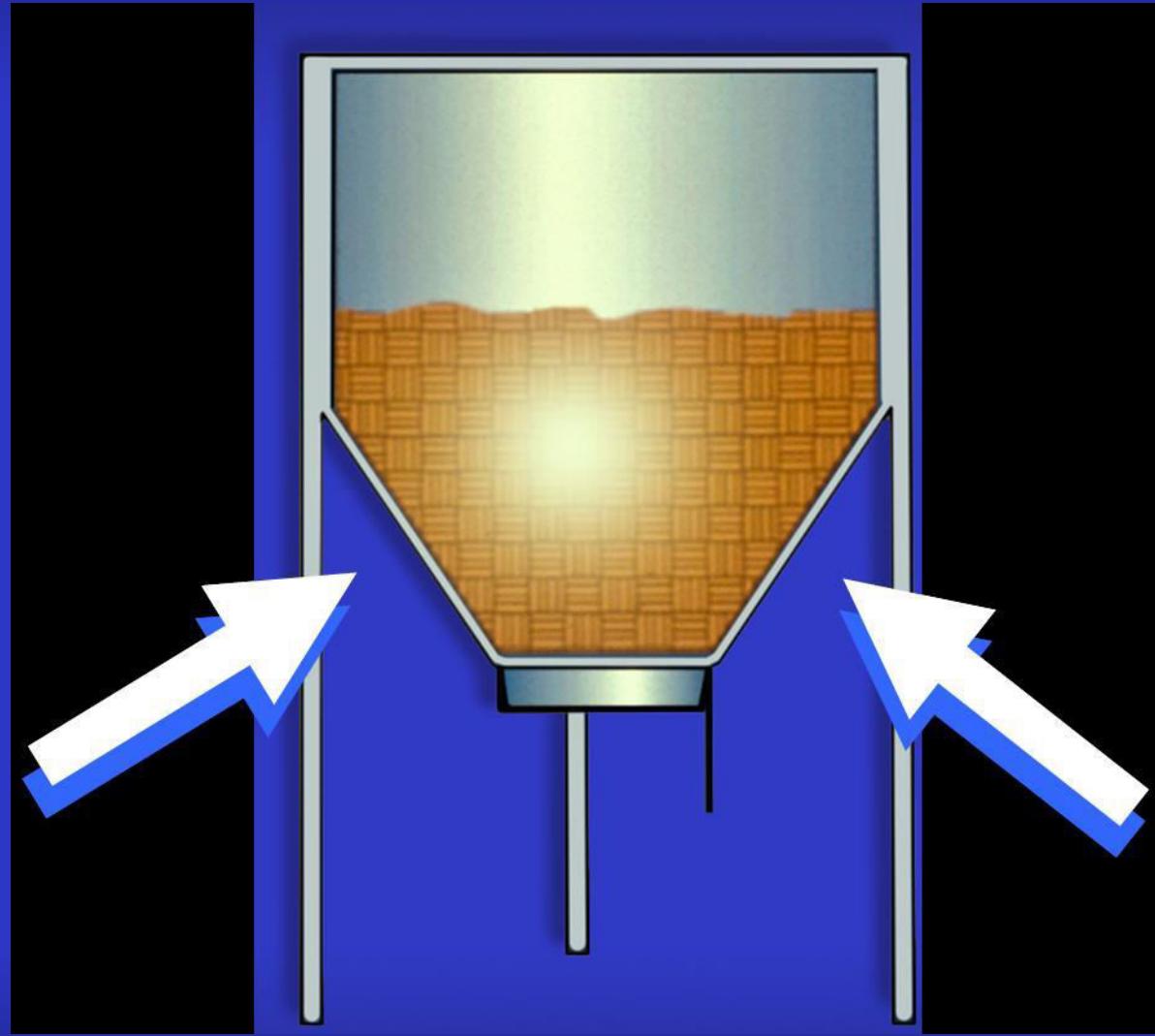
Soil Arching





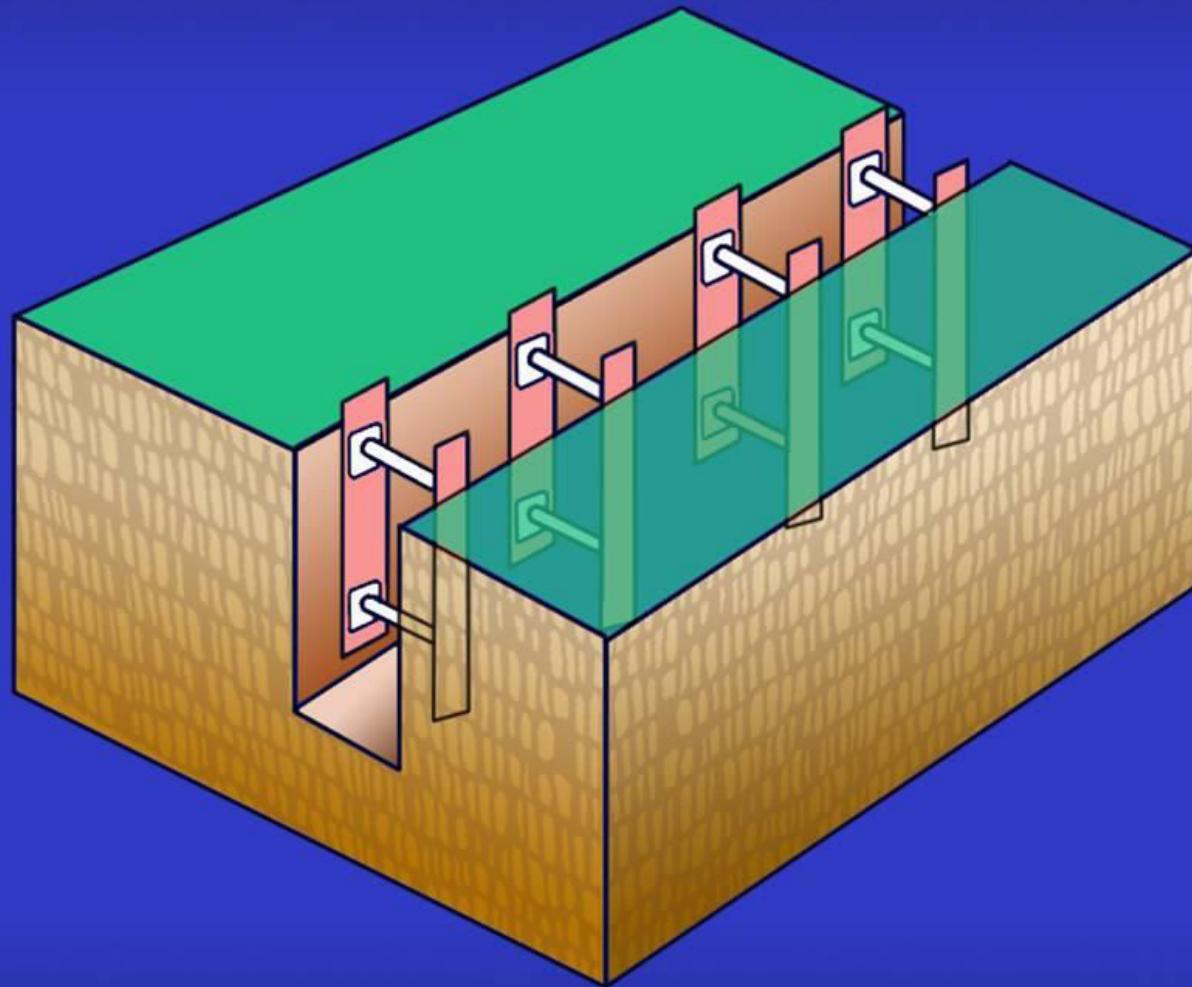
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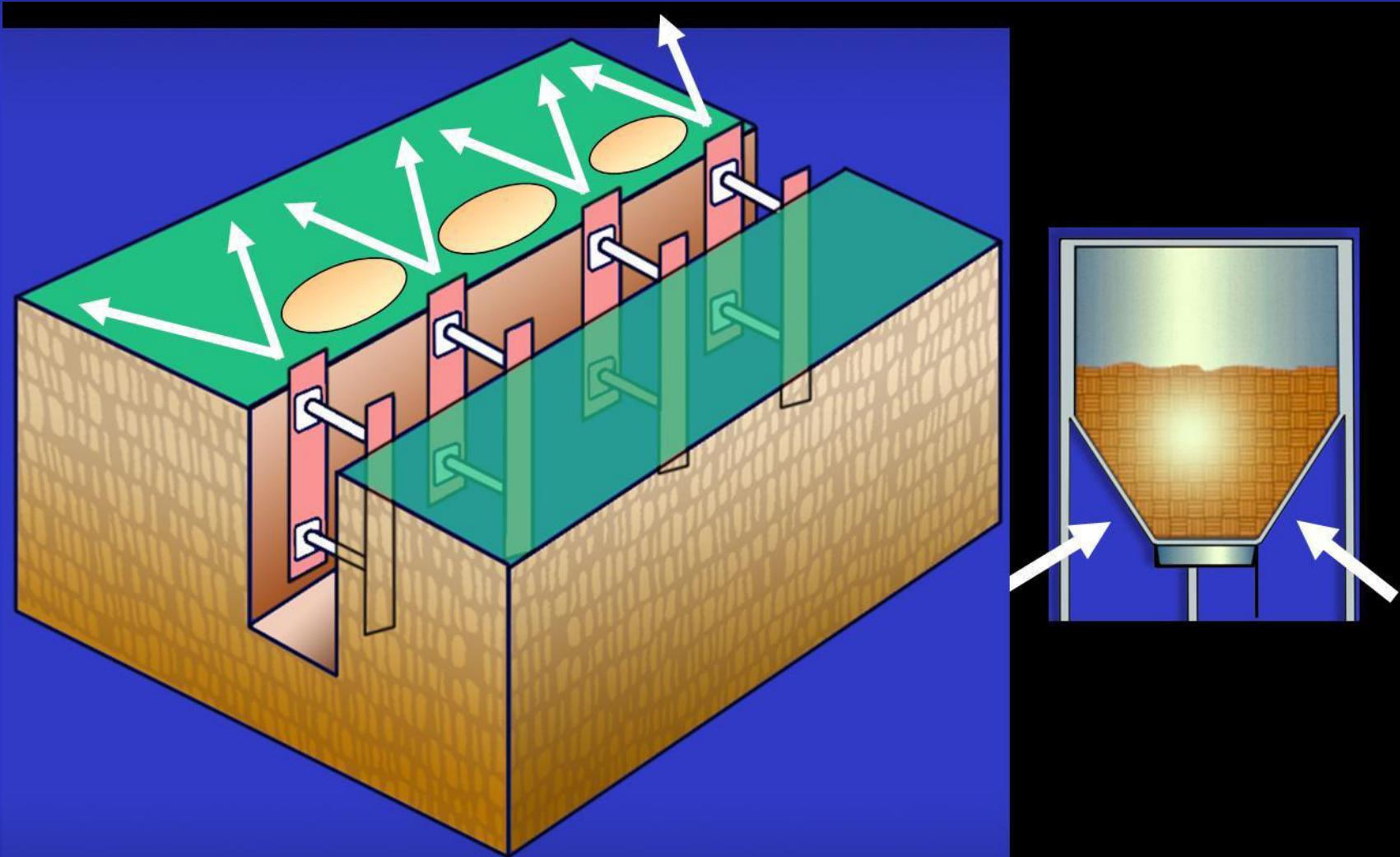
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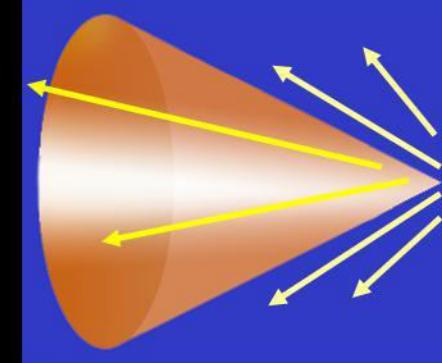
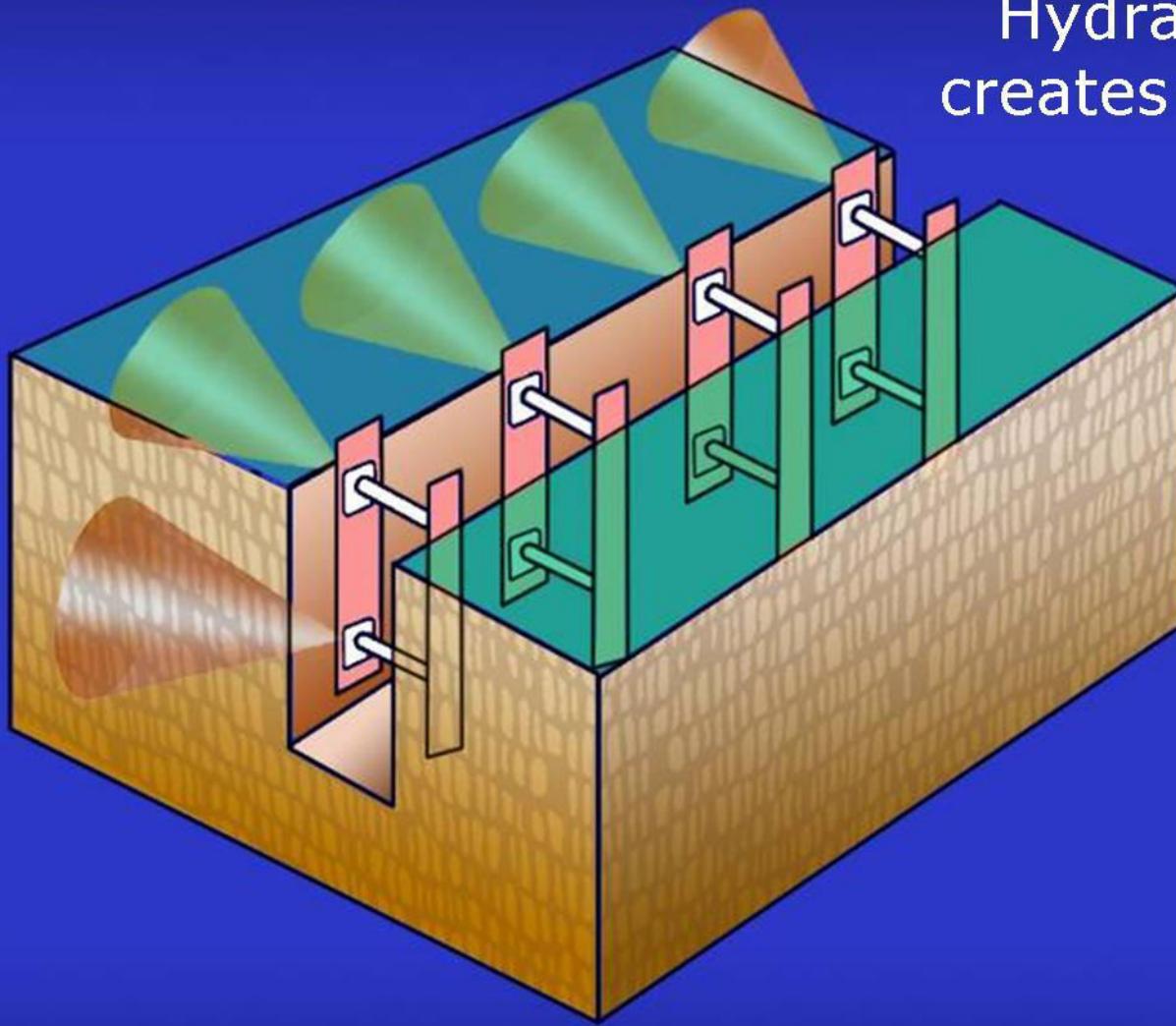


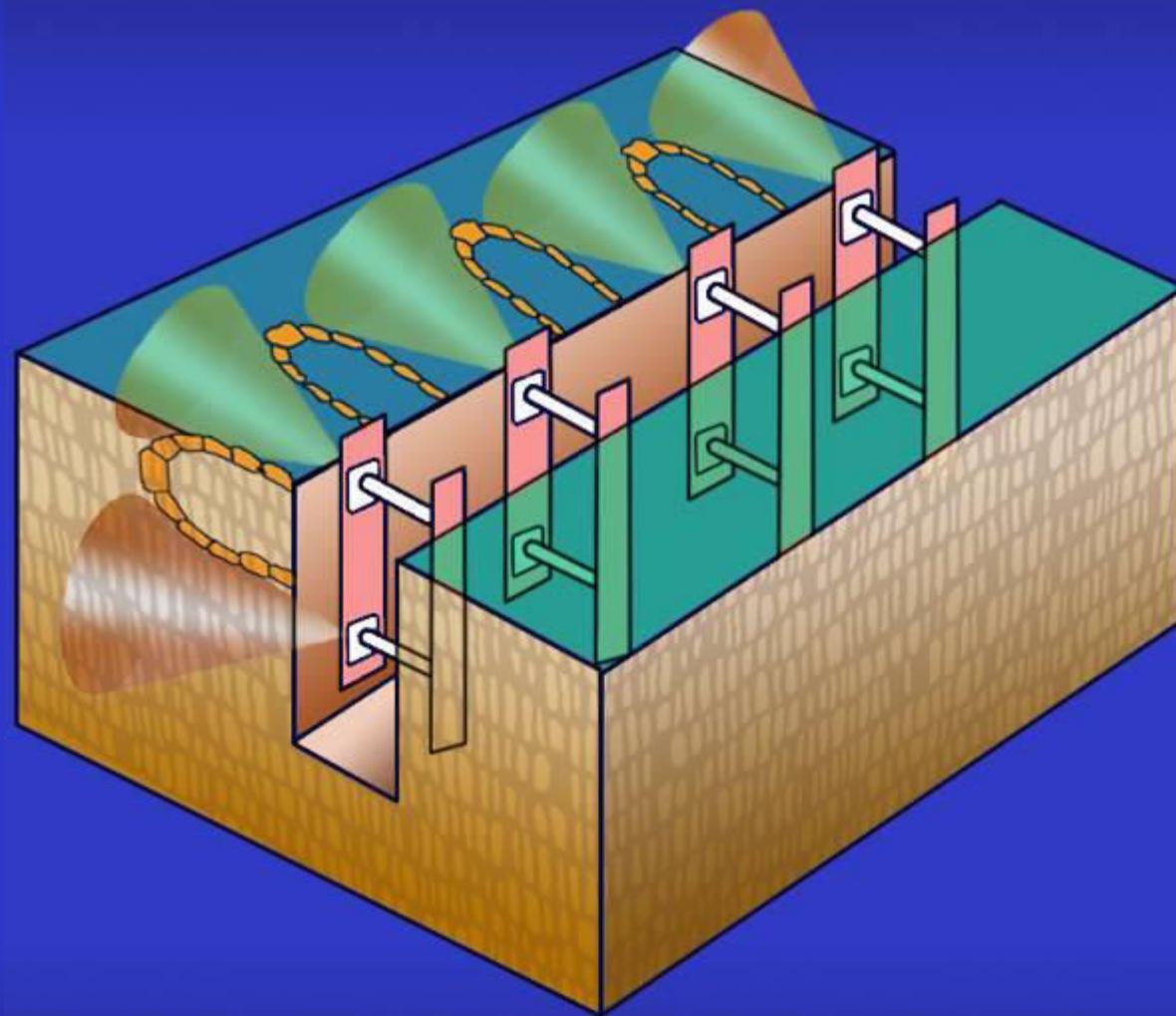


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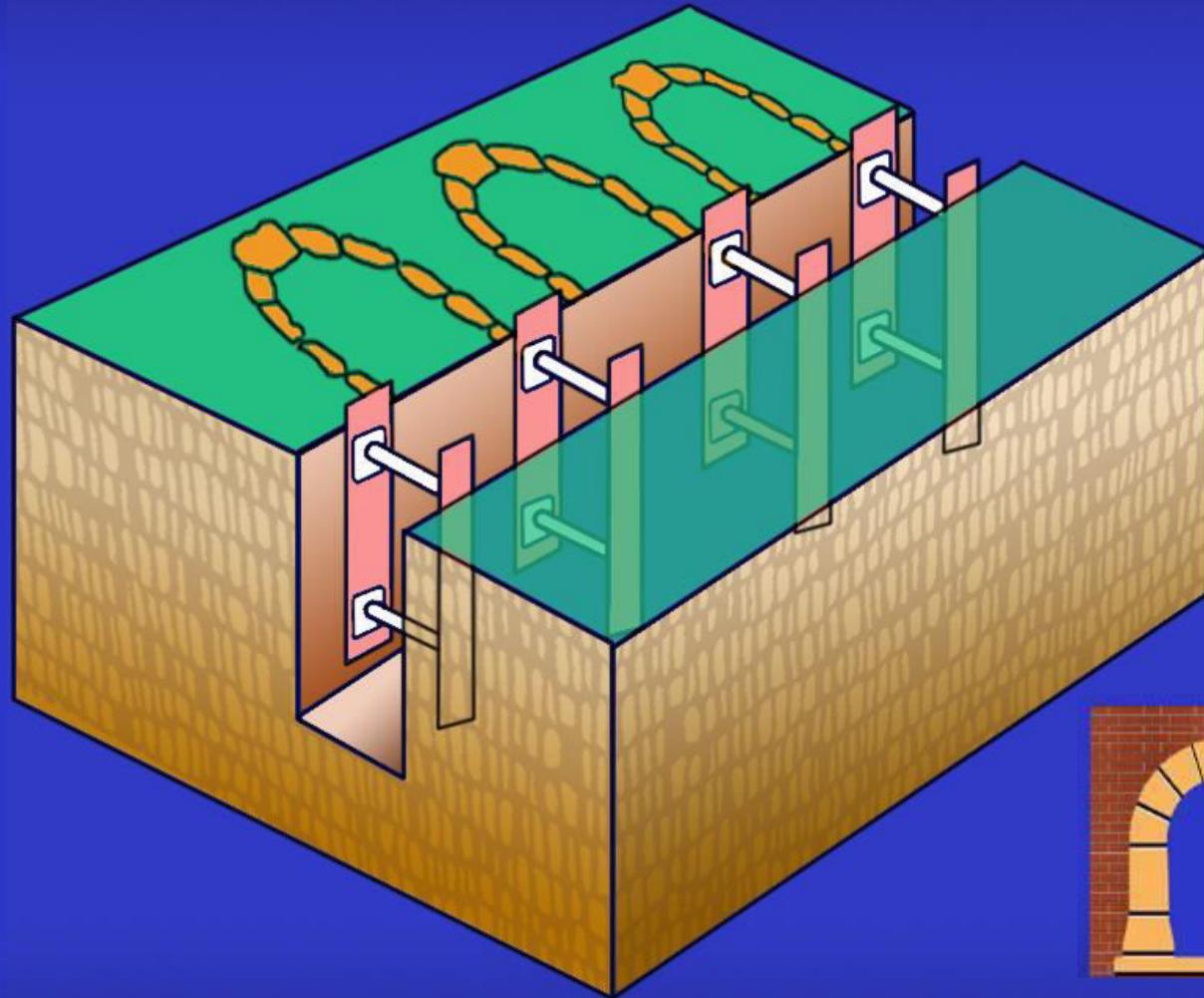
Hydraulic pressure creates compression cones.





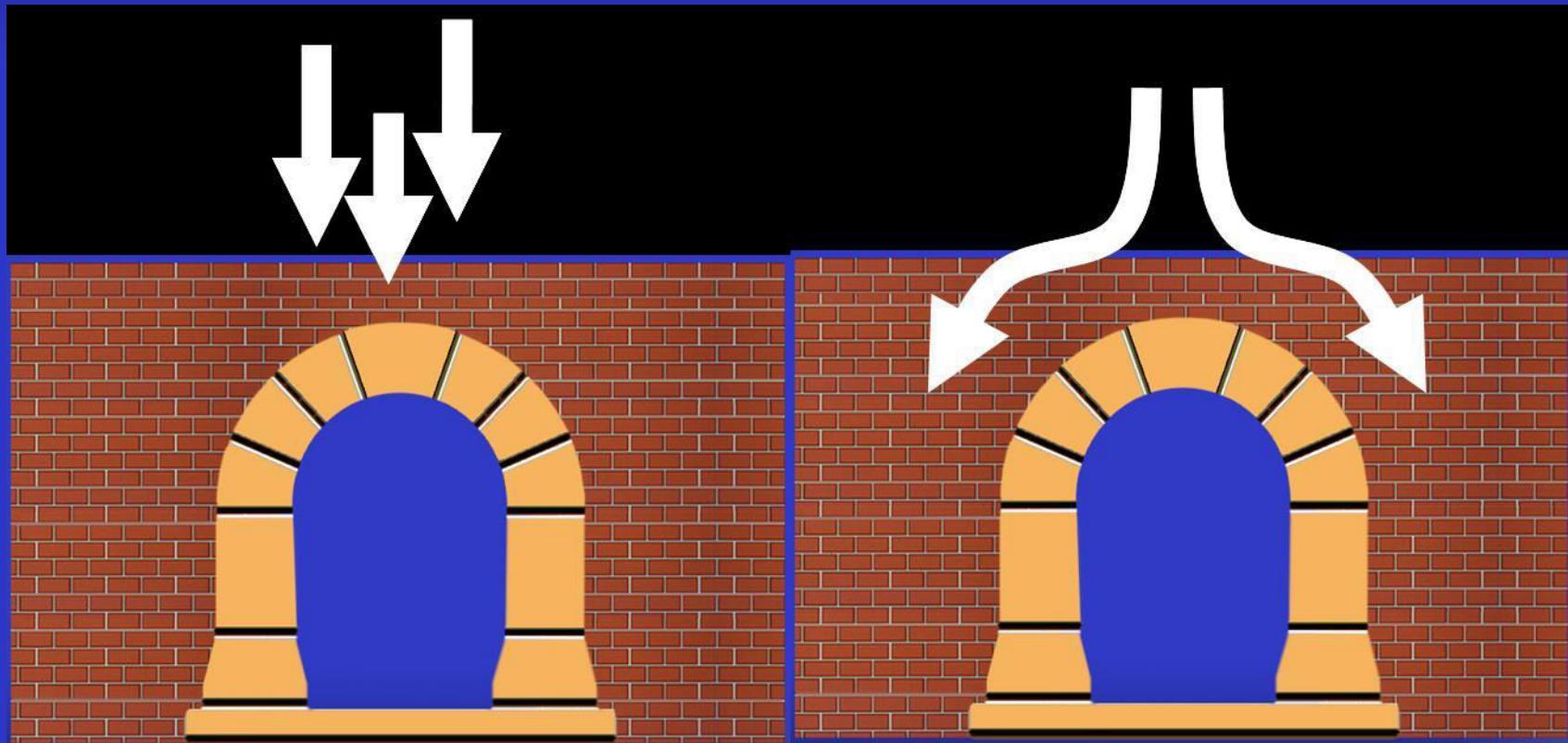
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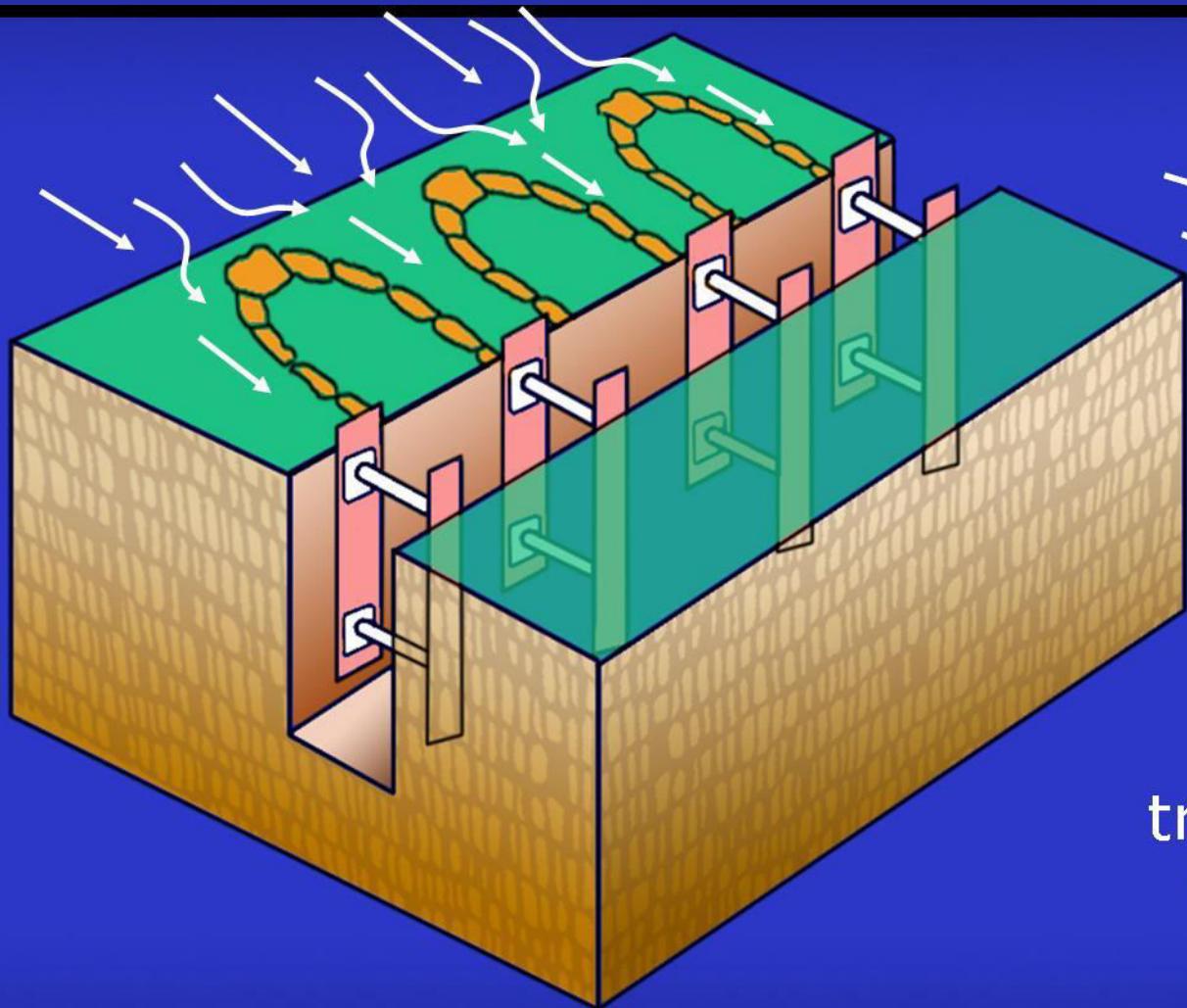


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Arches transfer the load to the legs.



Soil arching
transfers the load
to the cylinders.



Soil arching at work.





Soil arching does not extend past the last shore.



Vertical spacing of vertical shore.

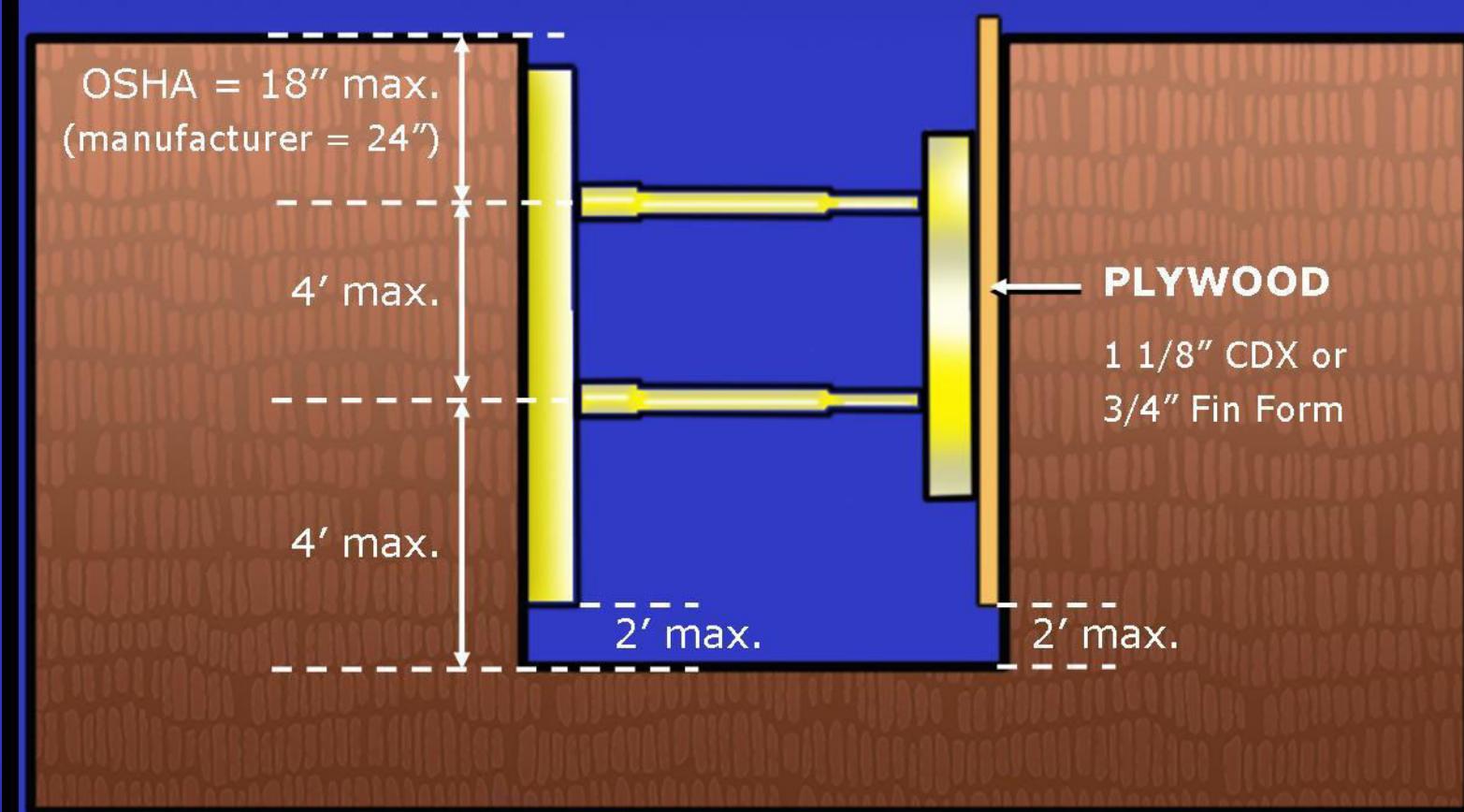


TABLE D - 1.2
Aluminum Hydraulic Shoring
Vertical Shores for Soil Type B

DEPTH OF TRENCH (feet)	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)	HYDRAULIC CYLINDERS		
			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 <i>Note (2)</i>	3 INCH DIAMETER
OVER 10 UP TO 15	6.5	4	2 INCH DIAMETER	2 INCH DIAMETER <i>Note (2)</i>	3 INCH DIAMETER
OVER 15 UP TO 20	5.5	4	2 INCH DIAMETER	2 INCH DIAMETER <i>Note (2)</i>	3 INCH DIAMETER
OVER 20	<i>Note (1)</i>				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

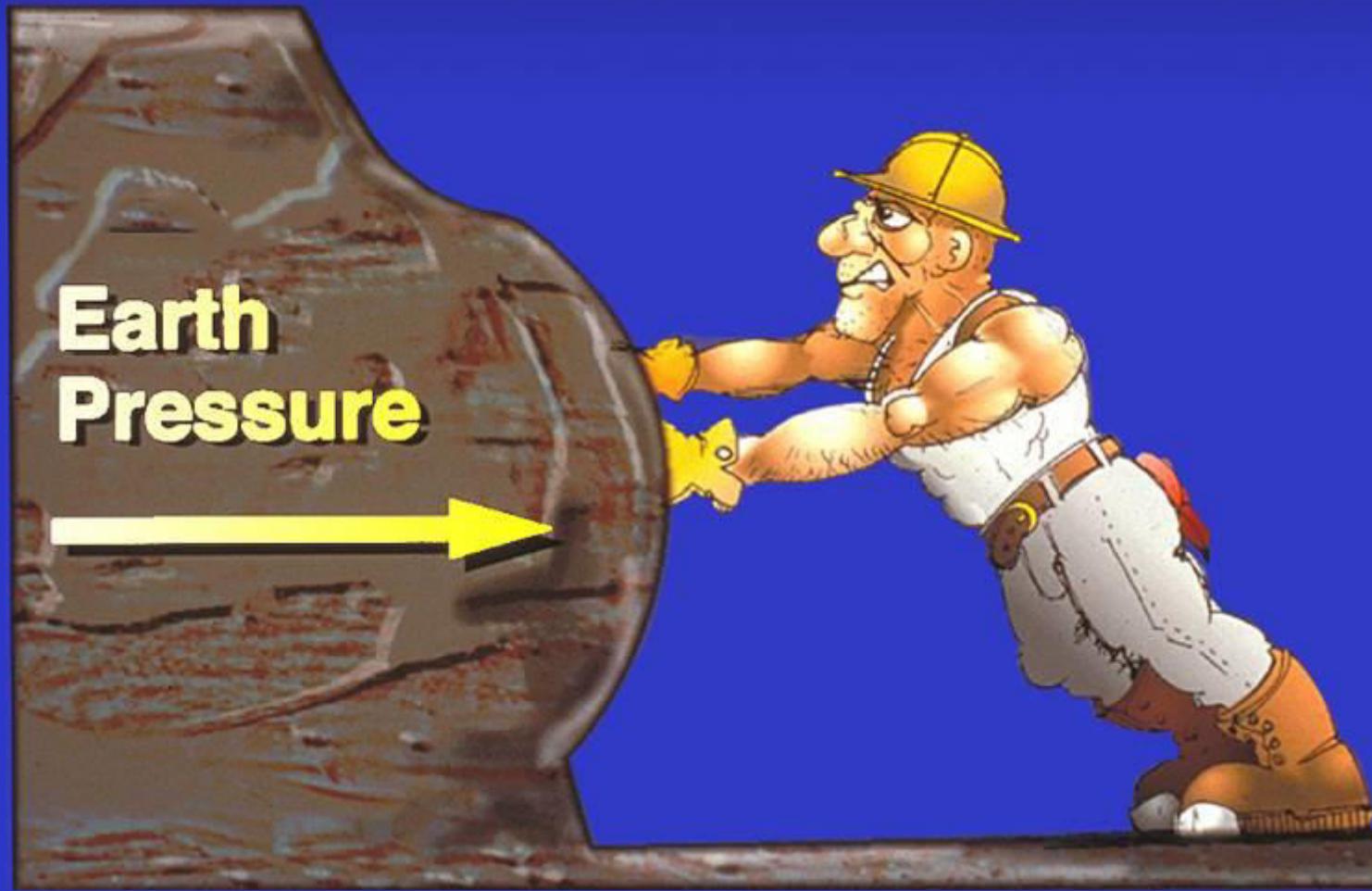
Note (1): See Appendix D, Item (g)(1)

Note (2): See Appendix D, Item (g)(2)

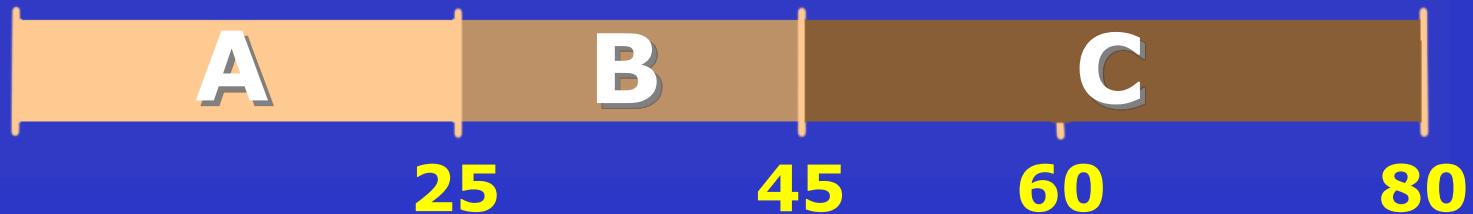


What about Vertical Shores in Type C Soil?





PCF



Equivalent Fluid Pressure
or
Equivalent Weight Effect



C-60





VERTICAL SHORES - TABLE VS-3

TYPE "C-60" SOIL
(See 3.3 for definition of C-60 Soil)

DEPTH OF EXCAVATION (feet)	HYDRAULIC CYLINDERS					SHEETING <i>Note (4)</i>	
	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING <i>Note (6)</i> (feet)	WIDTH OF EXCAVATION (feet)				
			0 TO 8	8 TO 12	12 TO 15		
0 TO 10	6 <i>Note (5)</i>	4	2" DIA	2" DIA	2" DIA <i>Note (1)</i>	<i>Note (2)</i>	
0 TO 20	4	4	2" DIA	2" DIA <i>Note (1)</i>	2" DIA <i>Note (1)</i>	<i>Note (7)</i>	
0 TO 25	4	4	2" DIA	2" DIA <i>Note (1)</i>	N/A	<i>Note (7)</i>	



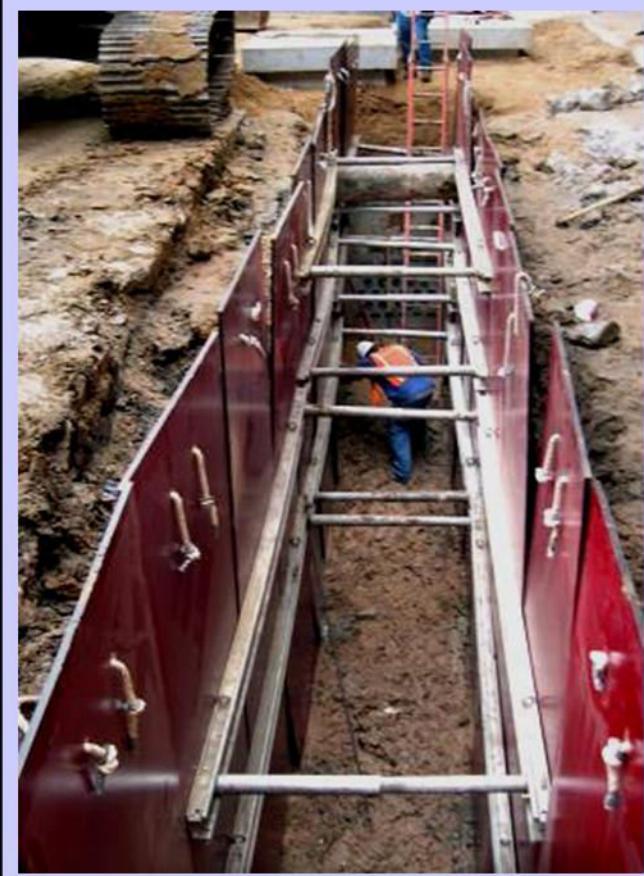
Engineered Shoring Plan



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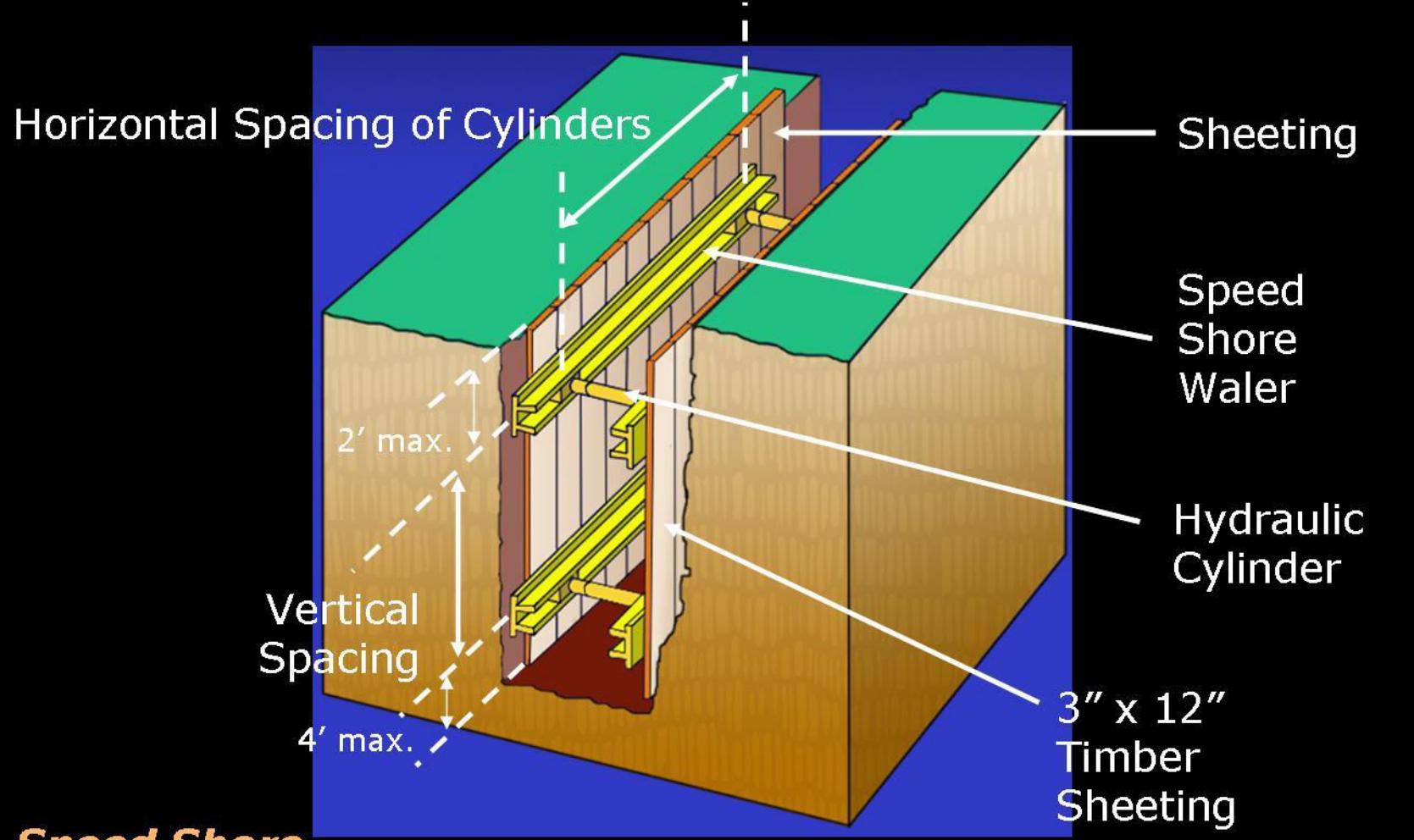


Waler Systems



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Speed Shore
Aluminum Hydraulic Shoring
Typical Waler System



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		
	VERTICAL SPACING (feet)	SECTION* MODULUS (in ³)	WIDTH OF TRENCHES (feet)						MAX. HORIZ. SPACING (on center)		
			UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO 15		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.



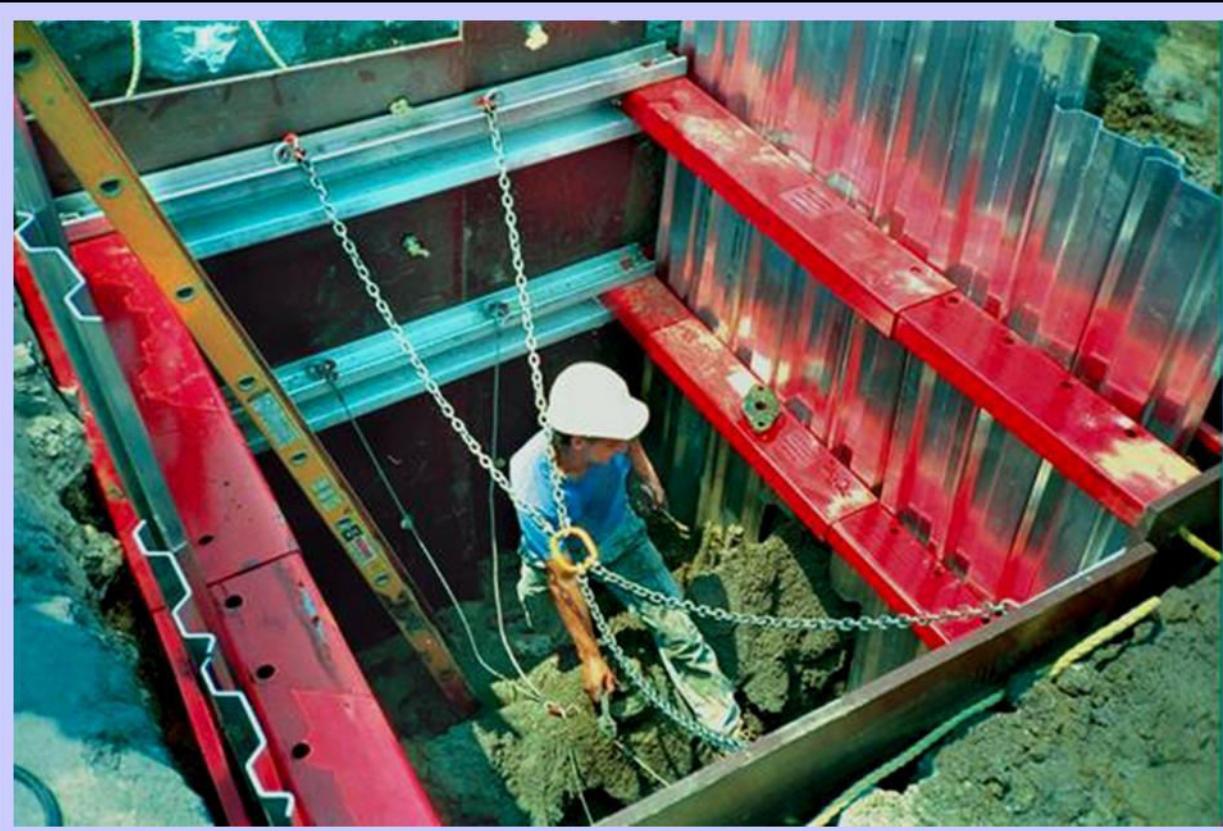
Manufacturer's Alternative Sheeting



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Waler with Speed-Strut End Beams



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4-Way Manhole Brace With Timber Sheeting



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4-Way Manhole Brace With Steel Plate



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Shield Systems



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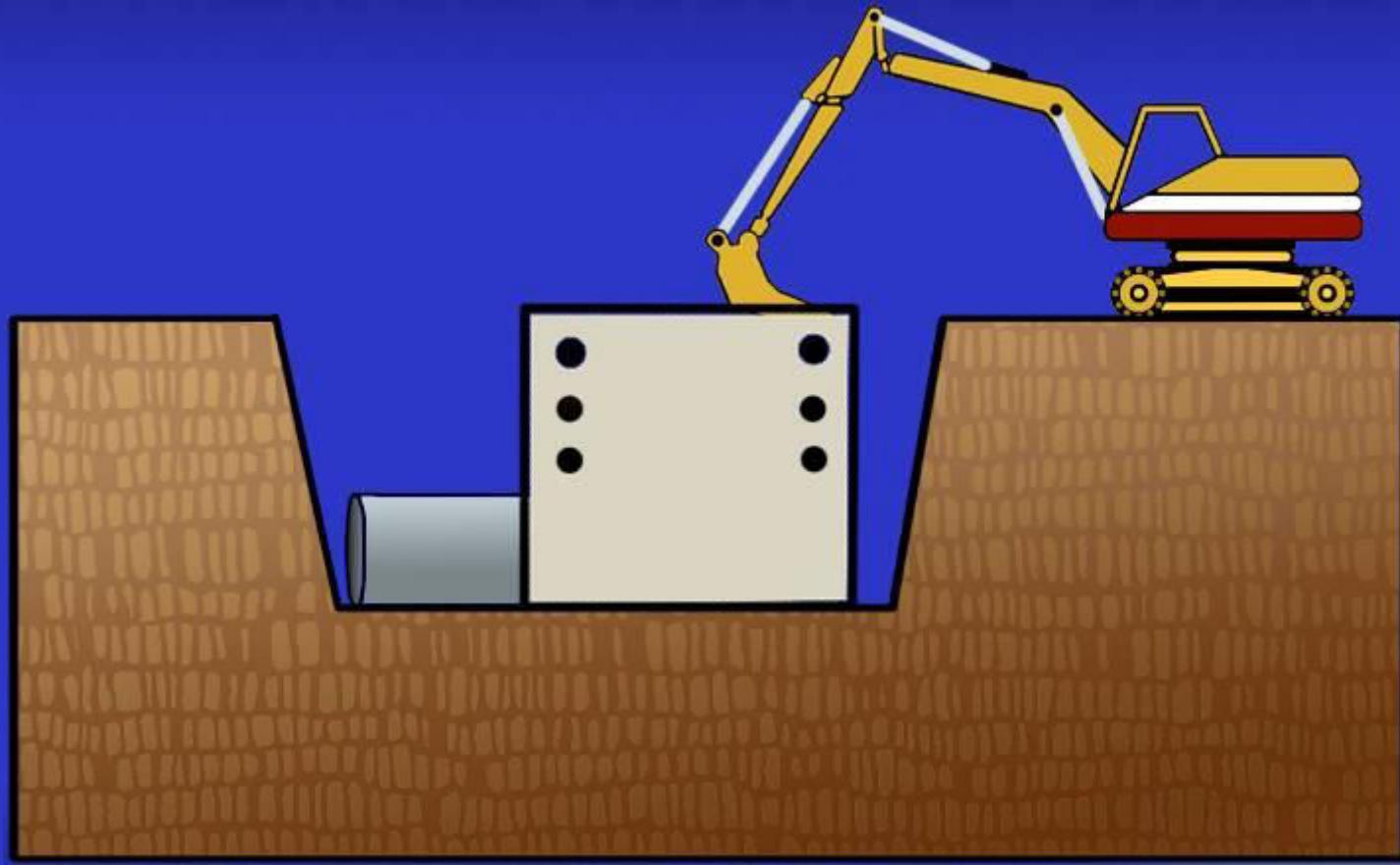




Utility Installation

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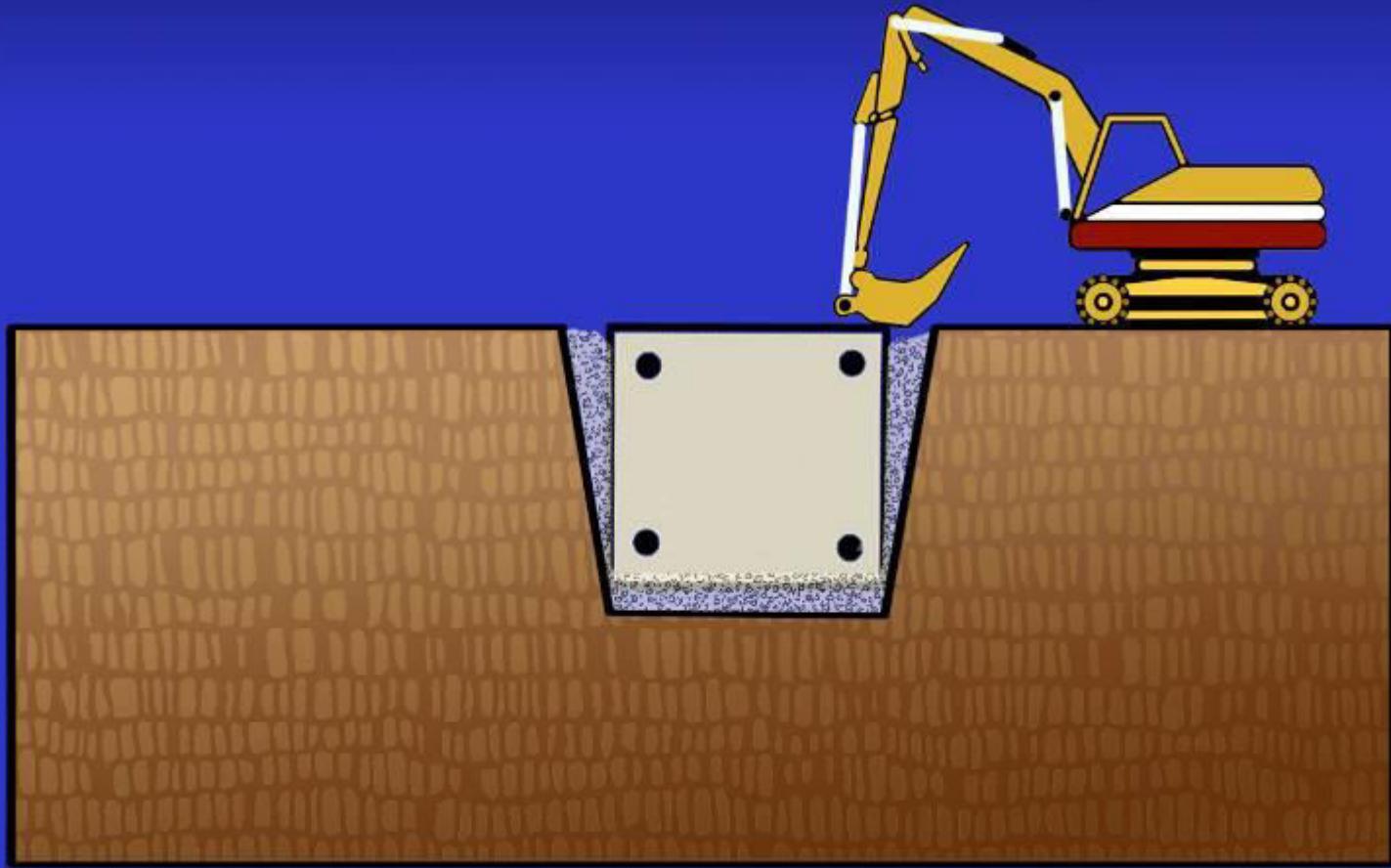
Utility Installation



Utility Repair

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Utility Repair

Shield Systems



Shields do not prevent cave-ins. They protect you when the cave-in occurs.

Employees may remain inside the shield when it is moved forward, but they may not be in the excavation when the shield is installed, removed, or raised vertically.





Employees are exposed to unsupported walls.



Shields must be certified.
Do not jury-rig or “field fabricate” your own.

Shield Certification



TABULATED DATA AND TRENCH SHIELD CERTIFICATION

SERIAL NUMBER: 3-2091	MODEL: TS-08 16 DW 6	
HEIGHT = 8 feet	LENGTH = 16 feet	THICKNESS = 6 inches
MAXIMUM LATERAL EARTH PRESSURE = 2,047 pounds per square foot		

MAXIMUM DEPTH OF EXCAVATION		
O.S.H.A. Soil Type	Equivalent Weight Effect (<i>p.c.f.</i>)	Depth "H" (feet)
A	25	50
B	35	50
B	45	48
C	60	37
C	80	29

Spreader Size = 8 inch Schedule 80 Pipe / Maximum Spreader Length = 20 feet

This shield is manufactured to meet the requirements of O.S.H.A. CFR 29, Part 1926, Subpart P. This shield must be used in a manner consistent with safe working procedures, federal, state, and local regulations, and manufacturer's instructions. Contact manufacturer for any non-standard use of this trench shield.





Anticipate worst conditions.

Beware of Limitations to Shield Use

** PSF rating and depths are based on short term exposure with excavation open a period of time equal to 24 hours or less.

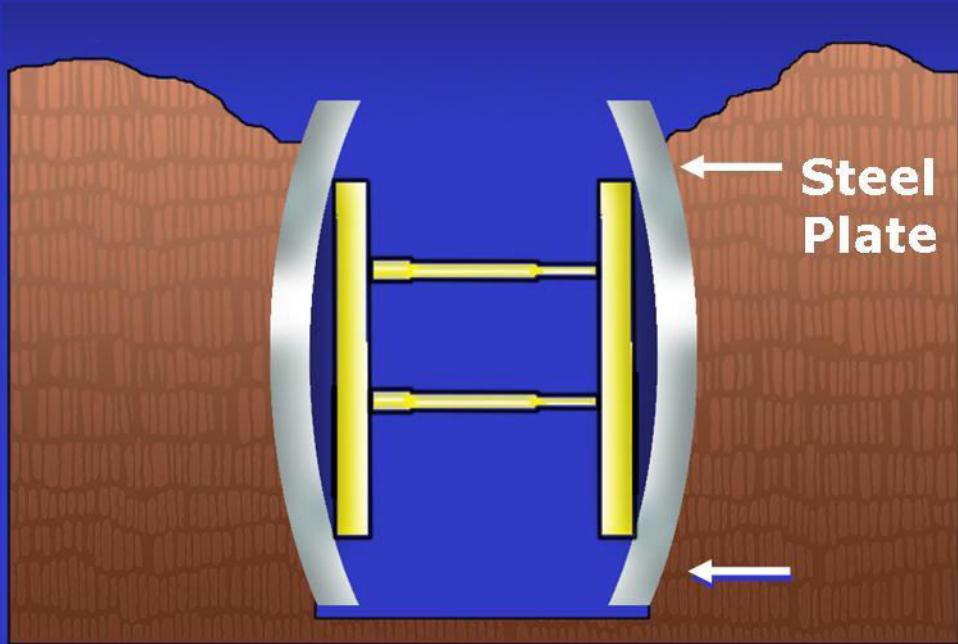
Type B not exceeding 45 PSF per foot of depth, and Type C nor exceeding 60 PSF per foot in depth.



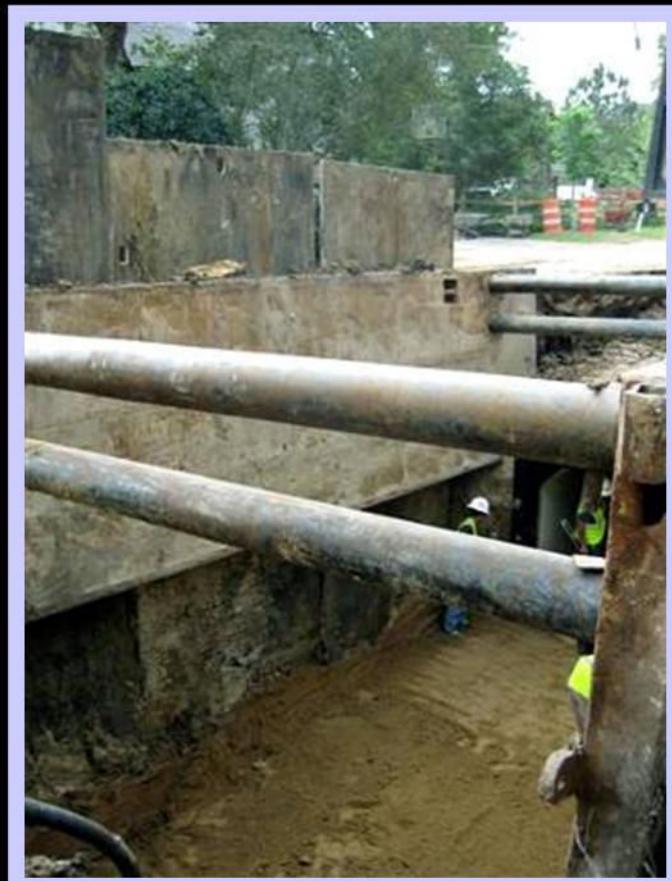


You may not exceed the rated capacity of any shield.





Do not use steel plates
behind shields.



It can cause the shield to be overloaded . . .





. . . with predictable results.



You cannot make any additions to, any subtractions from, or any alterations to any shield without written consent from the manufacturers or a registered professional engineer.



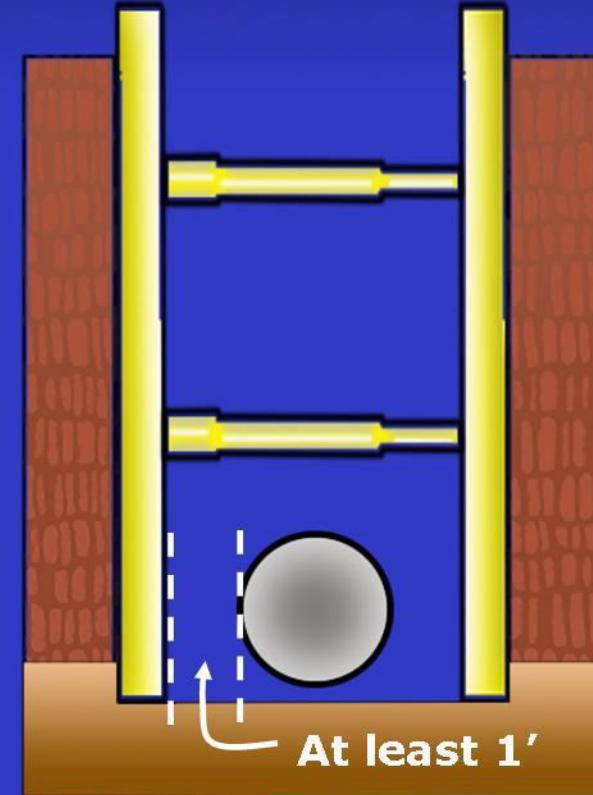
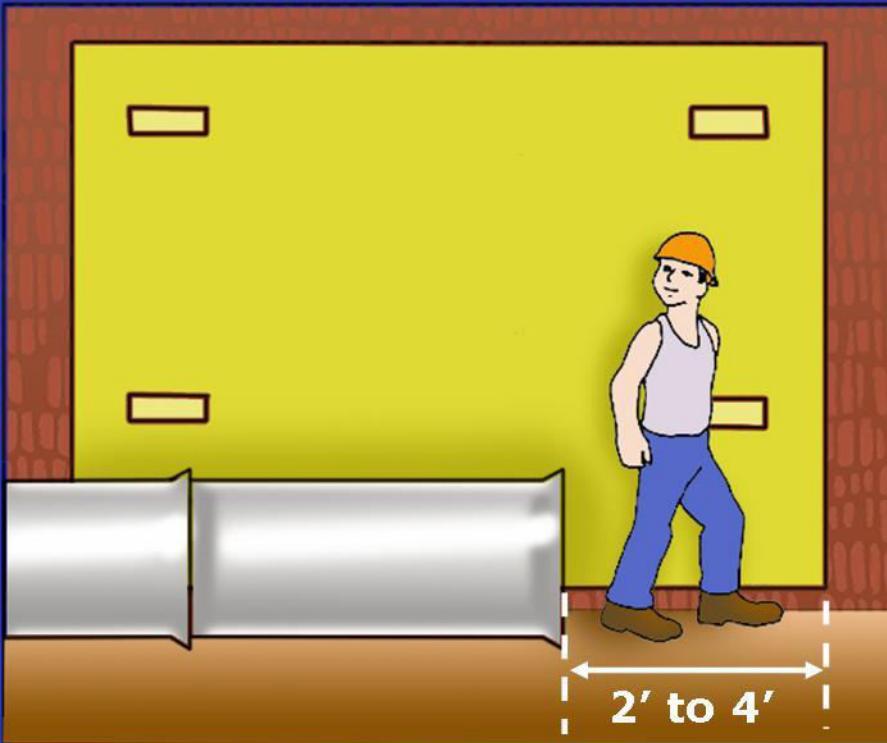


Do not remove
braces to clear
pipe.



Use arched or
high clearance
spreaders
instead.

Adequate Sizing



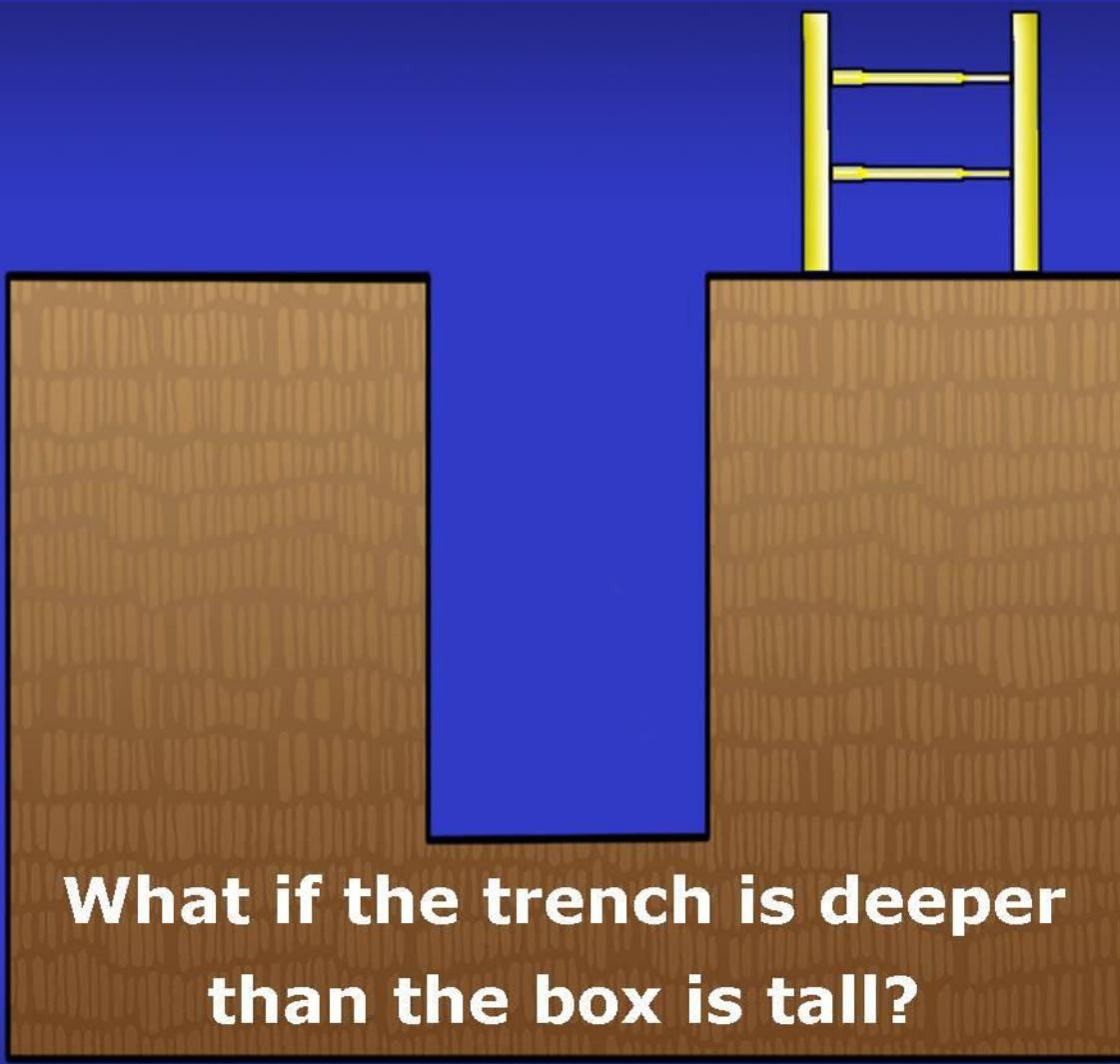
Allow 2 to 4 feet past the end of the pipe, and at least 1 foot alongside it for employee work space.





**Arm
Shore?**

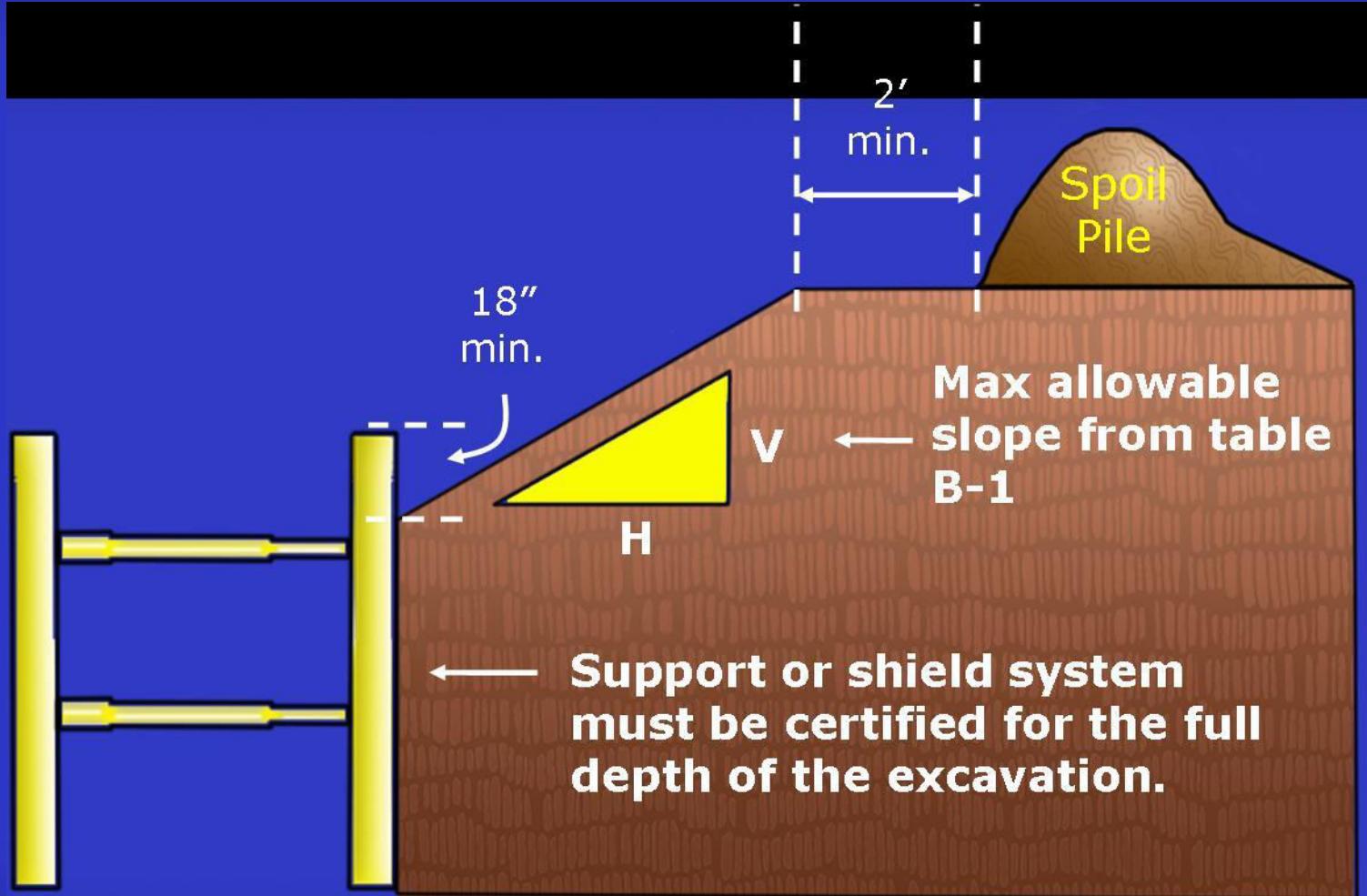


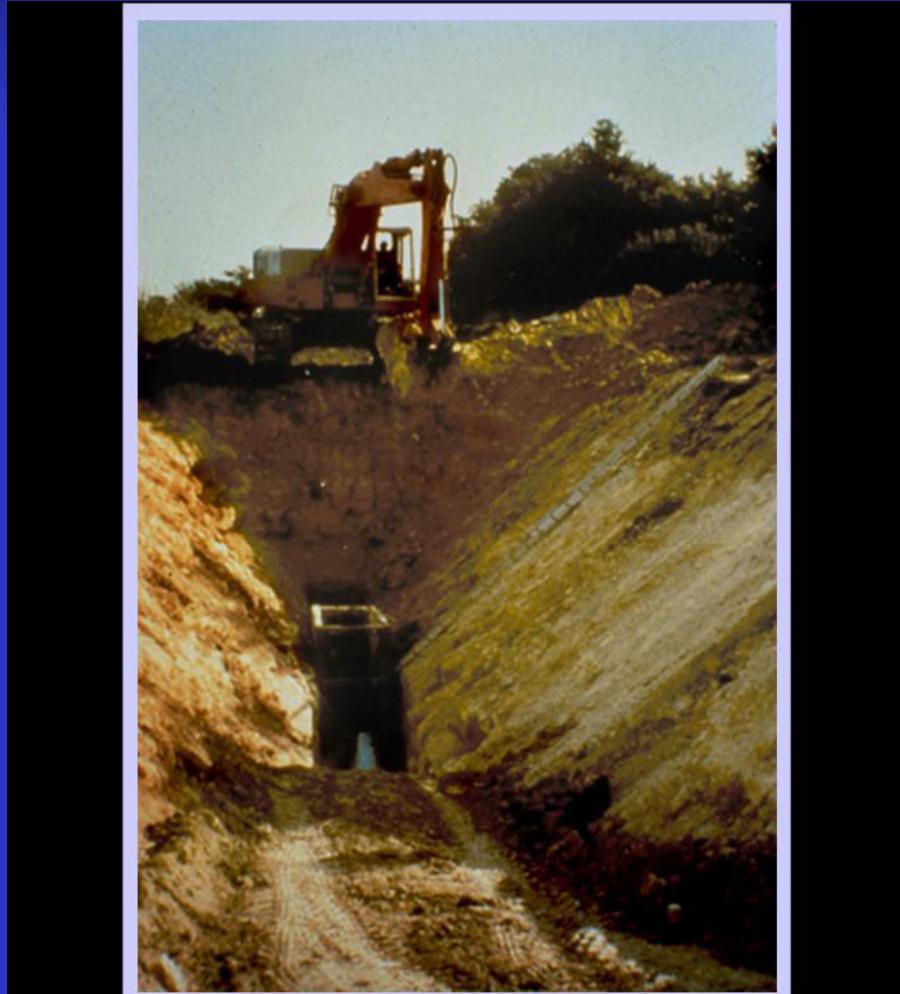


**What if the trench is deeper
than the box is tall?**



The upper portion of the trench wall can collapse and bury employees inside the shield.





Sloping and Shielding

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If the shield
and the
employees
are inside the
sloping line
(at right),
they are at
exposure.





Use end plate to prevent exposure at end of trench shield.

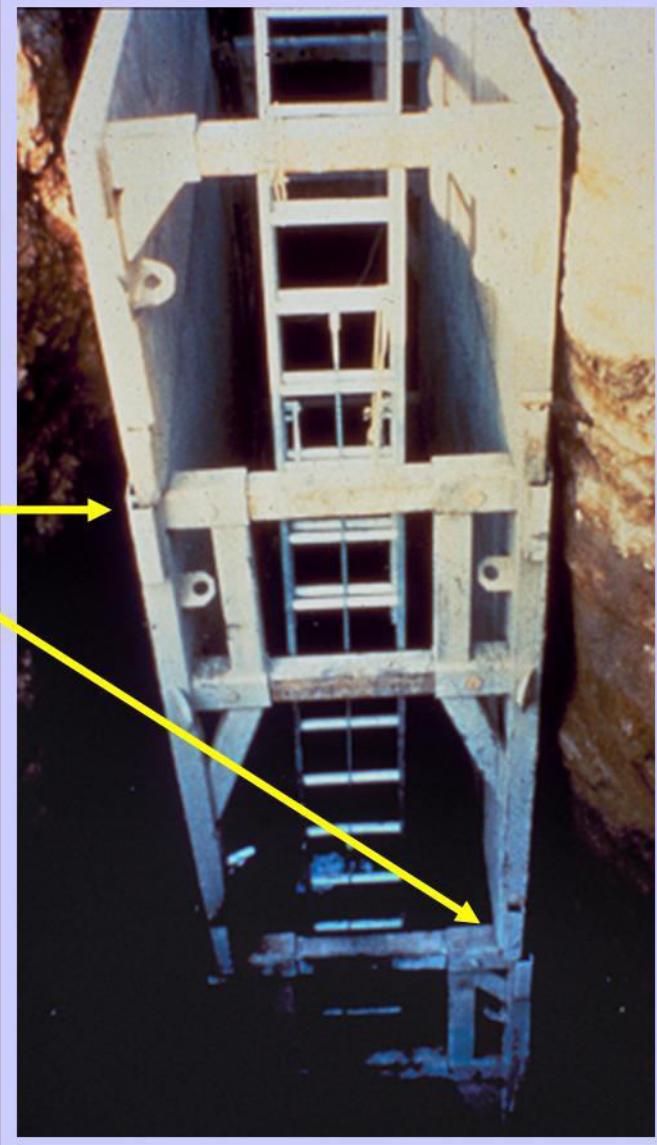
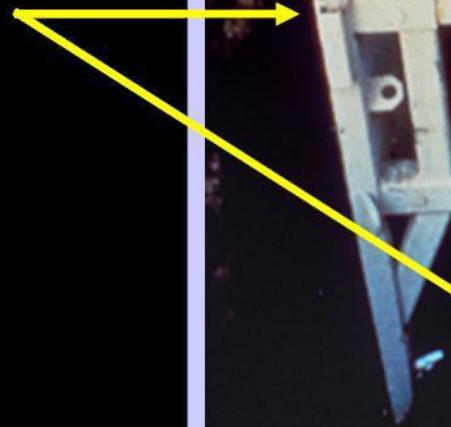




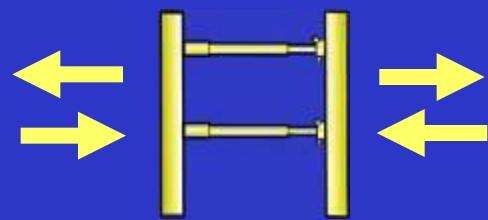
“Stacker” assemblies consisting of two or more shields, attached per manufacturers' specifications, may be used.



Stacking
pins are
missing.



No Lateral Shift

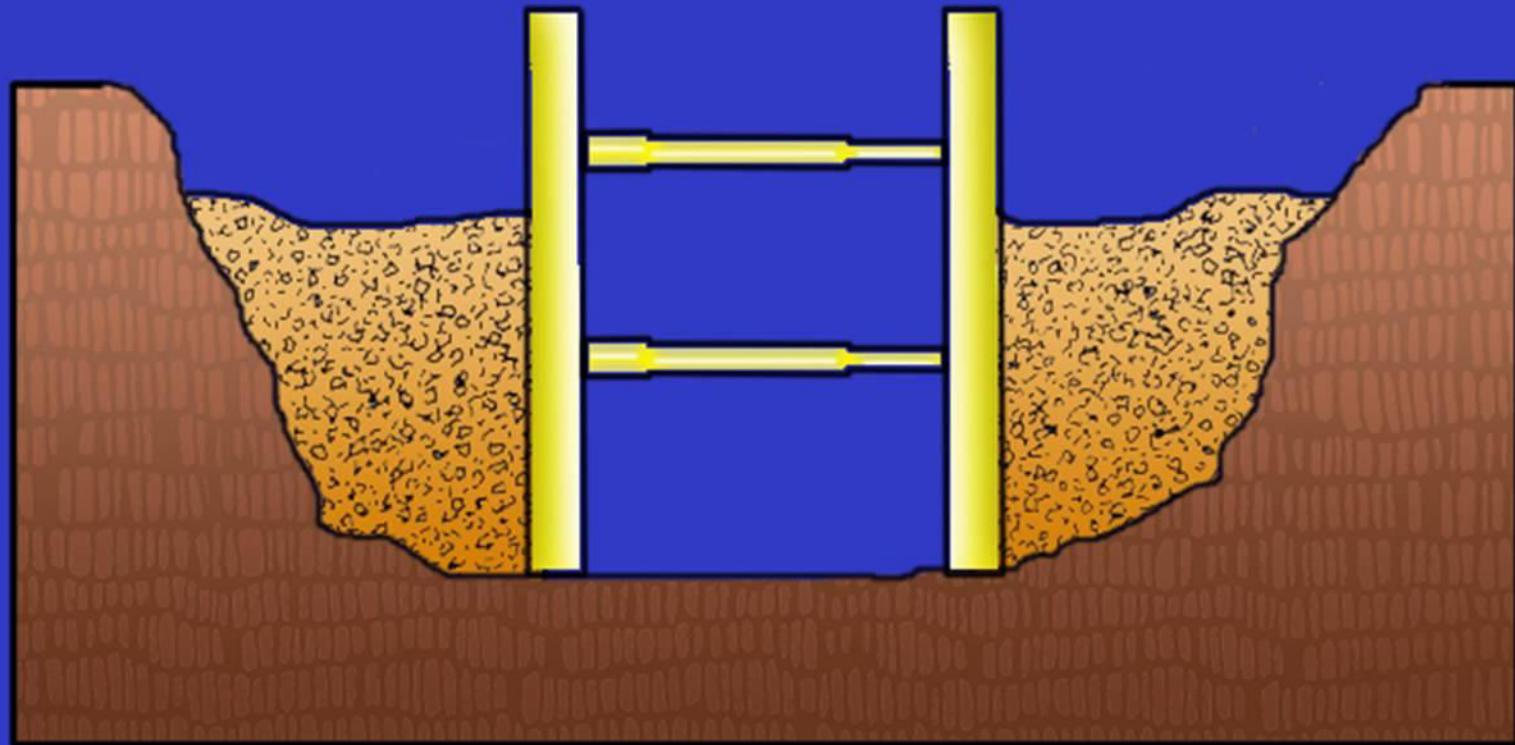




Prevent lateral shift by digging the trench with a minimum gap (4" – 6") between the shield and the trench wall.



Prevent lateral shift by backfilling half to two-thirds the height of the shield.





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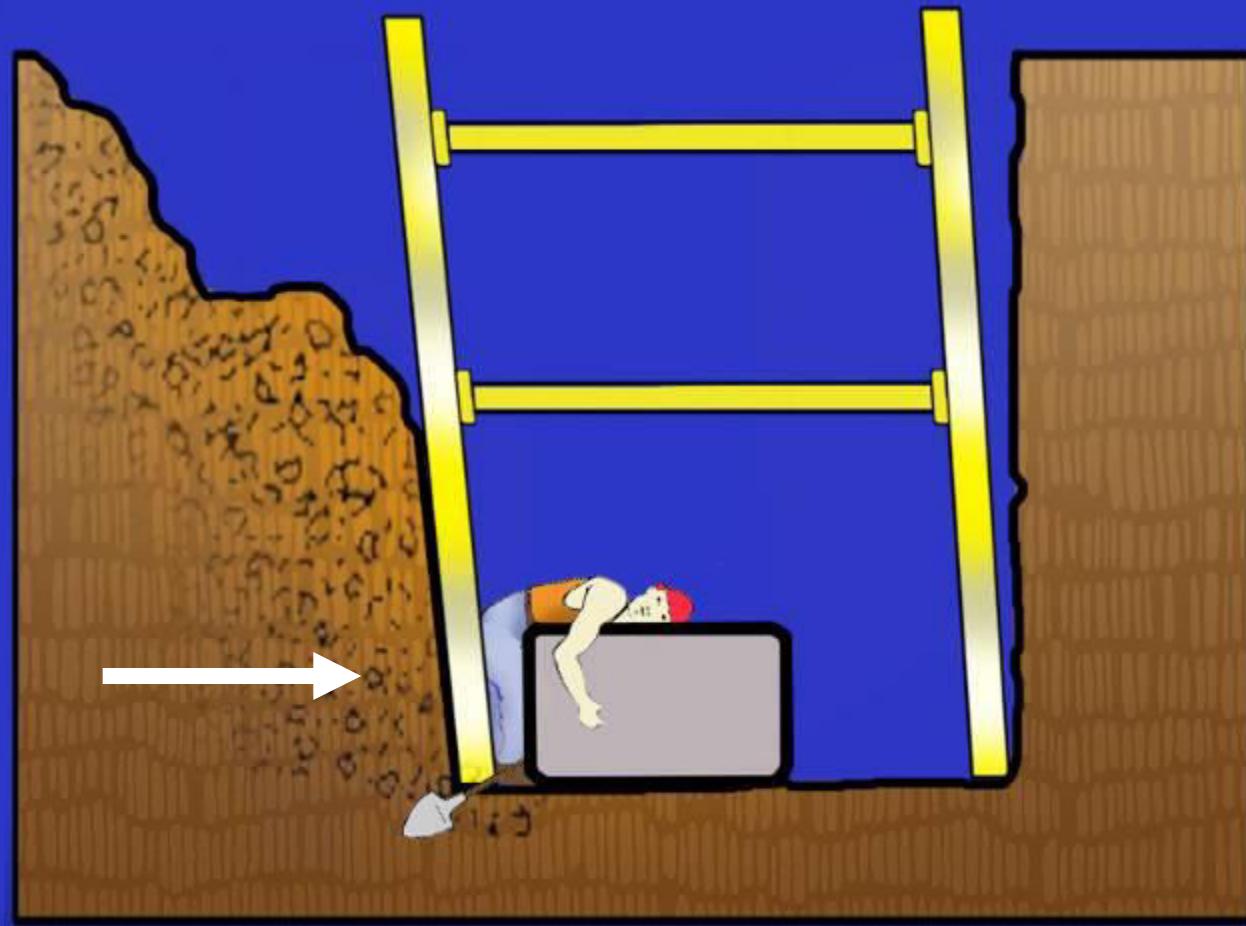


Lateral shift can result in an employee being crushed against the pipe.

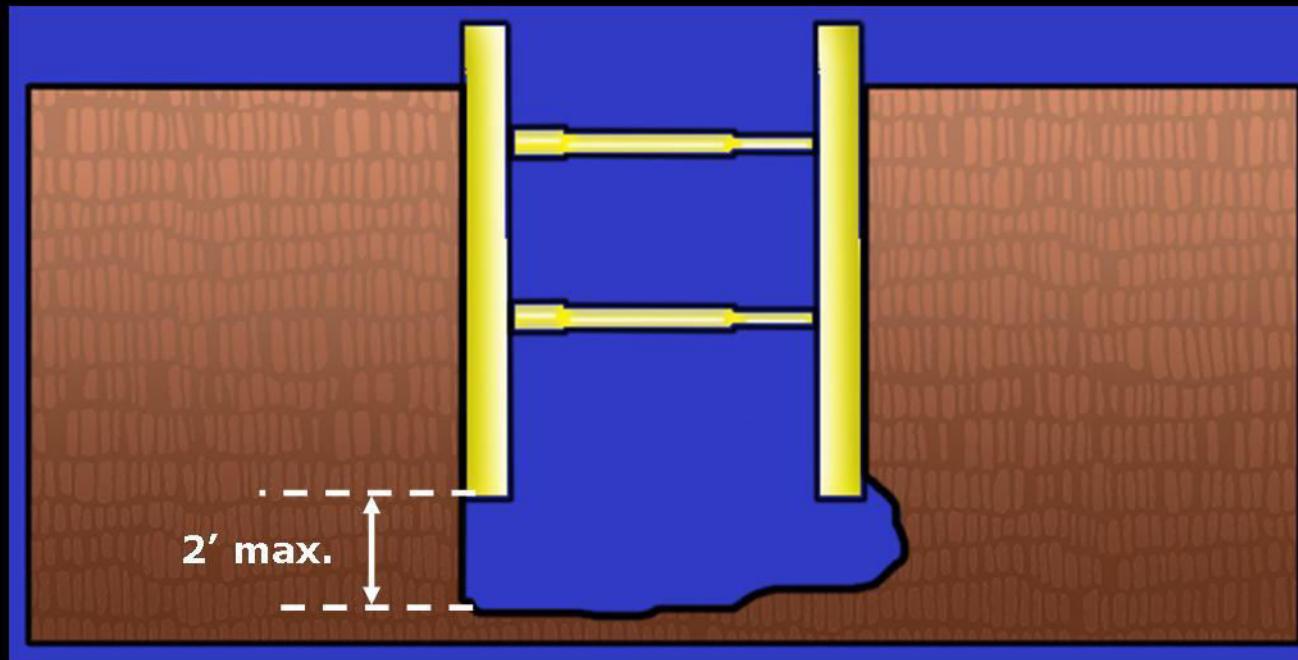
Check the Clearance!



Check the Clearance!



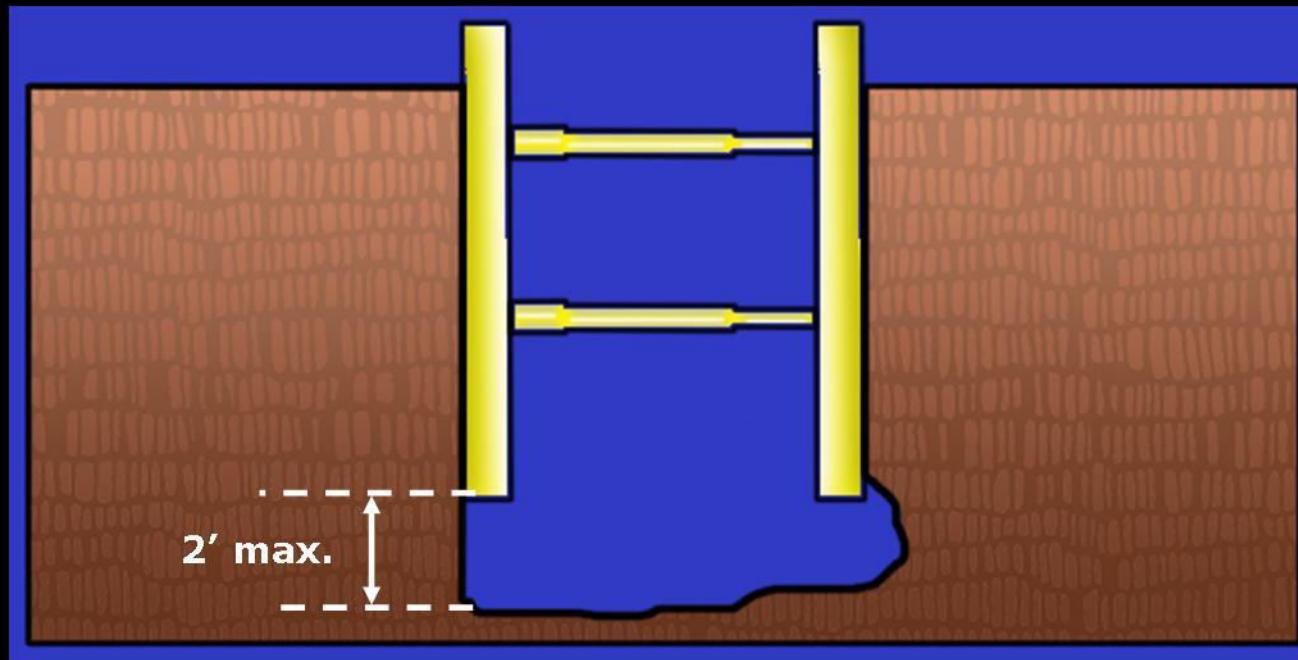
A shield or support system may ride 2' off the bottom if:



1. it is certified for the full depth.
2. no soil is caving under or behind it.



A shield or support system may ride 2' off the bottom if:



1. it is certified for the full depth.
2. no soil is caving under or behind it.





Unless he's a munchkin, the shield is
too high off the bottom.



The problem is not a lack of equipment...





...but rather
a lack of
commitment.



----- Incompetent Person



While everything is wrong with this job, the ironically amusing aspect is its location.



Needless to say, we replaced the shoring for them.

Fall Hazards

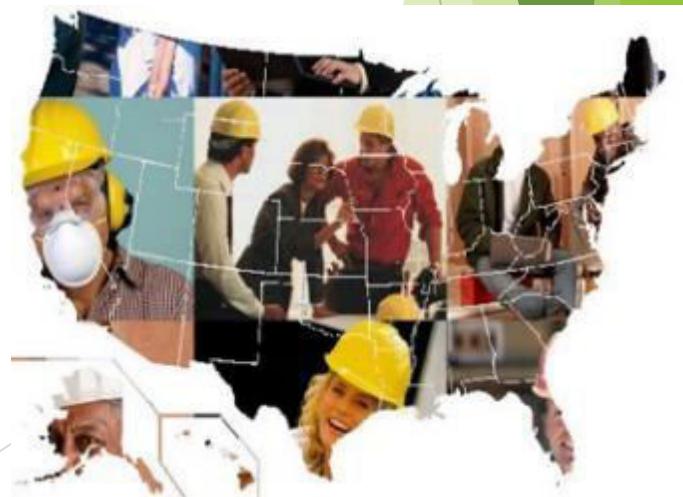
Fall Prevention in Construction
Susan Harwood Grant FY 17
SH-31220-SH7

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Introduction

The following presentations have been developed in both Spanish and English for the construction industry. These presentations focus in fall Hazards in construction.

This training materials will cover the fall hazards seen regularly on construction sites and will focus on the methods for the recognition and the prevention of these common hazards.



Fall Hazards – Overview

Fall Hazards

Building Structures

Exterior Construction Areas

Scaffolds

Stairs

Ladders

Accident Prevention

Guardrails

Warning Lines

Personal Fall Arrest Systems

Floor Covers

Fall Hazards

- ❑ Falls are one of the greatest hazards on construction sites.
- ❑ This program will help you recognize common fall hazards.
- ❑ The symbols will tell you if the situation in the picture is either safe or not safe.



Safe



Not safe

Fall Hazards Statistics

Each year workers die from falls.

During the year 2015:

- Total deaths from falls: 648
- Deaths in construction: 298
- A total of 46% of deaths in Construction are from falls
- Approximately 13% of all occupational deaths are falls



Fall Hazards

Fall hazards can be found on every construction site:

- Building structures
- Exterior construction areas
- Scaffolds
- Stairs
- Ladders



Building Structures

Work conditions 6' or more above lower level require the use of fall protection:

- Unprotected sides, edges
- Leading edges
- Excavations
- Walking/working surfaces



Building Structures

This worker is working 6' above the lower level without using fall protection.



Building Structures

When working at a height of 6' above the lower level you must use fall protection:

- Personal fall arrest systems
- Guardrails



Building Structures

- When working at a height of 6' above the lower level you must use fall protection.
- These workers are not utilizing a personal fall arrest system.



Building Structures

Guardrails must be maintained when working 6' above lower level.



Building Structures

Damaged or missing
guardrails must be
fixed immediately.



Exterior Construction Areas

- ❑ Falls from a short distance can result in serious injury.
- ❑ All workers must be protected from falling onto sharp materials.



Exterior Construction Areas

All open excavations and pier holes must be guarded or protected.



Scaffolds

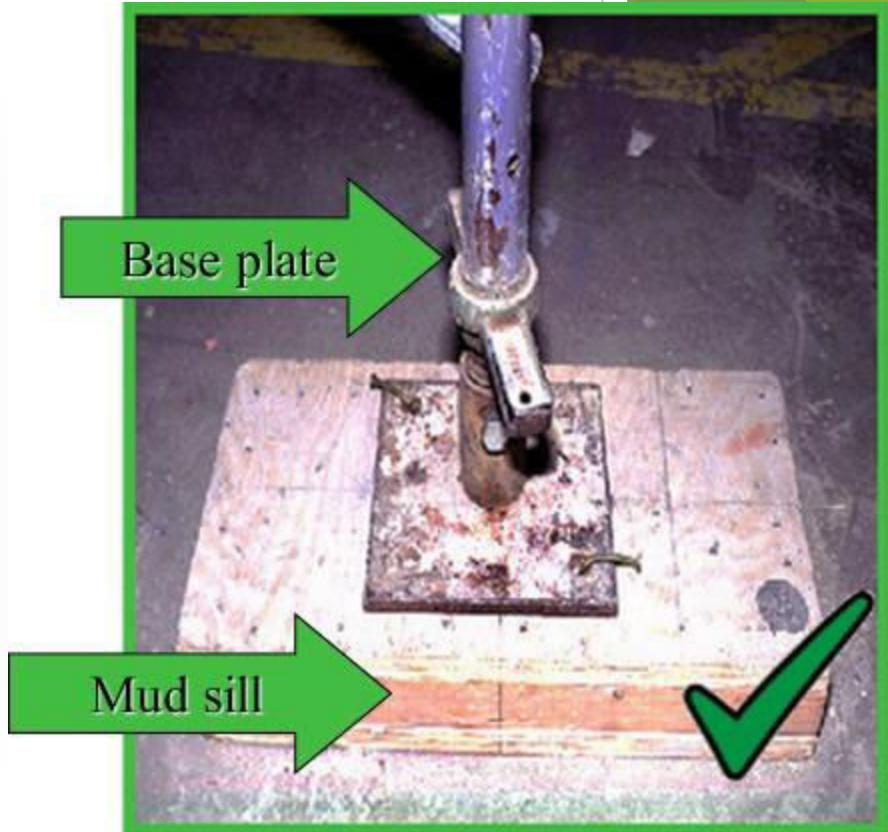
Scaffolds are elevated, temporary work platforms:

- Supported scaffold
- Guardrails
- Access ladders
- Powered work platforms



Scaffolds

- Scaffold bases must rest on a base plate and a mud sill.
- The base plate is designed to level and support the scaffold.



Scaffolds

Only work from scaffolds that are properly constructed and supported.



Scaffolds

Scaffolds used in stair wells must be properly constructed.



Scaffolds

When working on scaffolds 6' above lower level, guardrails must be installed.

