Trenching and Excavation: Safety and the Role of the Competent Person

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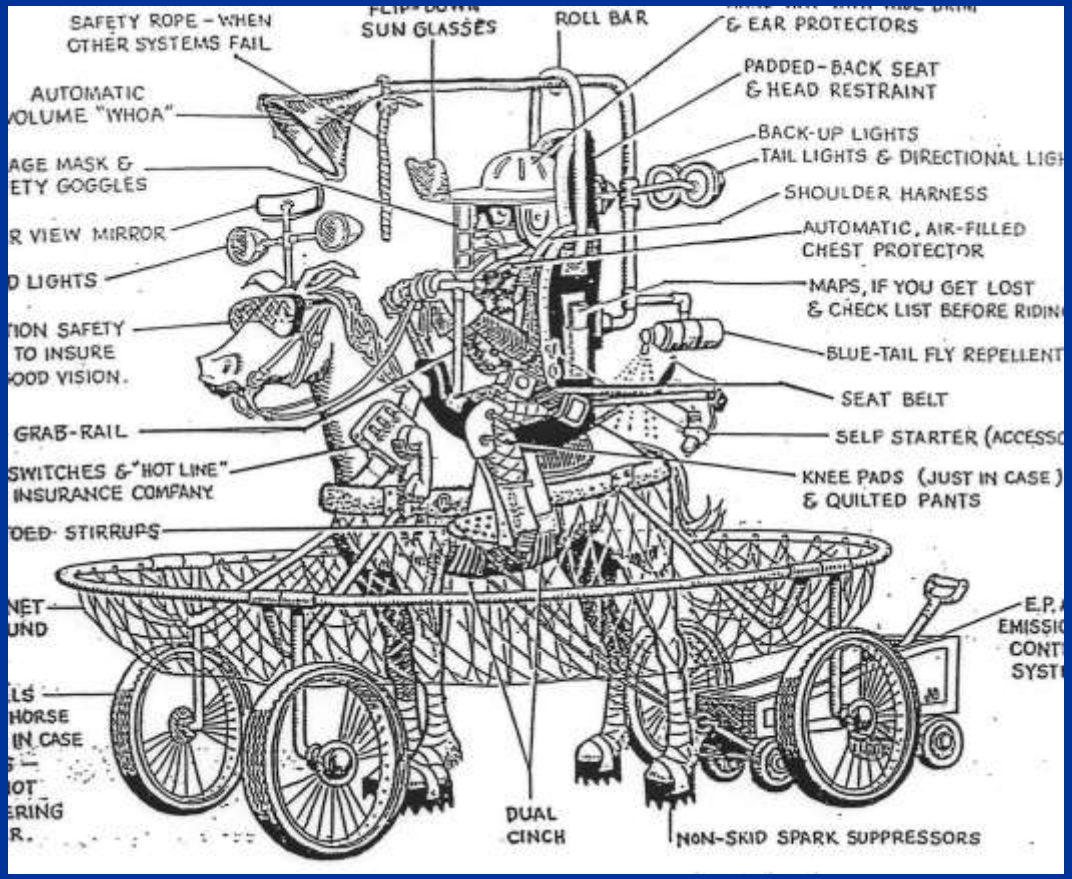
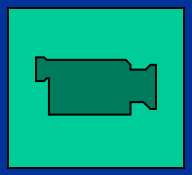

SAFETY ROPE – WHEN OTHER SYSTEMS FAIL
SUN GLASSES
ROLL BAR
& EAR PROTECTORS
PADDED-BACK SEAT & HEAD RESTRAINT
AUTOMATIC
BACK-UP LIGHTS
SHOULDER HARNESS
AUTOMATIC, AIR-FILLED CHEST PROTECTOR
MAPS, IF YOU GET LOST
BLUE-TAIL FLY REPELLENT
SEAT BELT
GRAB-RAIL
KNEE PADS (JUST IN CASE)
& QUILTED PANTS
DUAL CINCH
NON-SKID SPARK SUPPRESSORS




A & A
ALLIANCE
DANGER SIGNS


CAUTION


CAT


STEEL
PLATES

Arm
Shore?

Hierarchy of Controls

- Eliminate
- Control
  - Engineering
  - Administrative
- PPE

OSHA's Focus Four

- Falls
- Caught in or Between
- Struck By
- Electrocution

Excavation Safety

- Five S's
  - Safety
  - Soils
  - Sloping
  - Shoring
  - Shielding

Excavation Safety

- Safety
  - Competent Person
  - Underground Installations
  - Access and Egress
  - Exposures to vehicular traffic and overhead loads
  - Hazardous Atmospheres and emergency rescue equipment
  - Hazards of water accumulation
  - Stability of adjacent structures
  - Protection of employees from loose soil
  - Inspections
  - Fall Protection

Competent Person **means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.**

Training Requirements for the Competent Person

In the preamble to the Standard, OSHA says that, "…for the purposes of this standard, one must have had specific training in and be knowledgeable about soils analysis, the use of protective systems, and the requirements of the standard. One who does not have such training or knowledge cannot possibly be capable of recognizing existing and predictable hazards in excavation work or taking prompt corrective measures."

Specific Responsibilities of the Competent Person

- Conduct tests for soil classification.
- Understand standards and any data provided.
- Determine proper protective system.
- Recognize and reclassify soil after changes in conditions.
- Determine whether damage to excavation safety equipment renders it unusable

Specific Responsibilities of the Competent Person *(cont.)*

- Design of structural ramps.
- Location of underground installations/utilities.
- Monitor water removal equipment and operation.
- Perform daily inspections.
- Determine the necessity for a protective system if less than 5 feet deep.

Options of the Competent Person

1. Use the OSHA Standard for guidance with:

- Sloping
- Shoring with timber or aluminum hydraulic shoring
- Shielding

2. Use a Registered Professional Engineer to Provide:

- Tabulated data
- Manufacturers tabulated data
- A site specific design*

(*must be registered in the state where the work is being done.)

Registered Professional Engineers must be used if:

- The excavation is deeper than 20 feet.

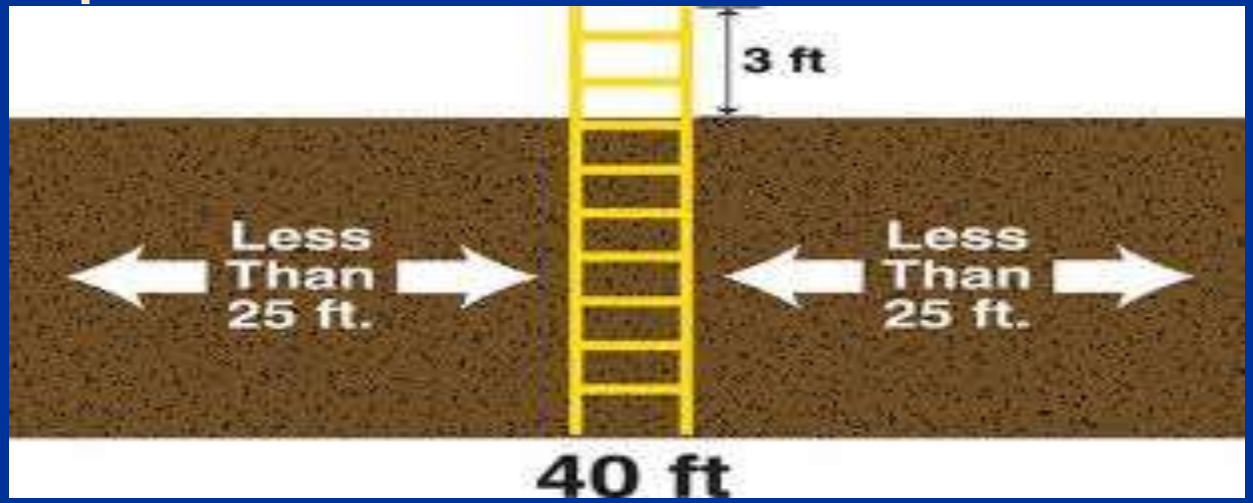
- An "alternate system" (such as sheet piling) that the Standard does not provide guidance for is used.

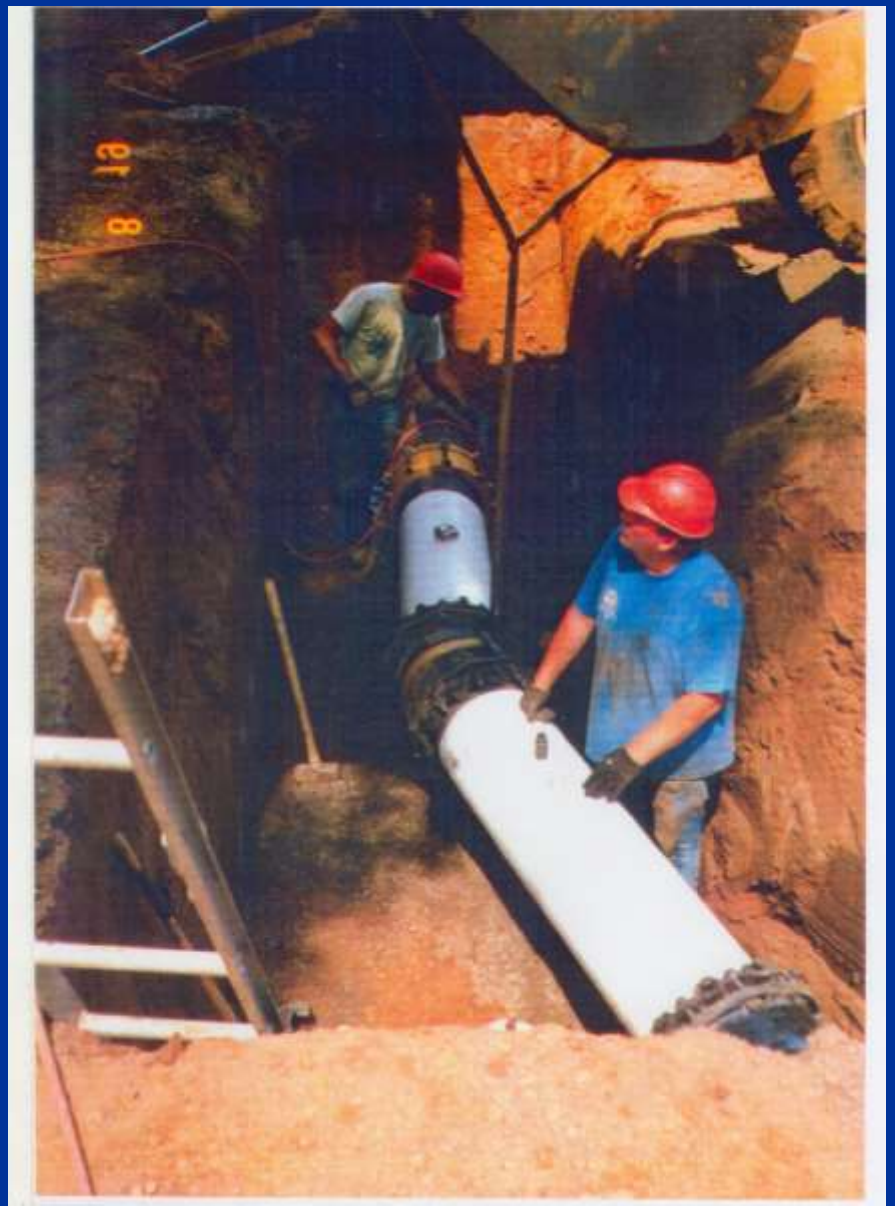
- If the excavator is at "variance" with the Standard (i.e. doing less than the Standard requires).

Note: OSHA expects that the engineer will be registered in a related area such as a civil, mechanical, geotechnical, or architectural engineer.


GAS
NO

Access and Egress – Ladder at 4’ Depth




8 ia

Specific Requirements

Exposure to Vehicular Traffic

Employees exposed to vehicles must wear warning vests or other suitable garments marked with or made of reflectorized or high visibility material.

Is this adequate?

Specific Requirements

Warning System for Mobile Equipment

When mobile equipment is operated adjacent to an open excavation and the operator does not have clear view of the edge, a warning system must be installed:

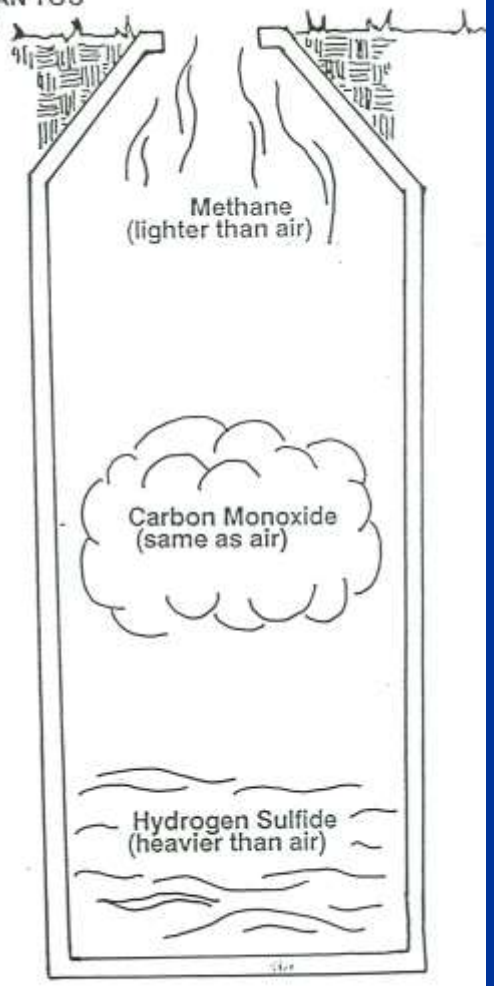
- ➔ **Barricades**
- ➔ **Hand or Mechanical Signals**
- ➔ **Stop Logs**
- ➔ **Earth Birm**

etc……

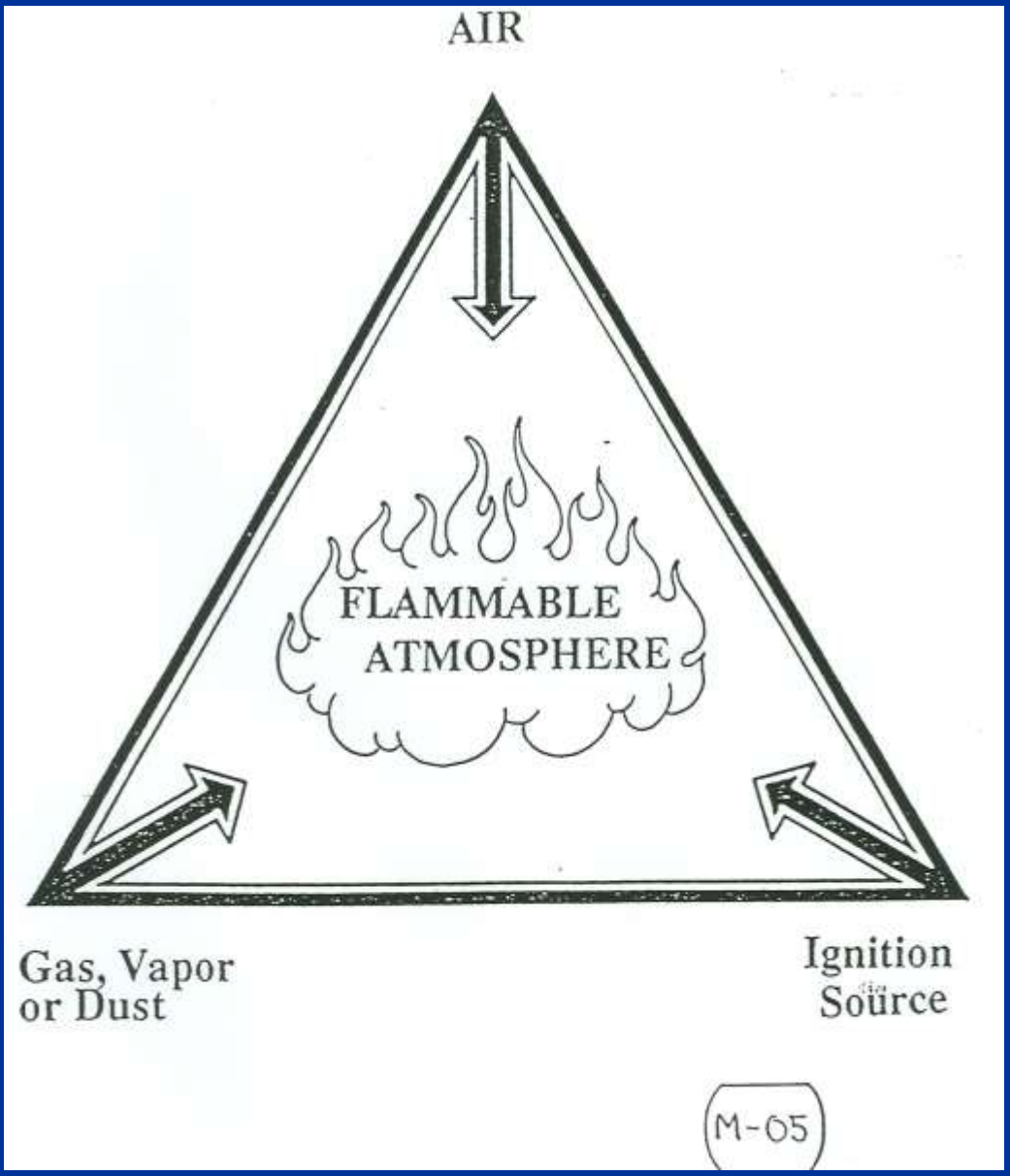
Acceptable Atmospheric Conditions

- Oxygen
  - 20.8% Normal
  - 19.5% Oxygen Deficient
  - 23.5% Oxygen Enriched
- Flammable Limits
  - 10% LEL/LFL
- Toxicity
  - Gases – CO, H2S, Chlorine,
  - Mists – Paint Spray, pressure washer
  - Vapors – Paints, degreasers, coatings, gases
  - Fumes – Welding/cutting
  - Dusts – 5', Asbestos, Silica

NEVER TRUST YOUR SENSES TO DETERMINE IF THE AIR IN A CONFINED SPACE IS SAFE! YOU CAN NOT SEE OR SMELL MANY TOXIC GASES AND VAPORS, NOR CAN YOU DETERMINE THE LEVEL OF OXYGEN PRESENT.



M-05-A


AIR
FLAMMABLE
ATMOSPHERE
Gas, Vapor
or Dust
Ignition
Source
M-05


11 3'93

Specific Requirements

Daily Inspections

Daily inspections of excavations, adjacent areas, and protective systems must be made by a **Competent Person** for evidence of a situation that could result in possible cave-ins, failure of protective systems, hazardous atmospheres, or other hazardous conditions.

Shoring?
Water?
Methane?
Spoils?
Undermining?
Vibration?
Utilities?
Sloughing?

Soils

- Stable Rock
- Type A
- Type B
- Type C
- C-60
- Acceptable Visual and Manual Testing
- Environmental impacts on soils stability

Manual Tests

- Pocket Penetrometer or Shear Vane
- Thumb Penetration
  - Unconfined compressive strength
- Plasticity
  - Thread test – 1/8 inch
  - Ribbon test – 2” long
- Dry Strength
- Sedimentary tests and textural chart

CP – Visual and Manual Inspection

Manual Tests

- Pocket Penetrometer or Shear Vane
- Thumb Penetration
  - Unconfined compressive strength
- Plasticity
  - Thread test - 1/8 inch
  - Ribbon test – 2” long
- Dry Strength
- Sedimentary tests and textural chart

Visual Tests

- Observe as excavated
- Estimates the range of aprticle sizes
- Fine grained-cohesive
- Clumps-cohesive
- Breaks up easy or does not clump – granular
- Observe the sides of the trench
- Tension cracks/fissures
- Spalling and raveling
- Layers that slope towards the excavation
- Surface water or seeping soils
- Water Table
- Sources of vibration
- Previously disturb

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- **Surface** water or seeping soils
- Water Table
- Sources of vibration
- Previously disturb

Type A Soil

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

Examples of Cohesive Soils are:

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

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 B Soil

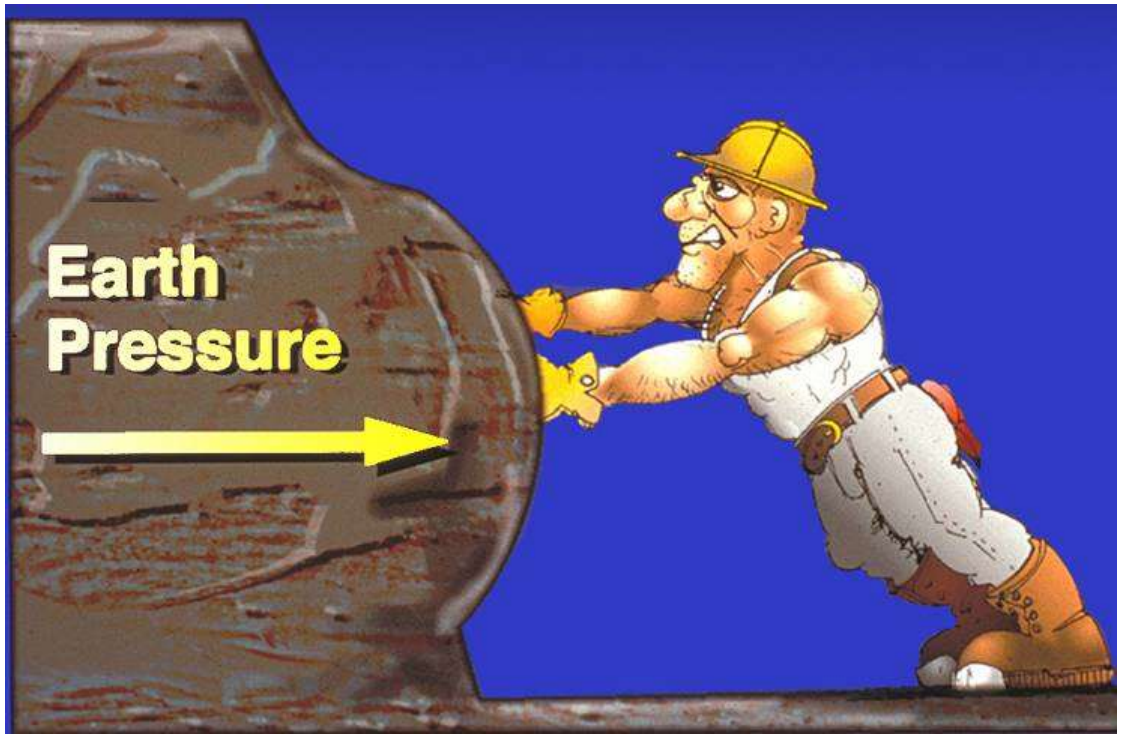
1. Cohesive soil with an unconfined compressive strength greater than .5 TSF, but less than 1.5 TSF.

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.

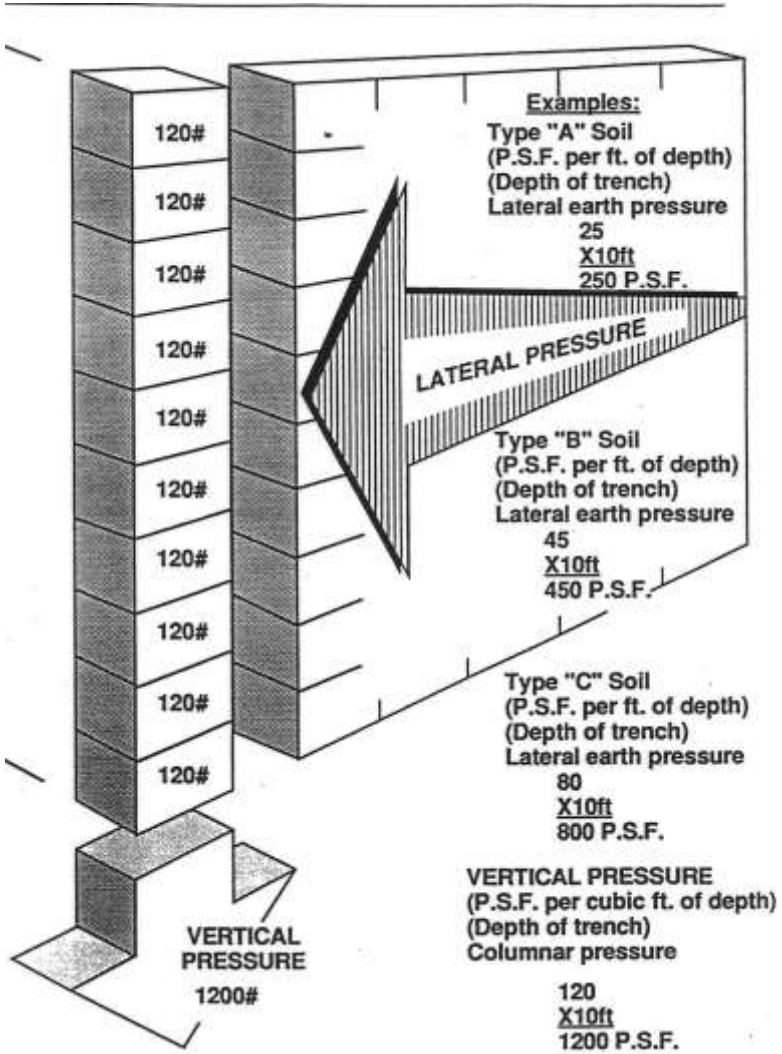
Type C Soil

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.

C-60


Earth
Pressure

	Stable Rock	Type A	Type B	Type C
Strength Characteristics	Solid Mineral Material	1.5 tsf. or Greater Unconfined Compressive Strength	.5 to 1.5 tsf. Unconfined Compressive Strength	.5 tsf. or Less Unconfined Compressive Strength
Physical Make-up	Natural Mineral Material	Highly Plastic Cohesive Soil	Plastic Cohesive Soil	Running, Granular Flowing or Submerged Soil
Lateral Pressure	Pa = 0 x H "Pressure Active" = Lateral Earth Pressure Determinant (Pounds per Square Foot) x Foot of Depth	Pa = 25 x H "Pressure Active" = Lateral Earth Pressure Determinant (Pounds per Square Foot) x Foot of Depth	Pa = 45 x H "Pressure Active" = Lateral Earth Pressure Determinant (Pounds per Square Foot) x Foot of Depth	Pa = 80 x H "Pressure Active" = Lateral Earth Pressure Determinant (Pounds per Square Foot) x Foot of Depth
Maximum Allowable Slope	0:1 90 degree (From Horizontal)	3/4: 1 53 degree (From Horizontal)	1:1 45 degree (From Horizontal)	1 1/2: 1 34 degree (From Horizontal)
Soils Other Than Cohesive		Cemented Soils such as Caliche and Hardpan	Granular Cohesionless Soils Like: Angular Gravel, Silt, Sandy Loam, Silty or Sandy Clay Loam	Granular Soils Like Sand, Loamy Sand, and Gravel. Submerged Soils


120#
120#
120#
120#
120#
120#
120#
120#
120#
120#
120#
VERTICAL
PRESSURE
1200#
LATERAL PRESSURE
Examples:
Type "A" Soil
(P.S.F. per ft. of depth)
(Depth of trench)
Lateral earth pressure
25
X10ft
250 P.S.F.
Type "B" Soil
(P.S.F. per ft. of depth)
(Depth of trench)
Lateral earth pressure
45
X10ft
450 P.S.F.
Type "C" Soil
(P.S.F. per ft. of depth)
(Depth of trench)
Lateral earth pressure
80
X10ft
800 P.S.F.
VERTICAL PRESSURE
(P.S.F. per cubic ft. of depth)
(Depth of trench)
Columnar pressure
120
X10ft
1200 P.S.F.

Protective Systems

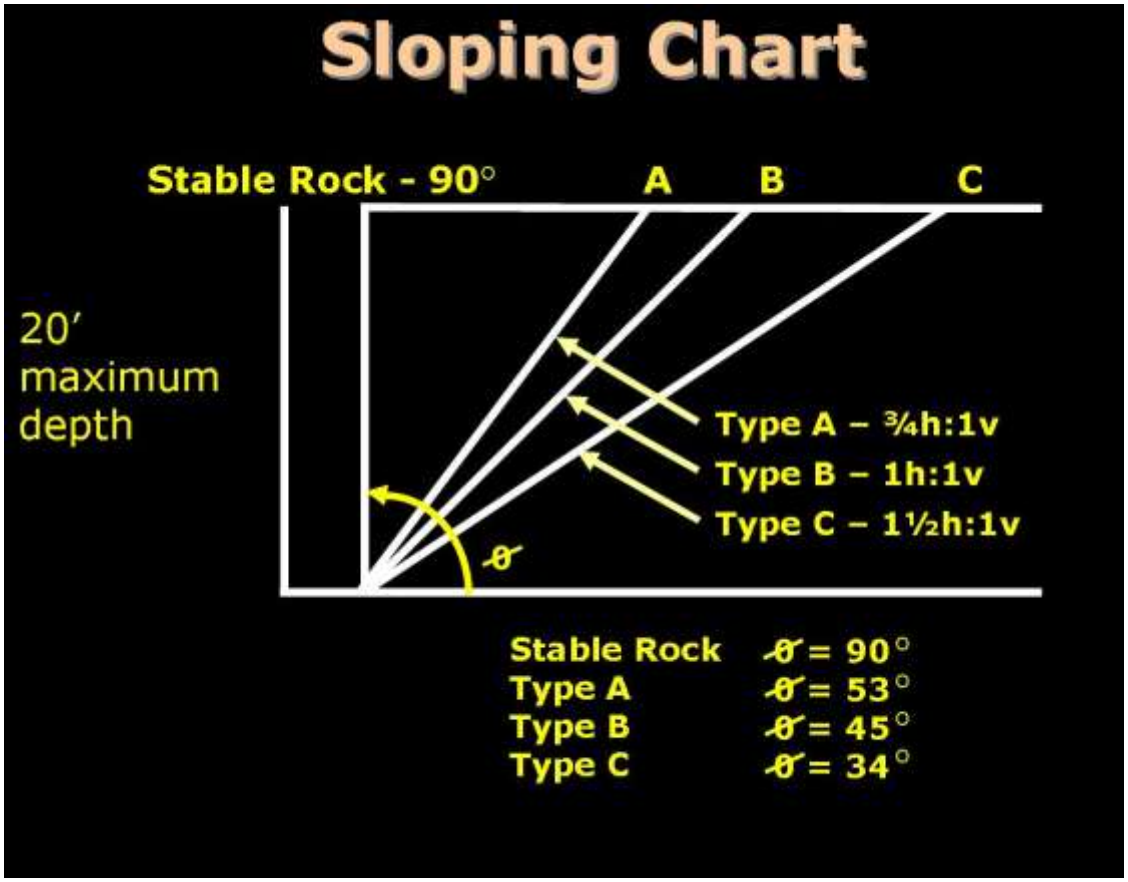
Sloping

Sloping and Benching Options

The options include:

1. Slope no steeper than 11/2 : 1 (34); or
2. The use of Appendices A and B; or
3. Designs using other tabulated data; or
4. Design by a Registered Professional Engineer.

Sloping Chart

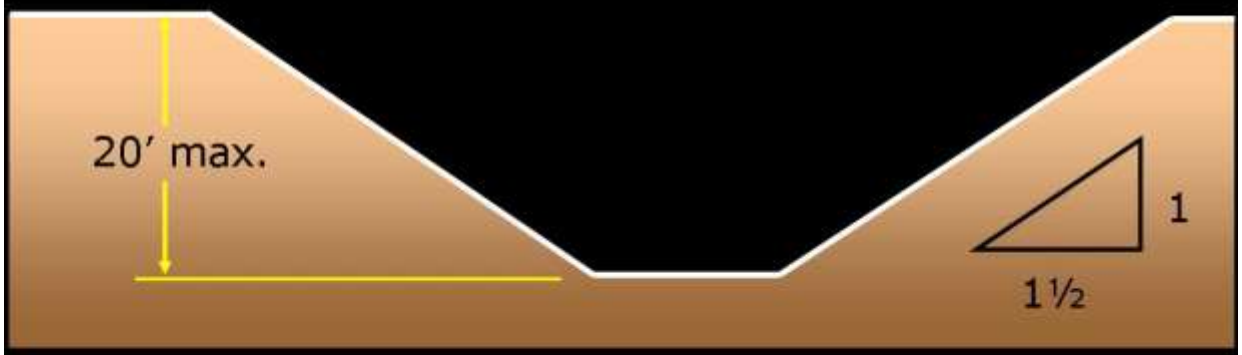


Stable Rock	$\theta = 90°$
Type A	$\theta = 53°$
Type B	$\theta = 45°$
Type C	$\theta = 34°$

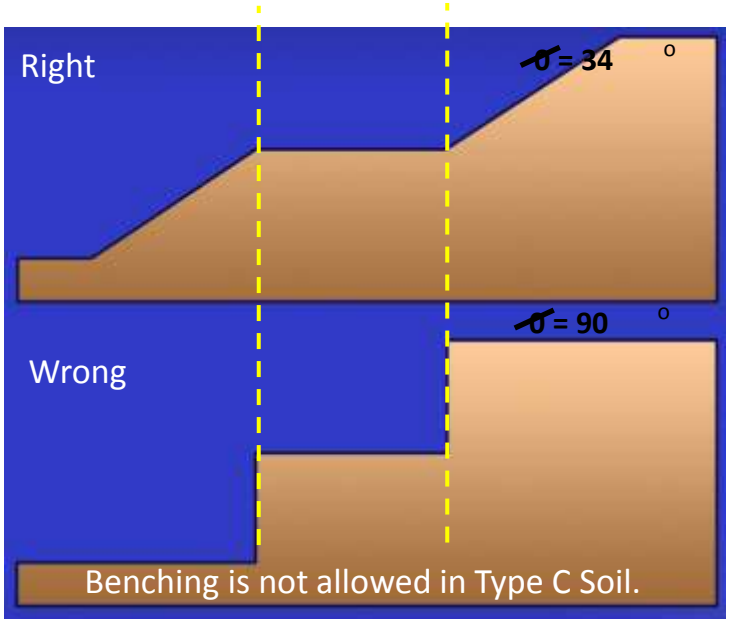
Excavation in Type C Soil

Type C

Simple Slope



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


Right
θ = 34 o
Wrong
θ = 90 o
Benching is not allowed in Type C Soil.

Requirements for Protective Systems

Sloping or Benching Option 2

Determination of Slopes and Configurations -

This option involves the use of Appendices A and B:

Appendix A is Soil Classification
Appendix B is Sloping & Benching

Maximum Allowable Slopes

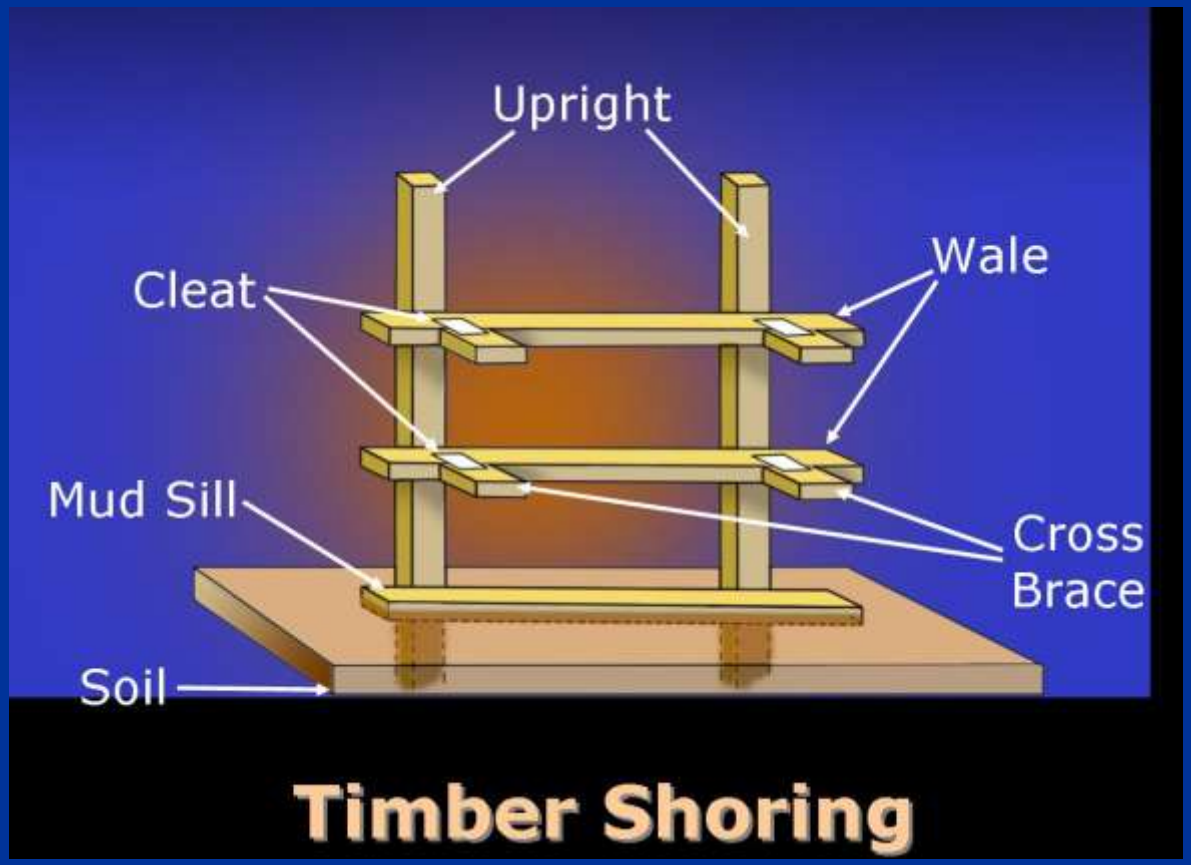
For Stable Rock is vertical (90°)
For Type A soil is 3/4:1 (53°)
For Type B soil is 1:1 (45°)
For Type C soil is 11/2:1 (34°)

Requirements for Protective Systems

Supports, Shields, and other Protective Systems

These four options include:

- ✓ The use of Appendices A and C, or D; or
- ✓ Designs using manufacturer's tabulated data; or
- ✓ Designs using other tabulated data; or
- ✓ Design by a Registered Professional Engineer.


Upright
Wale
Cleat
Mud Sill
Cross
Brace
Soil
Timber Shoring

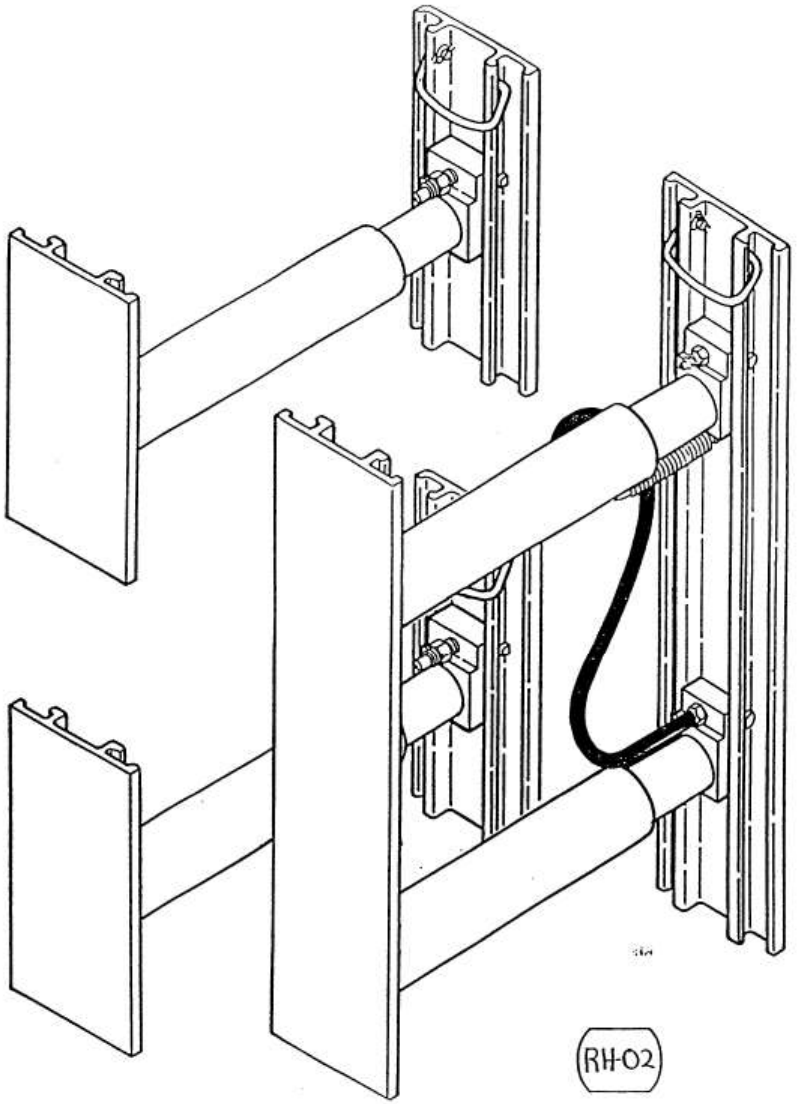
Overloading

Do not exceed allowable surcharge loads.

Aluminum Hydraulic Shoring

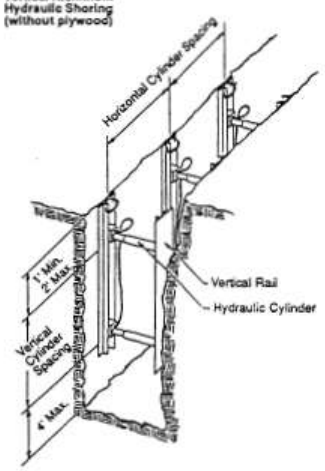
Vertical Shores

American
Shoring Inc.

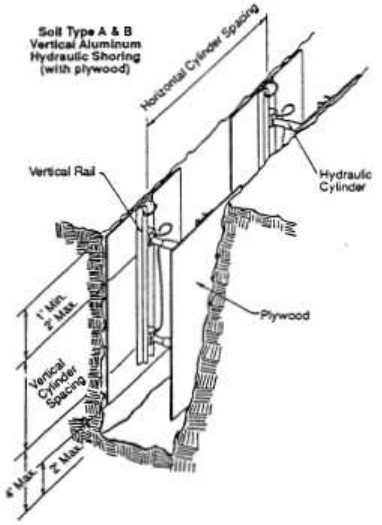

RH-02

VERTICAL SHORES
ALUMINUM HYDRAULIC SHORING
(EXAMPLES OF TYPICAL INSTALLATIONS)

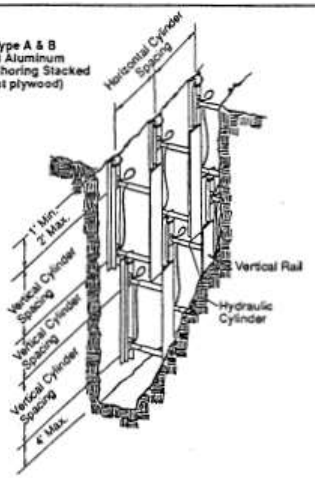
Soil Type A & B
Vertical Aluminum Hydraulic Shoring (without plywood)



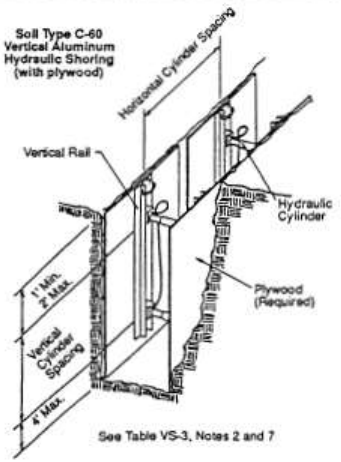
Soil Type A & B
Vertical Aluminum Hydraulic Shoring (with plywood)



Soil Type A & B
Vertical Aluminum Hydraulic Shoring Stacked (without plywood)

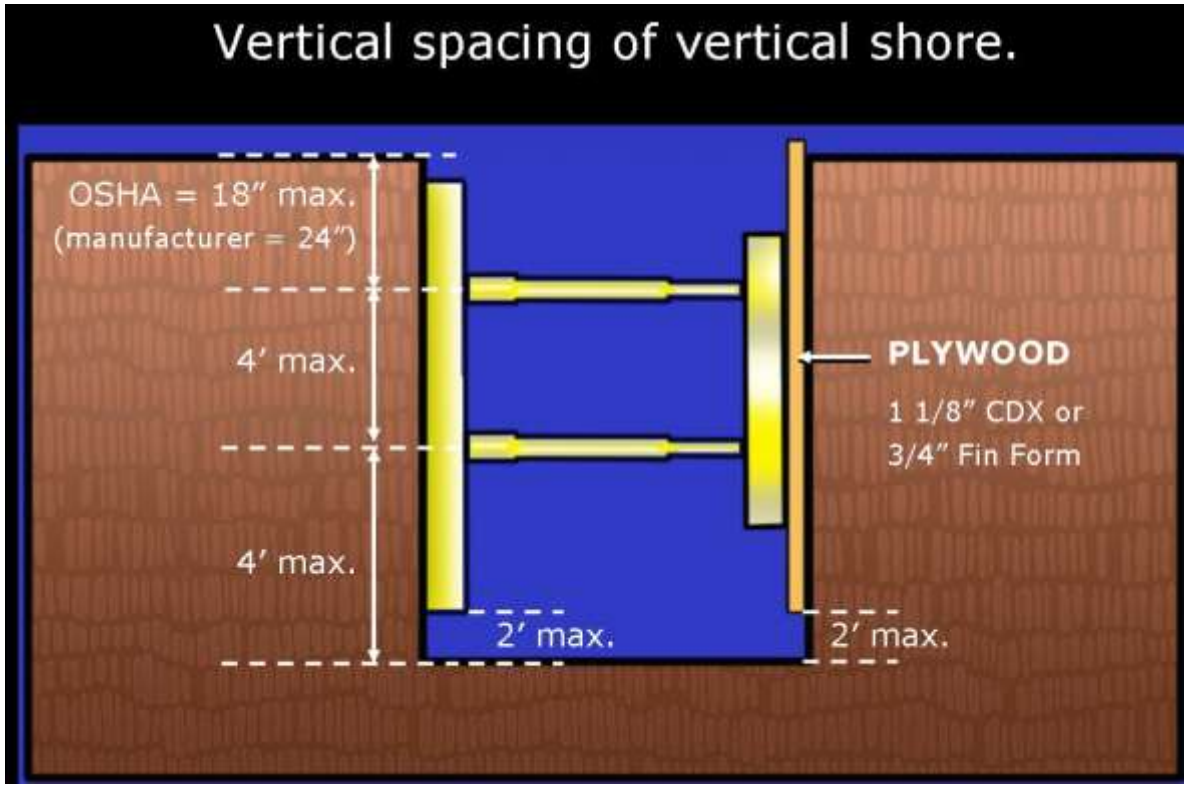


Soil Type C-60
Vertical Aluminum Hydraulic Shoring (with plywood)



See Table VS-3, Notes 2 and 7

Vertical spacing of vertical shore.



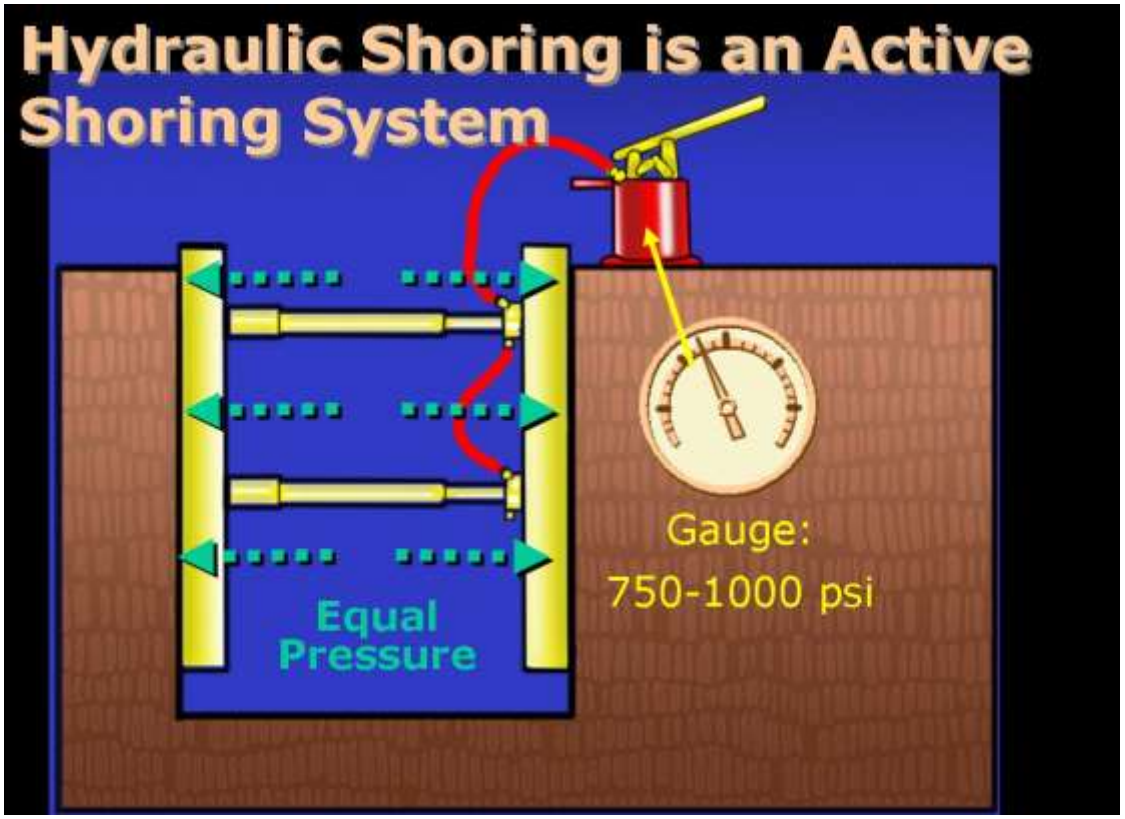
SPEED SHORE®

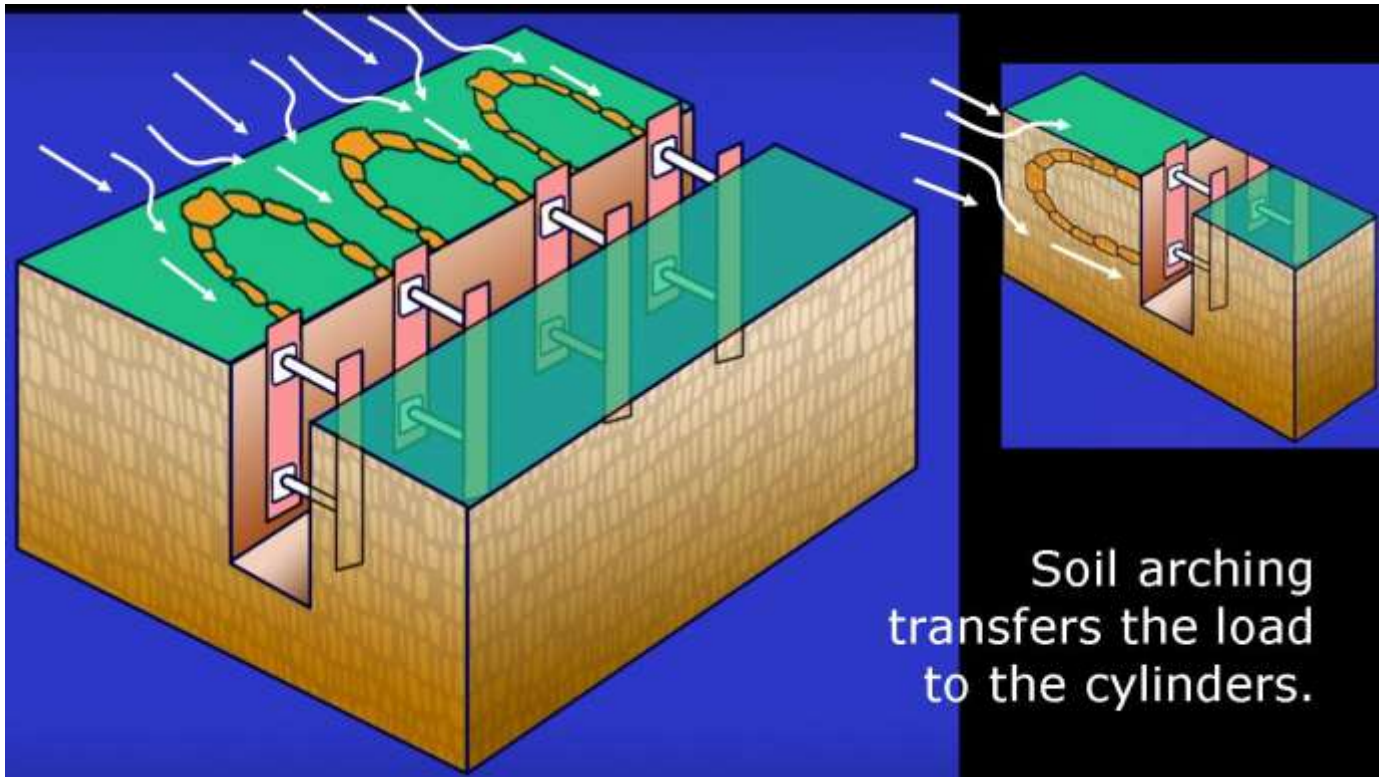
VERTICAL SHORES - TABLE VS-3

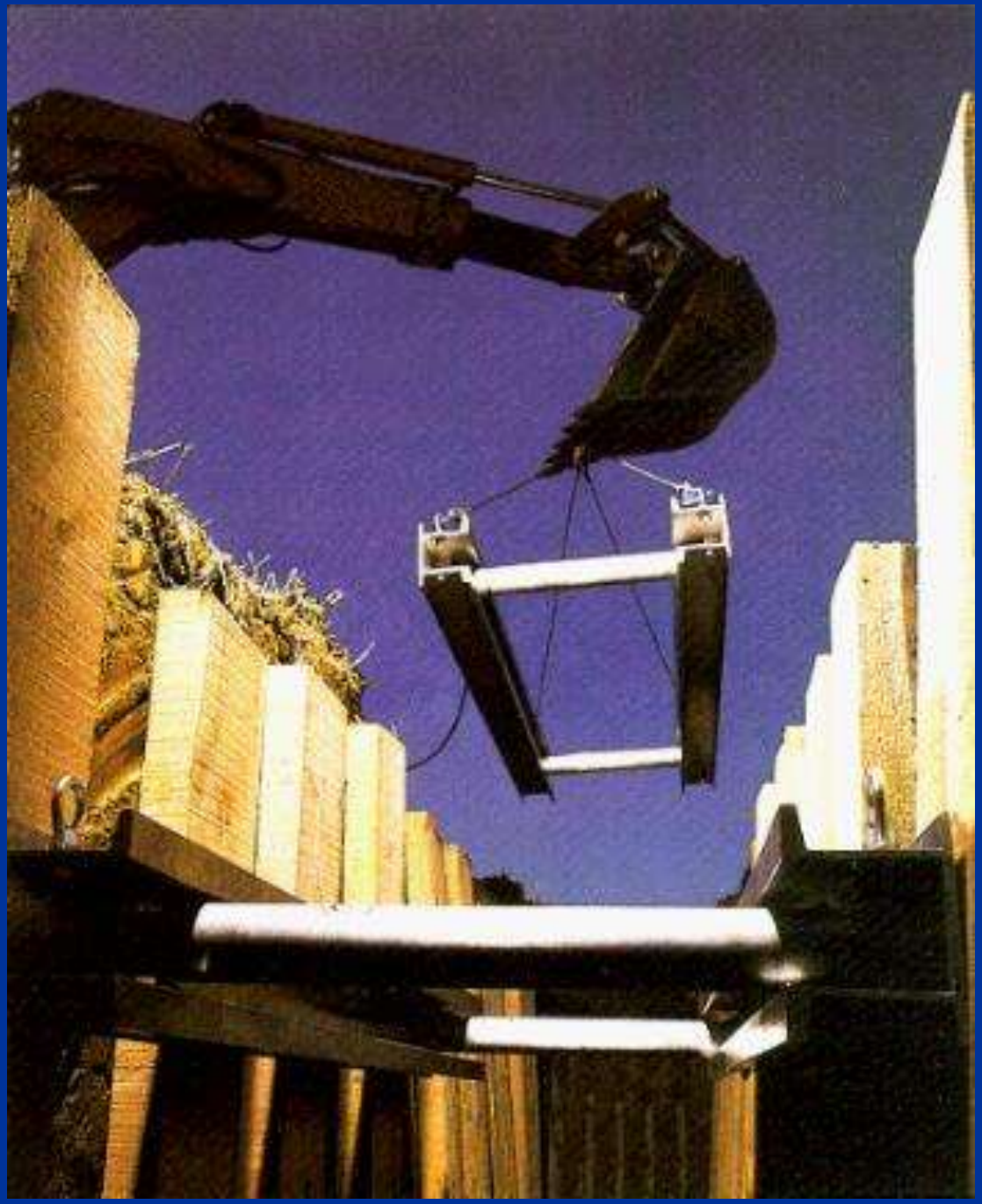
TYPE "C-60" SOIL

(See 3.3 for definition of C-60 Soil)

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


Hydraulic Shoring is an Active Shoring System
Gauge:
750-1000 psi
Equal Pressure

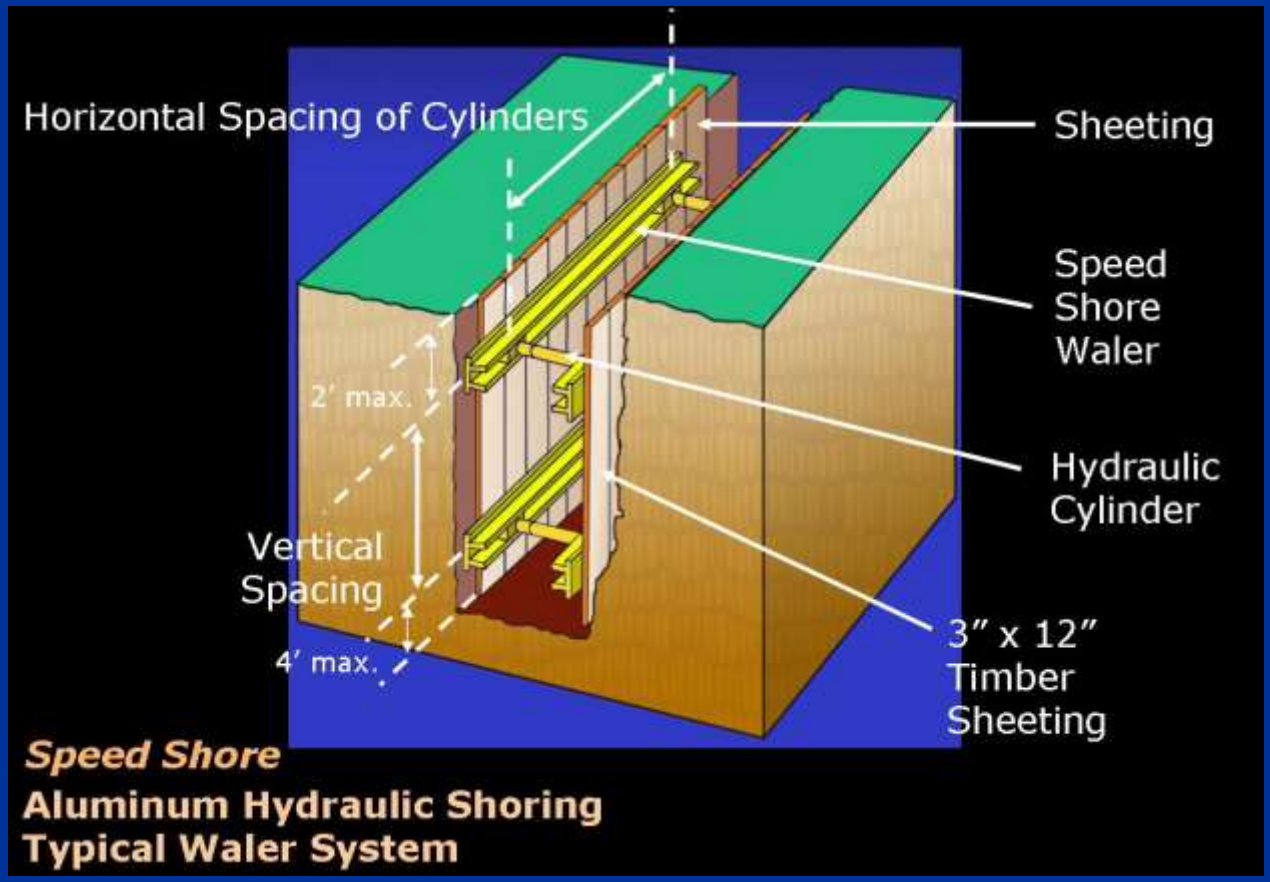

Soil arching
transfers the load
to the cylinders.



American
Shoring Inc.

Waler Systems

Waler Systems


Horizontal Spacing of Cylinders
Sheeting
Speed
Shore
Waler
2' max.
Hydraulic
Cylinder
Vertical
Spacing
4' max.
3" x 12"
Timber
Sheeting
Speed Shore
Aluminum Hydraulic Shoring
Typical Waler System

Type C Soils

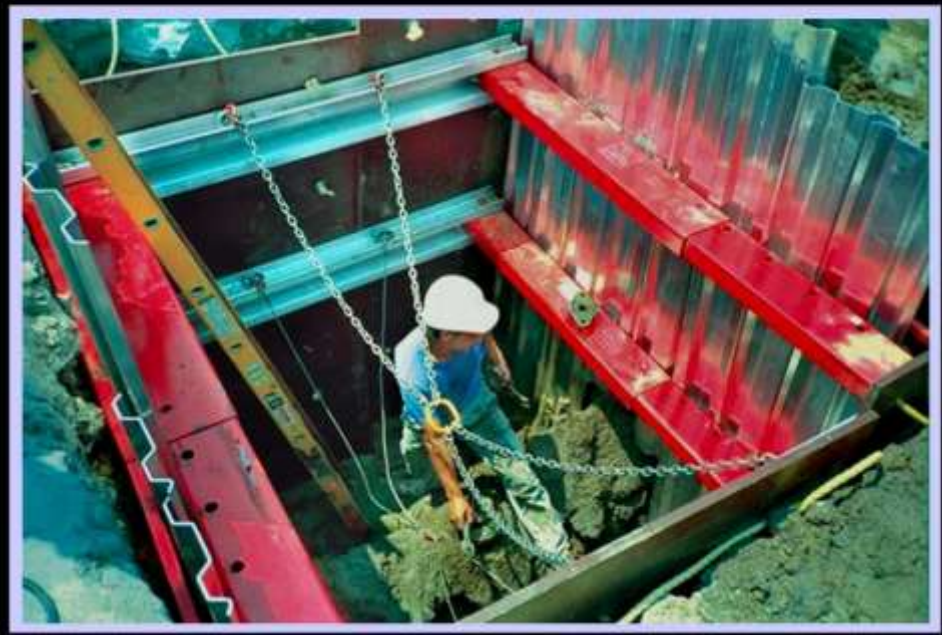
TABLE D - 1.4
Aluminum Hydraulic Shoring
Waler Systems for Soil Type C

DEPTH OF TRENCH (feet)	WALES		HYDRAULIC CYLINDERS						TIMBER UPRIGHTS		
			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.

American
Shoring Inc.

Waler with Speed-Strut End Beams



4-Way Manhole Brace With Steel Plate

Shield Systems

Shield Certification

SPEED SHORE®
PIONEERING TRENCH SAFETY

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 *(p.c.f.)*	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.

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.

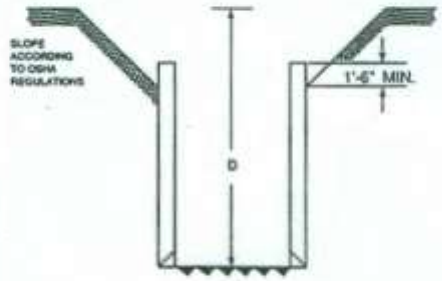
Type B not exceeding 45 PSF per foot of depth, and Type C nor exceeding 60 PSF per foot in depth.

SHIELD SIZE			D		
			SOIL TYPE TO BE EXCAVATED		
HEIGHT (FEET)	LENGTH (FEET)	MAXIMUM LATERAL EARTH PRESSURE CAPACITY AT TRENCH BOTTOM IN POUNDS PER SQUARE FOOT	TYPE A Stiff, cohesive soil. 25 PSF per foot of depth.	TYPE B Medium cohesive to granular soil. 45 PSF per foot of depth.	TYPE C Soft cohesive to submerged soil. 60 PSF per foot of depth.
8'	16'	1170	47'	26'	20'

LIMITATIONS IN USE OF TABLE

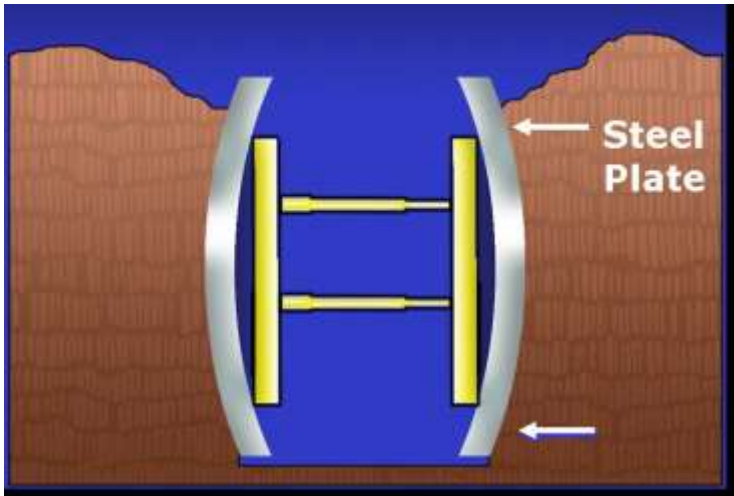
1. TRENCH SHIELD TO BE ASSEMBLED AND INSTALLED AS SHOWN AND IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.
2. BANK ABOVE TOP OF SHIELD TO BE LAID BACK ACCORDING TO OSHA REGULATIONS.
3. CONSULT MANUFACTURER WHEN BOTTOM OF SHIELD IS NOT AT TRENCH BOTTOM.
4. ADDITIONAL SHIELDS MAY BE STACKED WITH NO PENALTY IN DEPTH OF CUT.
5. DEPTHS OF CUTS SHOWN ARE BASED ON EXAMPLES OF VARIOUS SOIL CONDITIONS. VERIFY ACTUAL SOIL PRESSURES PRIOR TO EACH USE.
6. ANY MODIFICATIONS OR ALTERATIONS NOT ALLOWED UNLESS APPROVED IN WRITING BY EFFICIENCY PRODUCTION, INC.
7. DEPTH CERTIFICATION IS BASED ON SHORT TERM EXPOSURE WITH EXCAVATION OPEN A PERIOD OF TIME EQUAL TO 24 HOURS OR LESS. CONSULT THE MANUFACTURER SHOULD LONG TERM EXPOSURE BE REQUIRED.

DESCRIPTION	DESCRIPTION	DESCRIPTION
Clay, silty clay, sandy clay, clay loam, unconfined compressive strength of 1.5 tons per square foot or greater. (See note 8 on reverse side).	Clay with unconfined compressive strength greater than .5 TSF but less than 1.5 TSF, cohesionless gravel, silt, silt loam or sandy loam. (See Note 9 on reverse side).	Clay with unconfined compressive strength less than .5 TSF, submerged sand, clay or fractured rock that is not stable. (See Note 10 on reverse side).



CERTIFIED BY:
McCLURG & ASSOCIATES, INC. CONSULTING ENGINEERS
FEBRUARY 15, 1991

MANUFACTURED UNDER ONE OR MORE OF THE FOLLOWING U.S. PATENT NUMBERS:
4,090,365-4,114,383-4,259,029
ONE OR MORE OF THE FOLLOWING CANADIAN PATENT NUMBERS: 1,062,583-1,062,584

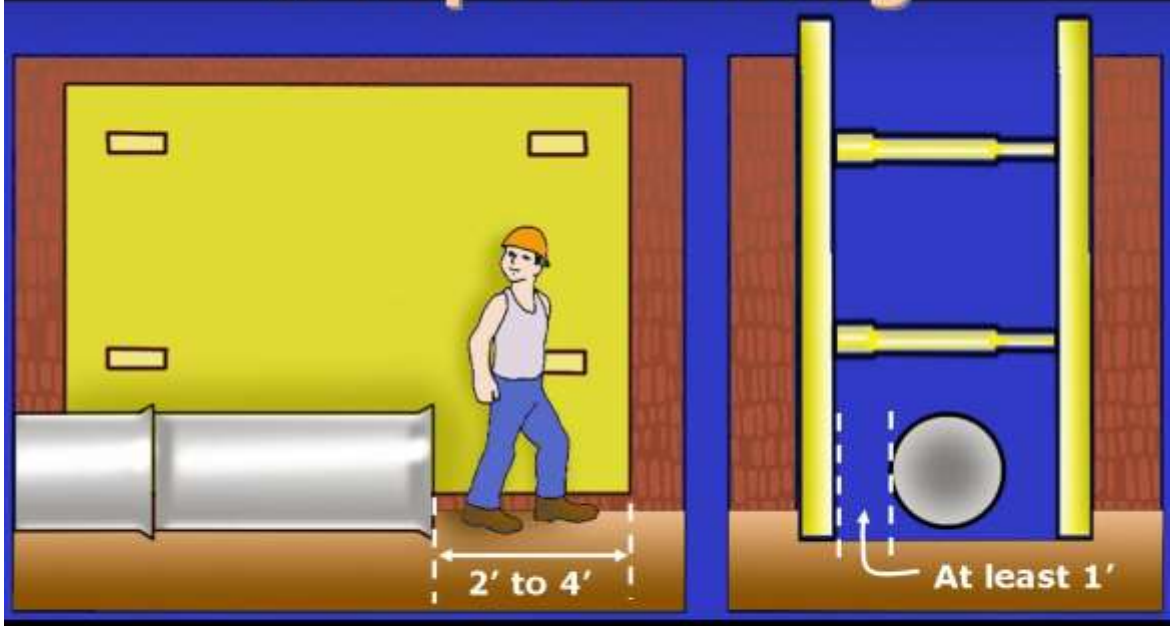


Do not use steel plates
behind shields.

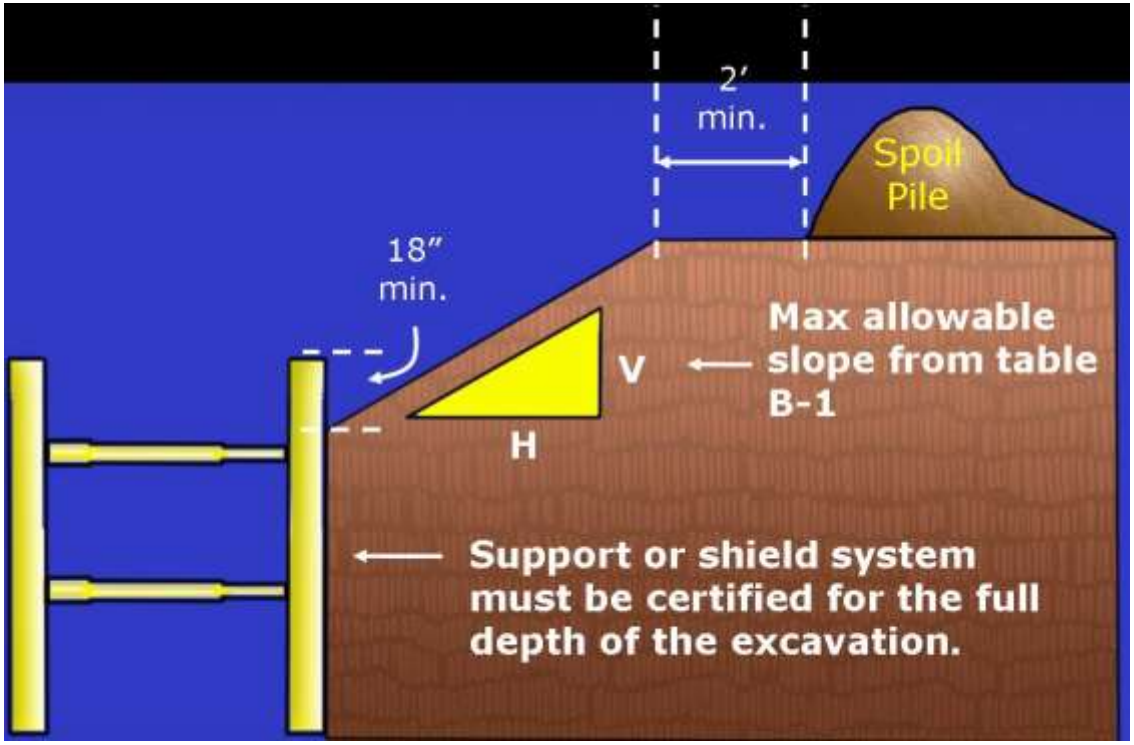
It can cause the shield to be overloaded . . .

. . . with predictable results.

Adequate Sizing

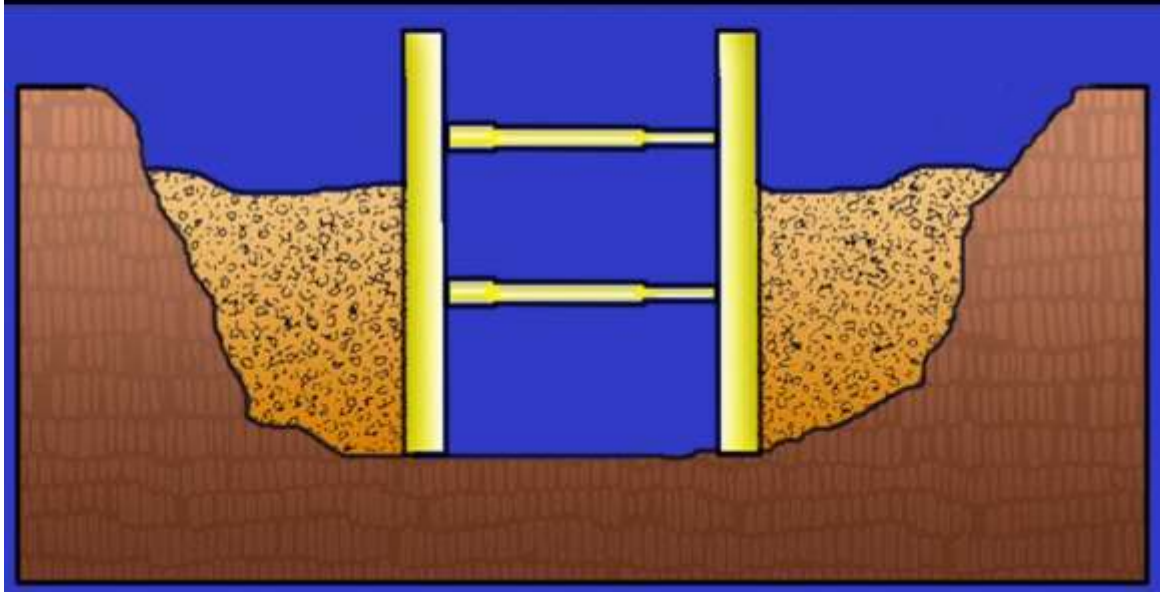


Allow 2 to 4 feet past the end of the pipe, and at least 1 foot alongside it for employee work space.


2′
min.
Spoil
Pile
18″
min.
V
H
Max allowable
slope from table
B-1
Support or shield system
must be certified for the full
depth of the excavation.

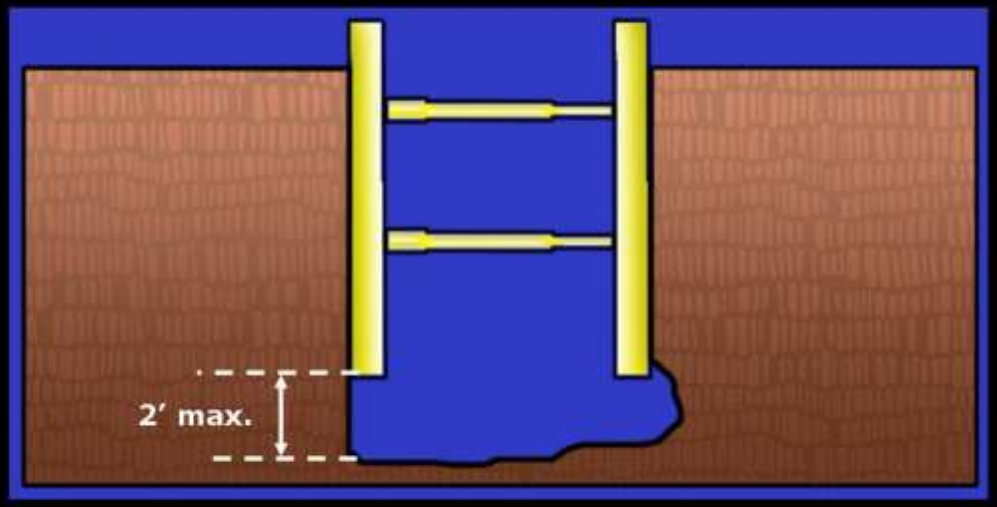

Use end plate to prevent exposure at end of trench shield.

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



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

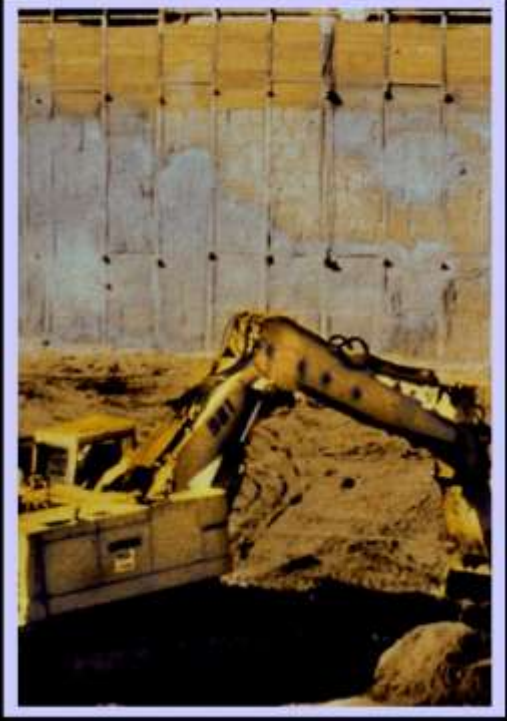
A shield or support system may ride 2′ off the bottom if:



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.

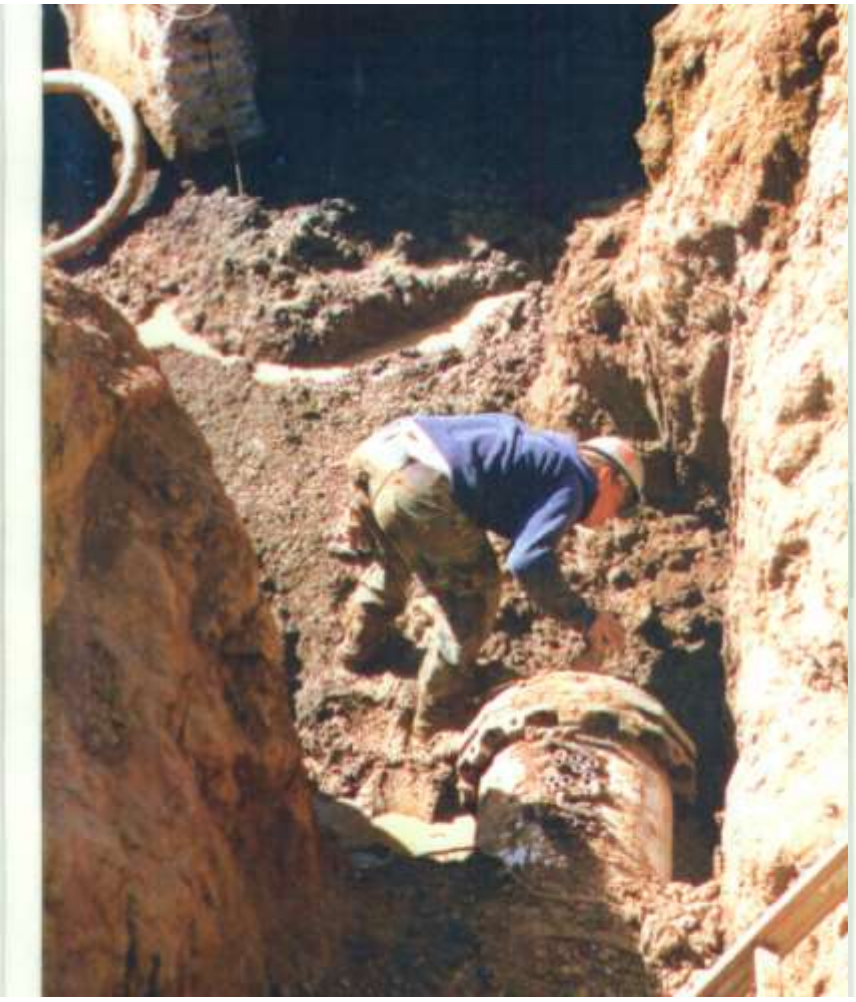
Soldier Piling



Soldier Piers

Soil Nailing

Slide Rail System



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

Needless to say, we replaced the shoring for them.

Thanks to the Susan Harwood Program Grant

The University of Texas at Arlington

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