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Prepared by: D.J. Satterfield	Shoring Installation Requirements	Page: 1 of 15
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		Effective: 3-1-23

GENERAL

The design tables in this construction standard are to be used by the competent person. A competent person is able to recognize hazards with a task and has the ability to mitigate those hazards. The competent person shall be experienced and knowledgeable in trenching and excavation procedures, soil identification, and the shoring and/or protective systems herein. It is the responsibility of the competent person to adequately protect workers in an excavation by installing shoring and/or protective systems bracing when necessary according to this construction standard.

The lead member of the crew shall be considered the competent person of the excavation unless otherwise designated. The competent person shall continually monitor the excavation for signs of deterioration such as seepage of water or soil movement. To the extent possible, keep the excavation dry at all times. Changing conditions will require adjustments to the shoring and/or protective systems. All personnel shall be trained in correct and safe use of the shoring and/or protective systems herein. All personnel are responsible for providing input to the competent person as needed to maintain a safe excavation.

For abnormal excavations or in any case where the competent person is unsure of the procedure or method of shoring required, the Construction Training Foreman is to be consulted.

The soil parameters use “C-60” soil, which is similar to an OSHA Type C soil, but will stand up long enough to install the shoring.

EXCAVATION SAFETY

The competent person will adhere to the following in executing responsibilities. Although the following are provided as guidelines, they are not intended to specifically cover all hazardous situations which may exist.

1. The competent person shall continually caution employees to remain out of an excavation whenever possible to reduce the odds of injury by cave-in.
2. Whenever it is necessary for an employee to enter any excavation, shoring should be considered first.
3. Cave-in can happen in any soil situation.
4. **At no time** shall job completion time or economy have priority over the safety of the worker.

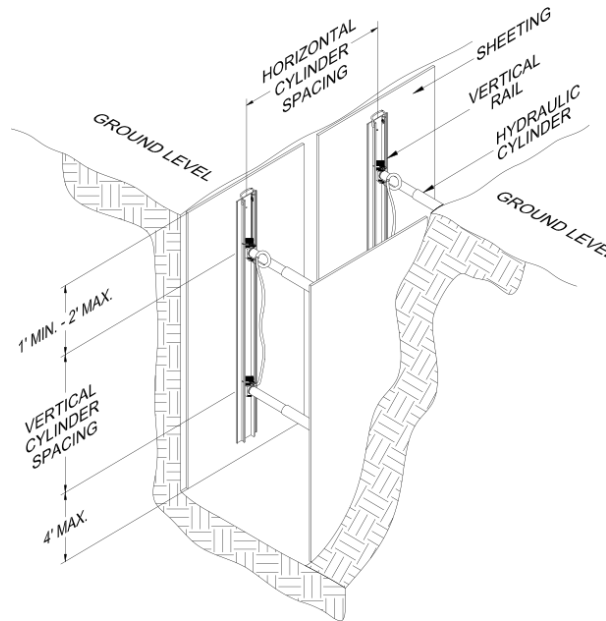
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5. There must be at least one employee on top of the ground surface to secure help in the event of a cave-in, if the excavation is over 4' in depth. **The top person must not leave workers unattended at any time.**
6. All materials and equipment will be kept as far back from the edge of the excavation as practicable. Excavated materials should not be placed closer than 24" from the edge of any excavation.
7. In excavations that are 4' or more in depth, a ladder is required. It must be within 25' of lateral travel for all workers and extend at least 3' above the top of the trench. The ladder must also be located within the shored area.
8. Where excavation is next to a bank, consider the height of the bank added to excavated depth as the depth for which shoring must be provided. Any slope or bench of a 3H:1V slope or greater does not need to be included in overall trench depth. See Fig. 14, page 15.
9. Cracks in the surface of the soil roughly parallel to the excavation and adjacent to it, from one foot to 6' from the edge, indicate the soil in the banks has already failed and if not shored, a cave-in is imminent. The full earth load will be on the shoring.

SITUATIONS WHERE SHORING MUST BE PROVIDED

1. Excavation in sandy, black, organic or other unstable soils, or in or near previously disturbed soils.
2. Excavation revealing ground water.
3. Excavation near vibration-producing devices, heavy traffic movement, railroad tracks or other such disturbances.
4. Construction equipment required within 4' of the trench.
5. Ditch depth of 5' or more in stable soil, less if the soil is unstable.
6. Excavations that closely parallel or intersect previous trenches, including those of existing underground lines. At the intersection of previous trenches, the entire width of previous trench and adjacent walls will be shored with consideration of the angle of intersection.
7. Excavated material from the trench is placed closer than 24" to the edge of the excavation.
8. Where workers have to be in a position that is seated, lying or kneeling on two knees in an excavation over 4' in depth.

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Hydraulic Vertical Shoring With Sheeting

Fig. 1

Sheeting is used only to prevent local raveling or sloughing of the trench face between the vertical shores.

1. In excavations 6' deep or less, only 1 hydraulic cylinder is required in each vertical plane. The cylinder shall be no more than 4' above the bottom of the excavation and no more than 2' below the top of the excavation. In excavations 6' to 10' deep there shall be a minimum of 2 hydraulic cylinders in each vertical plane. The horizontal spacing shall be as shown in Table 1, page 4 and Fig. 1, above.

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2. The vertical rails must have firm soil or a solid and stable filler behind the sheeting to bear on and distribute the cylinder load to the face of the excavation. Do not butt rails back to back across an excavation.
 3. The aluminum rails are designed to be used vertically, however, they may be orientated horizontally or diagonally if all other provisions herein are satisfied.
 4. The maximum vertical spacing between center lines of hydraulic cylinders is 4'.
 5. The faces of the excavation must be cut near vertical and straight.

* Revised Text 

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6. The shores shall be placed at the required spacing from end to end of the excavation with a minimum of 2 shores. There shall be a shore within 2' of each end of the excavation. If trench width is 4' or less, no end protection is required. See Fig. 2.

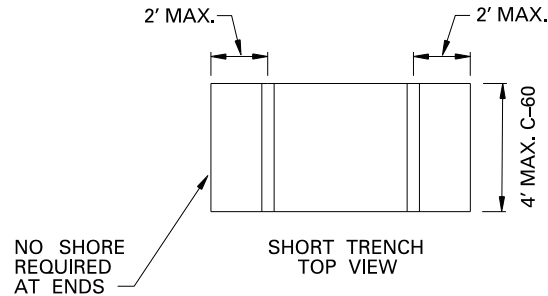


Fig. 2

7. No vertical or lateral loads shall be applied to the cylinders.
8. If shores are installed on the seam between two adjacent sheets of FinnForm, each FinnForm sheet shall bear a minimum of four inches on each vertical rail.

HYDRAULIC VERTICAL SHORING

Table 1

Depth of Excavation	HYDRAULIC CYLINDERS					Sheeting (Note 3)
	Maximum Horizontal Spacing	Maximum Vertical Spacing (Note 5)	Width of Excavation			
			0' to 8'	>8' to 12'	>12' to 15'	
0' to10'	6' (Note 4)	4'	2'' dia.	2'' dia.	2'' dia. (Note 1)	(Note 2)
>10' to 20'	4'	4'	2'' dia.	2'' dia. (Note 1)	2'' dia. (Note 1)	(Note 6)

* Speed Shore is only approved hydraulic vertical shoring

NOTES

- Two inch diameter cylinders shall have a structural steel tube oversleeve 3.5" x 3.5" x 0.1875" extension (installed over the aluminum oversleeve extension) or a steel tube oversleeve 3" x 3" x 0.1875" extension (installed without the aluminum oversleeve) that extends the full restricted length of the cylinder.
CAUTION: In either case, the aluminum load transfer plug and the aluminum inner sleeve shall be used or a steel load transfer plug shall be welded securely in place inside the steel oversleeve to transfer the load through the steel oversleeve to the socket pad.

- * 2. The bottom of the sheeting shall extend to within 2' of the bottom of the excavation. If there is an indication of a possible loss of soil from behind or below the support system, sheeting must extend to the bottom of the excavation.

* Revised Text 

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- * 3. 4' wide sheeting shall be used when feasible.
4. When 4' horizontal spacing is exceeded, the open spaces between the sheeting must be monitored for sloughing and raveling of the excavation face. If sloughing or raveling occurs 4' horizontal spacing must be used.
5. The bottom hydraulic cylinder shall be a maximum of 4' above the bottom of the excavation.
6. Sheeting shall extend to the bottom of the excavation.
7. For continuous main-laying jobs where brief operations (ie: soaping of joints) are in progress, only a single set of shoring (near the joint, if backfill is kept tight) is acceptable.

SHIELDING

In sloped excavations, the top of the shield (sidewall) must be a minimum of 18" above the bottom of the slope and the top struts/braces must be located below the bottom of the slope, see Fig. 3, below. In un-sloped excavations, the top of the shield (sidewall) may be flush with the ground surface, see Fig. 4, below, provided that the competent person determines that there is no hazard of objects rolling into the excavation. In either excavation, the trench may be no more than 12" wider or 12" longer than the shield.

Note: Only when using Speed Shore shielding (red end load spreaders), is Finn-Form acceptable as end protection.

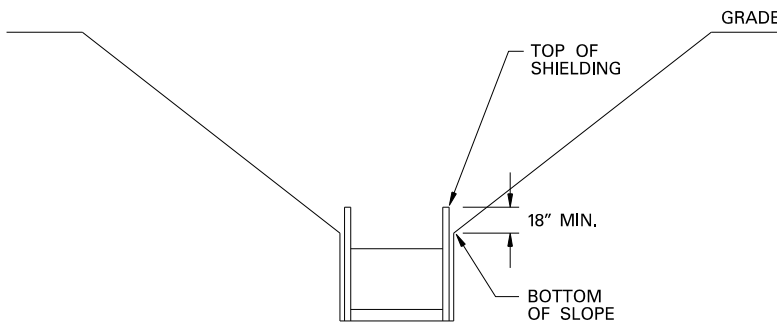


Fig. 3

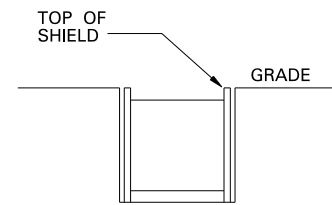


Fig. 4



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BUILD-A-BOX™ MODULAR TRENCH SHIELD SYSTEM OPTION

1. BUILD-A-BOX™ Modular Trench Shield Systems shall be used with telescoping spreaders and static braces pinned in place with two (2) supplied $\frac{5}{8}$ " diameter pins at each end of the strut or brace.
2. BUILD-A-BOX™ Modular Trench Shield Systems shall be handled by using the lifting lugs installed in holes provided in each panel or corner post. Stacking Brackets shall be used when stacking modular systems.
3. The bottom of the BUILD-A-BOX™ Modular Trench Shield System shall be located no more than two feet from the bottom of the excavation as long as no loss of soil from behind or below the shield is encountered. Proper benching of trench wall is required.
4. The maximum depth of excavation in which a BUILD-A-BOX™ Modular Trench Shield System can be used in is 20'.

Two-Sided Configurations



With telescoping spreaders and
full length corner posts



With full length corner posts and arches

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Three-Sided Configurations



With telescoping spreaders and removed bottom panel



With telescoping spreaders and end panels pinned 1' up in corner posts, allowing utility to run through

Four-Sided Configurations



With sectional corner posts and removed bottom panel



Stacked BUILD-A-BOX™
Modular Trench Shield System

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SHORING/BRACING MATERIAL AND DESIGN TABLES

Table 2

M.U.D. VERTICAL SHORING SYSTEM – 2”x12” VERTICAL UPRIGHT AND SCREW JACKS - "C-60" SOIL						
Depth of Trench (ft.)	Maximum Horizontal Spacing (ft.)	Maximum Vertical Screw Jack Spacing (ft.)	Width of Excavation (ft.)			Sheeting (FinnForm or Plywood)
			up to 3 ft.	>3 ft. to 6 ft.	>6 ft. - 12 ft.	
Up to 10'	4'	4'	1 ½” Dia. Jack	2" Dia. Jack	3" Dia. Jack	Not Required
>10' to 15'	4'	4'	2" Dia. Jack	2" Dia. Jack	3" Dia. Jack	Required

Note: For this method, the vertical 2”x12”s need to extend to within 2' of the bottom of the excavation (no embedment required)

Table 3

M.U.D. VERTICAL SHORING SYSTEM – PZ-22 SHEET PILE VERTICAL UPRIGHT AND SCREW JACKS - "C-60" SOIL						
Depth of Trench (ft.)	Maximum Horizontal Spacing (ft.)	Maximum Vertical Screw Jack Spacing (ft.)	Width of Excavation (ft.)			Sheeting (PZ-22 Sheet Pile)
			up to 3 ft.	>3 ft. to 6 ft.	>6 ft. - 12 ft.	
Up to 10'	4'	4'	1 ½” Dia. Jack	2" Dia. Jack	3" Dia. Jack	Not Required
>10' to 15'	4'	4'	2" Dia. Jack	2" Dia. Jack	3" Dia. Jack	Required

Note: For this method, the vertical PZ-22 sheet pile needs to extend to within 2' of the bottom of the excavation (no embedment required)

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Table 4

M.U.D. CANTILEVER SHEET PILE SYSTEM - GRANULAR SOIL - "C-60" SOIL			
Depth of Trench	Maximum Spacing Between Sheet Piles	Min. Sheet Pile Length (ft.)	Min. Sheet Pile Embed Below Trench (ft.)
5'	3"	17'	12'
6'	3"	20'	14'
7'	3"	22'	15'
8'	3"	25'	17'

Table 5

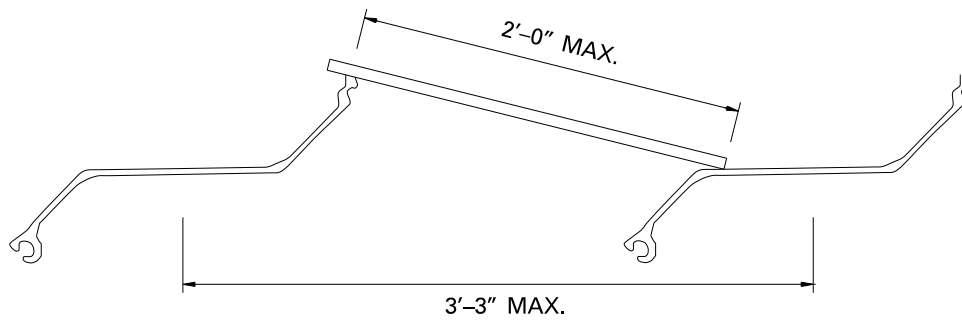
M.U.D. CANTILEVER SHEET PILE SYSTEM - COHESIVE SOIL - "C-60" SOIL			
Depth of Trench	Maximum Spacing Between Sheet Piles	Min. Sheet Pile Length (ft.)	Min. Sheet Pile Embed Below Trench (ft.)
5'	3"	9'	4'
6'	3"	11'	5'
7'	3"	13'	6'
8'	3"	16'	8'
9'	3"	19'	10'
10'	3"	23'	13'

Table 6

M.U.D. CANTILEVER SHEET PILE SYSTEM w/ FINNFORM - COHESIVE SOIL - "C-60" SOIL			
Depth of Trench	Maximum Spacing Between Sheet Piles *	Min. Sheet Pile Length (ft.)	Min. Sheet Pile Embed Below Trench (ft.)
5'	2'-0"	10'	5'
6'	2'-0"	12'	6'
7'	2'-0"	14'	7'
8'	2'-0"	17'	9'
9'	2'-0"	21'	12'
10'	2'-0"	25'	15'

* See FinnForm Option, Page 10

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FinnForm Option

The Design Tables 2 – 6, pages 8 – 9, are to be used to determine the materials needed to properly and safely shore the trench where the work will be conducted. The competent person of the excavation will decide which method of shoring to use. The design tables are based off “C-60” soil. “C-60” soil is granular or cohesive soil with an unconfined compressive strength less than 0.5 tsf (tons per square foot) or any submerged or freely seeping soil or adversely bedded soils. The design tables are adequate for the effect of a 20,000 lb. surcharge load set back 24” minimum from the edge of the trench. The tables are not adequate for any equipment, surcharge, or structures in excess of the 20,000 lb. load.

1. The faces of the trench shall be vertical and straight. The shoring shall bear on firm soil or solid filler. Shoring shall be set to within 3 degrees of vertical and shall line up across both sides of the trench. Screw jacks for braced shoring shall be installed horizontally, within 2 degrees, across the trench.
2. A minimum of two braced vertical shores shall be used for a trench. Trenches longer than 8’ shall have a minimum of three braced vertical shores spaced according to the design tables. Cantilevered sheet pile may be driven to protect the entire work area, or a minimum of 8’ long on both sides of the trench. Workers shall always work inside the shored area of the trench.
3. For braced shoring, the screw jack braces shall be installed per design Table 2, page 8. The lowest brace shall be no more than 4’ from the bottom of the trench. The top brace shall be no more than 2’ from the top of the trench. Use two braces minimum per vertical shoring member. See Fig. 5, page 11.

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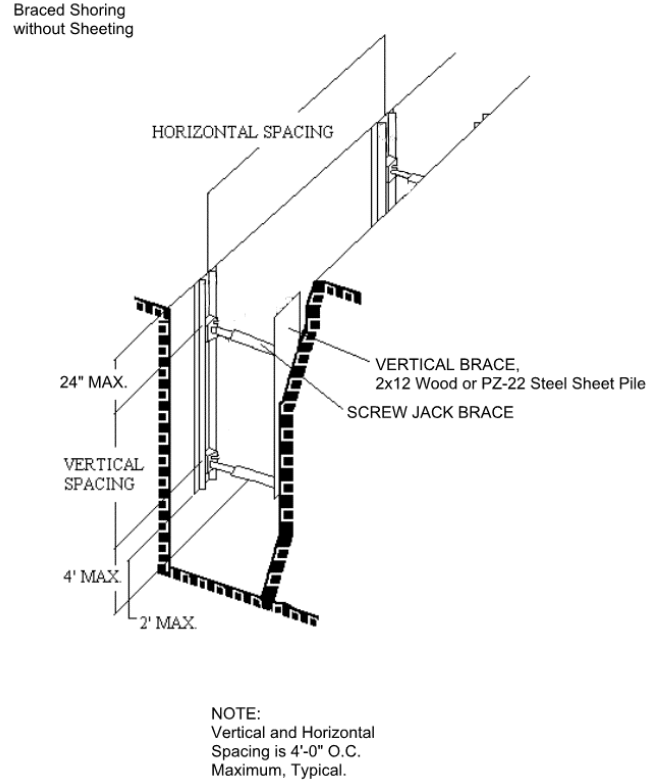


Fig. 5

4. There should not be vertical or lateral loads applied to the screw jack braces.
5. Screw jack braces, (shown in Fig. 6, below), shall be tensioned to 2,400 lbs. minimum. In order to ensure this load is met, the screw jacks shall first be hand tightened and then tightened with a 2'± long "cheater bar" as tight as possible. The vertical 2"x12" or sheet pile shall sink into the soil, but at maximum load, the soil should not give and the pressure in the screw jacks shall stabilize. The screw jacks should never loosen up in the trench. The pressure on the screw jacks shall be checked, before reentering the trench, every morning at a minimum, and retightened as required. The 1 ½" diameter pipe should be used with the 1 ½" screw jack. The 2" and 3" diameter pipes should always be used with the 2" screw jack. All pipe must be schedule 40 or heavier.

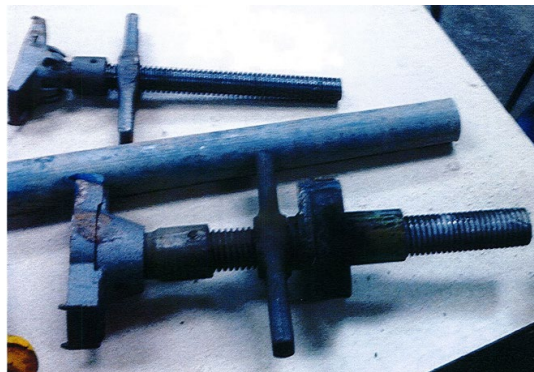


Fig. 6

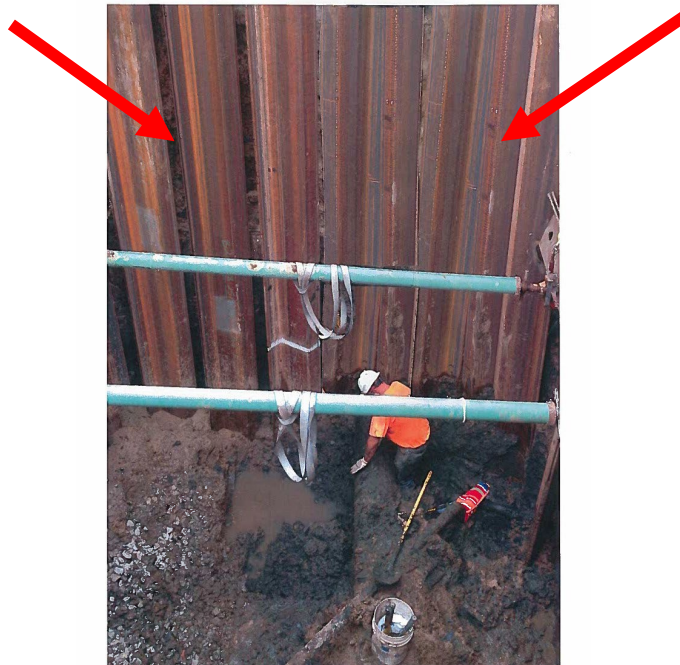
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6. Sheeting is required at any depth where soil separation or crumbling occurs. Sheeting is also required at the depths indicated in the design tables. For the braced 2" x 12" wood shoring, sheeting shall be FinnForm or plywood. Plywood sheeting shall be 1-1/8" thick CDX with a minimum allowable bending stress of 1,100 psi. FinnForm shall be 3/4" thick birch with a minimum allowable bending stress of 3,600 psi.
7. Acceptable sheet piling (see Fig. 7) shall be approved by Plant Engineering. When using sheet piling, they shall extend from the top to the bottom of the excavation. There are two options when installing sheet piling.



Sheet piling
Fig. 7

- A. Cantilever(standalone). Fig.8, below. See Table 4 for installation.



Cantilever(standalone)
Fig. 8

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B. Sheet piling with brace adapters. See Fig. 9, below.



Sheet piling brace adapter
Fig. 9

8. The depth of the excavation used to determine shoring requirements shall be measured from the top ground surface to the bottom of the trench.

When only the lower portion of a trench is to be shored and the remaining portion is benched or sloped at an angle steeper than three horizontal to one vertical (3H:1V), the allowable depth of excavation shall be measured from the top of the overall trench and not the toe of the sloped portion. See Fig. 10, page 14.

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All simple slope excavations 20' or less in depth shall have a maximum allowable slope of 1 ½:1. See Fig. 14, below.

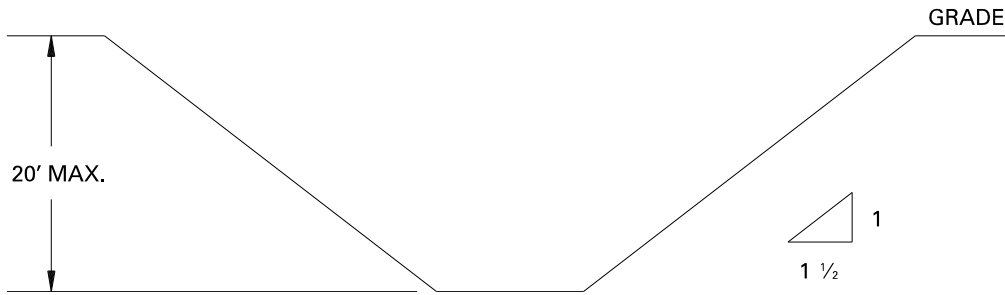


Fig. 14

Example of 3H:1V bench.

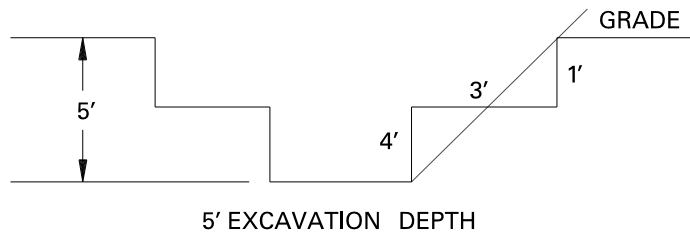


Fig. 15

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