



2. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).

APPENDIX C TO SUBPART P OF PART 1926—TIMBER SHORING FOR TRENCHES

(a) *Scope.* This appendix contains information that can be used timber shoring is provided as a method of protection from cave-ins in trenches that do not exceed 20 feet (6.1 m) in depth. This appendix must be used when design of timber shoring protective systems is to be performed in accordance with §1926.652(c)(1). Other timber shoring configurations; other systems of support such as hydraulic and pneumatic systems; and other protective systems such as sloping, benching, shielding, and freezing systems must be designed in accordance with the requirements set forth in §1926.652(b) and §1926.652(c).

(b) *Soil Classification.* In order to use the data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of this part.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables C-1.1, C-1.2, and C-1.3, and Tables C-2.1, C-2.2 and C-2.3 following paragraph (g) of the appendix. Each table presents the minimum sizes of timber members to use in a shoring system, and each table contains data only for the particular soil type in which the excavation or portion of

the excavation is made. The data are arranged to allow the user the flexibility to select from among several acceptable configurations of members based on varying the horizontal spacing of the crossbraces. Stable rock is exempt from shoring requirements and therefore, no data are presented for this condition.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix, and on the tables themselves.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations regarding Tables C-1.1 through C-1.3 and Tables C-2.1 through C-2.3 are presented in paragraph (g) of this Appendix.

(d) *Basis and limitations of the data*—(1) *Dimensions of timber members.* (i) The sizes of the timber members listed in Tables C-1.1 through C-1.3 are taken from the National Bureau of Standards (NBS) report, "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations." In addition, where NBS did not recommend specific sizes of members, member sizes are based on an analysis of the sizes required for use by existing codes and on empirical practice.

(ii) The required dimensions of the members listed in Tables C-1.1 through C-1.3 refer to actual dimensions and not nominal dimensions of the timber. Employers wanting to use nominal size shoring are directed to Tables C-2.1 through C-2.3, or have this choice under §1926.652(c)(3), and are referred to The Corps of Engineers, The Bureau of Reclamation or data from other acceptable sources.

(2) *Limitation of application.* (i) It is not intended that the timber shoring specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be designed as specified in §1926.652(c).

(ii) When any of the following conditions are present, the members specified in the tables are not considered adequate. Either an alternate timber shoring system must be designed or another type of protective system designed in accordance with §1926.652.

(A) When loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by a two-foot soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.

(B) When vertical loads imposed on cross braces exceed a 240-pound gravity load distributed on a one-foot section of the center of the crossbrace.

(C) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(D) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables.* The members of the shoring system that are to be selected using this information are the cross braces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are six tables of information, two for each soil type. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is then made. The selection is based on the depth and width of the trench where the members are to be installed and, in most instances, the selection is also based on the horizontal spacing of the crossbraces. Instances where a choice of horizontal spacing of crossbracing is available, the horizontal spacing of the crossbraces must be chosen by the user before the size of any member can be determined. When the soil type, the width and depth of the trench, and the horizontal spacing of the crossbraces are known, the size and vertical spacing of the crossbraces, the size and vertical spacing of the wales, and the size and horizontal spacing of the uprights can be read from the appropriate table.

(f) *Examples to Illustrate the Use of Tables C-1.1 through C-1.3.*

(1) *Example 1.*

A trench dug in Type A soil is 13 feet deep and five feet wide.

From *Table C-1.1*, for acceptable arrangements of timber can be used.

Arrangement #B1

Space 4x4 crossbraces at six feet horizontally and four feet vertically.

Wales are not required.

Space 3x8 uprights at six feet horizontally. This arrangement is commonly called "skip shoring."

Arrangement #B2

Space 4x6 crossbraces at eight feet horizontally and four feet vertically.

Space 8x8 wales at four feet vertically.

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Space 2x6 uprights at four feet horizontally.

Arrangement #B3

Space 6x6 crossbraces at 10 feet horizontally and four feet vertically.

Space 8x10 wales at four feet vertically.

Space 2x6 uprights at five feet horizontally.

Arrangement #B4

Space 6x6 crossbraces at 12 feet horizontally and four feet vertically.

Space 10x10 wales at four feet vertically.

Spaces 3x8 uprights at six feet horizontally.

(2) Example 2.

A trench dug in Type B soil in 13 feet deep and five feet wide. From Table C-1.2 three acceptable arrangements of members are listed.

Arrangement #B1

Space 6x6 crossbraces at six feet horizontally and five feet vertically.

Space 8x8 wales at five feet vertically.

Space 2x6 uprights at two feet horizontally.

Arrangement #B2

Space 6x8 crossbraces at eight feet horizontally and five feet vertically.

Space 10x10 wales at five feet vertically.

Space 2x6 uprights at two feet horizontally.

Arrangement #B3

Space 8x8 crossbraces at 10 feet horizontally and five feet vertically.

Space 10x12 wales at five feet vertically.

Space 2x6 uprights at two feet vertically.

(3) Example 3.

A trench dug in Type C soil is 13 feet deep and five feet wide.

From Table C-1.3 two acceptable arrangements of members can be used.

Arrangement #B1

Space 8x8 crossbraces at six feet horizontally and five feet vertically.

Space 10x12 wales at five feet vertically.

Position 2x6 uprights as closely together as possible.

If water must be retained use special tongue and groove uprights to form tight sheeting.

Arrangement #B2

Space 8x10 crossbraces at eight feet horizontally and five feet vertically.

Space 12x12 wales at five feet vertically.

Position 2x6 uprights in a close sheeting configuration unless water pressure must be resisted. Tight sheeting must be used where water must be retained.

(4) Example 4.

A trench dug in Type C soil is 20 feet deep and 11 feet wide. The size and spacing of members for the section of trench that is over 15 feet in depth is determined using Table C-1.3. Only one arrangement of members is provided.

Space 8x10 crossbraces at six feet horizontally and five feet vertically.

Space 12x12 wales at five feet vertically.

Use 3x6 tight sheeting.

Use of Tables C-2.1 through C-2.3 would follow the same procedures.

(g) Notes for all Tables.

1. Member sizes at spacings other than indicated are to be determined as specified in §1926.652(c), "Design of Protective Systems."

2. When conditions are saturated or submerged use Tight Sheeting. Tight Sheeting refers to the use of specially-edged timber planks (e.g., tongue and groove) at least three inches thick, steel sheet piling, or similar construction that when driven or placed in position provide a tight wall to resist the lateral pressure of water and to prevent the loss of backfill material. Close Sheeting refers to the placement of planks side-by-side allowing as little space as possible between them.

3. All spacing indicated is measured center to center.

4. Wales to be installed with greater dimension horizontal.

5. If the vertical distance from the center of the lowest crossbrace to the bottom of the trench exceeds two and one-half feet, uprights shall be firmly embedded or a mudsill shall be used. Where uprights are embedded, the vertical distance from the center of the lowest crossbrace to the bottom of the trench shall not exceed 36 inches. When mudsills are used, the vertical distance shall not exceed 42 inches. Mudsills are wales that are installed at the toe of the trench side.

6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

7. Placement of crossbraces. When the vertical spacing of crossbraces is four feet, place the top crossbrace no more than two feet below the top of the trench. When the vertical spacing of crossbraces is five feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

TABLE C-1.1

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE A $P_a = 25 \text{ X H} + 72 \text{ psf}$ (2 ft Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS **											
	CROSS BRACES				WALES				UPRIGHTS			
	HORIZ. SPACING (FEET)		WIDTH OF TRENCH (FEET)		VERT. SPACING (FEET)		SIZE (IN)		VERT. SPACING (FEET)		MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)	
5	UP TO 6	4X4	4X4	4X6	6X6	4	Not Req'd	---				
	UP TO 8	4X4	4X4	4X6	6X6	4	Not Req'd	---			2X6	2X8
10	UP TO 10	4X6	4X6	4X6	6X6	4	8X8	4		2X6		
	UP TO 12	4X6	4X6	6X6	6X6	4	8X8	4			2X6	
10	UP TO 6	4X4	4X4	4X6	6X6	4	Not Req'd	---				
	UP TO 8	4X6	4X6	6X6	6X6	4	8X8	4		2X6		
15	UP TO 10	6X6	6X5	6X6	6X8	4	8X10	4				
	UP TO 12	6X6	6X6	6X6	6X8	4	10X10	4			3X8	
15	UP TO 6	6X6	6X6	6X6	6X8	4	6X8	4				
	UP TO 8	6X6	6X6	6X6	6X8	4	8X8	4		3X6		
20	UP TO 10	8X8	8X8	8X8	8X10	4	8X10	4				
	UP TO 12	8X8	8X8	8X8	8X10	4	10X10	4				
OVER 20	SEE NOTE 1.											

* Mixed oak or equivalent with a bending strength not less than 850 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-1.2

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE B P_a = 45 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**											
	CROSS BRACES				WALES			UPRIGHTS				
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)			VERT. SPACING (FEET)			MAXIMUM ALLOWABLE HORIZONTAL SPACING		UPRIGHTS		
UP TO	UP TO	UP TO	UP TO	UP TO	UP TO	UP TO	UP TO	CLOSE	2	3		
5	6	4X6	4X6	6X6	6X6	6X6	5	6X8	5		2X6	
TO	8	6X6	6X6	6X8	6X8	6X8	5	8X10	5		2X6	
10	10	6X6	6X6	6X8	6X8	6X8	5	10X10	5		2X6	
	See Note 1											
10	6	6X6	6X6	6X8	6X8	6X8	5	8X8	5		2X6	
TO	8	6X8	6X8	8X8	8X8	8X8	5	10X10	5		2X6	
15	10	8X8	8X8	8X8	8X10	8X10	5	10X12	5		2X6	
	See Note 1											
15	6	6X8	6X8	8X8	8X8	8X8	5	8X10	5	3X6		
TO	8	8X8	8X8	8X8	8X10	8X10	5	10X12	5	3X6		
20	10	8X10	8X10	8X10	10X10	10X10	5	12X12	5	3X6		
	See Note 1											
OVER	SEE NOTE 1											
20												

* Mixed oak or equivalent with a bending strength not less than 850 psi.
 ** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-1.3

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *
 SOIL TYPE C P_a = 80 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**														
	GROSS BRACES			WIDTH OF TRENCH (FEET)			VERT. SPACING (FEET)		SIZE (IN.)		VERT. SPACING (FEET)		UPRIGHTS		
	HORIZ. SPACING (FEET)	UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15	UP TO 5	UP TO 5	UP TO 5	UP TO 5	UP TO 5	UP TO 5	UP TO 5	UP TO 5	UP TO 5
5	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	8X10	8X10	5	2X6				
TO 8		8X8	8X8	8X8	8X10	8X10	5	10X12	10X12	5	2X6				
TO 10		8X10	8X10	8X10	8X10	10X10	5	12X12	12X12	5	2X6				
	See Note 1														
10	UP TO 6	8X8	8X8	8X8	8X8	8X10	5	10X12	10X12	5	2X6				
TO 8		8X10	8X10	8X10	8X10	10X10	5	12X12	12X12	5	2X6				
	See Note 1														
15	UP TO 6														
	See Note 1														
TO 8		8X10	8X10	8X10	8X10	10X10	5	12X12	12X12	5	3X6				
	See Note 1														
15	UP TO 6	8X10	8X10	8X10	8X10	10X10	5	12X12	12X12	5	3X6				
TO 8															
	See Note 1														
20	UP TO 6														
	See Note 1														
OVER 20	SEE NOTE 1														

* Mixed Oak or equivalent with a bending strength not less than 850 psi.
 ** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.2

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *
 SOIL TYPE B P_a = 45 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **														
	CROSS BRACES						MALES			UPRIGHTS					
	HORIZ. SPACING (FEET)		WIDTH OF TRENCH (FEET)				VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)					
	UP TO	TO	UP TO	TO	UP TO	TO	UP TO	TO	TO	CLOSE	2	3	4	6	
5 TO 10	UP TO	4X6	4X6	4X6	6X6	6X6	6X6	5	6X8	5					
	TO	4X6	4X6	6X6	6X6	6X6	6X6	5	8X8	5			3X8		4X8
	UP TO	4X6	4X6	6X6	6X6	6X6	6X8	5	8X10	5					4X8
	See Note 1														
10 TO 15	UP TO	6X6	6X6	6X6	6X8	6X8	6X8	5	8X8	5					
	TO	6X8	6X8	6X8	8X8	8X8	8X8	5	10X10	5					4X10
	UP TO	6X8	6X8	8X8	8X8	8X8	8X8	5	10X12	5					4X10
	See Note 1														
15 TO 20	UP TO	6X8	6X8	6X8	8X8	8X8	8X8	5	8X10	5					
	TO	6X8	6X8	6X8	8X8	8X8	8X8	5	10X12	5					4X6
	UP TO	8X8	8X8	8X8	8X8	8X8	8X8	5	12X12	5					4X6
	See Note 1														
OVER 20	SEE NOTE 1														

* Douglas fir or equivalent with a bending strength not less than 1500 psi.
 ** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.3
 TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *
 SOIL TYPE C P_a = 80 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **											
	GROSS BRACES						MALES			UPRIGHTS		
	HORIZ. SPACING (FEET)		WIDTH OF TRENCH (FEET)				VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)		
	UP	TO	UP	TO	UP	TO				UP	TO	CLOSE
5 TO 10	UP	TO	6X6	6X6	6X6	6X6	8X8	5	8X8	5	3X6	
	UP	TO	6X6	6X6	6X6	6X6	8X8	5	10X10	5	3X6	
	UP	TO	6X6	6X6	6X6	6X6	8X8	5	10X12	5	3X6	
10 TO 15	UP	TO	6X8	6X8	6X8	6X8	8X8	5	10X10	5	4X6	
	UP	TO	8X8	8X8	8X8	8X8	8X8	5	12X12	5	4X6	
	See Note 1											
15 TO 20	UP	TO	8X8	8X8	8X8	8X8	8X10	5	10X12	5	4X6	
	See Note 1											
	See Note 1											
OVER 20	See Note 1											

* Douglas fir or equivalent with a bending strength not less than 1500 psi.
 ** Manufactured members of equivalent strength may be substituted for wood.

APPENDIX D TO SUBPART P OF PART 1926—ALUMINUM HYDRAULIC SHORING FOR TRENCHES

(a) *Scope.* This appendix contains information that can be used when aluminum hydraulic shoring is provided as a method of protection against cave-ins in trenches that

do not exceed 20 feet (6.1m) in depth. This appendix must be used when design of the aluminum hydraulic protective system cannot be performed in accordance with §1926.652(c)(2).

(b) *Soil Classification.* In order to use data presented in this appendix, the soil type or types in which the excavation is made must