WAR DEPARTMENT TECHNICAL MANUAL
TM 5-279

SUSPENSION BRIDGES

FOR

MOUNTAIN WARFARE

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By order of the **Secretary of War**:

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GENERAL

1 PURPOSE.—Suspension bridges (fig. 1) are used to carry light loads over long spans where swift or deep streams, deep ravines, and difficult approach roads or trails make impracticable the use of standard bridging equipage.

2 ADVANTAGES.—Suspension bridges for light loads have four advantages over other military bridges:

A For a given capacity they are lighter in weight per foot of bridge.

B They can be built to span gaps up to 400 feet with no intermediate supports.

C All bridge parts, with the exception of main cables and suspenders, can be built from local timber.

D Cable and equipment for construction can be divided into light, compact loads.

3 TYPES OF BRIDGE.—Three general types of suspension bridge are used in military operations:

A *Standard suspension bridge.*—A standard suspension bridge is built with standard equipage and material to carry specified loads. At present there are two types—a suspension footbridge and a light-equipment suspension bridge. These are covered in Chapters 2 and 3.

B *Nonstandard suspension bridge.*—A nonstandard suspension bridge is similar in design and construction to a standard bridge. It is built when heavier loads must be

crossed or when more permanent construction is desired. Design of nonstandard bridges is covered in Chapter 5.

C *Expedient suspension bridge.*—An expedient suspension bridge is built hastily, principally of local materials, and is used until a standard or nonstandard bridge can be constructed. Expedient bridges are described in Chapter 4.

4 STANDARD SUSPENSION BRIDGES.—A *Capacity.*— 1 - The suspension footbridge will carry one concentrated live load not exceeding 2,000 pounds. Three live loads of 1,000 pounds each are allowed on the bridge at one time provided they are separated by at least one-third the span length. For a detailed discussion of capacity see paragraph 9.

2 - The light-equipment suspension bridge will carry twice the live load of the suspension footbridge. See paragraph 56 for details.

B *Working party and construction time.*—Under favorable conditions a platoon of men requires 10 to 12 daylight hours to build a 300-foot suspension footbridge, while 12 to 15 daylight hours are required to build a 300-foot light-equipment suspension bridge. This does not include time to pack equipment and move to the bridge site.

C *Equipment.*—Special materials and equipment are available in engineer depots. Other equipment is organic with engineer platoons. Lists of materials and equipment used in constructing the standard bridges are given in Appendix I.

5 NONSTANDARD SUSPENSION BRIDGES.—A *Capacity.*—Since these bridges are designed to fit a particular situation the capacity varies with the design. Generally they are relatively heavy bridges. Chapter 5 describes three typical nonstandard bridges.

B *Working party and construction time.*—Heavier nonstandard bridges may require one engineer company. Construction time normally exceeds that required for the other two types of bridge. Five days to two weeks is required to build a 200- to 400-foot bridge for light vehicles.

C *Equipment.*—Normally materials are available in engineer depots. A portable sawmill and blacksmith forge and tool set may be necessary to make maximum use of local materials.

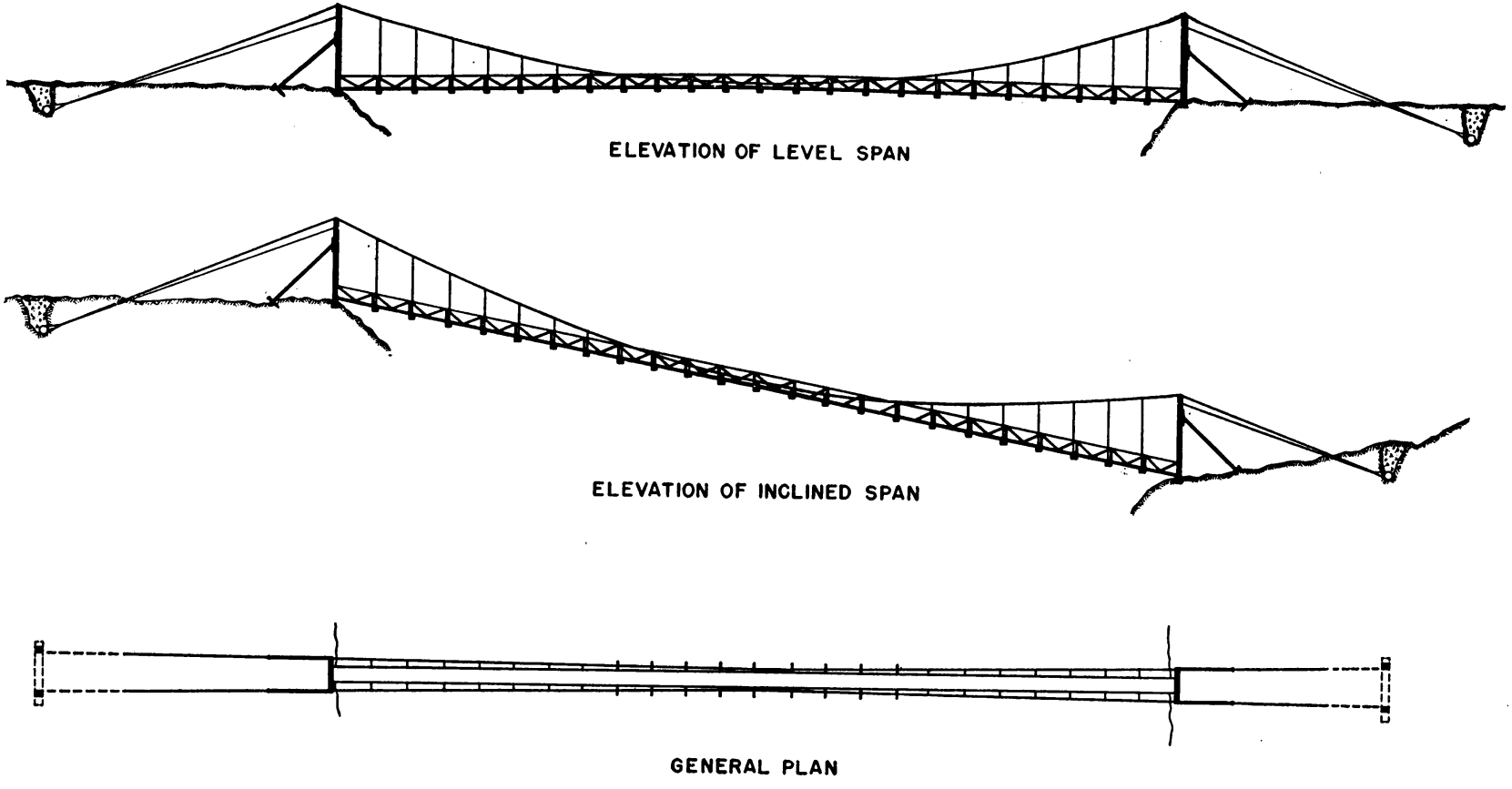


FIGURE 1. *Schematic diagram of standard suspension bridge. Spans from 40 to 300 feet can be built.*

6 EXPEDIENT SUSPENSION BRIDGES.—A *Capacity.*—These carry foot troops and pack animals only. Specific loads for illustrative types are given in Chapter 4.

B *Working party and construction time.*—Expedient bridges are constructed rapidly. One hundred feet of three-rope footbridge can be constructed by one squad in one-half hour; 100 feet of decked footbridge by one platoon in 3 hours.

C *Equipment.*—Local materials and tools from squad pioneer and carpenter sets are used.

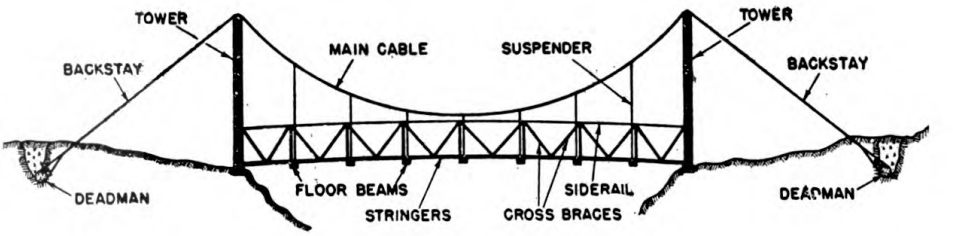


FIGURE 2. *Nomenclature of suspension bridge. This nomenclature is used throughout. Backstay and main cable are portions of a continuous cable.*

7 NOMENCLATURE (fig. 2).—A A suspension bridge is a *roadway* hung from two or more *main cables* stretched from bank to bank over towers and fastened to *deadmen.*

B Those portions of the main cables extending from the towers to the anchorages are called *backstays.*

C The roadway is supported by *suspenders* hung from the main cables.

D The suspenders are attached to *floor beams* which support the *stringers* on which the decking of the roadway is placed.

E To stiffen the bridge the live load is spread to several suspenders by the truss action of a section of siderail and its *cross braces.* Such a section is called a *stiffening truss.*

8 DESIGN FACTORS (fig. 3).—A *Dip* [fig. 3 (1)] is the amount of sag in the main cable; i.e., the vertical distance from the midpoint of a main cable to a line drawn between its points of support on the towers.

B *Span* is the horizontal distance between towers.

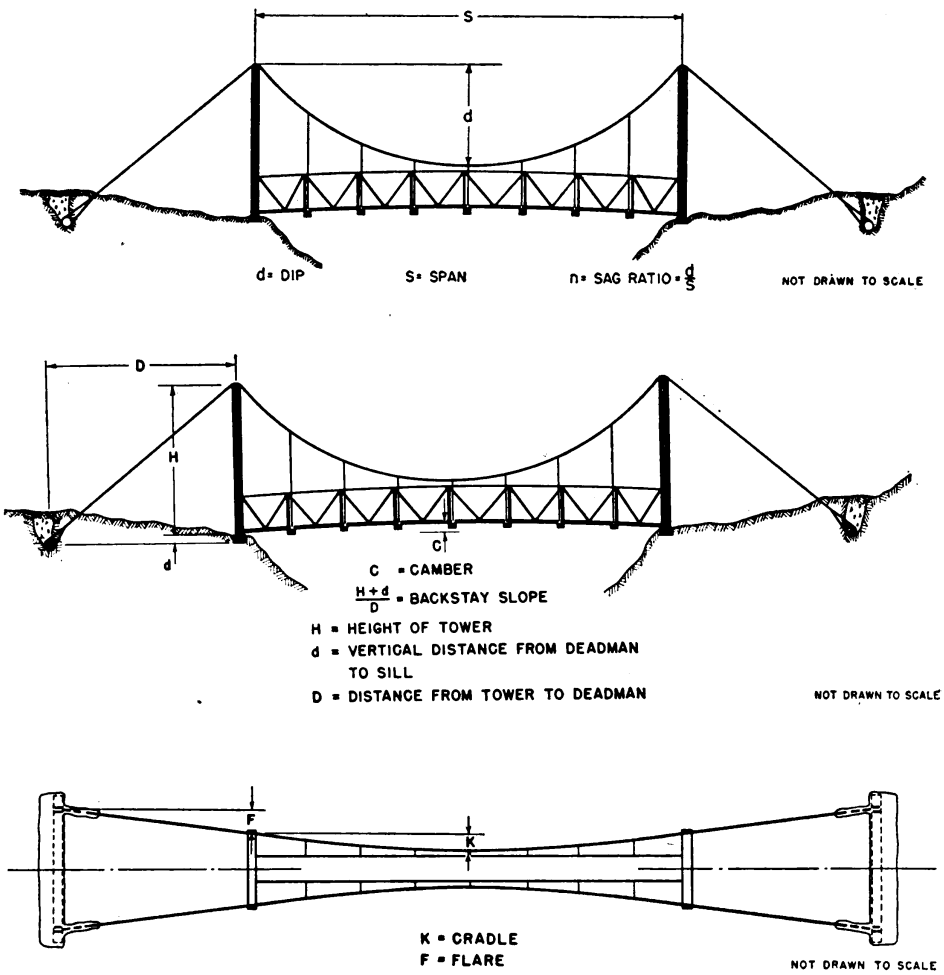


FIGURE 3. *Design factors of suspension bridges.* (1) *Dip and sag ratio. Dip and sag control the strength and stability of the bridge.* (2) *Camber and backstay slope. Camber allows for deflection under load. Backstay slope governs the stress in the cable; a cable on a flat slope takes small stress.* (3) *Cradle and flare help steady the bridge.*

C *Sag ratio* [fig. 3 (1)] is the ratio of the dip to the span. It varies from 1/20th or 5 percent to 1/6th or 16⅔ percent. If the main cables have a flat curve with low sag ratio, the bridge has more vertical stability but cable stress is high and strong anchorages are required. If the sag ratio is high there is less stress in the main cable and the anchorages may be placed closer to the towers. The sag ratio of the standard bridges described in Chapters 2 and 3 is 7 percent.

D *Camber* [fig. 3 (2)] is the vertical distance from the top of the floor beam in the middle of the span to a straight line drawn between the tops of the tower sills. The standard

bridges have a camber equal to 0.67 percent of the span length.

E *Cradle* [fig. 3 (3)] is the horizontal distance from the midpoint of a main cable to the straight line drawn between its points of support on the towers. Cradle increases lateral stability of the bridge. Usually it is 1.25 percent of the half-span length. It is fixed at 2 feet in the suspension footbridge and at 2 feet 3 inches in the light-equipment suspension bridge no matter what the span length.

F *Flare* [fig. 3 (3)] is the horizontal distance from the cable support on the towers to the cable at the anchorage. Flare increases the lateral stability of the bridge. Backstays are flared 2.5 to 3.5 percent of horizontal backstay length.

G *Backstay slope* [fig. 3 (2)] is the ratio of the difference in level between deadman and tower support of a main cable to the horizontal distance from the deadman to the tower. The full strength of the cable is utilized if the backstays make the same angle with the towers as the main cables. The standard suspension bridges use a backstay slope of 1 to 2½.

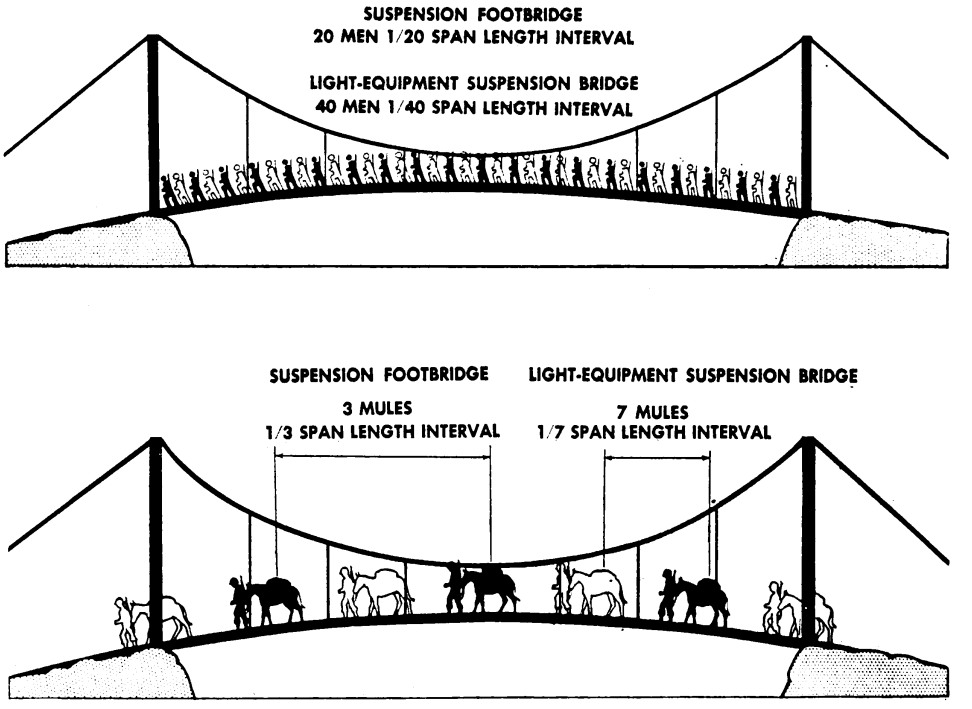


FIGURE 4. *Capacity of standard suspension bridges. The footbridge will carry the black figures only. The light-equipment bridge will carry both black and white figures.*

STANDARD SUSPENSION FOOTBRIDGE

SECTION I

GENERAL

9 CAPACITY (fig. 4).—All span lengths of the suspension footbridge have the same total capacity. The bridge will carry foot troops under full field pack or pack mules and handlers as follows:

A *Foot troops* (fig. 4).—Troops with full field pack spaced one-twentieth span length apart and crossing at route step in single file.

B *Pack mules* (fig. 4).—Three pack mules, each with a handler, and spaced one-third span length apart.

10 SPAN LENGTH.—A The suspension footbridge can be built to span gaps up to 300 feet between towers. The maximum span length is determined by the carrying capacity of the main cables.

B For spans less than 140 feet a modified tower is necessary. See paragraph 12.

CHAPTER 2
SECTION II

DESCRIPTION OF BRIDGE AND ERECTION EQUIPMENT

11 ERECTION CABLEWAY (fig. 5).—The standard bridge is constructed from both banks. To transport equipment to the far bank an erection cableway is built across the gap within 100 feet of the working sites. It is fastened to trees on either bank or to an *A*-frame as shown in figure 5.

12 TOWERS (figs. 6 to 10).—Towers to support the cables are constructed from local materials. Each tower consists of a sill, posts, a cap, and braces. The main cables are supported on saddle-block plates above the posts which are erected on the sill at 9-foot centers. Bracing between posts allows overhead clearance for a mule and rider. Height of towers for various span lengths is given in Table I. Towers may either be improvised, mainly from shaped logs, or prefabricated from lumber sawed at the site.

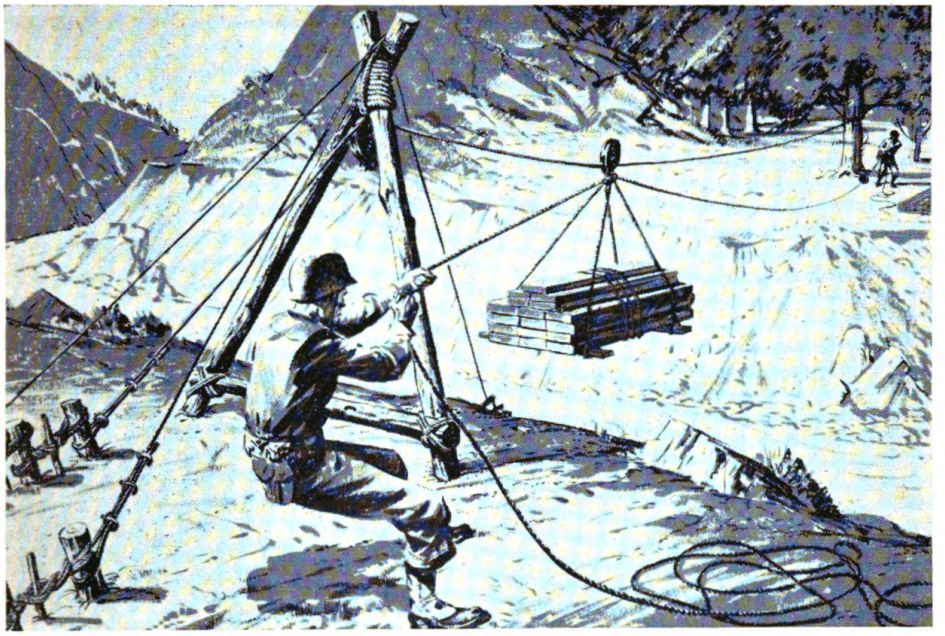


FIGURE 5. *Erection cableway. This is used to transport material to the far side and to transfer personnel during erection.*

TABLE I. *Height of towers for various span lengths.*

Span Length (20-Foot Increments)	Tower Height for Suspension Footbridge	Tower Height for Light-Equipment Suspension Bridge
	Top of Sill to Saddle	
40*	4 feet 3½ inches	5 feet 5 inches
60*	5 feet 5½ inches	6 feet 7 inches
80*	7 feet 4 inches	7 feet 5½ inches
100*	8 feet 10½ inches	10 feet 0 inches
120*	10 feet 5 inches	11 feet 6½ inches
140	11 feet 11½ inches	13 feet 1 inches
160	13 feet 6½ inches	14 feet 8 inches
180	15 feet 0 inches	16 feet 1½ inches
200	16 feet 6½ inches	17 feet 8 inches
220	18 feet 1 inches	19 feet 2½ inches
240	19 feet 7½ inches	20 feet 9 inches
260	21 feet 1½ inches	22 feet 3 inches
280	22 feet 8 inches	23 feet 9½ inches
300	24 feet 7½ inches	25 feet 9 inches

* Use improvised tower type-3.

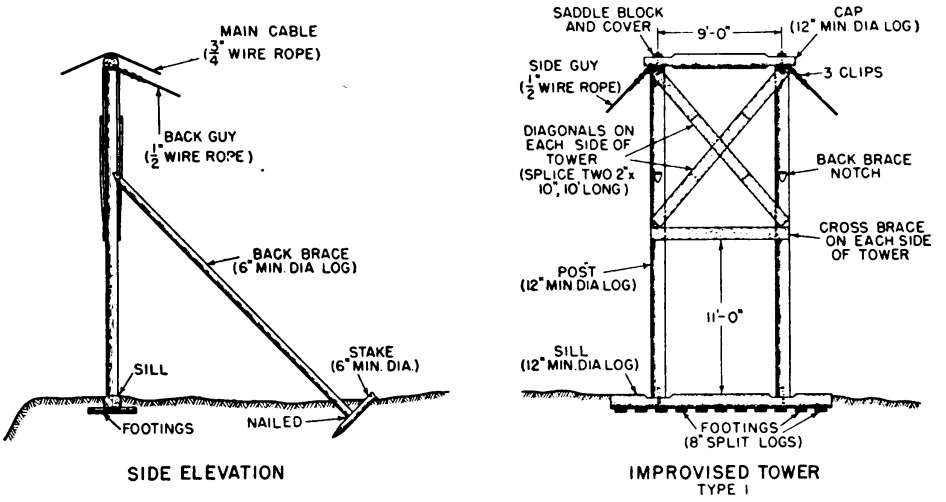


FIGURE 6. *Improvised tower type-1 for suspension footbridge. Used on long spans when dimension lumber is available.*

A *Improvised towers.*— 1 - *The type-1 tower* (fig. 6) is constructed of the following materials:

Back braces, two 6-inch logs
Cap, 10-inch log
Posts, two 12-inch logs
Sill, 12-inch log
Cross braces, 2- by 10-inch plank
Diagonals, 2- by 10-inch plank
Saddle blocks and saddle-block covers as described in paragraph 13.

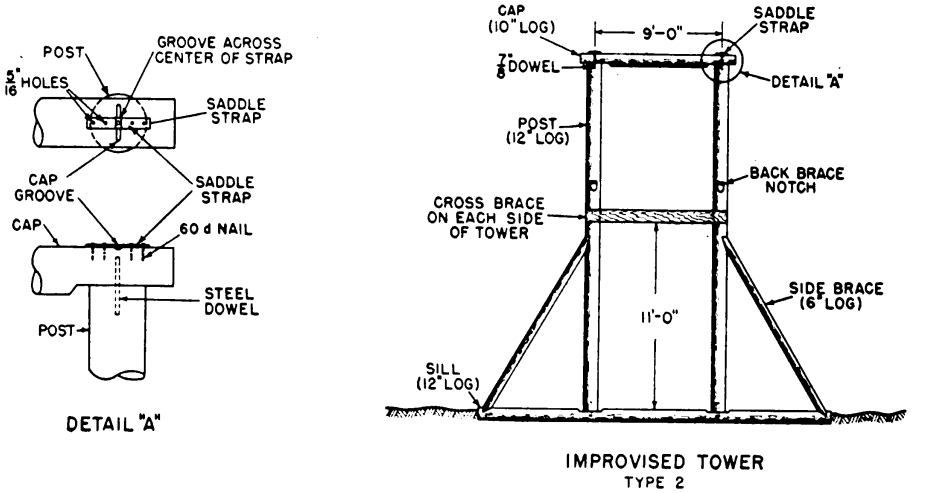


FIGURE 7. *Improvised tower type-2 for suspension footbridge. Used on long spans when dimension lumber is hard to obtain.*

3 - *The type-3 tower* (fig. 9) is used for spans less than 140 feet long where the main cables must be supported below the level of the cross brace, which must be at least 11 feet above the sill to provide clearance for a mule and rider. The tower is similar to the type-2 improvised tower except the cap serves as cross bracing and the cables are supported on short saddle posts attached by driftpins to the outside of the main posts of the tower.

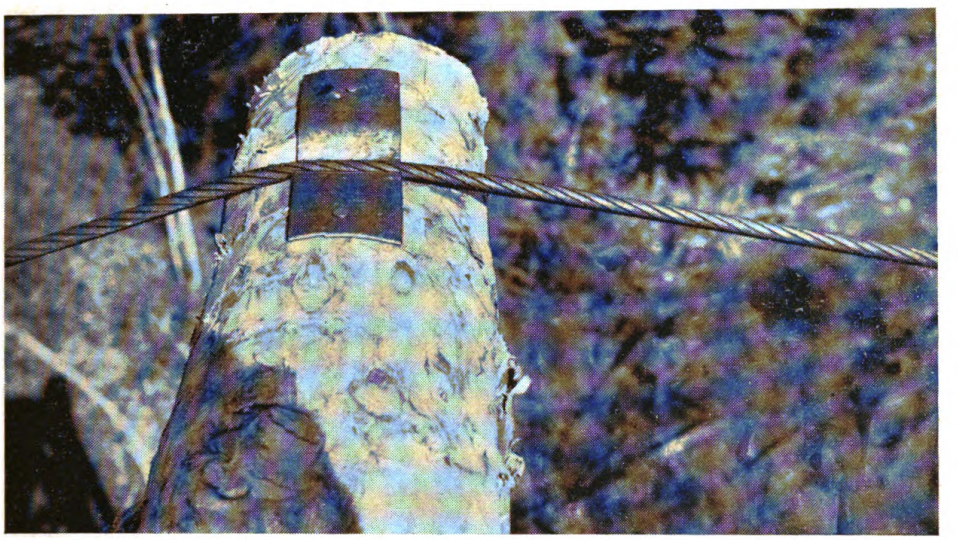


FIGURE 8. *Saddle strap for improvised tower type-2. Used to position and steady main cable on tower cap and to prevent the cable from shearing or wearing into the log.*

2 - *The type-2 tower* (fig. 7) is constructed of the following materials:

Back braces, two 6-inch logs
Posts, two 12-inch logs
Side braces, two 6-inch logs
Sill, 12-inch log
Cross braces, 2- by 10-inch plank
Saddle strap, see figure 8.

B *Prefabricated tower.*—If dimension lumber is available a prefabricated tower (fig. 10) can be built from planks 2- by 10 inches by 10 feet. The sill base is a built-up, lap-jointed piece, 4 by 10 inches by 15 feet. Two built-up, lap-jointed 8- by 10-inch posts are nailed to the sill 8 feet 5 inches inside to inside. The sides of the sill are two pieces, 2- by 10 inches, nailed to the sill base and the feet of the posts and

scabbed at their lap joints. Two 2- by 10-inch by 10-foot cap pieces then are nailed across the top of the posts. Two 2- by 10-inch cross braces are nailed on both sides of the posts 11 feet above the top of the sill. Diagonals are nailed to both sides of the posts above the cross bracing. Each diagonal consists of two lap-jointed pieces 2- by 10 inches by 10 feet long. Tower saddle blocks and covers (par. 13) are nailed to the top of each post to support the main cables.

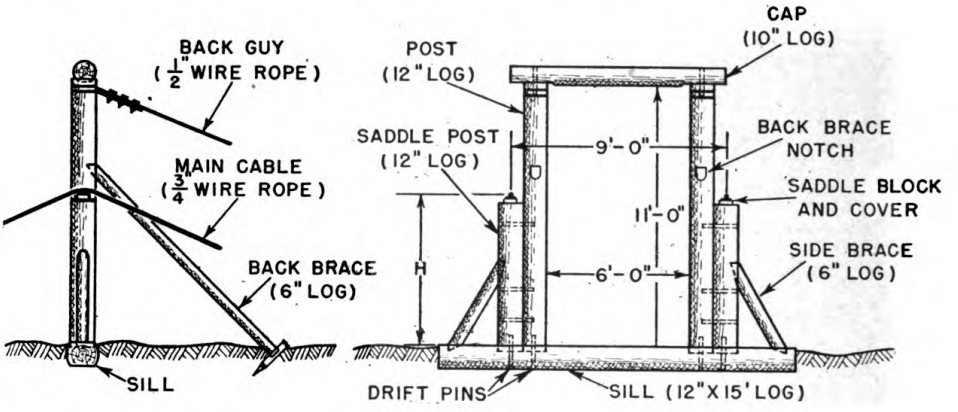


FIGURE 9. *Improvised tower type-3. Used on spans of 140 feet or less. The same tower design is used for the light-equipment bridge.*

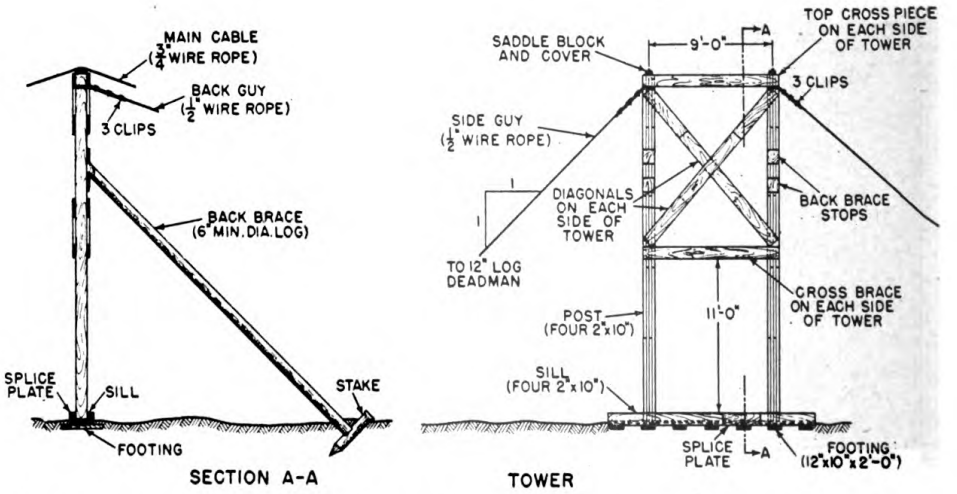


FIGURE 10. *Prefabricated tower for suspension footbridge. Used for all spans greater than 140 feet when dimension lumber is available.*

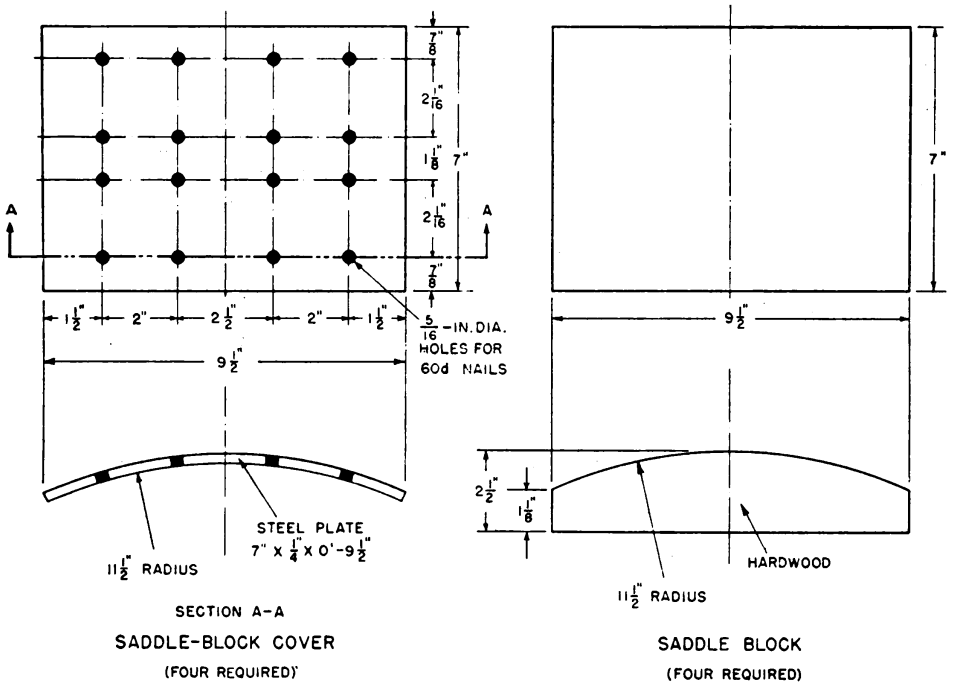


FIGURE 11. *Saddle block and cover. Used on prefabricated and improvised towers to position and steady main cable and to prevent shear and wear of cap.*

13 SADDLE-BLOCK COVERS (fig. 11).—These are 7- by 9½-inch plates ¼-inch thick used as main-cable bearing plates on the improvised type-1 and prefabricated towers. The saddle blocks and covers are drilled as shown (fig. 11) and spiked to the cap or top of the posts with 60-penny nails. Partly driven nails on each side of the cable keep it from slipping off the saddle-block cover.

14 TOWER GUYS.—One-half-inch wire rope is used for side and back tower guys. This rope is used initially for the erection cableway (par. 11). When all the far-side material has been crossed the cableway is taken down and the rope is cut to length for the guys.

The side guys run from the top of the posts to deadmen or holdfasts at each side of the towers and have a minimum slope of 1 to 1 (fig. 10).

The back guys run from the top of the posts to the main-cable deadman (figs. 12 and 13).

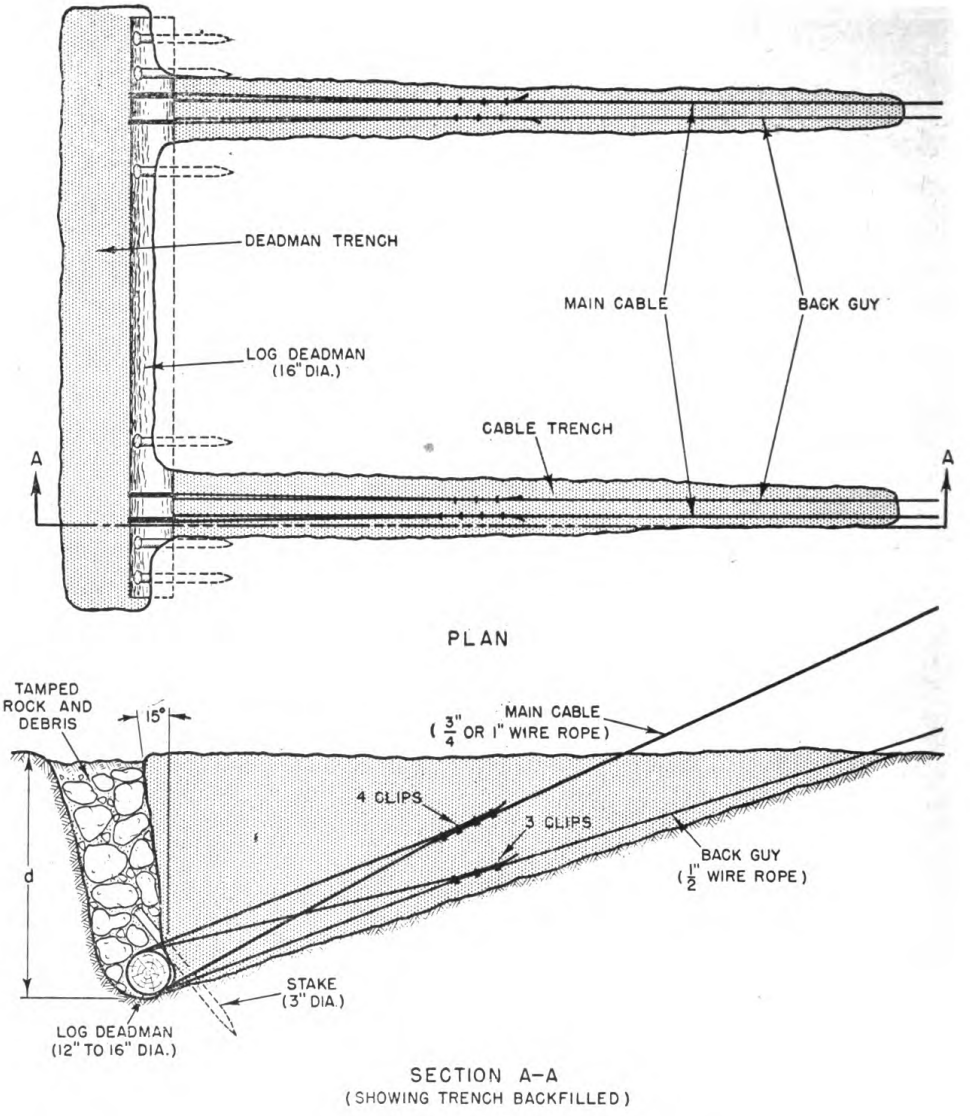


FIGURE 12. *Main-cable deadman. Used to anchor main-cable backstay and tower backguy.*

15 MAIN-CABLE DEADMAN (fig. 12).—A *Diameter.*—The deadman used at each end of the bridge to anchor the main cables is a log 12 to 16 inches in diameter and 19 feet long. The correct way to bury it is shown in figure 12.

B *Depth.*—Each cable exerts a maximum 24,000-pound pull on the deadman when the bridge is fully loaded; therefore the deadman must be designed to hold against a 48,000-pound pull. The depth to which the deadman is buried varies with the type of soil.

1 - Table II gives the holding capacity of a log deadman in sand-clay soil.

TABLE II. *Capacity of log deadman in ordinary soil.*

Depth to Top of Log (Ft.)	Capacity of Deadman (Lb/Sq. Ft.)		
	Slope of Cable (Vertical to Horizontal)		
	1/1	1/2½	1/3
3	950	1,375	1,450
4	1,750	2,400	2,600
5	2,800	3,800	4,000
6	3,800	5,450	5,800
7	5,100	7,500	8,000
8	6,000	8,750	9,000

To find how deep a deadman must be buried in ordinary earth find the effective cross-sectional area of the deadman's bearing surface in square feet. This is the product of the deadman's diameter and its length bearing against undisturbed soil. Divide the maximum pull on the deadman (48,000 pounds) by the effective cross-sectional area of the deadman. This gives the pressure in pounds per square feet on the deadman when the bridge is loaded to capacity. Reading in Table II down the column that corresponds to the slope of the backstay, find the depth to which the deadman must be buried to hold this pressure.

Example: Deadman—16-inch-diameter log.
Total length—19 feet.
Effective length—13 feet.
Note: Effective length is total length minus width of cable trenches.

Slope of backstay—
1 vertical to 2½ horizontal.

Effective cross-sectional area—

$$\frac{16}{12} \times 13 = 17.3 \text{ square feet.}$$

Pressure in pounds per square foot on the deadman—

$$\frac{48{,}000}{17.3} = 2{,}780 \text{ pounds per square foot.}$$

For a backstay with a slope 1 vertical to 2½ horizontal,

a deadman buried 5 feet will hold 3,800 pounds per square foot. Since the top of the deadman must be at least 5 feet below the surface of the ground the trench in which it is buried must be 6 feet 4 inches deep. It is a good practice to bury the deadman 1 or 2 feet deeper than the minimum requirements of Table II to allow for varying soil conditions.

2 - In loose, rocky soil the deadman should be buried 8 feet deep as illustrated in figure 12.

C *Length.*—The deadman is cut 19 feet long for all spans. The main cables are 9 feet apart at the towers and the backstays are flared outward 2½ percent to the deadman. The backstays are attached a minimum of 3 feet from the ends of the deadman.

D *Distance from tower.*—The horizontal distance D of the deadman back of the tower is 2½ times the difference in level (H + d) between the deadman and the top of the tower supporting the main cables. This gives a backstay slope of 1 vertical to 2½ horizontal (fig. 13).

16 MAIN CABLES (fig. 13).—A *Size of cable.*—The main cables are ¾-inch, 6 x 19, wire rope of high-grade plow steel (H.G.P.S.) with wire-rope center (W.R.C.).

B *Sag ratio.*—The sag ratio of the main cables of the suspension footbridge is 7 percent for all spans.

C *Backstay flare.*—The distance f from the bridge center line to the point at which a main cable is attached to the deadman is equal to the fixed distance (4½ feet) from the center line to the main-cable saddle plus the flare F. In the suspension footbridge flare F is 2½ percent of the horizontal distance D from tower to deadman.

Example: If $D = 50$ feet

$f = (50)\ (.025) + 4.5 = 5.75$ feet or 5 feet 9 inches.

D *Backstay slope.*—In the suspension footbridge backstay slope is fixed at 1 vertical to 2½ horizontal.

E *Cradle.*—The cable cradle in the suspension footbridge does not vary with span length. The main cables are 9 feet apart at the towers and 5 feet apart at the midpoint of the span. Hence the cradle or horizontal distance between the midpoint of a main cable and a line joining the tower supports of the cable is 2 feet.

F *Panel points.*—Suspenders hang from the main cables

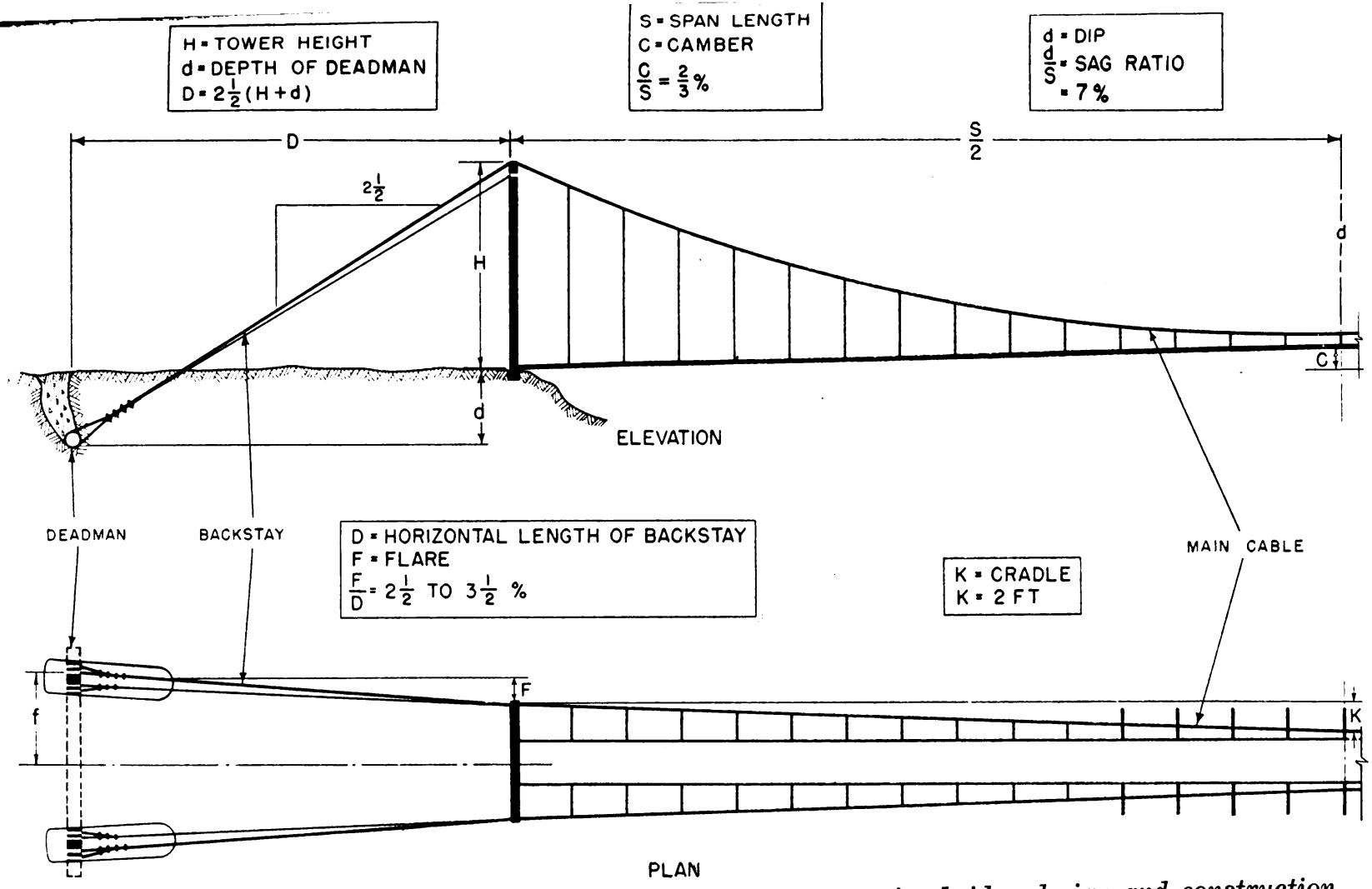


FIGURE 13. *Design of main cables. Factors used in suspension-bridge design and construction.*

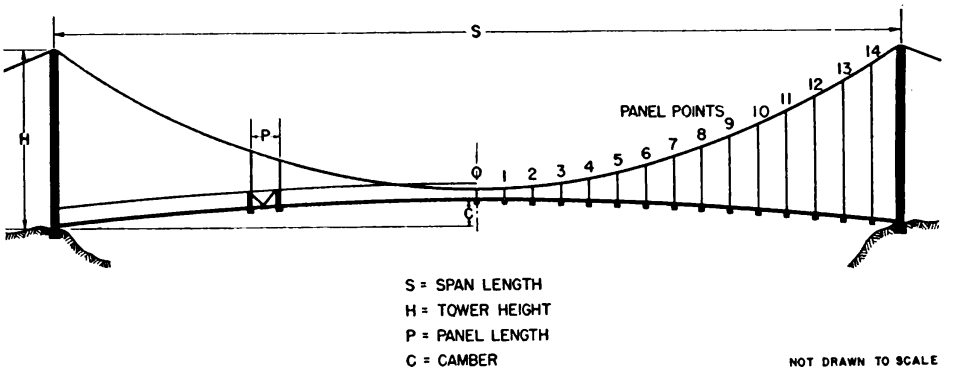


FIGURE 14. *Panel points and panel length. Panel points are numbered symmetrically from 0 at center span outward. Panel length is the distance from panel point to panel point.*

at panel points as shown in figure 14. The horizontal distance between two panel points is the length of one panel in the siderail truss.

17 SUSPENDERS.—A Three 250-foot coils of ½-inch, 6 x 19 H.G.P.S., wire rope are used for the suspenders. They may be either prefabricated or cut to length at the site.

B Table III is used to cut suspenders to length. It gives the effective and cut lengths of suspenders and the total number of suspenders of each length required for spans from 40 to 300 feet.

Effective suspender length is the distance from the main cable to the top of the floor beam.

Cut suspender length is the length of cable required to make a complete suspender.

Suspenders at each panel point are numbered as shown in figure 14.

18 CABLE CLIPS AND CLIP-TYPE CABLE BANDS (fig. 15).—A Main cables, tower guys, and suspenders are tied back with ¾- and ½-inch wire-rope clips.

B Clip-type cable bands connect the suspenders to the main cables. Thimbles are used at the connection to prevent shearing the suspender cable.

19 FLOOR AND SIDERAIL SYSTEM (figs. 16 and 17).—A The following wood members are used in the floor and siderail system of the suspension footbridge:

1 - *Floor beams.*—A 4- by 4-inch floor beam 10 feet

11⅝ inches long is used at each of the nine middle panel points (numbered 4 to 0 to 4). The outer panel points (numbered 5 to 14) use 4- by 4-inch floor beams, 5 feet 7 inches long, at each panel point.

2 - *Stringers.*—Two 4- by 4-inch stringers 10 feet 11⅝ inches long are used in each panel.

3 - *Floor planks.*—Eighteen 2- by 6-inch floor planks 5 feet long, spaced ¾ inch apart, are used in each bay.

4 - *Toeboards.*—Two 2- by 6-inch toeboards 10 feet long are used in each panel as curbs.

5 - *Siderail posts.*—Two 2- by 4-inch siderail posts are used at each panel point.

6 - *Siderails.*—Two 2- by 4-inch siderails 10 feet long are used in each panel.

7 - *Saw-tooth braces.*—Four 1- by 6-inch planks 7 feet 8 inches long are used as bracing in each bay—two per siderail.

8 - *Knee braces.*—Two 2- by 4-inch knee braces 4 feet 8 inches long with 2- by 4- by 6-inch fillers are used at each of the nine middle panel points (numbered 4 to 0 to 4).

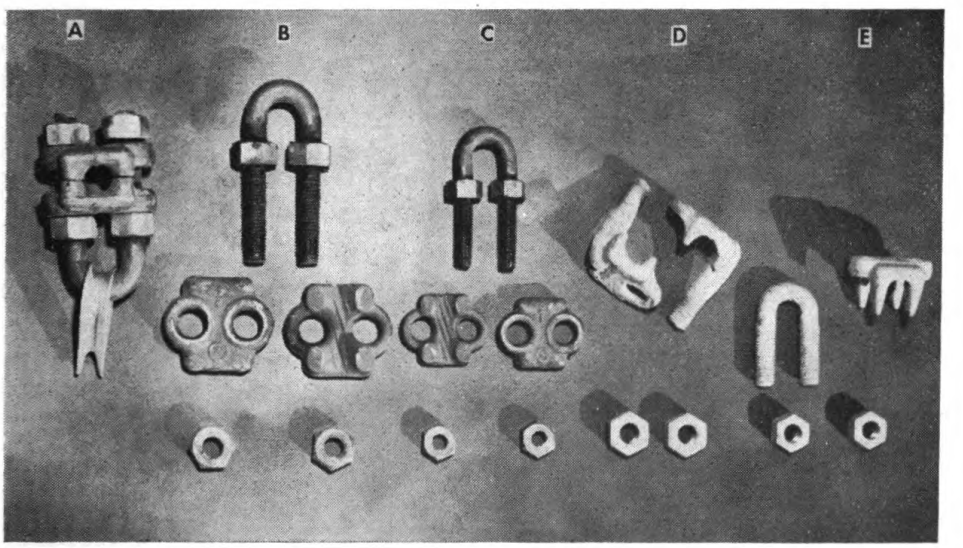


FIGURE 15. *Cable clips and clip-type cable bands.*

A. *One-inch clip-type cable band assembled with ½-inch thimble.*

B. *Three-quarter-inch clip-type cable band disassembled.*

C. *One-half-inch clip-type cable band disassembled.*

D. *Three-quarter-inch fist-grip clip disassembled.*

E. *One-half-inch wire-rope clip disassembled.*

TABLE III. *Effective and cut suspender lengths for various spans of standard suspension footbridge.*

Panel Point	Number Required	40 Feet *		60 Feet *		80 Feet *		100 Feet *	
		Effective	Cut	Effective	Cut	Effective	Cut	Effective	Cut
0	2	1′ 2½″	5′ 4½″	1′ 2½″	5′ 4½″	1′ 2½″	5′ 4½″	1′ 2½″	5′ 4½″
1	4	2′ 9½″	5′ 11½″	1′ 8½″	5′ 10½″	1′ 6″	5′ 8″	1′ 6″	5′ 8″
2	4		TOWER	3′ 2½″	7′ 4½″	2′ 9″	6′ 11″	2′ 5″	6′ 7″
3	4				TOWER	4′ 8″	8′ 11″	3′ 11½″	8′ 1½″
4	4						TOWER	6′ 0″	10′ 2″
5	4								TOWER

* Use improvised tower, type-3.

Panel Point	Number Required	120 Feet *		140 Feet		160 Feet		180 Feet	
		Effective	Cut	Effective	Cut	Effective	Cut	Effective	Cut
0	2	1′ 2½″	5′ 4½″	1′ 2½″	5′ 4½″	1′ 2½″	5′ 4½″	1′ 2½″	5′ 4½″
1	4	1′ 5½″	5′ 7½″	1′ 5″	5′ 7″	1′ 4½″	5′ 6½″	1′ 9½″	5′ 6½″
2	4	2′ 2½″	6′ 6½″	1′ 11″	6′ 1″	1′ 10½″	6′ 0″	1′ 10½″	6′ 0½″
3	4	3′ 6″	7′ 10″	3′ 1½″	7′ 3½″	2′ 11″	7′ 1″	2′ 9″	6′ 11″
4	4	5′ 2½″	9′ 6½″	4′ 8½″	8′ 10½″	4′ 3″	8′ 5″	3′ 11″	8′ 1″
5	4	7′ 7″	11′ 9½″	6′ 8½″	10′ 10½″	6′ 11½″	11′ 1½″	5′ 5½″	9′ 7½″
6	4		TOWER	9′ 1½″	13′ 3½″	8′ 1″	12′ 3″	7′ 4″	11′ 6″
7	4				TOWER	10′ 6½″	14′ 8½″	9′ 7″	13′ 9″
8	4						TOWER	12′ 1½″	16′ 3½″
9	4								TOWER

TABLE III. *Effective and cut suspender lengths for various spans of standard suspension footbridge (Continued).*

Panel Point	Number Required	200 feet		220 feet		240 feet		260 feet		280 feet		300 feet	
		Effective	Cut	Effective	Cut	Effective	Cut	Effective	Cut	Effective	Cut	Effective	Cut
0	2	1′ 2½″	5′ 4½″	1′ 2½″	5′ 4½″	1′ 2½″	5′ 4½″	1′ 2½″	5′ 4½″	1′ 2½″	5′ 4½″	1′ 2½″	5′ 4½″
1	4	1′ 4½″	5′ 6½″	1′ 4″	5′ 6″	1′ 4″	5′ 6″	1′ 4″	5′ 6″	1′ 3½″	5′ 5½″	1′ 3½″	5′ 5½″
2	4	1′ 10″	6′ 0″	1′ 9″	5′ 11″	1′ 8½″	5′ 10½″	1′ 8″	5′ 10″	1′ 7½″	5′ 9½″	1′ 7½″	5′ 9½″
3	4	2′ 7″	6′ 9″	2′ 5½″	6′ 7½″	2′ 4″	6′ 6″	2′ 3″	6′ 5″	2′ 2½″	6′ 4½″	2′ 1½″	6′ 3½″
4	4	3′ 8″	7′ 10″	3′ 5″	7′ 7″	3′ 3″	7′ 5″	3′ 0″	7′ 2″	2′ 11½″	7′ 1½″	2′ 10″	7′ 0″
5	4	5′ 0½″	9′ 2½″	4′ 6″	8′ 8″	4′ 5½″	8′ 7½″	4′ 2″	8′ 4″	3′ 11½″	8′ 1½″	3′ 9½″	7′ 11½″
6	4	6′ 8½″	10′ 10½″	6′ 3″	10′ 5″	6′ 9½″	10′ 11½″	5′ 5½″	9′ 7½″	5′ 1½″	9′ 3½″	4′ 11″	9′ 1″
7	4	8′ 8½″	12′ 10½″	8′ 0½″	12′ 2½″	7′ 5½″	11′ 7½″	7′ 0″	11′ 2″	6′ 7″	10′ 9″	6′ 3″	10′ 5″
8	4	11′ 0″	15′ 2″	10′ 1½″	19′ 3½″	9′ 5″	13′ 7″	8′ 9″	12′ 11″	8′ 2½″	12′ 4½″	7′ 9½″	11′ 11½″
9	4	13′ 7″	17′ 9″	12′ 3½″	16′ 7½″	11′ 7″	15′ 9″	10′ 9″	14′ 11″	10′ 0½″	14′ 2½″	9′ 6½″	13′ 8½″
10	4		TOWER	15′ 2″	19′ 4″	14′ 0″	18′ 2″	13′ 0″	17′ 2″	12′ 2″	16′ 4″	11′ 5½″	15′ 7½″
11	4				TOWER	16′ 8½″	20′ 10½″	15′ 6″	19′ 8″	14′ 6″	18′ 8″	13′ 7½″	17′ 9½″
12	4						TOWER	18′ 2½″	22′ 4½″	17′ 0″	21′ 2″	16′ 0″	20′ 2″
13	4								TOWER	19′ 8½″	23′ 10½″	18′ 7″	22′ 9″
14	4										TOWER	21′ 4½″	25′ 6½″
15	4												TOWER

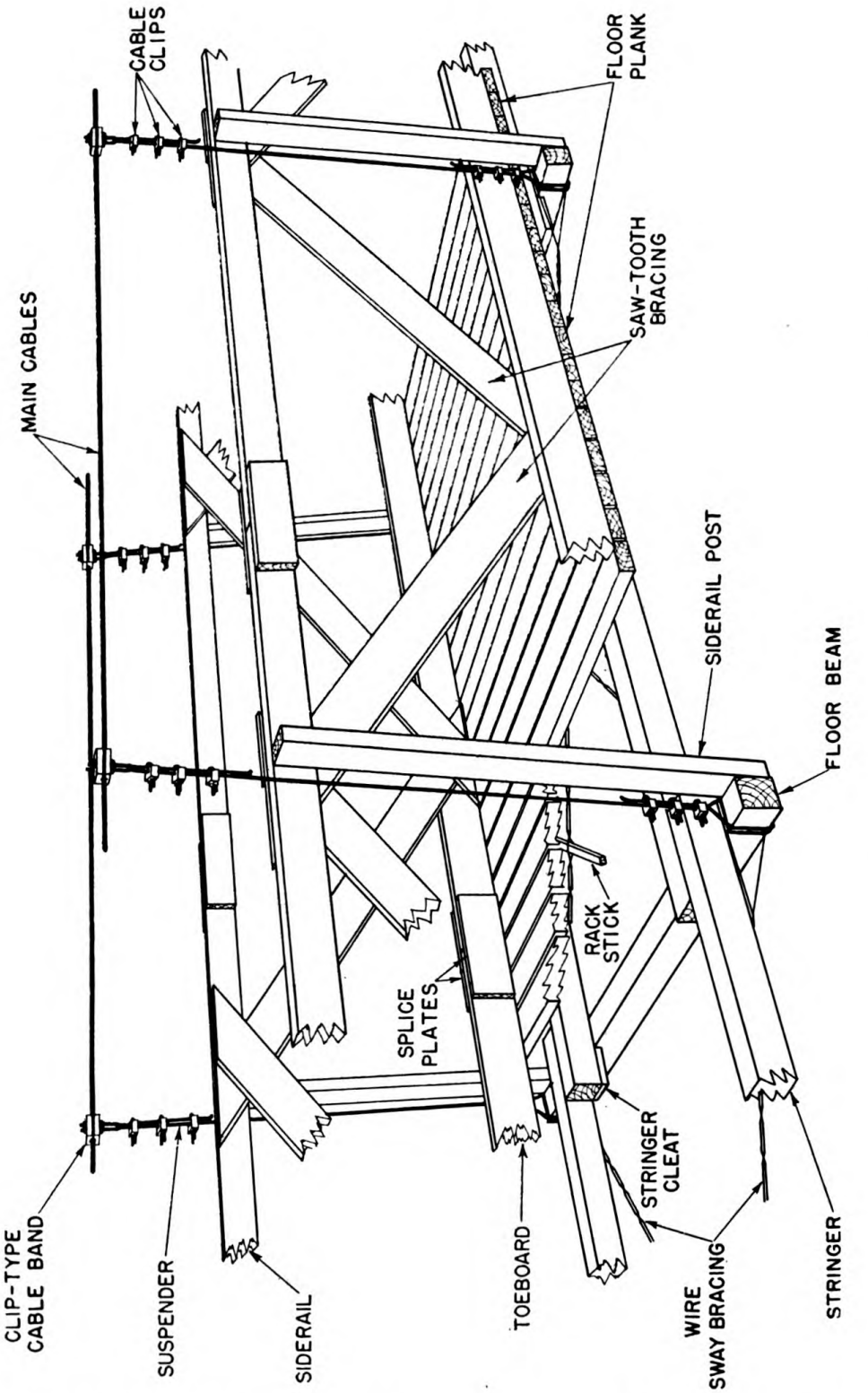
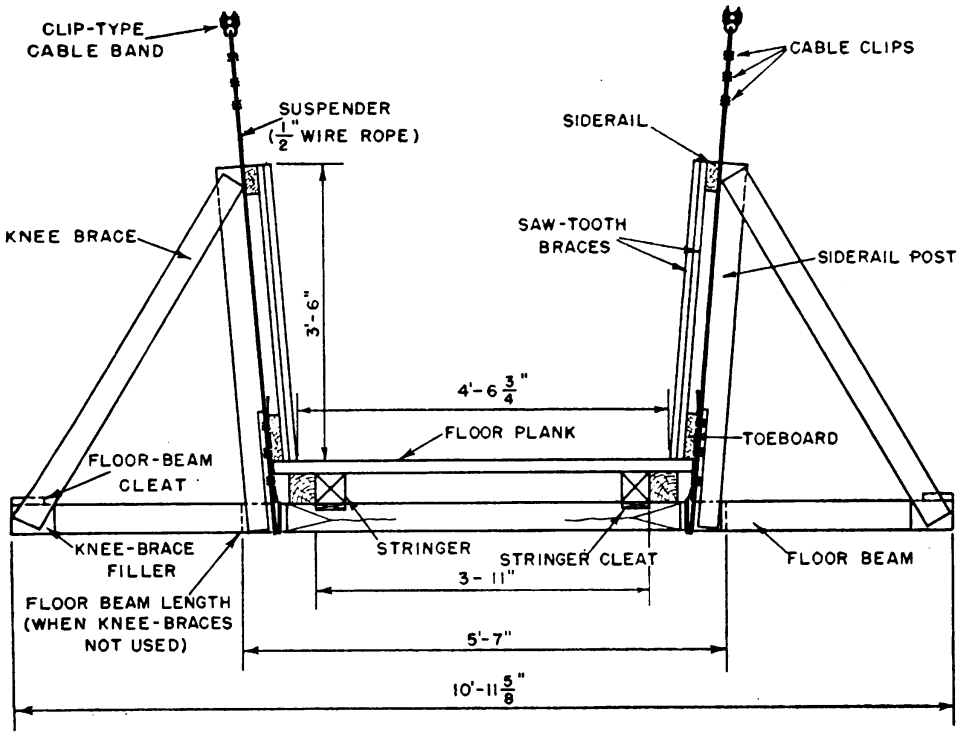


FIGURE 16. *Floor and siderail system. Cutaway view of floor system showing wire sway bracing in place and rack stick wedged under flooring.*



ARTICLE	NO. REQD. PER PANEL	SIZE
SIDERAILS	2	2" X 4" X 10'-0"
SAW-TOOTH BRACES	4	1" X 6" X 7'-8"
TOEBOARD	2	2" X 6" X 10'-0"
SIDERAIL POSTS	2	2" X 4" X 4'-3 3/4"
KNEE BRACES **	2	2" X 4" X 4'-8"
KNEE BRACE FILLERS **	2	2" X 4" X 0'-6"
FLOOR BEAMS (NO KNEE BRACES)*	2	4" X 4" X 5'-7"
FLOOR BEAMS (WITH KNEE BRACES)**	2	4" X 4" X 10'-11 5/8"
STRINGERS	2	4" X 4" X 10'-11 5/8"
FLOOR PLANKS	18	2" X 6" X 5'-0"

* PANEL POINTS 5 THRU 14
** PANEL POINTS 0 THRU 4

FIGURE 17. *Hanger assembly and parts required for floor and siderail system of suspension footbridge. Cross section and bill of materials for each 10-foot panel.*

9 - *Cleats and scabs.*—Cleats and scabs used to splice toeboards and siderails are made of 1- by 6-inch planks 1 foot 6 inches long. Approximately 350 linear feet of 1- by 6-inch plank is required.

B Three hundred pounds of 20-penny nails are required for the floor and siderail system.

C The floor camber is 1.33 percent of the half-span length. The bridge will be cambered automatically if the proper sag ratio and suspender lengths are used as described in paragraphs 16 and 17.

20 HORIZONTAL SWAY BRACING (fig. 18).—Approximately 2,000 feet of No. 9 galvanized wire is used for horizontal sway bracing. Two racking sticks are required for each panel.

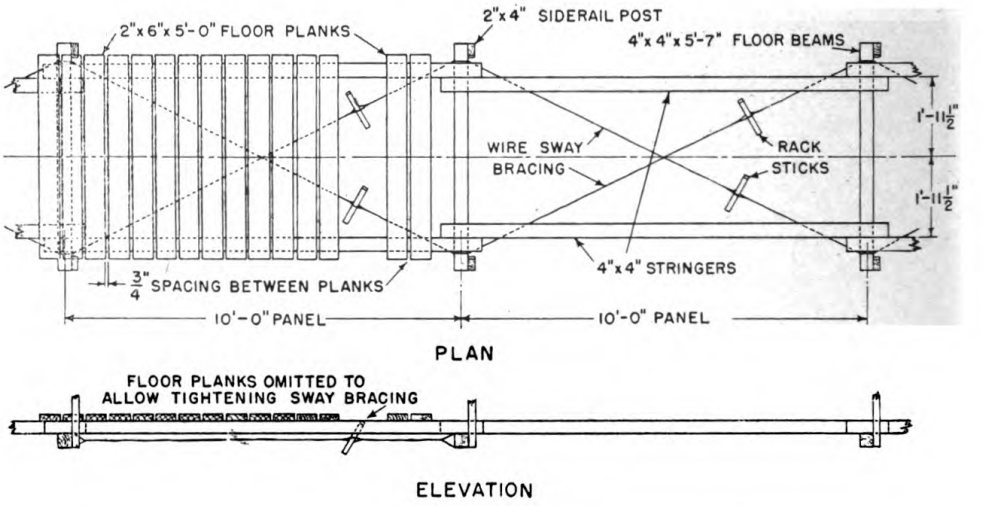


FIGURE 18. *Wire sway bracing of suspension footbridge. Sway bracing increases stability and minimizes side sway.*

21 ERECTION EQUIPMENT.—The erection equipment necessary to build the bridge is given in Appendix I. This is a suggested list; equipment may be varied to meet the situation and the terrain at the bridge site. At the present time the portable sawmill and air compressor are being redesigned. The list will be varied as new power equipment is developed and becomes available.

22 PORTABLE SAWMILL.—Generally a portable sawmill is used in bridge construction to make maximum use of local materials. It is used at the site to cut floor planks, siderails and siderail bracing, tower bracing, and prefabricated tower lumber. For safety, five men are assigned to operate the saw. These men are trained to set up and dismantle the saw and to follow all safety rules. When a sawmill is available, bridge construction depends upon its operation; it must be set up immediately upon arriving at the bridge site and be kept in continuous operation.

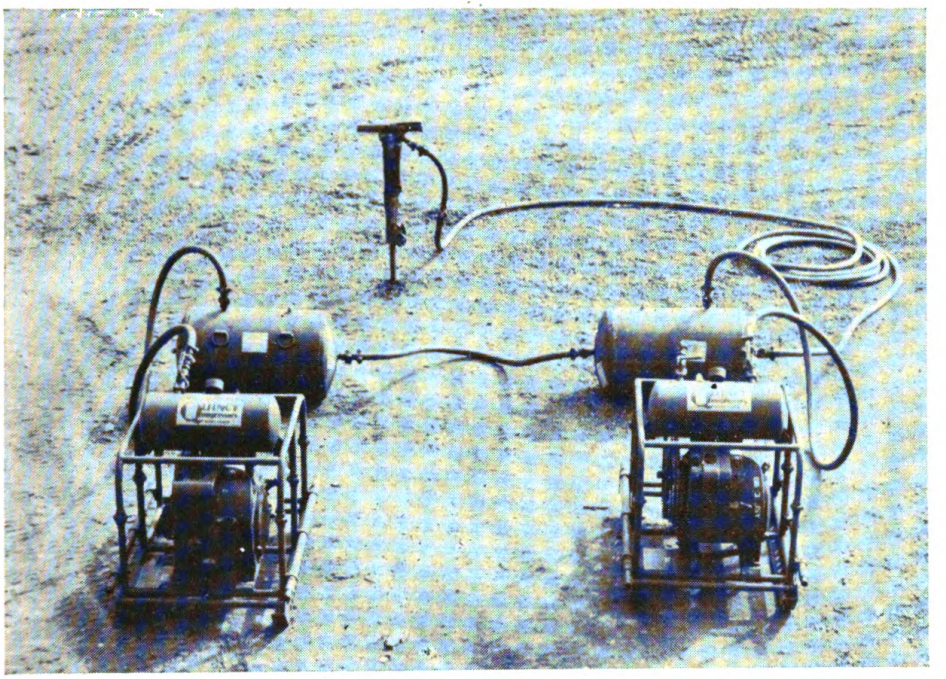


FIGURE 19. *Portable air compressors (20 c.f.m.), receiver tank, and jack hammer. Used to facilitate sill and deadman excavation.*

23 PORTABLE AIR COMPRESSORS (fig. 20).—Two 20-cubic-feet per minute, gasoline-engine-driven, portable air compressors are used in excavating sill and deadman positions. At this time a 55-cubic-feet per minute portable air compressor is being developed and will replace the two 20-cubic-foot per minute units. At high altitude the compressors are used in series in conjunction with a 7-cubic-foot receiver tank. One hundred feet of rubber hose is available. The actual drilling is done with a 35-pound jack hammer. Gasoline hammers may be used if portable compressors are not available.

24 CHAIN SAW (fig. 20).—Two 24-inch gasoline-engine-driven chain saws are used in felling timber and cutting it to length.

25 RADIO SETS.—A portable receiver and transmitter set (SCR 536B) is used to coordinate operations on both sides of the gap.

26 TRANSIT.—A transit and stadia rod is used to measure gap and bridge length and in tower-setting. Bridge-length determination is discussed in paragraph 37*c*(1) (*b*).

CHAPTER 2
SECTION III

TRANSPORTATION

27 PACK MULES.—Bridge equipage may be carried by pack mules, ¼-ton trucks, or trail tractors. The bridge is designed to be carried by pack train. Table IV gives pack-mule loadings for a 300-foot suspension footbridge. If a portable sawmill is not available the dimension lumber must be packed to the bridge site. See note 1 Table IV.

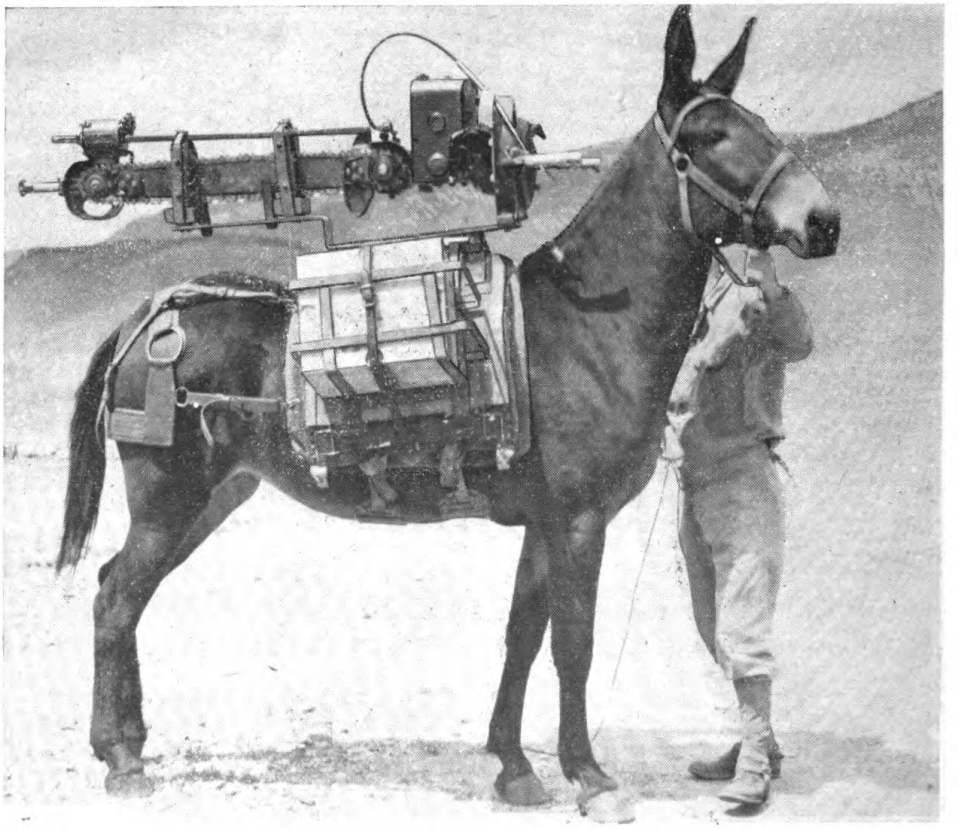


FIGURE 20. *Chain saw on pack mule. Chain saw is used at the site to fell timber and cut it to length.*

TABLE IV. *Pack-mule loadings.*

Number of		Load
Mules	Handlers	
15	5	Portable sawmill and sawmill accessories. [1]
1	1	Sawmill power unit (heavy load).
5	2	Main cables.
2	1	Suspender rope and tower-guy cable.
1		Suspender-rope clips, spare tools.
1	1	Clip-type cable bands, thimbles, and cable clips.
1		Hardware.
4	1	Carpenter levels, ⅝-inch hemp rope, wrenches, braces and bits, pliers, files, seizing wire, sharpening stones, wire-rope cutters, cloth tapes, radio sets, gas and oil for power tools.
2	1	Cable cars, axes, adzes, timber carriers, sledges.
2	1	Gasoline saws, chain, carew cutters, grips, hack saw, hand saws, round and flat steel.
1	1	Peavies, picks, shovels, mattocks.
1	1	Transit, rods, ratchet chain hoists, hand wrench, tapes.
3	2	Portable compressors, tank, snatch block.
1	1	Blasting machine, crow bars, claw hammers, snatch blocks, rope tackle.
1	1	50 pounds of dynamite, fuse cord, blasting reel, tarpaulin.
41	19	Total mules and men required.

[1] If saw mill is not available mules are used to carry floor plank, siderail braces, siderail posts and knee braces.

28 CABLE PACK.—When cable is carried on an artillery pack saddle it is coiled on a ground frame made of eight stakes as shown in figure 21.

One mule can carry 18 full-frame turns of ¾-inch wire rope or 40 of ½-inch wire rope.

The main cables are carried in two 500-foot lengths by pairs of mules. Each mule carries 244 feet of cable and the mules are connected by a 12-foot length of the cable. The main cable must never be cut.

SITE SELECTION

29 SITE SELECTION.—The bridge site should be as near as possible to the route it supplements and should require minimum approach-road or trail construction.

The maximum bridge length is 300 feet.

The site should be close to a source of 12- to 16-inch diameter timber.

The roadway center line should be as level as possible. Slopes over 10 percent are hard to climb and make bridge

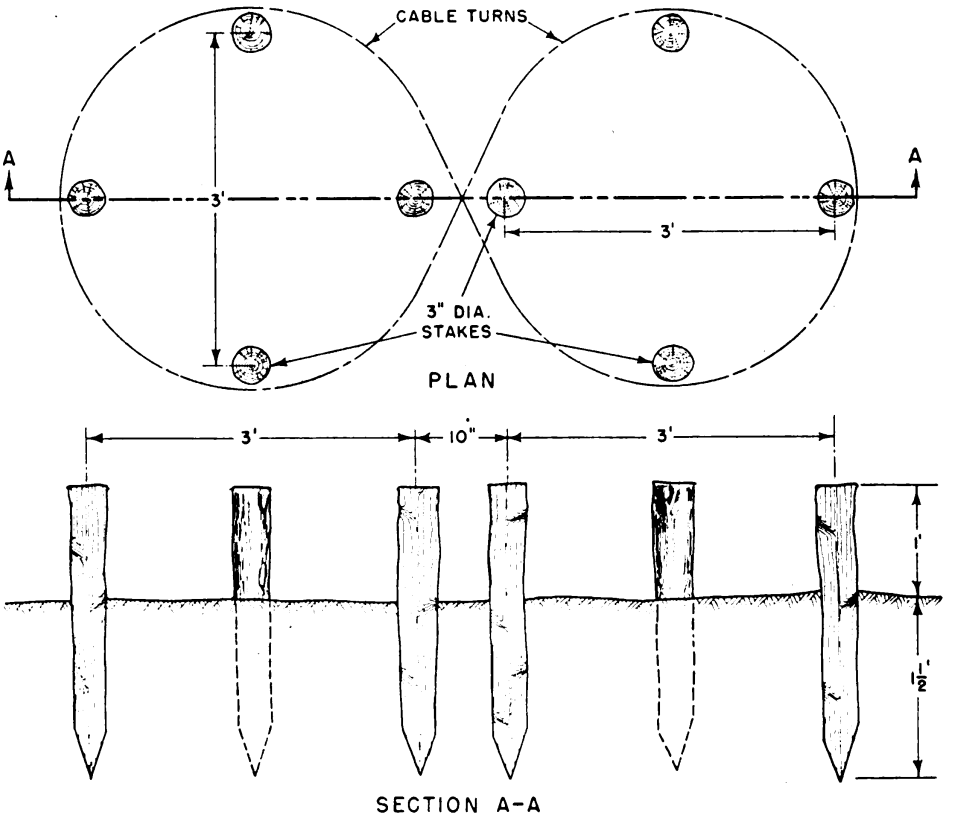


FIGURE 21. *Cable frame. Frame stakes are driven into ground at loading site and cable coiled as shown.*

erection difficult. The level span is easiest to build and maintain as well as easiest to cross.

Tower and deadman foundations must be firm. Under full load the tower foundation must support 25,000 pounds. The placing of the deadmen will vary with the slope of the ground and the slope of the backstays. Backstay slope must be 1 vertical to 2½ horizontal or less.

SECTION V

CONSTRUCTION PROCEDURE

30 GENERAL.—The bridge is constructed simultaneously from both banks in three phases or shifts. Each phase takes about 4 daylight hours. The principal tasks in each phase are summarized in this section.

31 FIRST PHASE.—A Lay out bridge site, work areas, and stock-pile sites.

B Set up sawmill for operation. Cut floor planks and stock pile near tower sites.

C Cut floor beams, stringers, and siderail posts by hand and dress with adz. One floor beam, two stringers, and two siderail posts are needed in each panel. The members are stock piled at the near- and far-side tower sites for use during the second phase.

D Prepare sill foundations.

E Start excavation for deadmen and cable trenches, using portable compressors for hard digging. Explosives may be used to facilitate rock excavation.

F Cut and fit logs for towers, and assemble towers.

When sill foundations are completed erect towers and brace with timber fore and back braces.

G Install erection cableway to carry materials and personnel across gap and for use in placing main cables. In the second phase, when bridge is partially completed, cableway is dismantled and cable used for tower guy lines.

H Place main cables when towers are erected and braced and deadmen are in position. For method of placing cables see paragraph 43.

32 SECOND PHASE.—A Saw and stock pile remainder of floor planks, siderails, toeboards, saw-tooth brace, and splice plates. Cut by hand, trim, and stock pile floor beams, stringers, and siderail posts. Saw-tooth braces are cut after the siderails and toeboards. Splice plates are used at splices in toeboards and siderails.

B Assemble hangers from two siderail posts, a floor beam, and two suspenders complete with thimble, clips, and cable bands. Take assemblies to bridge and place as described in paragraph 49C.

Cut and assemble suspenders at site. Effective and cut suspender lengths, number and designation of suspenders, and total number of cut lengths required for various spans are given in Table III.

C Assemble suspenders, clips, and cable bands as follows:

1 - For suspender to main cable connection use ½- to ¾-inch clip-type cable band. In assembly, pass suspender cable over a thimble and place 12-inch running end against standing part. Use three ½-inch cable clips, spaced 3 inches apart, to clamp standing part to running end. Then fasten clip-type cable band to thimble on suspender. Suspender is now ready for connection to main cable.

2 - For the suspender to floor beam connection pass suspender one and one-half turns around floor beam and clip running end back on standing part as described above. Floorbeam corners are notched to eliminate sharp turns in cable.

Suspenders are attached to floor beam so distance from cable-band center to top of floor beam is equal to effective suspender length given in Table III. This length is measured when suspender is taut; it must be rechecked and suspender cable readjusted when the bridge is complete.

D Install suspended floor beams and stringers simultaneously from both sides. Use erection scaffold (fig. 27) or safety cable cars to place, fasten, and adjust hanger assemblies on main cables.

Procedure is as follows:

1 - Hanger assembly is given to two men on erection scaffold who fasten clip-type cable bands on suspender to main cables and slide hanger 10 feet toward center of bridge.

2 - Stringers then are placed and nailed to sill and floor beams. Suspenders are made vertical, and cable bands tightened.

3 - Another hanger is brought forward and steps 1 and 2 are repeated; this time stringers are nailed to floor beams. Cleats are nailed to underside of stringers to keep them in place on floor beams.

This method of floor-beam stringer assembly is repeated at each panel point. Stringers are used as floor beams at panel points 0 to 4, and knee braces are used to brace siderails. Panels 5 to 14 use short floor beams and cables are nailed to siderail posts to support siderails.

E Lay floor planks ¾ inch apart and nail in place. Omit three floor planks temporarily in each panel to permit installation of wire sway bracing.

F When flooring is completed install siderails and toeboards, making splices 2 or 3 feet from siderail posts.

G Install saw-tooth bracing.

H Install wire sway bracing as described in paragraph 54, and tighten both wires simultaneously with rack sticks. Place and nail flooring to cover gap used to install sway bracing.

33 THIRD PHASE.—A Complete flooring as described in previous paragraph.

B Adjust suspender lengths and check all cable clips and cable bands to see they are fast.

C Construct needed approach roads or trails.

D Stock-pile as repair material 5 extra floor beams; 10 extra siderails, toeboards, stringers, and saw-tooth braces; 30 extra floor planks; 100 linear feet of 2- by 6-inch planks; extra nails; and extra ½-inch cable.

E Place approach siderails around main cable and bridge portal to guide pack animals.

34 TESTING BRIDGE CAPACITY.—Before loading the completed bridge to maximum capacity, test it with light loads to make sure the anchorages, clip connections, and so on are secure.

Under no conditions will the suspension bridge be loaded beyond the maximum capacity given in paragraph 9.

SECTION VI

WORKING PARTIES

35 PERSONNEL.—One platoon is required to construct the bridge. The time required under ideal conditions is 10 to 12 daylight hours.

36 WORKING PARTIES.—A suggested organization of working parties is listed in Table V. Detailed procedures for each party

TABLE V. *Organization and duties of working parties.*

FIRST PHASE—

Party	Personnel		Duties
	NCO	Men	
Layout	1	2	With officer: Lay out bridge center line and tower points. Measure span length. Lay out sill foundation and deadman excavation. Lay out near- and far-side working areas. (Men join other parties; 1 NCO and one man to far-side deadman party, one man to near-side deadman party.)
Sawmill-and-timber	1	16	Cut logs for sawmill. Cut floor planks with sawmill. Help set up cableway. Help place main cable.
Erection-cable-way	—	2	Install cableway. Operate cableway. Help place main cable.
Floor-beam and stringer	—	3	Cut floor beams, siderail posts, and stringer timbers by hand. Dress floor beams, siderail posts, and stringers. Stock-pile floor beams and stringers.
Near-side tower-fabrication and main-cable	1	5	Cut tower logs. Fabricate tower. Set up and brace tower. Place main cable.
Near-side sill-and deadman-excavation	1	5	Excavate for tower sill. Excavate for deadman. Cut and place deadman. Help set up tower. Partially backfill deadman excavation. Backfill tower-sill excavation. Help place main cables.
Far-side tower-fabrication	1	5	Cut tower logs. Fabricate tower. Set up and brace tower. Place main cable.
Far-side sill-and deadman excavation	1	5	Excavate for tower sill. Excavate for deadman. Cut and place deadman. Help set up tower. Partially backfill deadman excavation. Backfill tower-sill excavation. Help place main cables.

TABLE V. *Organization and duties of working parties.*

SECOND PHASE—

Party	Personnel		Duties
	NCO	Men	
Sawmill-and-timber	1	14	Cut logs for sawmill. Operate sawmill. Cut floor planks with sawmill. Cut siderails, toeboards, saw-tooth braces, and splice plates.
Erection-cableway	—	2	Operate erection cableway. Dismantle cableway when flooring is partially complete. Help put up tower guys.
Floor-beam	—	4	Cut and dress floor beams, siderail posts, and stringers by hand.
Hanger	—	4	Construct hangers. Cut and attach suspender ropes to hangers.
Near-side erection-scaffold	1	1	Put up scaffold. Place hangers. Attach suspender ropes to main cables.
Near-side floor	1	3	Assist in placing hangers. Place stringers. Put on flooring. Place toeboards.
Near-side tower-guy	—	3	Place side-guy holdfasts. Cut tower braces, if used. Cut timber for sawmill section. Help dismantle erection cableway. Put up tower guys.
Far-side erection-scaffold	1	1	Put up erection scaffold. Place hangers. Attach suspender ropes.
Far-side floor	1	3	Assist placing hangers. Place stringers. Put on flooring. Place toeboards.
Far-side tower-guy	—	3	Place side-guy holdfasts. Cut tower braces, if used. Cut timber for sawmill section. Help dismantle erection cableway. Put up tower guys.

TABLE V. *Organization and duties of working parties.*

THIRD PHASE—

Party	Personnel		Duties
	NCO	Men	
Sawmill-and-timber	1	10	Cut logs for sawmill. Operate sawmill. Saw siderails and braces. Help build bridge approach. Dismantle and pack saw.
Siderail	2	12	Place siderails. Place approach siderails. Post warning and capacity signs.
Sway-bracing	1	8	Install sway bracing. Nail flooring. Check all suspender clips and cable bands. Help clean-up section.
Approach and clean-up	1	8	Put in approaches. Backfill deadman and cable trench. Clean up area, pack tools and equipment.

are given in the following paragraphs. The details given need not be adhered to rigidly. They are presented to assist untrained troops in erecting the bridge for the first time. Variations in site conditions, personnel, and equipment will necessitate many changes in actual construction operations.

37 LAYOUT PARTY (officer, noncommissioned officer, and 2 men).—

A *Duties.—*

1 - Lay out bridge center line and tower locations.
2 - Measure span length.
3 - Lay out sill and deadman excavation points.
4 - Lay out near- and far-side working areas.

B *Equipment.—*

1 ea. Transit
3 ea. Stadia rod
2 ea. Hammer
1 ea. 50-foot measuring tape
1 ea. Radio set

C *Personnel and tasks.—*

1 - *Officer and one man.—*

(a) Pick out tower site on near side.

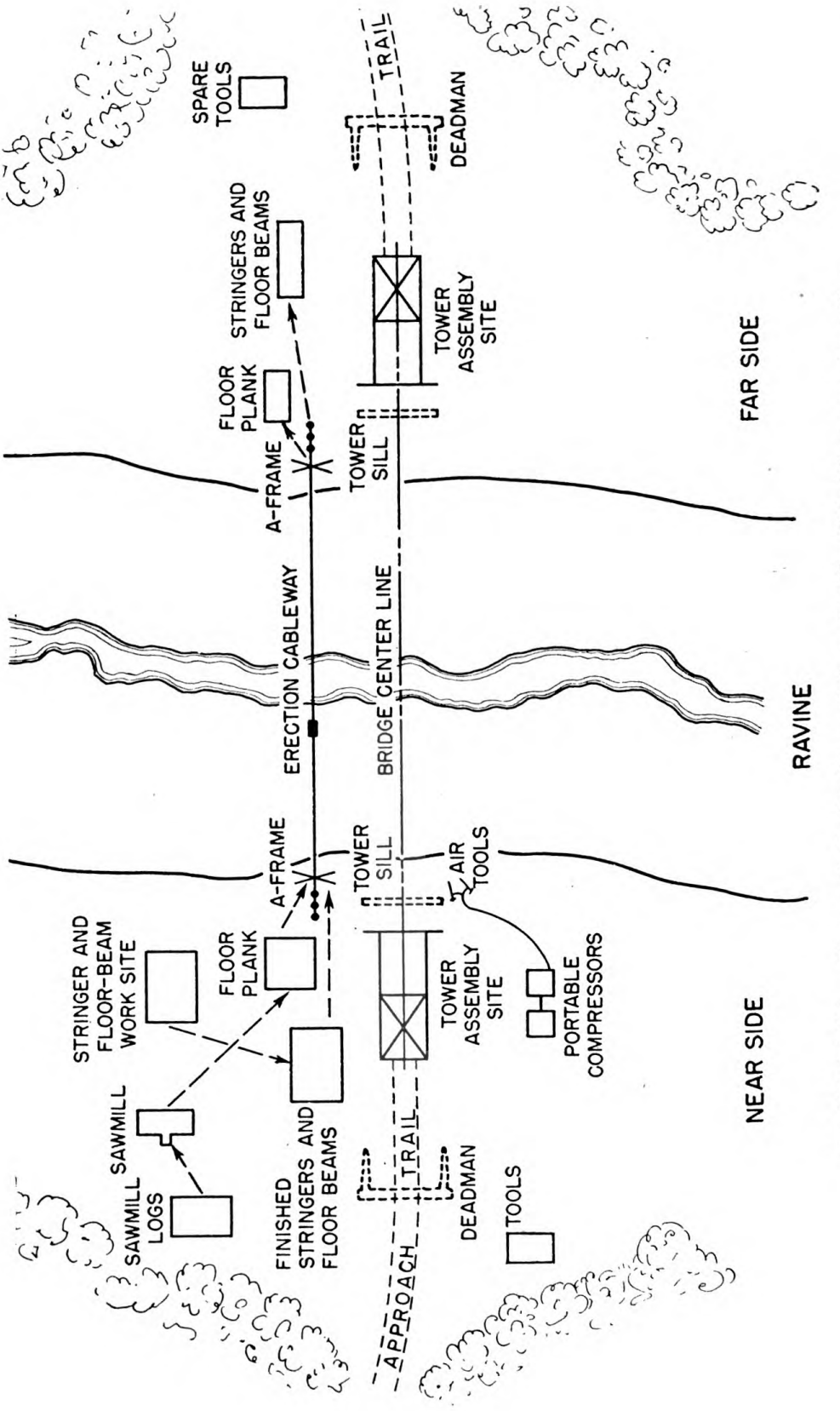


FIGURE 22. *Suggested site layout for standard bridge construction.*

(b) Officer directs noncommissioned officer to tower site on far side (see par. 29). Distance to far side is measured by stadia. Span length, tower-to-tower, must be divisible by 20 feet so standard suspender lengths can be maintained (Table III).

(c) Stakes are driven at both tower sites on center line.

(d) A back sight is taken to extend center line back of near-side tower site and a 50-foot base line is set off to aline tower at right angles to center line. Back-sighted center line is used to set near-side deadman. Tower-sill excavation site is staked out with tracing tape.

(e) Tower height now is computed. Tower height from top of sill (ground level to main cable) is 7.67 percent of span length (sag ratio plus bridge camber) plus 1 foot 2½ inches (effective length of center suspender). For example, for a 240-span tower height would be 7.67 percent of 240 feet plus 1 foot 2½ inches, or

$(.0767 \times 240) + (1.21) = 19.61$ feet or 19 feet 7½ inches.

(f) Distance from tower to deadman may be measured with 50-foot tape. If ground is level, distance from tower to deadman is 2½ times sum of tower height and depth of deadman excavation. Slight uphill or downhill ground slope to the deadman does not change deadman distance appreciably. If ground slope is steep deadman position to furnish a 1 vertical to 2½ horizontal backstay slope is determined by successive trials with tape and transit.

(g) Deadman excavation and backstay ditches are laid out with stakes and tracing tape.

2 - *Noncommissioned officer and one man.*—Transit is sent to opposite bank and far-side tower and deadman sites are laid out same as those on near side.

3 - *Officer, noncommissioned officer, and two men.*—

(a) Working areas are laid out. Sawmill should be near erection cableway and near-side tower. There should be room close to tower site, to stock-pile timbers and finished planks and to stock tools not in use. Be sure, however, that sawmill and stockpile are out of the way of other operations.

(b) Tools are stock-piled.

(c) Men join other parties when layout is complete. Noncommissioned officer and men on far side join far-

side deadman party. Man on near side joins near-side deadman party.

A recommended site layout is shown in figure 22.

38 SAWMILL-AND-TIMBER PARTY (noncommissioned officer and 16 men.)—

A *Duties.—*

1 - Set up sawmill.
2 - Operate sawmill.
3 - Cut floor plank.
4 - Help install cableway.
5 - Help place main cable.

B *Equipment.—*

3 ea. Double-bit ax
1 ea. Adz
4 ea. Peavy
2 ea. Timber carrier
2 ea. Round-pointed shovel
2 ea. Pick
1 ea. 60-inch crowbar
1 ea. Portable power sawmill and gasoline engine
1 ea. Carpenter's hammer
1 ea. Cross-cut handsaw
1 ea. Carpenter's level
1 ea. 12-pound sledge
1 ea. Gasoline chain saw
4 ea. Log chain
2 ea. Steel wedge

C *Personnel and tasks.—*

1 - *Noncommissioned officer and seven men.—*

(a) Level off sawmill site.

(b) Cut and dress sawmill foundation timbers.

(c) Place sawmill foundation timbers.

(d) Install sawmill and motor. Level sawmill by blocking under sawmill frame. Connect mill and motor.

(e) Operate mill. Cut 2- by 6-inch floor plank.

2 - *Nine men.—*

(a) Three men cut 12- to 18-inch-diameter timbers for floor planks: two with gasoline chain saw cutting timbers into 10-foot logs and one with mule dragging logs to sawmill.

(b) Six men help erection-cableway party and

then rejoin sawmill-and-timber party. Four cut timber and two with mules haul timber to sawmill site.

(c) When towers and deadman are in place all nine men used in cutting timber go to far side and join other parties to place main cables. See paragraph 43. When main cables are placed these men resume cutting timber.

39 ERECTION-CABLEWAY PARTY (two men).—

A *Duties.—*

1 - Install and operate cableway.

2 - Help place main cables.

B *Equipment.—*

1 ea. 600-foot length of ½-inch wire rope
10 ea. ½-inch wire-rope clip
1 ea. 12-pound sledge
1 ea. 60-inch crowbar
1 ea. Carpenter's hammer
2 ea. Double-bit ax from timber section
3 ea. Snatch blocks
600 feet of hemp rope as trolley-pull line

C *Personnel and tasks.*—Two men, aided by six men from sawmill-and-timber party.

1 - *Eight men.—*

(a) Lay out ½-inch wire rope to be carried across gap.

(b) Four men take one end of wire rope, carry it down near side, and pull it up far side.

(c) Four men on both sides cut 10-inch logs for *A*-frame if 12-inch trees are not available at site as cableway towers.

(d) If *A*-frame is used 1-1-1 holdfasts are installed and *A*-frame set up and braced preparatory to stringing cableway.

(e) Cable is attached to far-side holdfast and strung over far-side *A*-frame or fastened to tree as cableway tower.

(f) Three men from timber party go to near side.

(g) Seven men at near side stretch cable over near-side *A*-frame and attach cable to holdfast.

(h) Attach cable-car pull lines and install cable car.

(i) Six men rejoin sawmill-and-timber party.

2 - *Two men.*—

(a) Operate cableway.

(b) Transfer all personnel, tools, materials, and equipage.

(c) Stock-pile materials at far side as they are transferred.

3 - *Two men.*—

Help place main cable.

40 FLOOR BEAM AND STRINGER PARTY (three men).—

A *Duties.*—

Cut and dress timber for floor beams and stringers and stock-pile it.

B *Equipment.*—

1 ea. Ax

2 ea. Adz

C *Personnel and tasks.*—

1 - *One man.*—

(a) Cuts 6-inch-diameter logs to 4-foot 3-inch, 5-foot 7-inch, and 11-foot lengths.

(b) Stock-piles logs at floor-beam and stringer dressing sites.

2 - *Two men.*—

(a) Dress 5-foot 7-inch and 11-foot lengths to 4- by 4-inch cross section.

(b) Split 4-foot 3-inch timbers and dress to 2- by 4-inch cross section.

(c) Stock-pile 4- by 4-inch floor beams and stringers and 2- by 4-inch siderail posts at floor-beam and stringer stock piles near cableway and bridge center line.

41 NEAR-SIDE TOWER-FABRICATION PARTY (noncommissioned officer and five men).—

A *Duties.*—

1 - Cut tower logs.

2 - Fabricate tower.

3 - Set up and brace tower.

4 - Place main cable.

B *Equipment.*—

1 ea. Two-man saw
1 ea. Ax
1 ea. Adz
1 ea. Peavy
1 ea. Timber carrier
1 ea. Crow bar
2 ea. Carpenter's hammer
2 ea. Cross-cut 26-inch hand saw

C *Personnel and tasks.*—

1 - *Noncommissioned officer and five men with two mules.*—

(a) Cut timbers for tower to length and size specified for improvised towers in paragraph 12.

(b) Drag timbers to tower-fabrication site.

FIGURE 23. *Tower sill on rock foundation. Sill foundation is levelled. Footings may be used to spread loads.*

2 - *One man.*—
   (a) Dresses sill.
   (b) Cuts and dresses footings, if necessary.
   (c) Drills dowel holes in sill.

3 - *Noncommissioned officer and four men.*—
   (a) Lay out and space posts.
   (b) Dress tops and bottoms of posts.
   (c) Drill dowel-pin holes in tops and bottoms of posts.
   (d) Dress top cap.
   (e) Drill dowel-pin holes in cap.
   (f) Nail saddle block and cover plate, or saddle strap, to cap.

4 - *Noncommissioned officer and five men.*—
   (a) Assemble sill, caps, and guys (fig. 23).
   (b) Nail on diagonal braces (if used) and cross pieces.
   (c) Notch posts and sill for side braces, if used, and nail on side braces.
   (d) Place and level footings, if used.

5 - *Noncommissioned officer and seven men (two from sill-and-deadman excavation party).*—
   (a) Erect tower.
   (b) Notch tower for backstay, if used, and install backstay.
   (c) Brace tower with front, back, and sidestays.

6 - *Noncommissioned officer and five men* help place cable as explained in paragraph 43.

42 FAR-SIDE TOWER-FABRICATION PARTY (noncommissioned officer and five men).—

A *Duties.*—
Same as in paragraph 41A.

B *Equipment.*—
1 ea. Two-man saw
1 ea. Ax
2 ea. Adz
1 ea. Peavy
1 ea. Timber carrier
1 ea. Crow bar

2 ea. Carpenter's hammer
2 ea. Cross-cut 26-inch hand saw

C *Personnel and tasks.*—

Steps 1, 2, 3, 4, and 5 are the same as those of near-side tower-fabrication party. See paragraph 41C.

Step 6. Noncommissioned officer and five men help place cable as explained in paragraph 43.

43 MAIN-CABLE PARTY (officer, 4 noncommissioned officers, and 28 men drawn from other parties).—

A *Duties.*—
Place main cables.

B *Erection equipment or tools.*—
16 ea. ¾-inch wire-rope clip
2 ea. 1½-ton ratchet chain hoist
8 ea. 1⅛-inch-opening crescent wrench
600 feet of ⅝-inch manila rope

C *Personnel and tasks.*—

Note.—All join main-cable party to place main cables except three men cutting floor beams and stringers and one noncommissioned officer and seven men operating sawmill.

1 - *Near-side party (2 noncommissioned officers and 10 men).*—

(a) Tie a 600-foot erection-cableway; haul line to end of main cable and string it over near-side tower saddle, across gap, and over far-side tower saddle to far-side cable party.

(b) When cable reels are used they are placed on a frame behind tower and cable pays out in a straight line from top of reel over tower saddle. Near-side party pays out cable slowly and guides it over tower saddle. At all times cable is kept clear of trees and other obstructions in gap. When cable is placed and clipped at far-side, it is unreeled at near side, placed around deadman, and temporarily clipped back on itself.

(c) When cable is transported on pack animals it is wound on a cable frame as shown in figure 21, and explained in paragraph 28. Cable is left on mules until ready to be placed, then taken off first mule, laid on ground, and paid out one loop at a time. To avoid kinking, when cable is lifted off first mule figure-eight coil is turned upside down and free end tied to ⅝-inch manila haul line. Cable is paid off top of

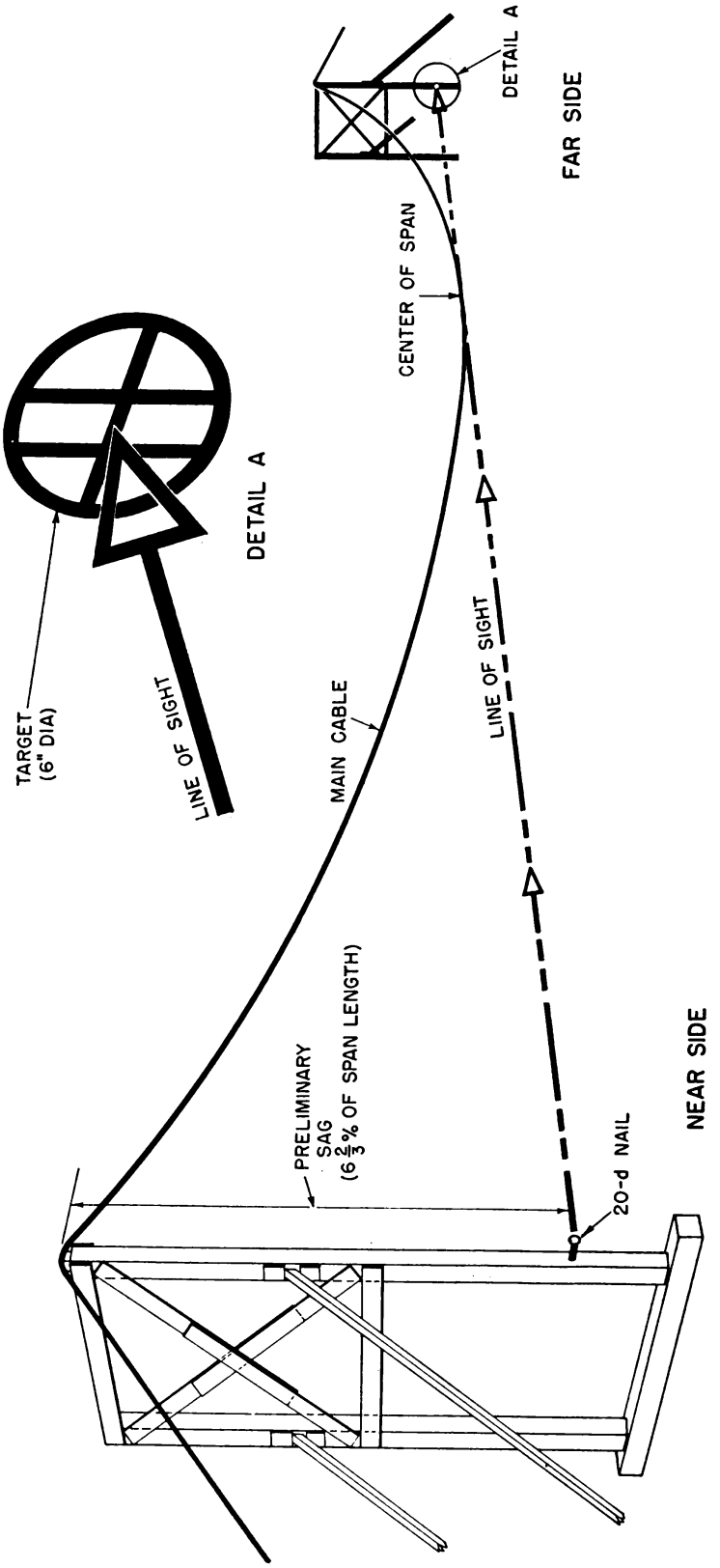


FIGURE 24. *Setting main-cable sag. Line of sight will not vary when bridge is constructed on a slope. Target made of top of tin can is placed same distance from cable as 20-d nail.*

figure-eight coil. When first coil has been completely paid out second coil is taken off its mule, paid out, placed around deadman, and clipped back upon itself. In no case is cable cut. Extra cable is coiled near deadman.

2 - *Far-side party (officer, 2 noncommissioned officers and 18 men).*—

This party receives the $\frac{5}{8}$-inch manila rope, strings it over far-side tower, and hauls cable over both towers to far-side deadman. Cable is given one and one-half turns around deadman clipped back on itself with four $\frac{3}{4}$-inch clips.

3 - *Second main cable.*—

Second cable is placed in the same way.

4 - *Setting cable to preliminary sag ratio.*—

Final cable adjustment is made with a ratchet chain hoist. A nail-and target combination used to set cable is shown in figure 24. Target center is placed on far-side post $6\frac{2}{3}$ percent of span length from top of tower saddle. Sighting nail is driven in side of near-side post at same level.

Example: 200-foot span

$6\frac{2}{3}$ percent of 200 feet = .0667 x 200 = 13.33 feet or 13 feet 4 inches.

Cable is unclipped at near-side deadman and ratchet chain hoist attached. Cable is tightened until line of sight between nail and target coincides with lowest point of main cable (fig. 24). Cable is clipped back on itself with four cable clips.

44 NEAR-SIDE AND FAR-SIDE DEADMAN-EXCAVATION PARTY (noncommissioned officer and five men on each side).—

A *Duties.*—

1 - Excavate for tower sill and deadman.
2 - Cut and place deadman.
3 - Help set up tower.
4 - Partially backfill deadman excavation.
5 - Backfill tower excavation to tower sill.
6 - Help place main cables.

B *Equipment (each site).*—

1 ea. Two-man saw
1 ea. Two-bladed ax
1 ea. Peavy
5 ea. Round-pointed shovel
5 ea. Railroad pick

5 ea. Pick mattock
2 ea. Air compressor (at one site only[1])
1 ea. Blasting machine, 10-cap capacity
25 ea. Blasting cap
25 pounds 40% dynamite

C *Personnel and tasks, noncommissioned officer and five men at each site.—*

1 - *Noncommissioned officer and one man.—*

(a) Dig tower-sill hole.
(b) Level hole to receive footings.
(c) Join tower-fabrication party to set up tower.
(d) Backfill on tower sill.

2 - *Four men.—*

(a) Dig hole for deadman. Depth depends on soil condition. See paragraph 15.
(b) Dig trenches for main cables and tower guys.
(c) Cut 12- to 16-inch-diameter tree for deadman.
(d) Place deadman.
(e) Partially backfill deadman excavation (see fig. 25).

3 - *Compressors.—*

Place portable compressors in series. This means they can be used at only one site at a time. If compressors are needed on both sides, complete excavation at near side first.

4 - *Dynamite.—*

Use dynamite to speed excavation in rock. Take care not to breach soil on which deadman will rest.

5 - *Noncommissioned officer and five men.—*

Join far-side tower-fabrication party to help place main cables.

45 SAWMILL-AND-TIMBER PARTY (noncommissioned officer and 14 men).—

A *Duties.—*

1 - Operate sawmill.
2 - Cut floor plank.
3 - Cut siderail plank.

[1] One 55 cubic-foot-per-minute compressor will replace the two listed here. See paragraph 23.

B *Equipment.*—
1 ea. Portable sawmill
1 ea. Two-man saw
4 ea. Double-bladed ax

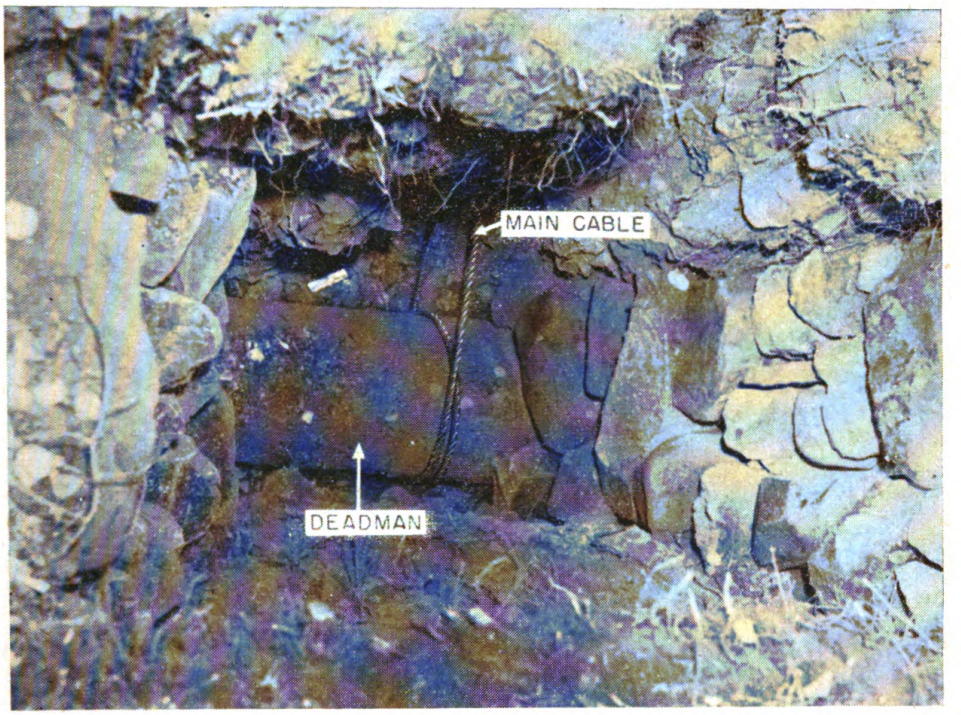


FIGURE 25. *Partial backfill of deadman. Trench is left open at point where cable is attached to adjust main-cable length and cable clamps.*

4 ea. Timber carrier
1 ea. 12-pound sledge
1 ea. Crow bar
6 ea. Peavy
1 ea. Chain saw

C *Personnel and tasks.*—

1 - *Eight men.*—Cut logs for sawmill.

2 - *Noncommissioned officer and six men.*—Operate sawmill:

(a) Finish cutting floor planks, 18 per panel.
(b) Cut siderails, two per panel.
(c) Cut toeboards, two per panel.
(d) Cut splice plates, four per panel.
(e) Cut saw-tooth braces, four per panel.

46 ERECTION-CABLEWAY PARTY (two men).—

A *Duties.*—

1 - Operate cableway.

2 - Dismantle cableway when preliminary flooring is complete.

3 - Help place tower guys.

B *Equipment.*—

4 ea. Safety cable car

2 ea. Adjustable wrench

C *Personnel and tasks.*—

1 - *Two men.*—

(a) Transfer to far side all far-side material fabricated or cut on near side.

2 - *Four men near side and four men far side* (Six men drawn from near- and far-side tower-guy parties).—

(a) Dismantle erection cableway.

(b) Cut ½-inch cable into four 150-foot pieces to be used as tower guys.

3 - *Two men.*—Help tower-guy parties place tower guys.

47 FLOOR-BEAM AND STRINGER PARTY (four men).—

A *Duties.*—See paragraph 40.

B *Equipment.*—

1 ea. Two-man saw

2 ea. Ax

3 ea. Adz

C *Personnel.*—Four men.

D *Tasks.*—See paragraph 40.

48 HANGER PARTY (four men).—

A *Duties.*—

1 - Construct hanger frames.

2 - Cut and attach suspenders to frame.

B *Equipment.*—

4 ea. Carpenter's hammer

1 ea. 1⅛-inch crescent wrench

4 ea. Wire-rope cutter

C *Personnel and tasks.*—

1 - *Three men.*—

(a) Trim siderail posts and floor beams.

FIGURE 26. *Assembled hanger. Hanger is assembled on near side and given to far side party to be installed.*

(b) Notch floor beams for suspenders.
(c) Assemble hanger (fig. 26).

2 - *One man.*—
(a) Measures and cuts suspenders.
(b) Attaches suspenders to floor beam.
(c) Attaches thimble and top clips and adjusts effective length of suspenders.

49 NEAR-SIDE AND FAR-SIDE ERECTION-SCAFFOLD PARTIES (non-commissioned officer and one man each).—

A *Duties.*—
1 - Install erection scaffold (fig. 27).
2 - Place hangers (fig. 28).
3 - Attach and adjust suspender ropes.

B *Equipment (each party).*—
2 ea. Flexible safety cable car or two snatch blocks and 2- by 6-inch by 10-foot scaffold plank

2 ea. 10-foot, ½-inch cable sling
4 ea. ½-inch clip
2 ea. 25-foot pieces ⅝-inch hemp rope for safety slings
2 ea. Crescent wrench
2 ea. Plumb bob and line

C *Personnel and tasks (noncommissioned officer and one man each party).—*

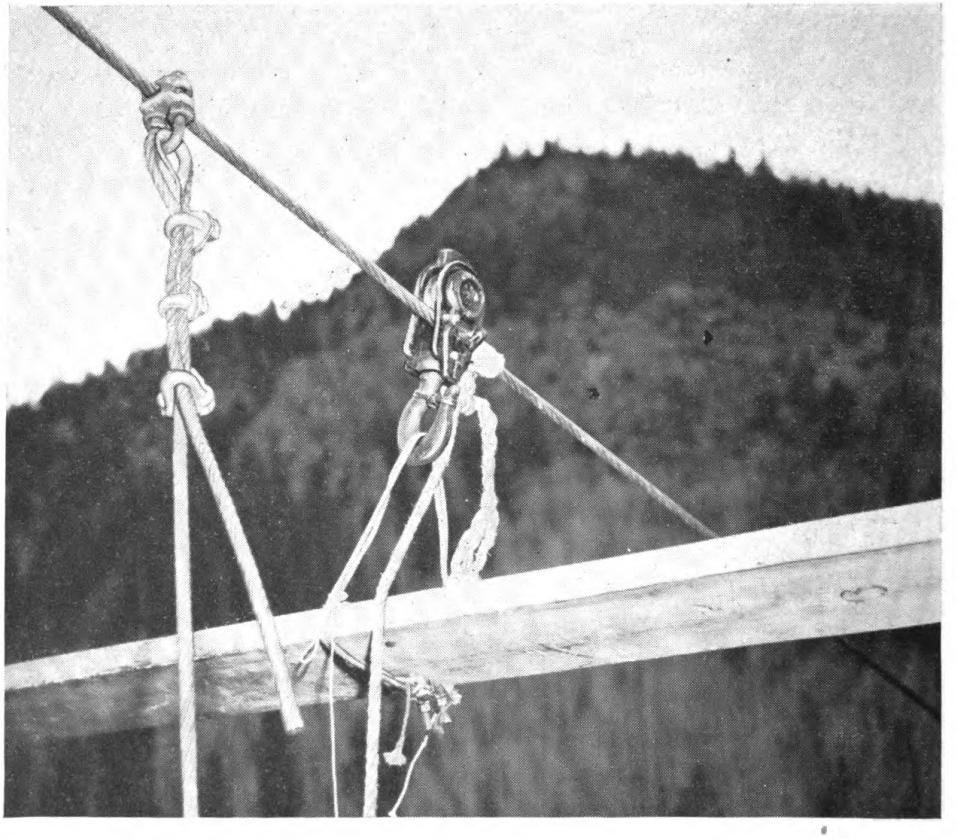
1 - Install safety cable cars.

2 - Attach hanger-assembly suspender ropes loosely at shoreward panel point and slide suspenders 10 feet out to their position.

3 - When stringers are placed and nailed, adjust suspenders to a vertical position with help of plumb bob and make clip-type cable band fast to main cable (see fig. 29).

4 - Repeat with each hanger assembly.

FIGURE 27. *Detail of erection scaffold. Scaffold snatch block is held by a knotted safety line on the down-slope side.*



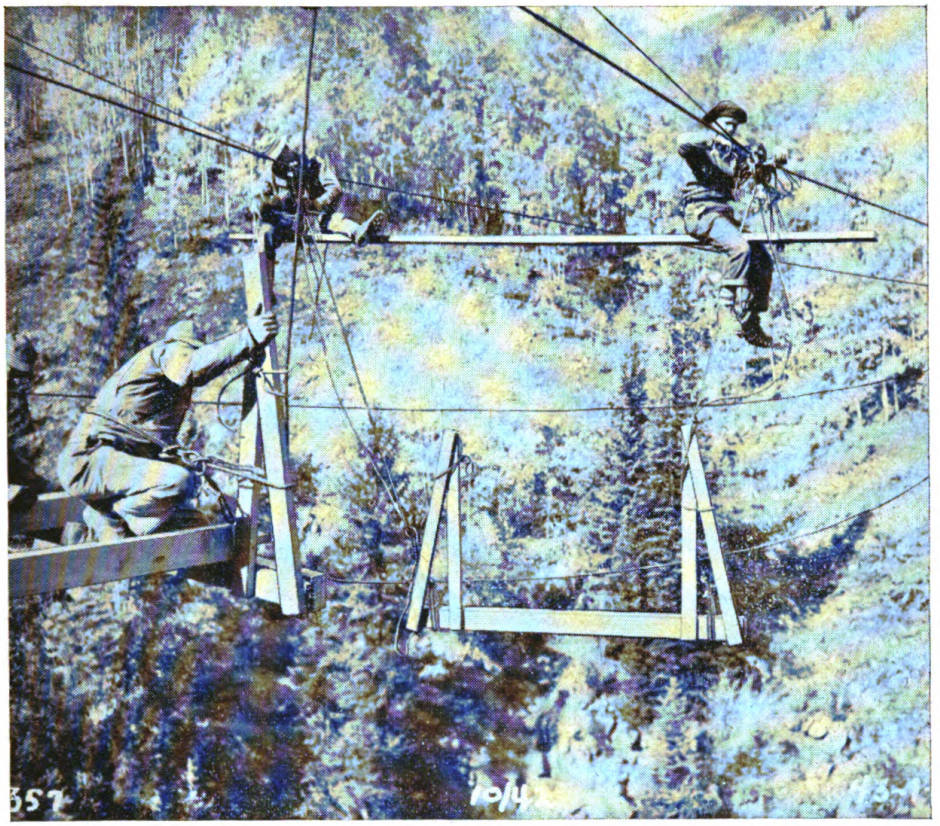


FIGURE 28. *Placing hanger. Erection-scaffold men place hanger at proper length. Note safety rope on floor-party man at left.*

50 NEAR- AND FAR-SIDE FLOOR PARTIES (noncommissioned officer and three men each).—

A *Duties.—*

1 - Assist in placing hangers.

2 - Place and nail stringers.

3 - Put on part of flooring.

4 - Place and nail toeboards and siderails.

B *Equipment.—*

3 ea. Claw hammer

150 pounds of 20-penny nails

C *Personnel and tasks (noncommissioned officer and three men).—*

1 - Hand hanger-assembly suspenders to erection-scaffold party.

2 - Place stringers on hanger assembly and nail stringers to floor beam (fig. 30).

3 - Lay part of flooring, leaving out three floor planks at each end of panel to facilitate placing and tightening wire sway bracing.

4 - When flooring is completed to midspan start placing and nailing siderails and toeboards. Make splices of toeboards and siderails as shown in figure 16.

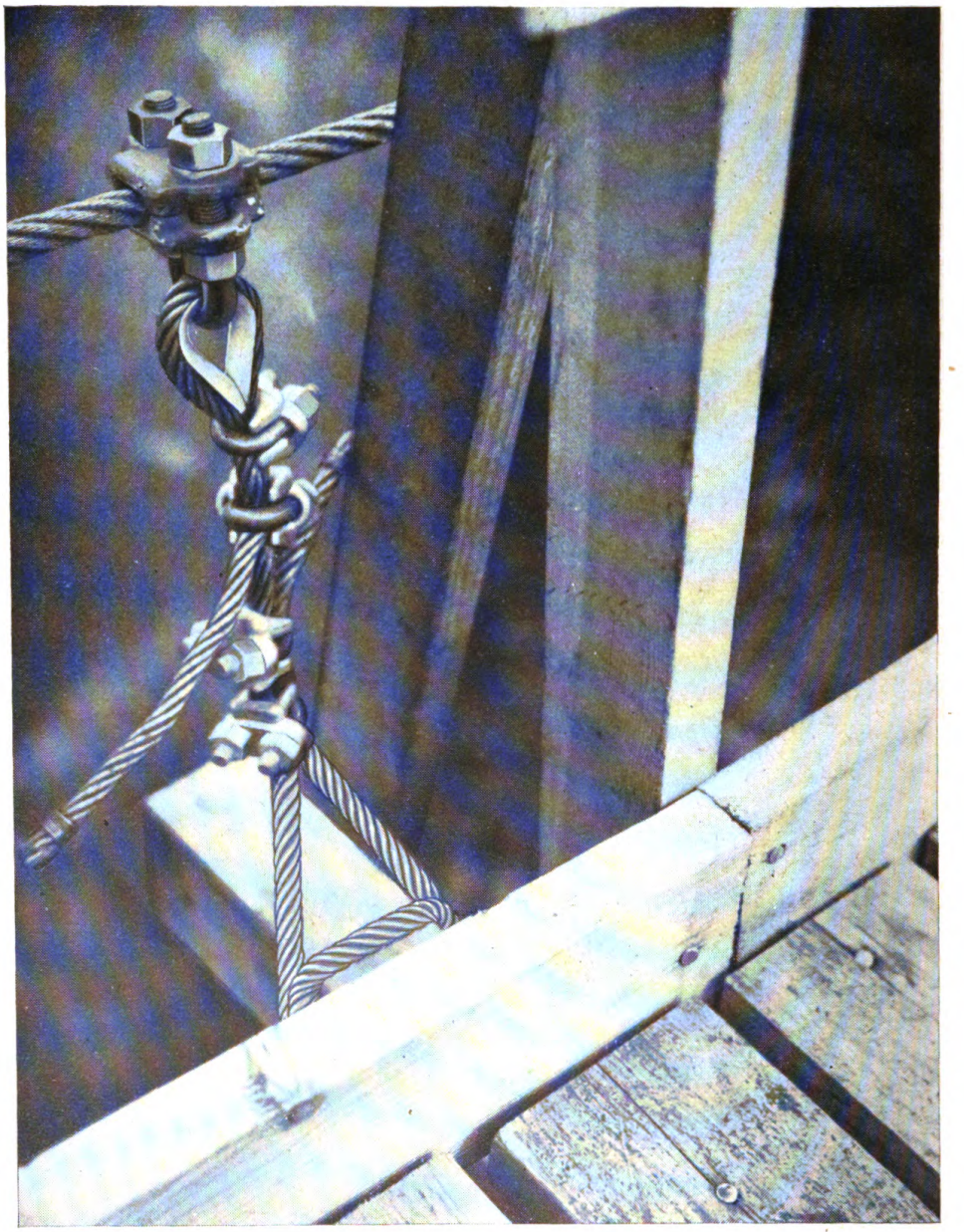


FIGURE 29. *Suspender in place. Center suspender clipped in place. Note suspender is wrapped once around floor beam.*

FIGURE 30. *Placing stringers. Stringers must be placed from temporary scaffold plank. After the stringers are placed and nailed into position, the erection-scaffold party receives next hanger assembly and goes forward to next panel point.*

51 NEAR- AND FAR-SIDE TOWER-GUY PARTIES (three men each).—

A *Duties.—*

1 - Place side-guy holdfasts.
2 - Cut tower braces, if used.
3 - Help cut timber for sawmill-and-timber party.
4 - Help erection-cableway party dismantle erection cableway.
5 - Cut and place back guys.

B *Equipment (each party).—*

3 ea. Round-pointed shovel
3 ea. Pick
2 ea. Portable air compressor[1]
1 ea. Adz
1 ea. 26-inch cross-cut saw

C *Personnel and tasks (each party).—*

1 - *Three men.—*

(a) When side guys are used place holdfasts or

deadmen to hold tower guys. Side tower guys are held with 1-1-1 holdfast or a deadman 6 feet long, buried 4 feet. Tower guys have 1 to 1 slope and holdfasts are placed one post-length away from tower. For example, if post of tower is 20 feet long, side guy is placed 20 feet from base of post and at right angles to center line of bridge.

(b) When log side and back braces are used, cut them to length, dress, and trim them to fit notches in posts.

(c) Join sawmill and timber party, cutting and hauling timber until erection cableway is to be dismantled.

(d) Join erection-cableway party in dismantling cableway.

2 - *Three men assisted by one man from erection-cableway party.*—

(a) Cut ½-inch cable into tower guys. Two back tower guys and two side tower guys (if used) are needed on each side. Tower guys require one and one-half turns around deadman and tower post. Length of each tower guy is found by measuring length from top of tower to deadman or holdfast, and adding 25 feet to back-guy length and 20 feet to side-guy length.

(b) Attach back and side guys, using three ½-inch cable clips on each tie back, a total of six ½-inch cable clips on each guy line.

52 SAWMILL-AND-TIMBER PARTY (noncommissioned officer and 10 men).—

A *Duties.*—

1 - Cut timber.
2 - Saw siderails.
3 - Help build bridge approach.
4 - Dismantle and pack saw.

B *Equipment.*—

1 ea. Portable sawmill
2 ea. Two-man saw
1 ea. Gasoline chain saw
4 ea. Ax
4 ea. Adz
6 ea. Peavy
4 ea. Timber carrier

[1] One 55 cubic-foot-per-minute compressor will replace the two listed here. See paragraph 23.

1 ea. 12-pound sledge
1 ea. Crow bar
2 ea. Carpenter's hammer

C *Personnel and tasks.*—

1 - *Noncommissioned officer and six men.*—

(a) Finish cutting siderails.

(b) Cut extra floor planks, siderail planks, and tower diagonals. These are left at site for repair work.

(c) Cut timber for approach siderails.

(d) Dismantle and pack saw.

2 - *Four men.*—

(a) Cut timber for sawmill.

(b) Join approach party in building approaches to bridge.

FIGURE 31. *Approach siderails. Used to guide men and animals from approach trail to bridge.*

53 SIDERAIL PARTY (2 noncommissioned officers and 12 men).—

A *Duties.—*

1 - Place siderails.
2 - Place approach siderails (fig. 31).
3 - Post warning and capacity signs.
4 - Join clean-up party in packing equipment.

B *Equipment.—*

5 ea. Hammer
4 ea. Hand saw

C *Personnel and tasks.—*

1 - *Four men.*—Bring up siderails, toeboards, and saw-tooth braces.

2 - *Noncommissioned officer and seven men.—*

(a) Trim and place siderails, toeboards, and saw-tooth braces.

(b) Cut and place approach siderails.

3 - *Noncommissioned officer and one man.—*

(a) Determine number of warning signs required.

(b) Make warning and capacity signs.

4 - *All party personnel.*—Join clean-up and approach party and pack equipment.

54 SWAY-BRACING PARTY (noncommissioned officer and 8 men).—

A *Duties.—*

1 - Install sway bracing.
2 - Nail flooring.
3 - Check all wire-rope clips and clamps.
4 - Help clean-up party.

B *Equipment.—*

2 ea. Pair 8-inch pliers
5 ea. Carpenter's hammer
4 ea. Wire-rope cutter
4 ea. 12-inch carew wire cutter
2,000 feet No. 9 galvanized-steel wire

C *Personnel and tasks (noncommissioned officer and eight men).—*

1 - Cut wire into 30-foot lengths.

2 - Install diagonal sway bracing. Working through gap in flooring run wire under flooring and wrap one and one-half turns around floor beam. Run wire diagonally under

FIGURE 32. *Wire sway bracing of suspension footbridge. Rack sticks twist wires tight; they are held in place by locking them against floor plank.*

floor to opposite side of floor beam at other end of panel. Wrap one and one-half turns around floor beam. Beams are notched to take wire sway bracing. Then run wire back to gap in flooring and splice loose ends. Install opposite bracing in same manner. Tighten diagonals with rack sticks. Install floor planks in flooring gap. Figure 32 shows flooring and wire sway bracing in position with rack stick tight and held against floor plank.

3 - Check all nuts on wire clamps and clips to see they are tight and correctly placed and spaced.

4 - Join approach and clean-up party.

55 APPROACH AND CLEAN-UP PARTY (noncommissioned officer and eight men).—

A *Duties.—*

1 - Clear and build approach trails.

2 - Backfill deadman and cable trench.
3 - Clean up area, stock-pile repair parts.
4 - Pack equipment and tools.

B *Equipment.*—
2 ea. Ax
12 ea. Round-pointed shovel
18 ea. Pick
1 ea. 12-pound sledge
1 ea. Crow bar
2 ea. Air compressor[1]

C *Personnel and tasks* (*noncommissioned officer and eight men*).—Joined by the rest of platoon as other parties finish their jobs.

1 - Clear and grub all trees on approaches to bridge. See that approaches are well-drained.

2 - Backfill cable trenches. Install rock pile on earth mound and guardrail around base of cables so cables will not be bumped or scraped when pack mules pass.

3 - Clean up sawmill site, stock-pile spare lumber.

4 - Pack all extra material and tools.

[1] One 55 cubic-foot-per-minute compressor will replace the two listed here. See paragraph 23.

STANDARD LIGHT-EQUIPMENT SUSPENSION BRIDGE

SECTION I

GENERAL

56 GENERAL.—The bridge will carry foot troops with full field pack, pack mules and handlers, or ¼-ton trucks and trail tractors, as follows:

A *Foot troops* (fig. 4).—Troops with full field pack spaced one-fortieth span length apart and crossing at route

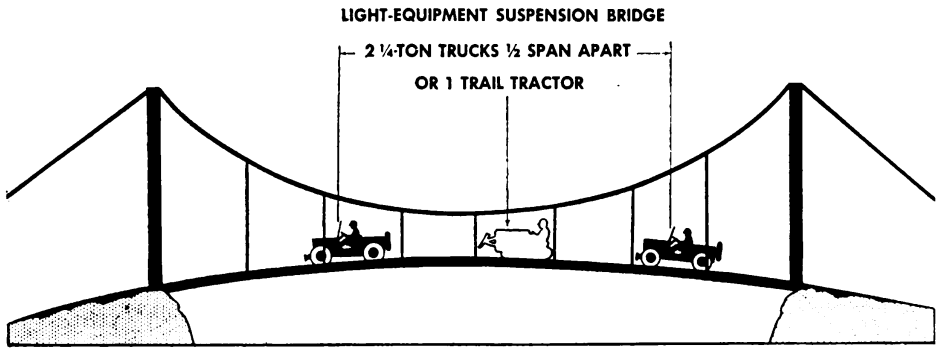


FIGURE 33. *Capacity of light-equipment suspension bridge. The bridge will carry two ¼-ton trucks or one trail tractor.*

step in single file. For example, 40 men can cross a 300-foot span at 3-pace intervals.

B *Pack mules* (fig. 4).—Seven pack mules, each with handler, spaced one-seventh span length apart. For example, on a 300-foot span mules maintain 15-pace intervals.

C *Quarter-ton trucks and trail tractors* (fig. 33).—Two ¼-ton trucks one-half span length apart or one trail tractor (fig. 34).

57 SPAN LENGTH.—A Maximum span length is 300 feet.

B For spans under 140 feet a modified tower must be used. See paragraph 10B.

FIGURE 34. *Trail tractor. Used to clear and construct trails and light-equipment roads.*

DESCRIPTION OF BRIDGE AND ERECTION EQUIPMENT

58 GENERAL.—The light-equipment suspension bridge is similar in design and construction to the suspension footbridge. To avoid repetition similar parts are referred to but not described.

59 ERECTION CABLEWAY.—See paragraph 11.

60 TOWERS.—Towers are constructed from materials found at the site.

A *Improvised towers.*—Improvised towers, types 1 and 2, are built as shown in figures 35 and 36. Timbers are 12-inch logs; bracing is made of 2- by 10-inch cut lumber. The uprights are doweled to the sill and the cap pieces are 12 feet inside to inside.

B *Prefabricated tower* (fig. 37).—If dimension lumber is available the tower can be built using plank 2 by 10 inches by 10 feet. The sill base is constructed as shown in figure 38. It is a built-up, lap-jointed piece, 4 by 10 inches by 15 feet.

Two built-up, lap-jointed, 8- by 10-inch posts are nailed to the sill 12 feet 2 inches inside to inside of posts. Two 2- by 10-inch pieces are nailed to the sides of the sill base and posts as shown and are scabbed to the lap joints. Two 2- by 10-inch by 10-foot cap pieces are nailed across the top of the posts, and one 2- by 10-inch cross brace is nailed to each side of the posts 11 feet above the sill. Diagonal bracing is nailed to both sides of the posts above the cross braces. Tower saddle blocks and cover plates are nailed to the top of each post. Cover plates support the main cables.

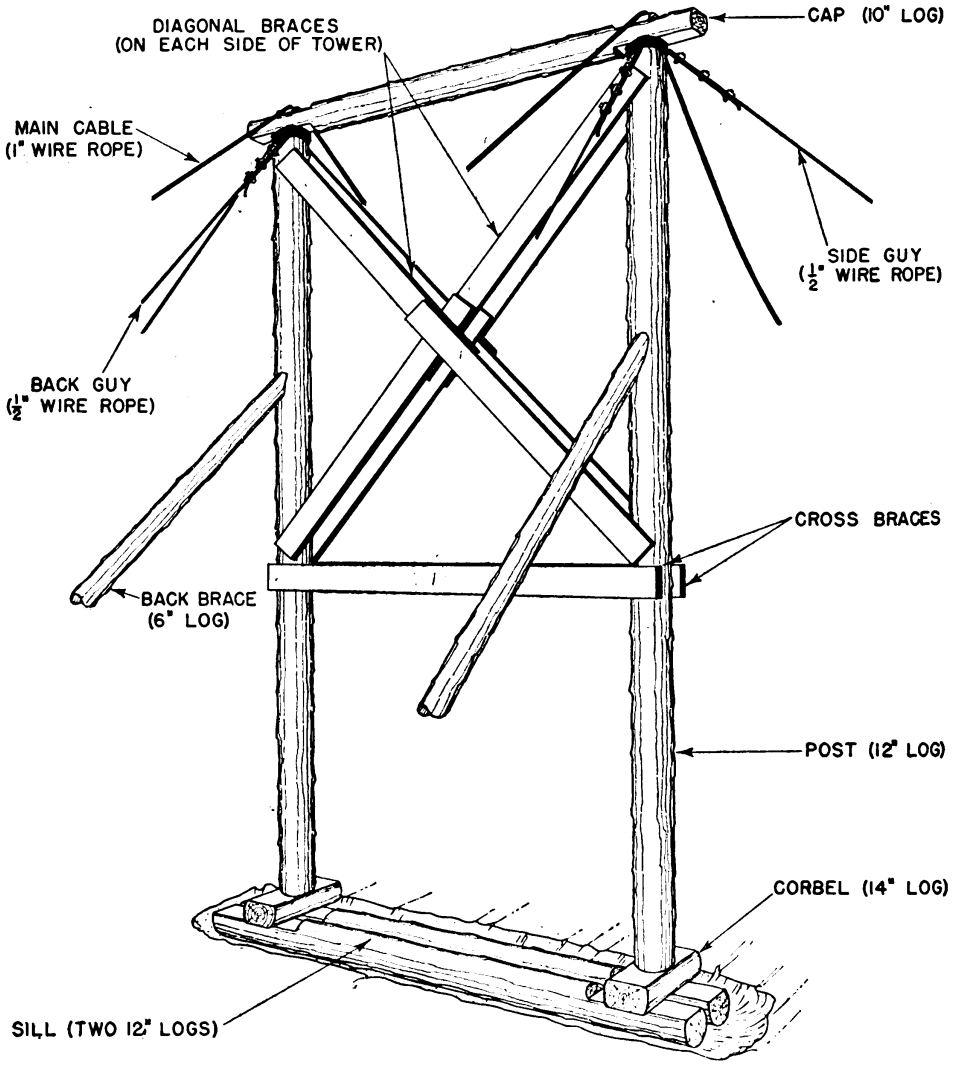


FIGURE 35. *Improvised tower, type-1, for light-equipment suspension bridge. Used on long spans when dimension lumber is available for bracing.*

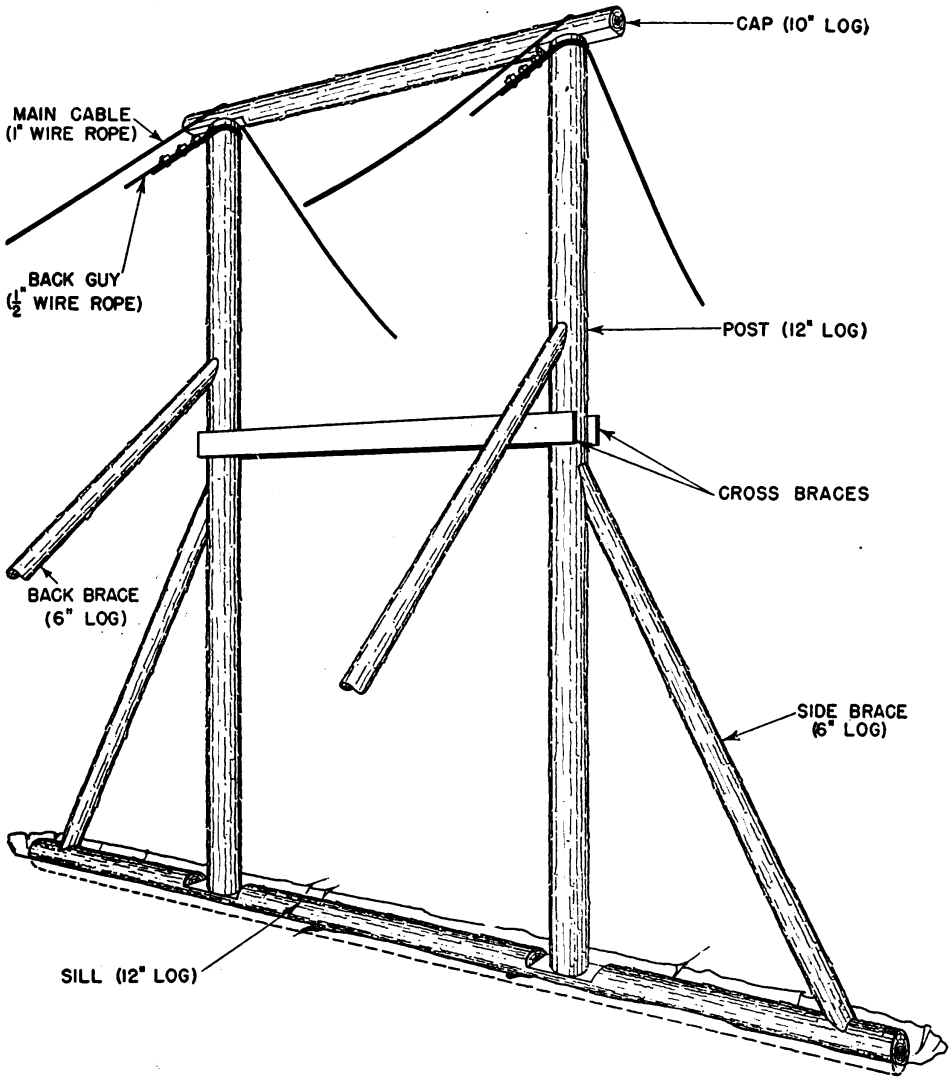


FIGURE 36. *Improvised tower, type-2, for light-equipment suspension bridge. Used for long spans when dimension lumber is not available.*

61 SADDLE-BLOCK COVERS.—See paragraph 13.

62 TOWER GUYS.—See paragraph 14.

63 MAIN-CABLE DEADMAN.—The main-cable deadman must hold against a 30-ton pull. For deadman design see paragraph 15.

64 MAIN CABLES.—The main cables are 1-inch, 6 x 19, wire ropes W.R.C., H.G.P.S. For details on installing cables see paragraphs 16 and 43.

65 SUSPENDERS.—See paragraph 17A. Table VI gives the effective and cut lengths of suspenders and the total number of suspenders of each length required for 40- to 300-foot spans of the light-equipment suspension bridge.

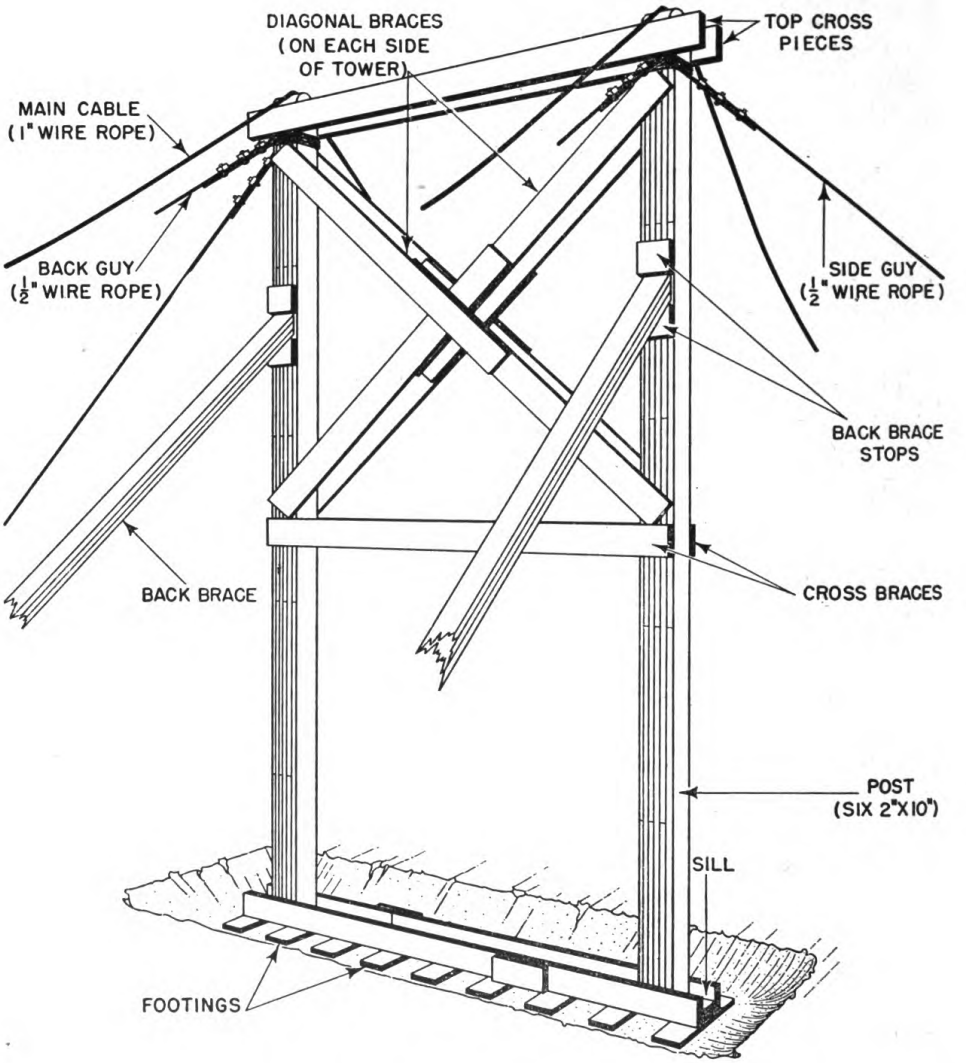


FIGURE 37. *Prefabricated tower for light-equipment suspension bridge. Used for long spans when dimension lumber is available.*

66 CABLE CLIPS AND BANDS.—Suspenders and main cables are tied back with ½- and 1-inch wire-rope clips respectively. To connect the ½-inch suspenders to the 1-inch main cables, clip-type cable bands (1 inch - ½ inch) are used. Thimbles are used at the main cable to suspender connections to prevent shearing the ½-inch suspender cable.

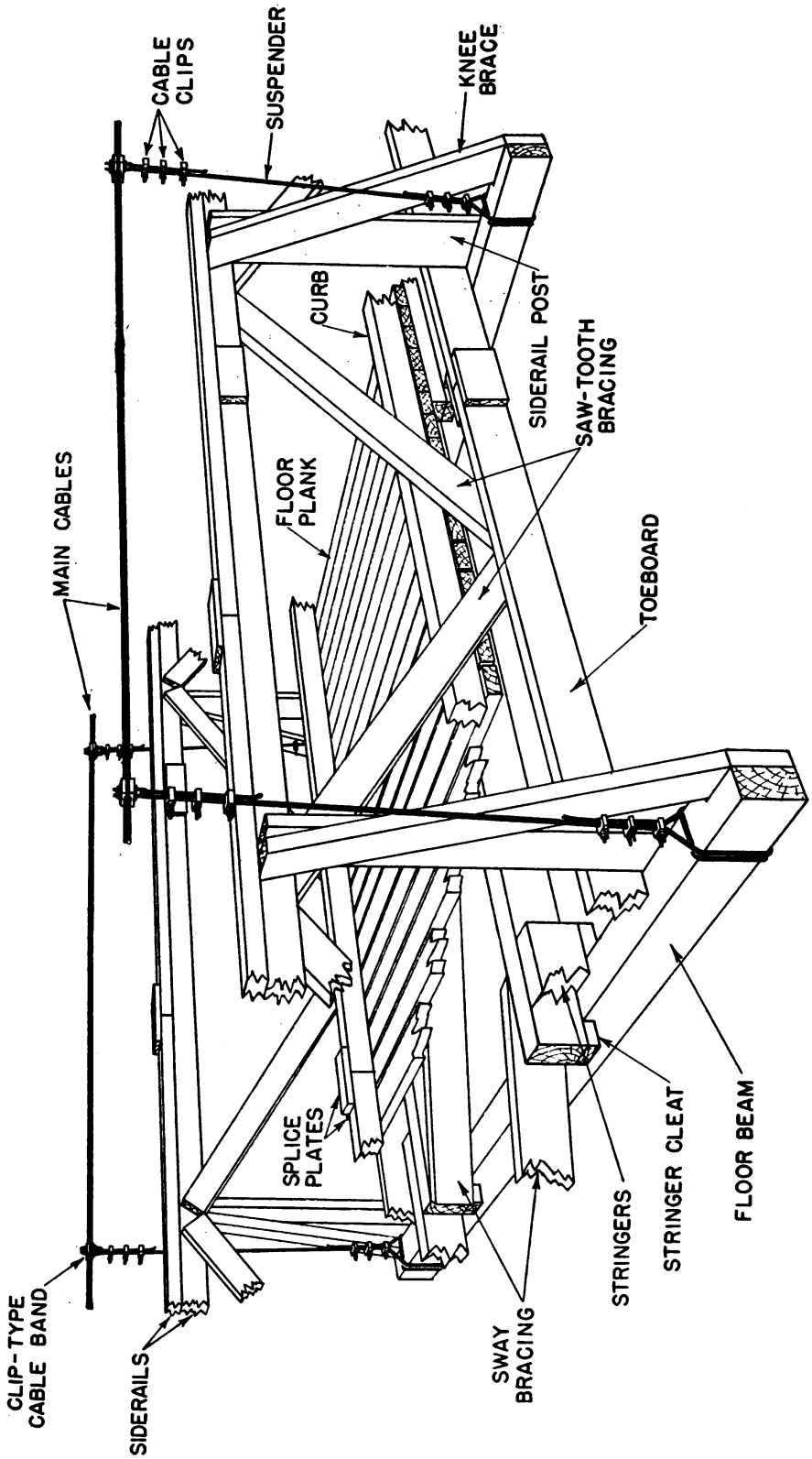


FIGURE 38. *Floor and siderail system of light-equipment suspension bridge.*

TABLE VI. *Effective and cut suspender lengths for various spans of light-equipment suspension bridge.*

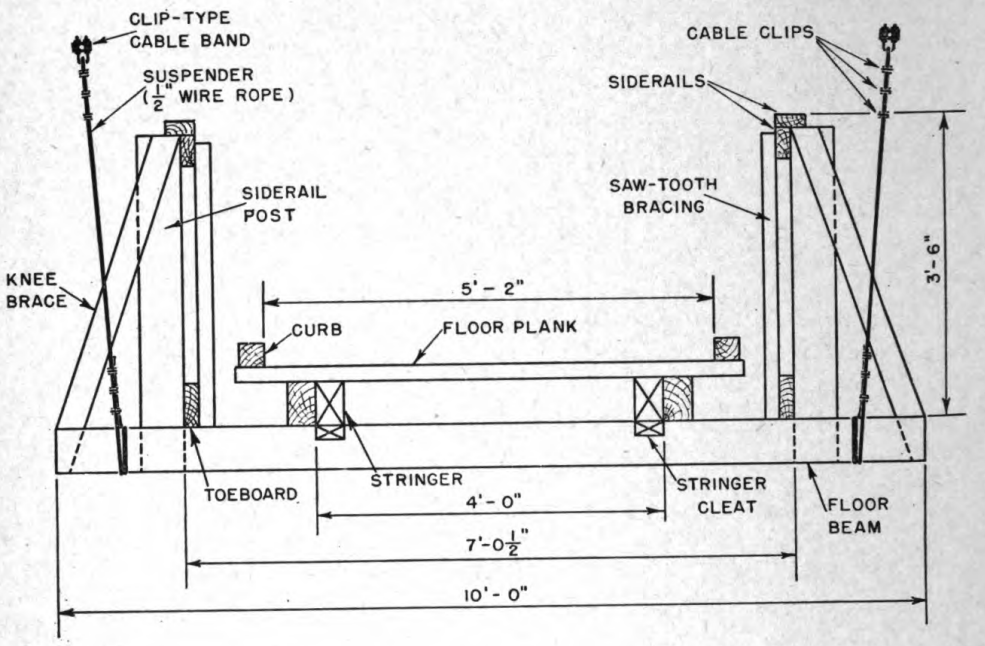
Panel Point	Number Required	40 Feet *		60 Feet *		80 Feet *		100 Feet *	
		Effective	Cut	Effective	Cut	Effective	Cut	Effective	Cut
0	2	2′ 4″	7′ 7″	2′ 4″	7′ 7″	2′ 4″	7′ 7″	2′ 4″	7′ 7″
1	4	3′ 11″	9′ 2″	2′ 10″	8′ 2″	2′ 8″	7′ 11″	2′ 7½″	7′ 10½″
2	4		TOWER	4′ 4″	9′ 7″	3′ 10½″	9′ 1½″	3′ 7″	8′ 10″
3	4				TOWER	5′ 9½″	11′ 0½″	5′ 1″	10′ 4″
4	4						TOWER	7′ 2″	12′ 5″
5	4								TOWER

* Use improvised tower.

Panel Point	Number Required	120 Feet *		140 Feet		160 Feet		180 Feet	
		Effective	Cut	Effective	Cut	Effective	Cut	Effective	Cut
0	2	2′ 4″	7′ 7″	2′ 4″	7′ 7″	2′ 4″	7′ 7″	2′ 4″	7′ 7″
1	4	2′ 7″	7′ 10″	2′ 6½″	7′ 9½″	2′ 6½″	7′ 9½″	2′ 6″	7′ 9″
2	4	3′ 4″	8′ 7″	3′ 1″	8′ 4″	2′ 11½″	8′ 2½″	3′ 0½″	8′ 3½″
3	4	4′ 7½″	9′ 10½″	4′ 3″	9′ 6″	4′ 0½″	9′ 3½″	3′ 10½″	9′ 1½″
4	4	6′ 4″	11′ 7″	5′ 10½″	11′ 1½″	5′ 5″	10′ 8″	5′ 1″	10′ 4″
5	4	7′ 8½″	12′ 11½″	7′ 10″	13′ 1″	8′ 1″	13′ 4″	6′ 7½″	11′ 10½″
6	4		TOWER	10′ 3″	15′ 6″	9′ 2½″	14′ 5½″	8′ 6″	13′ 9″
7	4				TOWER	11′ 8½″	16′ 11½″	10′ 8″	15′ 11″
8	4						TOWER	13′ 3″	18′ 6″
9	4								TOWER

TABLE VI. (*Continued*).

Panel Point	Number Required	200 feet		220 feet		240 feet		260 feet		280 feet		300 feet	
		Effective	Cut	Effective	Cut	Effective	Cut	Effective	Cut	Effective	Cut	Effective	Cut
0	2	2′ 4″	7′ 7″	2′ 4″	7′ 7″	2′ 4″	7′ 7″	2′ 4″	7′ 7″	2′ 4″	7′ 7″	2′ 4″	7′ 7″
1	4	2′ 6″	7′ 9″	2′ 5½″	7′ 8½″	2′ 5½″	7′ 8½″	2′ 5½″	7′ 8½″	2′ 5½″	7′ 8½″	2′ 5″	7′ 8″
2	4	2′ 11½″	8′ 2½″	2′ 11″	8′ 2″	2′ 10″	8′ 1″	2′ 9½″	8′ 0½″	2′ 9½″	8′ 0½″	2′ 8½″	7′ 11½″
3	4	3′ 8½″	8′ 11½″	3′ 7″	8′ 10″	3′ 6″	8′ 9″	3′ 5″	8′ 8″	3′ 4″	8′ 7″	3′ 3″	8′ 6″
4	4	4′ 9½″	10′ 0½″	4′ 7″	9′ 10″	4′ 4½″	9′ 7½″	4′ 2″	9′ 5″	4′ 1″	9′ 4″	3′ 11½″	9′ 2½″
5	4	6′ 2″	11′ 5″	5′ 8″	10′ 11″	5′ 7″	10′ 10″	5′ 3½″	10′ 6½″	5′ 1″	10′ 4″	4′ 11″	10′ 2″
6	4	7′ 10″	13′ 1″	7′ 4½″	12′ 7½″	6′ 11½″	12′ 2½″	6′ 7″	11′ 10″	6′ 3½″	11′ 6½″	6′ 0½″	11′ 3½″
7	4	9′ 10″	15′ 1″	9′ 2½″	14′ 5½″	8′ 7½″	13′ 10½″	8′ 1½″	13′ 4½″	7′ 8½″	12′ 11½″	7′ 4½″	12′ 7½″
8	4	12′ 1½″	17′ 4½″	11′ 3″	16′ 6″	10′ 6½″	15′ 9½″	9′ 10½″	15′ 1½″	9′ 4½″	14′ 6½″	8′ 11″	14′ 2″
9	4	14′ 9″	20′ 0″	13′ 5″	18′ 8″	12′ 8½″	17′ 11½″	11′ 10½″	17′ 1½″	11′ 1½″	16′ 4½″	10′ 8″	15′ 11″
10	4		TOWER	16′ 3½″	21′ 8½″	15′ 2″	20′ 5″	14′ 1½″	19′ 4½″	13′ 3½″	18′ 6½″	12′ 7″	17′ 10″
11	4				TOWER	17′ 10″	23′ 1″	16′ 7½″	21′ 10½″	15′ 7½″	20′ 10½″	14′ 9″	20′ 0″
12	4						TOWER	19′ 4″	24′ 7″	18′ 1½″	23′ 4½″	17′ 1½″	22′ 4½″
13	4								TOWER	20′ 11″	26′ 2″	19′ 8½″	24′ 11½″
14	4										TOWER	22′ 6″	27′ 9″
15	4												TOWER



ARTICLE	NO. REQD. PER PANEL	SIZE
SIDERAILS	4	2" X 4" X 10'-0"
SIDERAIL POST	2	2" X 6" X 3'-10"
SAW-TOOTH BRACES	4	2" X 4" X 5'-8"
KNEE BRACE	2	2" X 4" X 4'-1"
TOEBOARD	2	2" X 6" X 10'-0"
FLOOR BEAM	2	6" X 6" X 10'-0"
STRINGER	2	4" X 6" X 11'-0"
STRINGER CLEAT	2	2" X 4" X 3¼"
FLOOR PLANK	18	2" X 6" X 5'-10"
CURB	2	4" X 4" X 10'-0"

FIGURE 39. *Hanger assembly and parts required for floor and siderail system of light-equipment suspension bridge.*

67 FLOOR AND SIDERAIL SYSTEM (fig. 38 and 39).—A *Floor beams.*—A 6- by 6-inch floor beam 10 feet long is used at each panel point.

B *Stringers.*—Two 11-foot stringers are used in each panel.

C *Floor plank.*—Eighteen 2- by 6-inch floor planks 5 feet 10 inches long are used in each bay. They are spaced ¾ inch apart.

D *Curbs.*—Two 4- by 4-inch by 10-foot curbs are used in each panel.

E *Toeboards, siderail posts, siderails, saw-tooth braces, siderail braces, and cleats and scabs.*—See paragraph 19 and figure 39.

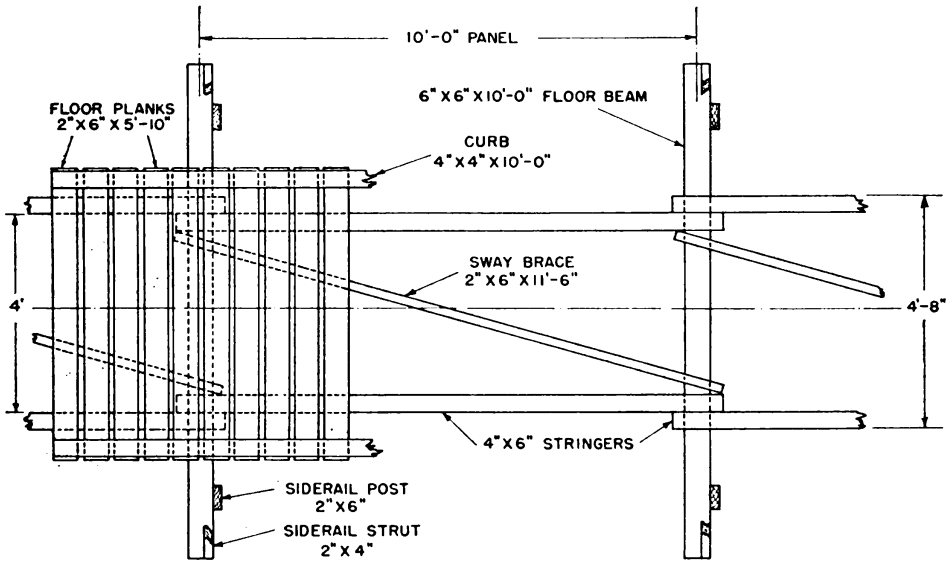


FIGURE 40. *Timber sway bracing of light-equipment suspension bridge.*

68 HORIZONTAL SWAY BRACING (fig. 40).—One 2- by 6-inch plank 11 feet 6 inches long is used for horizontal sway bracing in each bay.

69 ERECTION EQUIPMENT.—The construction equipment needed to build the bridge is given in Appendix II. This is a suggested list of equipment which may be varied to meet the situation and the terrain at the bridge site.

70 SPECIAL EQUIPMENT.—A *Portable sawmill.*—See paragraph 22.

B *Portable air compressors.*—See paragraph 23.

C *Chain saw.*—See paragraph 24.

D *Radio sets.*—See paragraph 25.

E *Transit.*—See paragraph 26.

CHAPTER 3
SECTION III

TRANSPORTATION

71 PACK MULES AND VEHICLES.—For transportation by pack mule see paragraph 27 and Table IV. Three extra mules are required to carry the heavier main cables. The materials may be split up and carried in ¼-ton trucks and trailers or in trail-tractor trailers.

72 CABLE PACK.—See paragraph 28.

SECTION IV

SITE SELECTION

73 SITE SELECTION.—See paragraph 29.

CONSTRUCTION OF BRIDGE AND WORKING PARTIES

74 GENERAL.—The bridge is constructed simultaneously from both banks. Organization of personnel is as given in Section VI, Chapter 2. Construction procedure varies only in the time required to construct the bridge and in the placing of flooring.

75 ERECTION TIME.—The bridge is constructed in three phases or shifts. Each phase takes about 5 daylight hours.

76 ERECTION PROCEDURE.—**A** Hangers are placed and spaced as described in paragraphs 32 and 49. Two stringers are nailed to the floor beams and suspenders are given final adjustment. Sway bracing is nailed diagonally corner to corner of the stringers and flooring is placed and nailed.

B Siderails are placed after the flooring of the whole bridge has been completed.

C Siderails, toeboards, saw-tooth braces, and curbs are placed in the last 5-hour period.

Note.—All hangers, panel points 0 to 14, are alike and are constructed as shown in figures 38 and 39.

77 SUSPENDERS.—Suspenders are cut to length and installed as described in paragraph 39. Lengths of suspenders for the light-equipment suspension bridge are given in Table VI.

CHAPTER 4

EXPEDIENT SUSPENSION BRIDGES

SECTION I

THREE-ROPE BRIDGE

78 CAPACITY.—The three-rope bridge (fig. 41) will carry five men under full field pack at 5-pace intervals.

79 SPAN.—The bridge can span gaps up to 150 feet. Longer spans are unsafe, being unstable when loaded at midspan.

80 SAG RATIO.—A 5 percent sag ratio is used, the dip in the main-cable ropes being one-twentieth of the span length. Example:

Span length = 120 feet
Sag ratio = 5 percent
$D = \frac{1}{20} \times 120 = 6$ feet

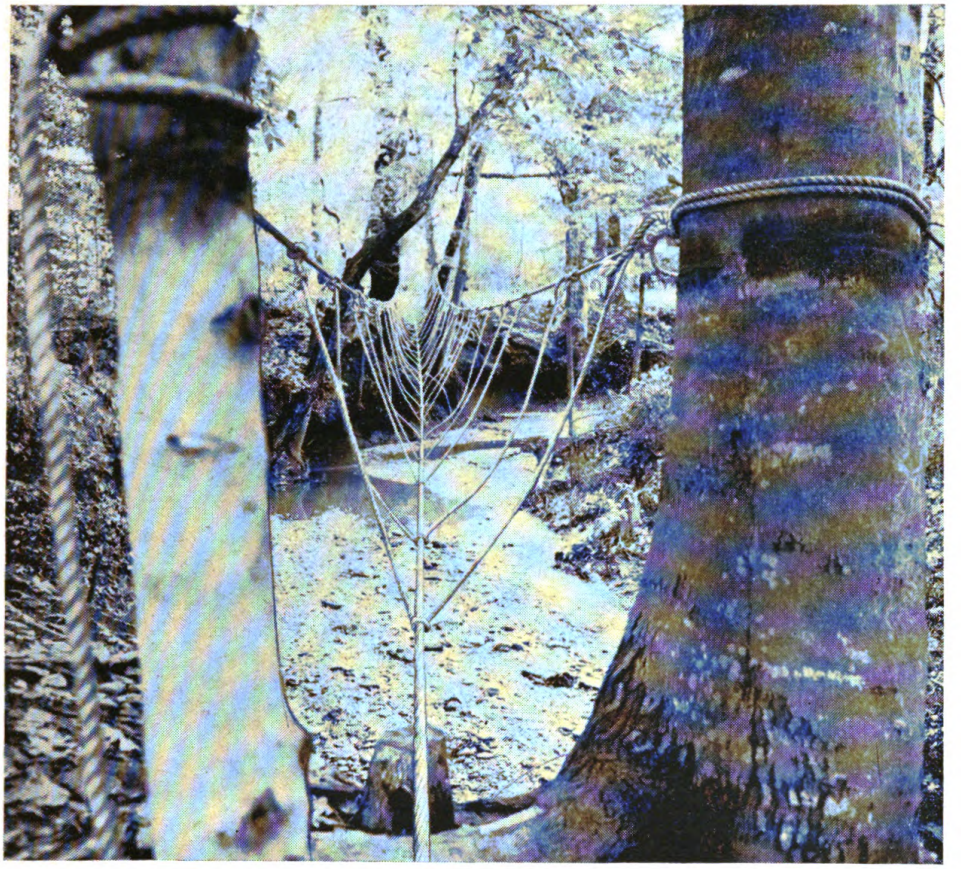


FIGURE 41. *Three-rope bridge. An expedient used to cross foot troops.*

81 MATERIALS REQUIRED.—The cables consist of one 1-inch tread rope and two ¾-inch hand ropes. The suspenders are ½-inch rope. A set of blocks is required to erect bridges with spans exceeding 100 feet.

82 TIME AND PERSONNEL.—One squad of 12 trained men can cut and whip all ropes and construct a 100-foot bridge in 45 minutes. If the suspender ropes have been previously cut and whipped the bridge can be built in 30 minutes.

83 BRIDGE SITE.—The completed span must be less than 150 feet from anchorage to anchorage.

Trees of 10-inch minimum diameter are required as anchorages for the tread rope; 8-inch trees are necessary for the hand ropes.

When the bridge crosses a stream the anchorages must be high enough to keep the middle of the span above water.

84 RECOMMENDED ERECTION PROCEDURE (fig. 42).—A The length of the required span is measured by tying a piece of tracing tape to the far-and near-side anchorages and allowing it to sag 5 percent. The tread and hand ropes are sufficiently longer than the span to allow for the lashings tied to the anchorages.

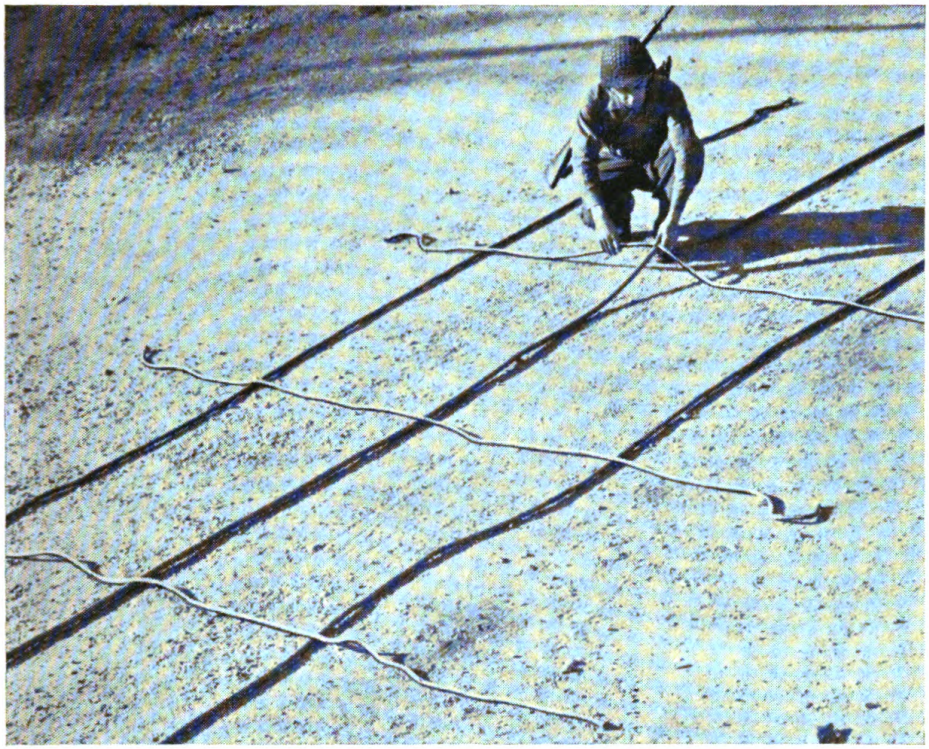
B The tread and hand ropes are laid out as shown in figure 42 (1). The 1-inch rope is between the two ¾-inch ropes. The ropes are placed 3 feet apart.

C The suspender ropes are cut 12 feet long and placed on the tread and hand ropes at 2-pace intervals. The end suspenders are placed far enough from the ends of the ropes to allow enough rope to make the ties at the anchorages.

D The suspenders are tied to the 1-inch tread rope with a clove hitch. The two ends of the suspender ropes pass under the tread rope as shown in figure 42 (2).

E Each hand rope is then lifted elbow-high as shown in figure 42 (3) and the suspender is tied to it by a clove hitch or a rolling hitch. The running end may be tied back to the standing part with two half hitches. The other suspenders are attached in the same manner.

F The squad ties the first 12 suspenders simultaneously. If more suspenders are used, they are tied in the same man-



1

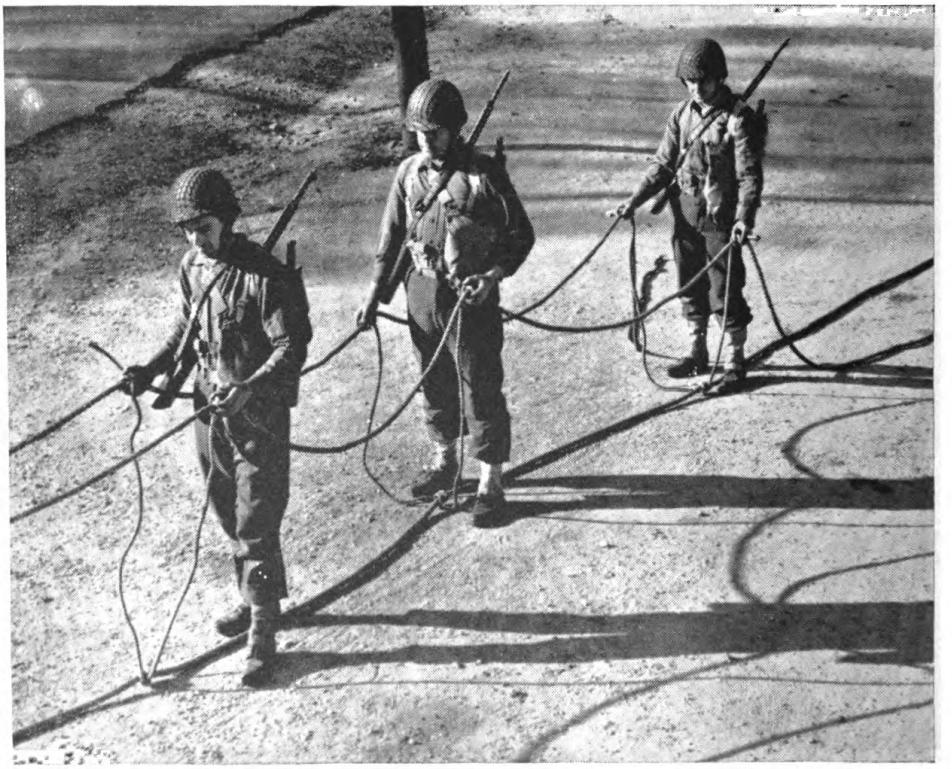
FIGURE 42. *Erection of three-rope bridge.* (1) *Ropes are laid out on ground near site.* (2) *Suspenders are tied to tread rope.*

2

3

FIGURE 42. *Erection of three-rope bridge.* (3) *Suspenders are tied to hand rope. Note that hand rope is elbow-high.* (4) *Assembled bridge is carried into position.*

4



ner. The assembly then is carried to the bridge site as shown in figure 42 (4).

G The three cables are pulled to the far side by a ½-inch line and tied to the far-side anchorages with a bowline or a mooring knot. If the bowline is used an extra turn is taken around the anchorages at the far side. The running ends are tied back to the standing parts with two or three half hitches.

H When all ropes are anchored on the far side a ½-inch line is tied to the tread rope on the near side and its sag is adjusted. The tread rope is then tied to its anchorage with a mooring hitch. The hand ropes are pulled tight in the same way and are made fast with mooring hitches (fig. 43).

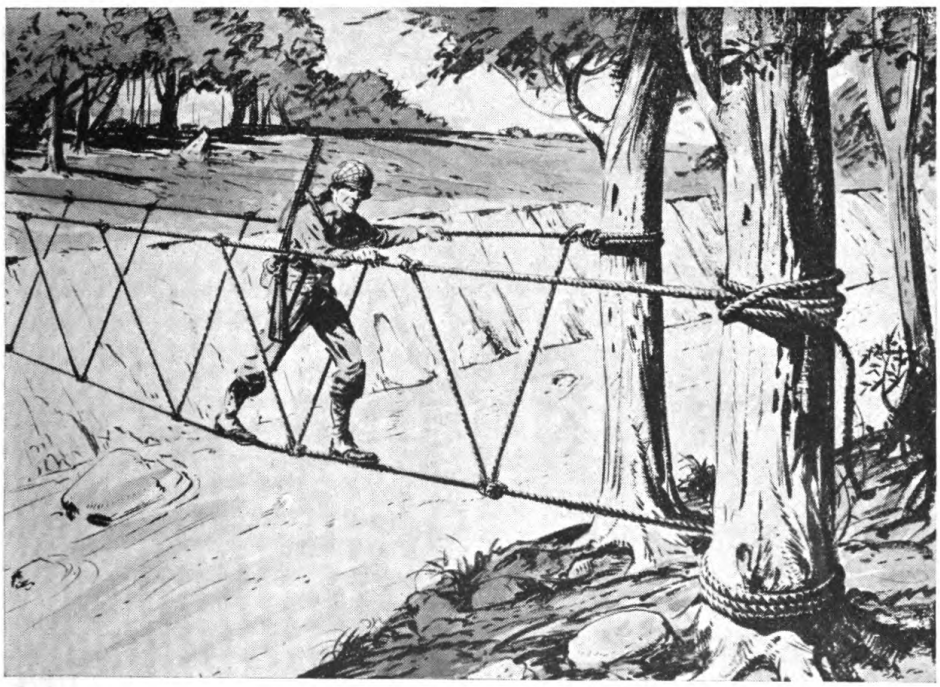


FIGURE 43. *Expedient-bridge anchorage. Anchorage is made to trees on either bank.*

85 COMPLETED BRIDGE.—When the bridge is complete (fig. 44) it is tested to see that all knots and ties are properly made and suspender ropes are adjusted. Frequent inspection and adjustment of knots and ties is necessary.

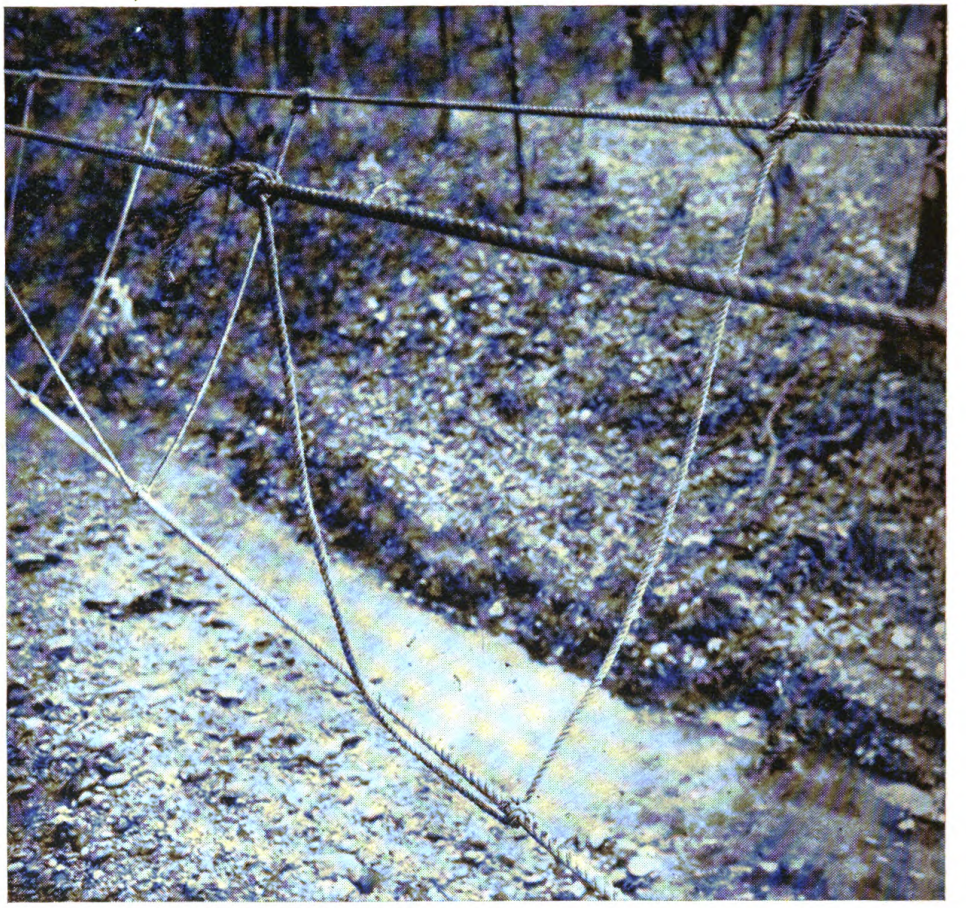


FIGURE 44. *Suspender detail of three-rope bridge.*

SECTION II

EXPEDIENT FOOTBRIDGE

86 CAPACITY.—This bridge (fig. 45) will carry foot troops with full field pack, or pack mules and handlers, as follows:

A *Foot troops.*—Seven men under full field pack maintaining 5-pace intervals and crossing at route step in single file.

B *Pack mule.*—One pack mule and handler.

87 SPAN.—The bridge can span gaps up to 100 feet.

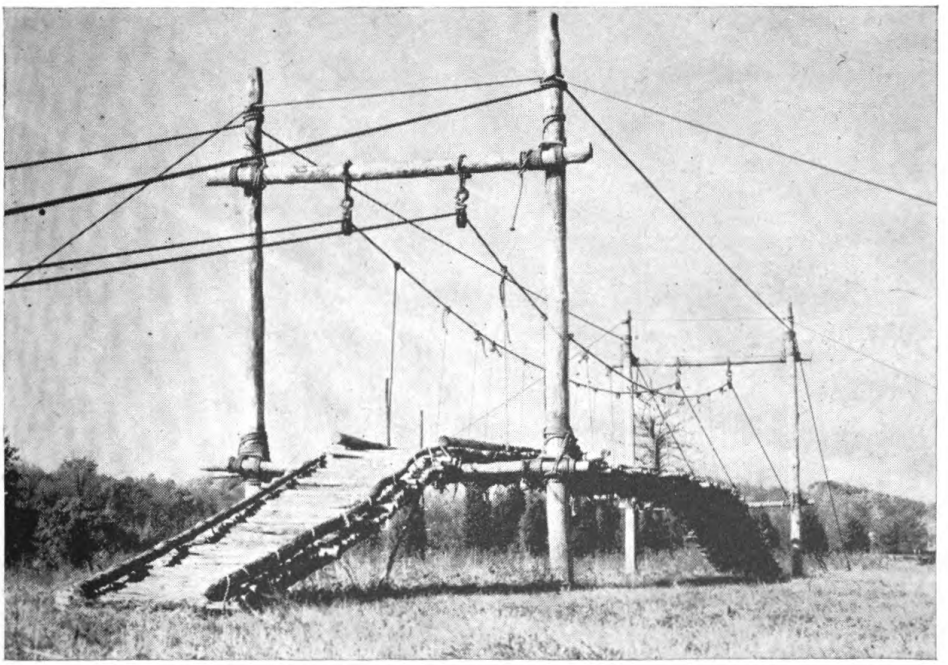
88 SAG RATIO.—A 5 percent sag ratio is used.

89 MATERIALS REQUIRED.—The materials used for the bridge illustrated in figure 45 are given below. Dimensions and amount of materials will vary with the span and site.

A *Main cable.*—The main cables are 1-inch rope. Two 250-foot coils are required.

B *Suspenders.*—The suspenders are ¾-inch rope. Two are used at each panel point. Panel points are 6 feet apart. Effective and cut suspender lengths are given for each panel point in Table VII.

FIGURE 45. *Expedient footbridge. Bridge built using manila rope and material found at the site. Erection will be rapid if troops are first trained by dry-land erection.*



C *Tower guys.*—1 - Side guys require two 150-foot coils of ¾-inch fiber rope.

2 - Tower-to-tower back guys require two 250-foot coils of ¾-inch rope.

D *Tower lashings.*—1 - Four 50-foot lengths of ¾-inch rope are required to lash cap to tower uprights.

2 - Tower floor-beam lashings, if used, require four 70-foot lengths of ¾-inch rope.

E *Floor lashing.*—Four 75-foot lengths of ¾-inch rope are used on the approach ramps. Two 35-foot lengths of ¾-inch rope are used in each panel to hold flooring.

F *Main-cable saddle assembly.*—Four 8-inch snatch blocks and four 8-foot lengths of 1-inch rope are used as main-cable saddles.

G *Deadman.*—A suitable log is used as a deadman.

H *Towers.*—

1 - *Posts.*—Two 10-inch, 20-foot posts.

2 - *Cap.*—An 8-inch log 10 feet long.

3 - *Tower floor beam.*—An 8-inch log 10 feet long is used to support the first panel and the approach ramp.

4 - *Sill and footings.*—Sills, if used, are notched 12-inch timbers. Footings are of split logs. Rock and boulders placed in a hole 4 feet square and 4 feet deep furnish adequate tower-upright foundations.

I *Floor system.*—

1 - *Floor beam.*—A 6-inch log 5 feet long is used at each panel point as a floor beam.

2 - *Stringers.*—Two 6-inch logs 8 feet long are used in each panel as stringers.

3 - *Curbs.*—Two 5-inch logs are used in each panel as curbs.

4 - *Flooring.*—Four-inch logs 5 feet long are used as flooring.

90 TIME AND PERSONNEL.—One platoon can erect a 100-foot bridge in 6 hours.

91 BRIDGE SITE.—The bridge site must meet the following requirements.

TABLE VII. *Effective and cut suspender lengths of expedient footbridge.*

Panel Point	Number Required	48 feet		60 feet		72 feet		84 feet		96 feet		108 feet	
		Effective	Cut	Effective	Cut	Effective	Cut	Effective	Cut	Effective	Cut	Effective	Cut
0	2	4′ 0″	10′ 0″	4′ 0″	10′ 0″	4′ 0″	10′ 0″	4′ 0″	10′ 0″	4′ 0″	10′ 0″	4′ 0″	10′ 0″
1	4	4′ 2″	10′ 2″	4′ 2″	10′ 2″	4′ 1½″	10′ 1½″	4′ 1½″	10′ 1½″	4′ 1″	10′ 1″	4′ 1″	10′ 1″
2	4	4′ 8½″	10′ 8½″	4′ 7″	10′ 7″	4′ 6″	10′ 6″	4′ 5″	10′ 5″	4′ 4½″	10′ 4½″	4′ 4″	10′ 4″
3	4	5′ 11½″	11′ 11½″	5′ 3½″	11′ 3½″	5′ 1″	11′ 1″	4′ 11″	10′ 11″	4′ 10″	10′ 10″	4′ 8½″	10′ 8½″
4	4		TOWER	6′ 3½″	12′ 3½″	5′ 11″	11′ 11″	5′ 8″	11′ 8″	5′ 5½″	11′ 5½″	5′ 3½″	11′ 3½″
5	4				TOWER	7′ 0″	13′ 0″	6′ 7″	12′ 7″	6′ 3″	12′ 3″	6′ 0″	12′ 0″
6	4						TOWER	7′ 8½″	13′ 8½″	7′ 3″	13′ 3″	6′ 9½″	12′ 9½″
7	4								TOWER	8′ 5″	14′ 5″	7′ 11″	13′ 11″
8	4										TOWER	9′ 1½″	15′ 1½″
9	–												TOWER
Tower Height	2	6′ 10½″		7′ 7″		8′ 4″		9′ 0″		9′ 9″		10′ 6″	

A Have span length less than 100 feet.

B Have timber available near site.

C Provide solid sill and deadman foundations.

92 ERECTION PROCEDURE.—A The erection of the expedient footbridge follows in general the procedure used to erect the standard suspension footbridge. The bridge site and bridge center line are laid out. Sill and deadman excavations are staked out and dug. Tower logs are cut, dressed, and assembled on the ground. The lashings are as shown in figure 46.

The towers and deadmen are placed and the main cables are strung, set, and made fast.

Suspender and floor-beam assemblies are fabricated and placed. Stringers are lashed to the floor beams and the flooring of 1½-inch to 2½-inch poles is installed. Five-inch curb logs are placed on the flooring directly over the stringers. Then ¾-inch rope is wound around the curb logs and stringers to hold the flooring in place. See figure 45.

93 PACK-TRAIN FLOOR SYSTEM.—If the bridge is to carry mules the flooring is covered with a 2-inch layer of gravel and coarse sand. A siderail of 3-inch poles is lashed to the suspenders to guide the mules in crossing. Each mule is led across by a handler and only one mule is on the bridge at one time.

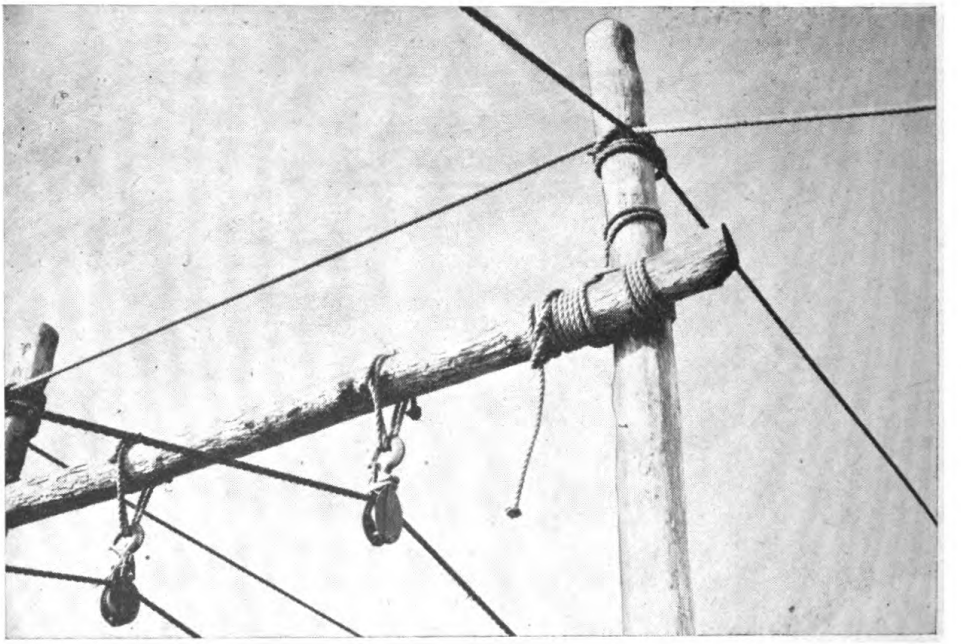


FIGURE 46. *Tower lashing. The strength of the bridge is determined by this tower lashing.*

NONSTANDARD SUSPENSION BRIDGES

SECTION I

BRIDGE DESIGN

94 GENERAL.—The design of a suspension bridge requires an analysis of the following items:

A Loads to be carried.
B Panel length and stringers.
C Floor beams.
D Stiffening truss and sway bracing.
E Dead load.
F Suspenders.

G Sag ratio.
H Main cables.
I Towers.
J Tower bracing and back guys.
K Anchorages.

95 LOADS.—One or a combination of the following loads may be carried.

A Foot troops with full field packs.
B Loaded pack animals.
C One-quarter-ton truck with normal load.
D Trail tractor.
E Three-quarter ton weapon carrier with normal load.

96 PANEL LENGTH AND STRINGER DESIGN.—To maintain the general parabolic shape of main cables the panel lengths should be between 10 and 15 feet. As a general rule 10 feet is practical. Stringers for 10-, 12-, 14-, and 15-foot panel lengths may be designed by using Table VIII.

97 EXAMPLE OF STRINGER DESIGN.—
Load to be carried — ¼-ton truck
Panel length = 10 feet
Stringers available are 2- by 6-inch plank
Gross weight of ¼-ton truck = 3,250 pounds
From Table VIII, safe gross load of stringer 1 inch wide by 6 inches deep by 10 feet long is 0.19 tons.
Each 2- by 6-inch by 10-foot stringer will support 0.38 tons.

TABLE VIII. *Safe gross load in tons per inch of stringer width.*

Span in Feet	Depth of Beam in Inches					
	6	8	10	12	14	16
10	.19	.34	.55	.80	1.05	1.40
12	.15	.28	.44	.65	.90	1.15
14	.13	.24	.37	.55	.75	.95
15	.12	.22	.35	.50	.70	.90

NOTE: For round timber, use diameter of timber as depth and 0.4 of diameter as width.

0.38 tons = 760 pounds, gross load.

$$\text{Number of stringers} = \frac{\text{Gross weight of truck}}{\text{Loads each stringer supports}}$$

$$= \frac{3{,}250}{760} = 4.3 \text{ or } 5 \text{ stringers}$$

Hence five 2- by 6-inch 10-foot stringers are used.

98 FLOOR BEAMS.—Floor beams to hold the specified loads are given in Table IX.

99 STIFFENING TRUSS AND SWAY BRACING.—The action of the stiffening truss is to furnish vertical stability by spreading the load to two or more suspenders. The siderail and its cross braces may be designed to furnish this stiffening action. *V*-shaped bracings as shown are recommended.

Sway bracing or wind bracing furnishes lateral stability to the bridge. Wire or wood sway bracing is recommended for bracing a bridge.

100 DEAD LOAD.—Dead load is calculated in pounds per panel. It includes the weight of parts listed below.

2 suspenders
1 floor beam
2 stringers and (floor planks)
2 toeboards
2 side posts
2 kneebraces
4 braces
2 to 4 siderails
2 curbs (if used)
Cable clips and bands

TABLE IX. *Floor-beam size for given load.*

Load	Floor-beam Cross Section
Foot troops with full pack Loaded pack animals with handlers	4 by 4 inches
¼-ton truck with normal load	6 by 6 inches
¾-ton weapons carrier with normal load	8 by 8 inches

101 SUSPENDERS.—Suspenders are designed to carry the dead and live load plus an allowance for impact. The effect of wind is neglected.

The dead load is calculated as described in paragraph 100. The live load used is the gross weight of troops, animals, or vehicle. See Table X.

Impact is assumed to be equal to the total live load.

To find the total weight on both suspenders at a panel point take the sum of the following:

1 - Dead load (one panel)
2 - Live load
3 - Impact

The weight carried by one suspender is half the sum of these three factors. To find the size of suspender cable required for a given load see Appendix II.

102 LENGTH OF SUSPENDERS (fig. 47).—Suspender lengths are obtained from the formula:

$$h = L + \left(\frac{n}{N}\right)^2 (C + d)$$

in which h = effective suspender length
L = effective length of center suspender
n = panel point of suspender
N = panel point of tower
C = camber of bridge
d = dip of main cable

Example:

L = 5 feet 0 inches
$n = 2$
$N = 4$
C = 2 feet
d = 8 feet
$h = 5 + \left(\frac{2}{4}\right)^2 (2 + 8) = 7\frac{1}{2}$ feet

103 SAG RATIO.—The sag ratio of nonstandard bridges varies from 5 to 15 percent.

The nonstandard foot bridge described in paragraph 108 uses a 5 percent sag ratio. Heavier nonstandard bridges use a 10 percent sag ratio.

TABLE X. *Live loads for suspender design.*

Load	Gross Weight
Foot troops	200 pounds
Pack animal and handler	1,000 pounds
¼-ton truck	3,250 pounds
¾-ton weapons carrier	5,240 pounds

104 MAIN CABLE.—Main-cable design is governed by the load on the suspenders and the sag ratio.

In main-cable design the total load on the bridge—dead load, live load, and impact—is calculated. Table XI gives the relation between sag ratio and tension in main cables.

Example:

Using Table XI find maximum tension on both main cables:

Assume span 200 feet, sag ratio 10%

Suspended weight of bridge	20,000 pounds
Live load on bridge	8,000 pounds
Impact on bridge	8,000 pounds
Total	36,000 pounds

Maximum tension in all cables for 10-percent sag ratio is 36,000 x 1.35 = 48,600 pounds (see column 2, Table XI).

If two main cables are used each must have a tensile strength of 24,300 pounds. See Appendix II.

The length of the cable required to span the gap is the sum of the cable length between towers, the two back-stay lengths, and the turns and ties at the deadmen.

Using the length factor in column (3) of Table XI, the cable required to span the gap between towers =

200 x 1.026 = 205.2 feet.

105 TOWERS.—Towers take the downward thrust of the main cables. Twelve- by twelve-inch timbers as posts and cap pieces will take military loads including the 2½-ton truck.

TABLE XI. *Main-cable design data.*

(1) Sag Ratio	(2) Maximum Tension in Both Main Cables, in Parts of Total Suspended Weight of Bridge and Load	(3) Length of Cable Between Towers, in Parts of Span Length
7%	1.94	1.012
8%	1.57	1.018
9%	1.46	1.022
10%	1.35	1.026
11%	1.23	1.033
12½%	1.12	1.041
16 2/3 %	.90	1.070

106 BRACING AND GUY LINES.—All towers have back, side, and fore braces of 6- to 8-inch timbers.

Side and back guys of ½-inch wire rope are used to brace the towers. Side guys have a 1 to 1 slope, while back guys are fastened to the main-cable deadman and have a 2½ horizontal to 1 vertical slope.

107 ANCHORAGES.—Design and placing of a deadman is described in paragraph 15. The total pull exerted on the deadman by the cables is the same as the maximum tension in all cables described in paragraph 104.

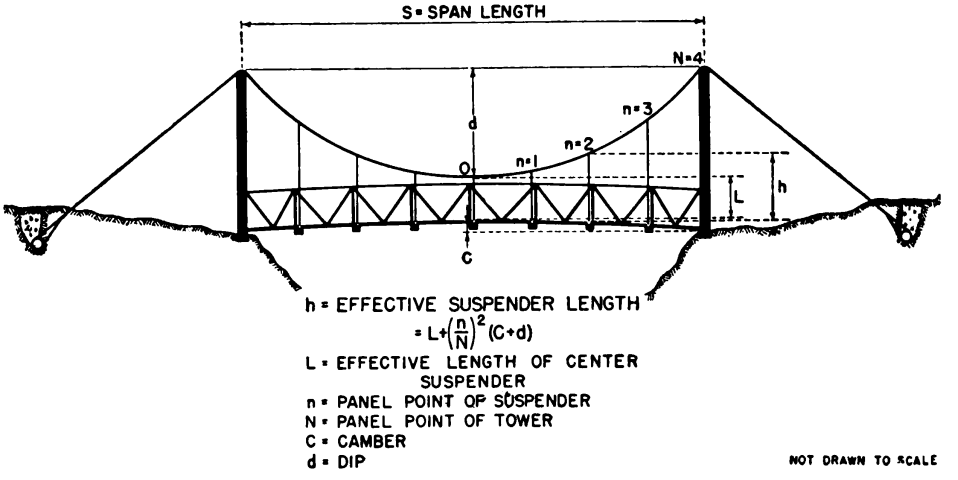


FIGURE 47. *Length of suspenders. Formula used to find EFFECTIVE suspender length.*

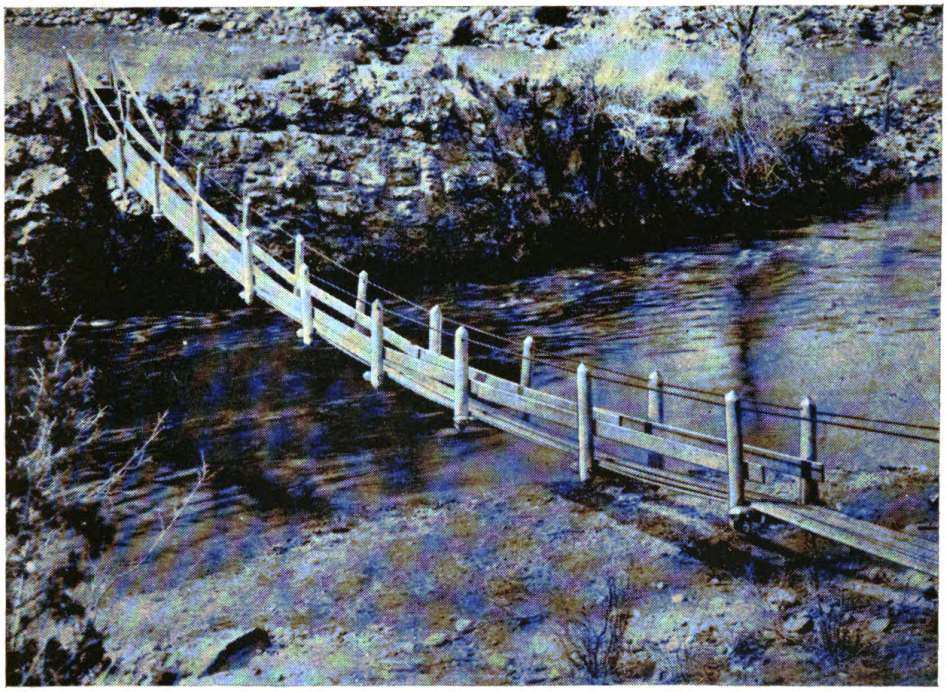


FIGURE 48. *Nonstandard footbridge.*

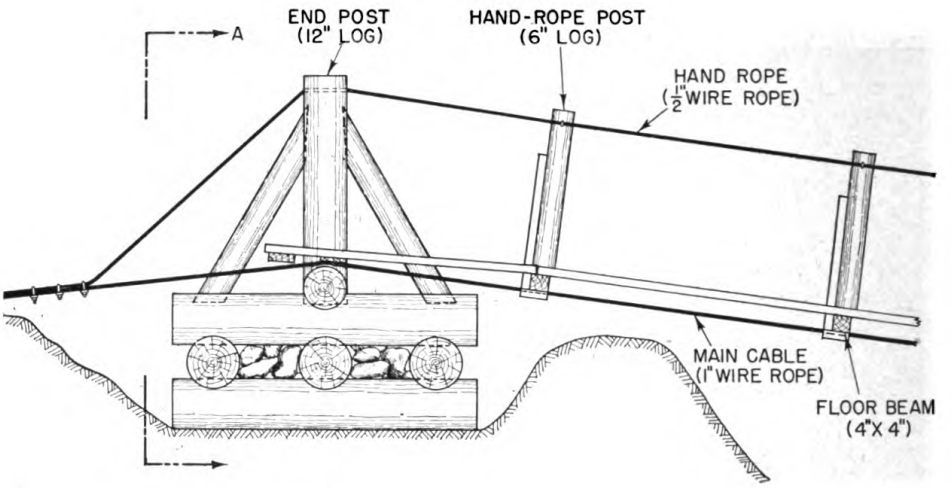
SECTION II

TYPICAL NONSTANDARD BRIDGES

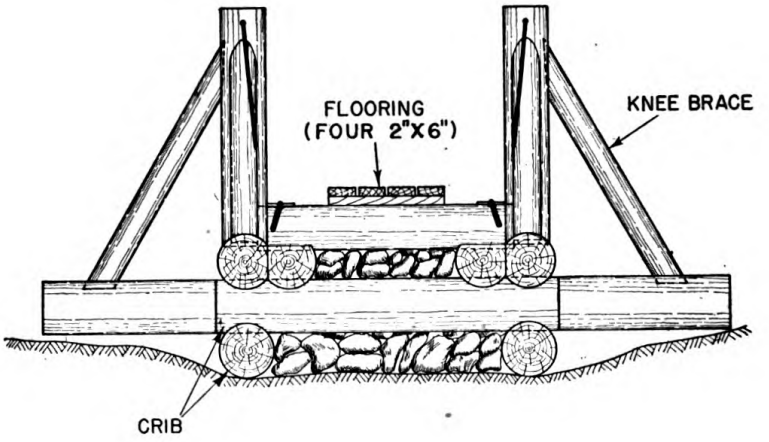
108 NONSTANDARD FOOTBRIDGE (fig. 48).—In this bridge the main cables support the flooring and extra capacity is added by the carrying power of the ½-inch handrail cables. No cable suspenders are used. The sag ratio is 5 percent. The bridge may be built in spans up to 150 feet in length.

The bridge will cross foot troops at 3-pace intervals. Pack animals cannot be crossed.

Design features are covered in figures 49 and 50.



ELEVATION



SECTION A-A

FIGURE 49. *Nonstandard footbridge design. Posts are used as suspenders.*

109 PACK-TRAIN SUSPENSION BRIDGE (fig. 51).—This is a more permanent bridge of 4,000-pound capacity. It may be built to span gaps up to 300 feet.

Its main design features are shown in figures 52 and 53. Its capacity may be doubled by adding an extra set of 1-inch main cables.

With one set of main cables, as shown, it will carry 40 foot troops or 8 pack mules and handlers.

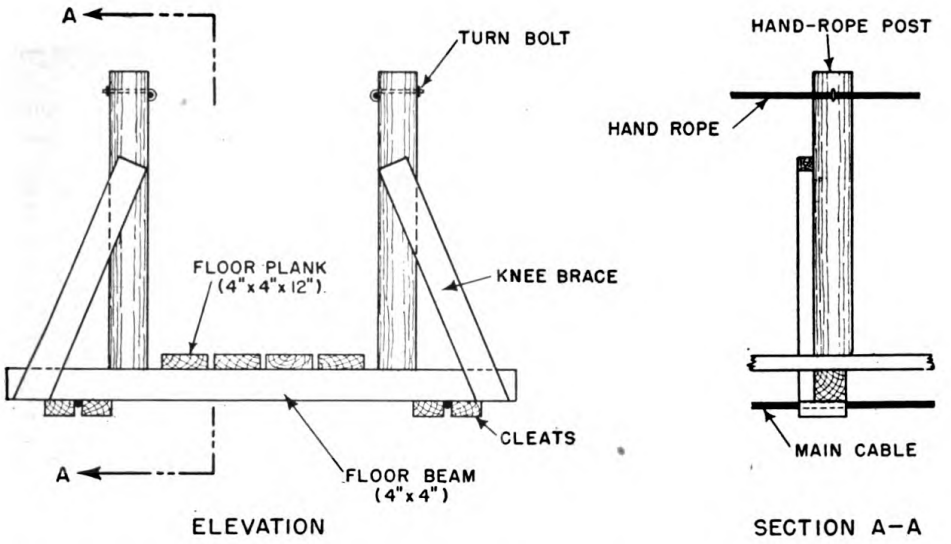


FIGURE 50. *Hanger assembly of nonstandard footbridge.*

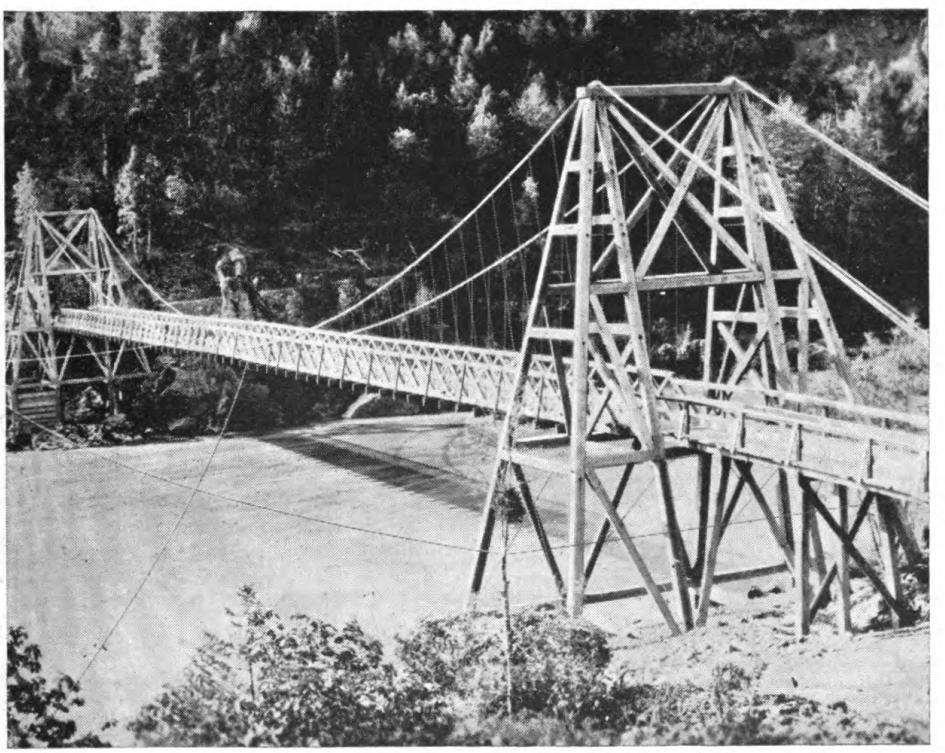


FIGURE 51. *Pack-train suspension bridge. Used when a heavy type of bridge is required for mule traffic. Note tower design.*

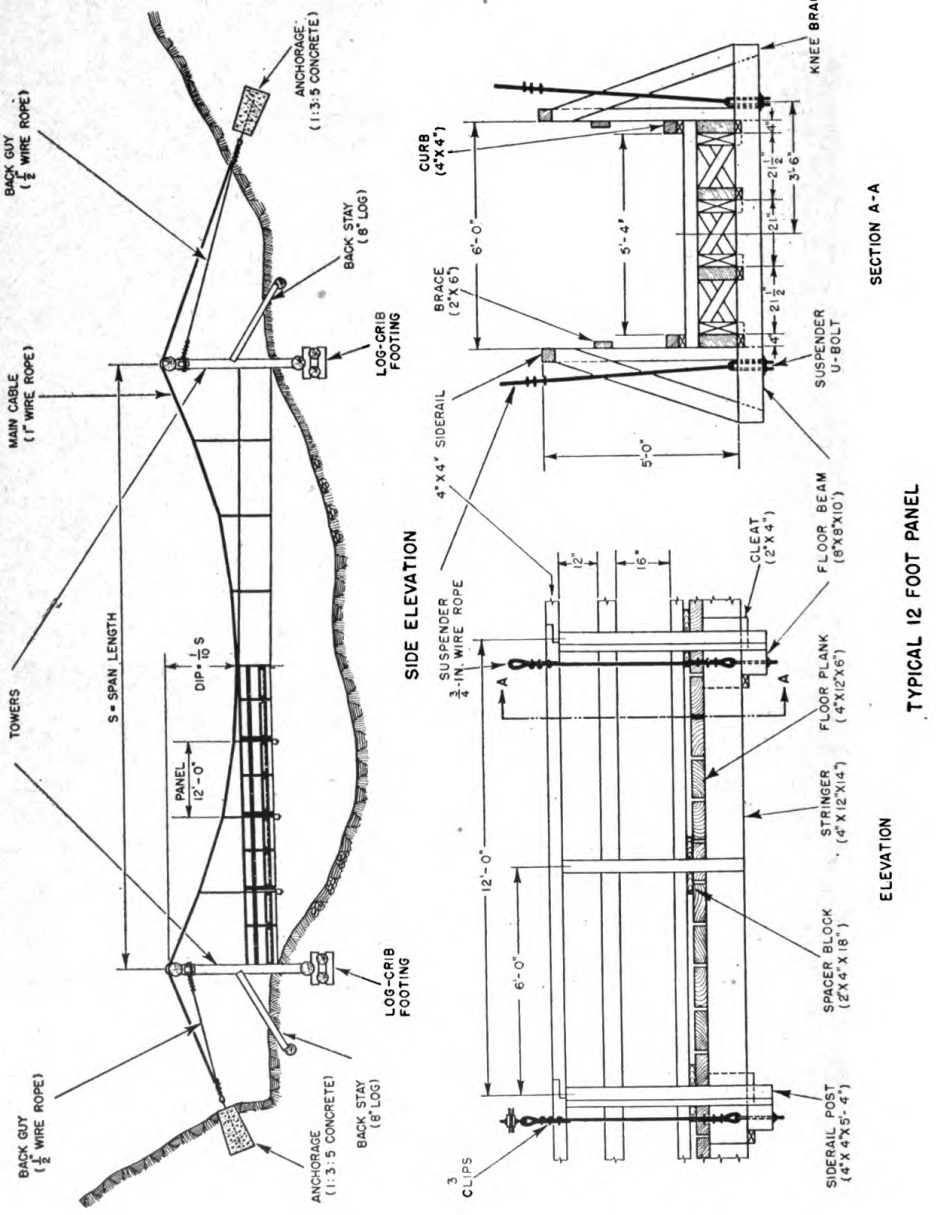


FIGURE 52. *Pack-train suspension bridge. General view and hanger assembly.*

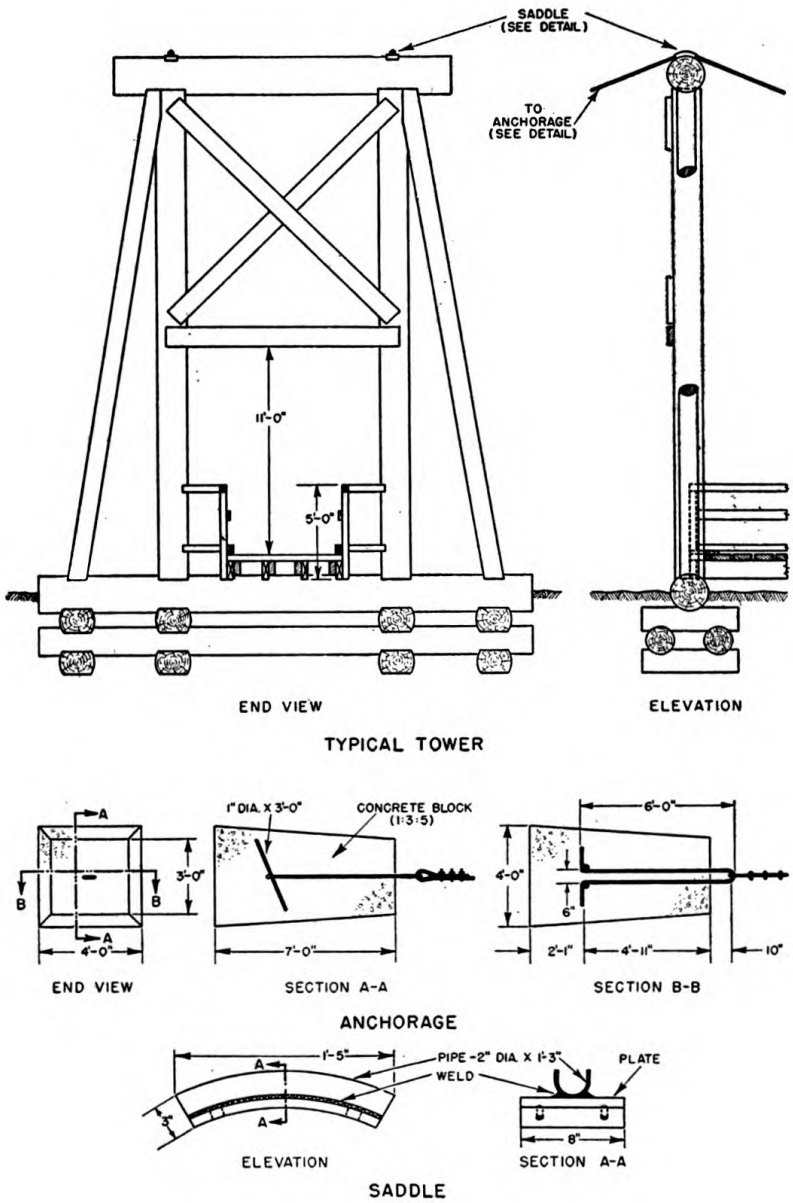


FIGURE 53. *Pack-train suspension bridge. Tower and anchorage.*

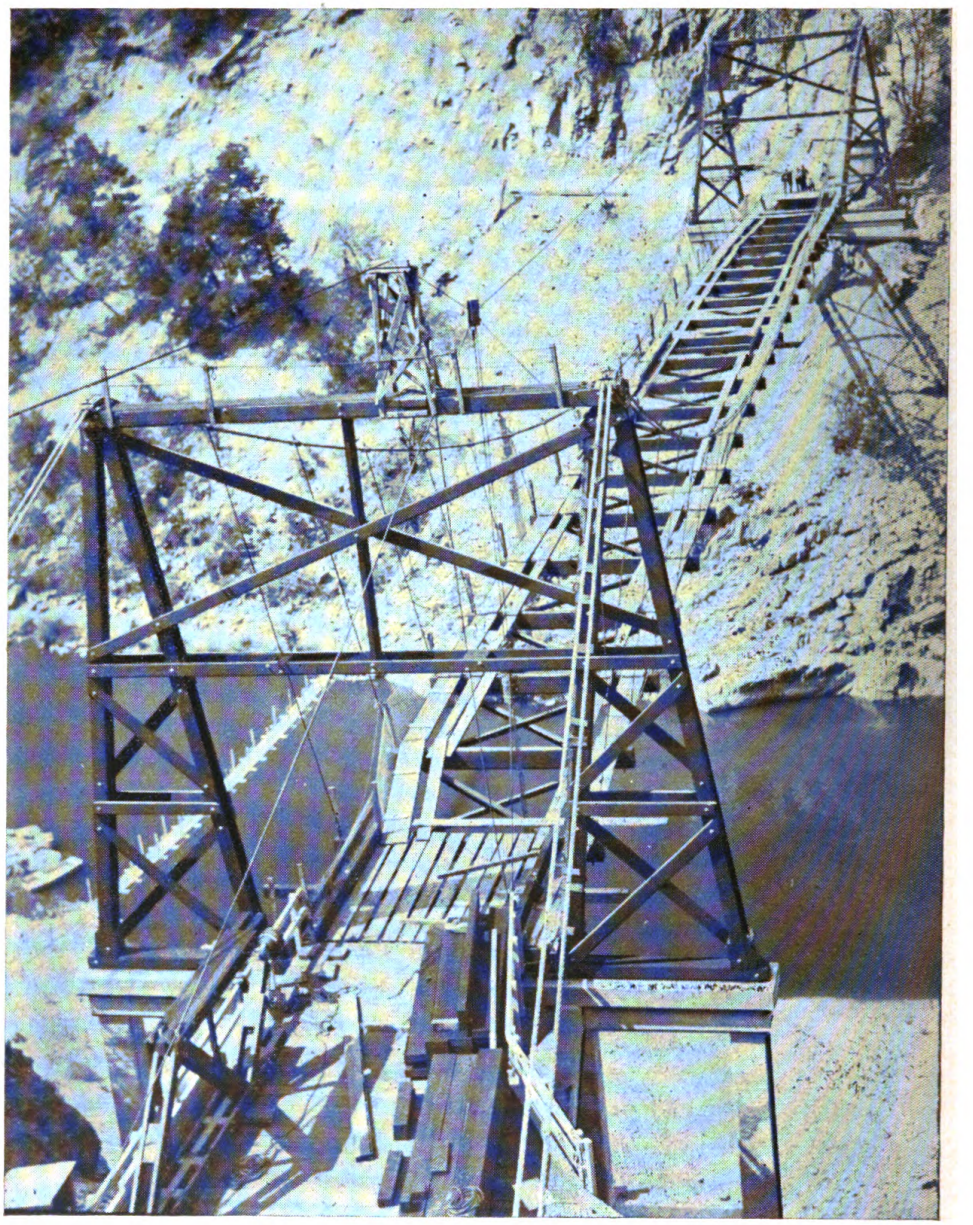


FIGURE 54. *Vehicular suspension bridge. Bridge under construction before placing stringers.*

110 VEHICULAR SUSPENSION BRIDGE.—Figures 54 and 55 show a vehicular suspension bridge. Sets of four to six 1-inch cables are used as main cables.

Clips, anchorage *U*-bolts, suspender *U*-bolts, and tower fittings are made in a blacksmith shop. Tower members are bolted and doweled. Concrete anchorages are used instead of deadmen.

Erection procedure generally is the same as that of standard bridges. Five days to 2 weeks is required to build 150- to 400-foot spans.

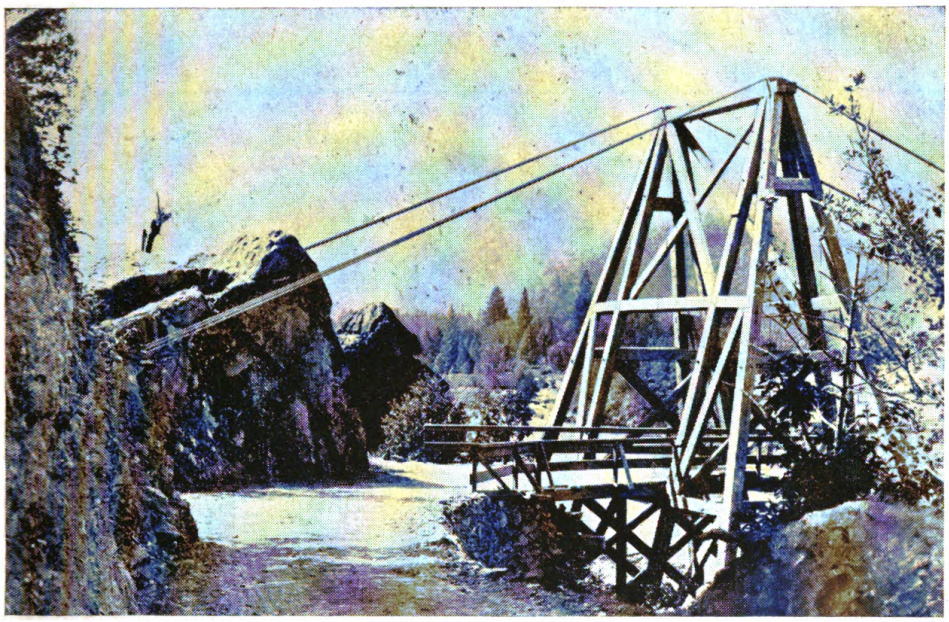


FIGURE 55. *Vehicular suspension bridge-tower.*

MATERIALS AND EQUIPMENT FOR STANDARD SUSPENSION BRIDGES

TABLE XII. *Lumber for suspension footbridge (cut at site).*

Mark	Article	Number of Pieces Required		Size of Piece
		Per Article	For 300-Ft. Span[1]	
T1	Tower post	10	44	2 x 10 x 10' 0"
T2	" sill	7	16	"
T3	" cross-brace	2	5	"
T4	" diagonal	8	18	"
T5	" top crosspiece	2	5	"
T6	" saddle block	2	5	"
T8	" back brace	2	2	6"-min.-dia. log
T9	" back-brace stop	4	9	1 x 10 x 10' 0"
		Per Panel		
R1	Siderail	2	66	2 x 4 x 10' 0"
R2	" splice	4	132	1 x 4 x 1' 6"
R3	Saw-tooth bracing	4	132	1 x 6 x 7' 8"
R4	Toeboard	2	66	2 x 6 x 10' 0"
R5	" splice	4	132	1 x 6 x 1' 6"
R6	Siderail post	2	66	2 x 4 x 4' 3"
R7	" knee brace	2	20	2 x 4 x 4' 8"
R8	" knee-brace filler	2	20	2 x 4 x 0' 6"
F1	Floor beam	1	25	4 x 4 x 5' 7"
F2	Stringer	2	76	4 x 4 x 10' 11⅝"
F2	Floor beam	1	10	4 x 4 x 10' 11⅝"
F3	Floor plank	18	570	2 x 6 x 5' 0"
F4	Rack stick	2	66	2"-min.-dia. stick
	Deadman	—	2	12"-min.-dia. log

Note: [1] Includes spare pieces.

TABLE XIII. *Cable and hardware for 2,000-pound bridge.*

MARK	ARTICLE	UNIT	NO. REQ'D	SIZE
T7	Tower saddle-block cover plate	ea	4	Bent plate 7x¼x0'9½"
C1	Main cable	500'0"	2	¾"-dia., 6x19, W. R. C.
C2	Main-cable clip	ea	30	For ¾"-dia. rope
C3	Clip-type cable band	ea	80	For ¾"-dia. main cable and ½"-dia. suspender
C4	Suspender wire-rope clip	ea	300	For ½"-dia. rope
	Suspender rope	750'0"	1	½"-dia., 6x19, W. R. C.
	Tower guy	600'0"	1	½"-dia., 6x19, W. R. C.
T10	Tower guy holdfast	ea	12	Rod 1"-dia. x 3'0"
	Wire sway bracing	ft	2000	#9 gage galv. steel wire
	Spikes for tower saddle blocks	lbs	64	60d. galv. steel
	Nails for floor and siderail	lbs	300	20d. galv. steel
T11	Dowel	ea	8	Rod ¾"-dia. x 12"

TABLE XIV. *Cable and hardware for light-equipment suspension bridge.*

MARK	ARTICLE	UNIT	NO. REQ'D.	SIZE
T7	Tower-saddle block cover plate	ea.	4	Bent plate 8x¼x0' 9½"
C1	Main cable	500'-0"	2	1"-dia., 6x19, W. R. C.
C2	Main-cable clip	ea.	30	1" dia. rope
C3	Clip-type cable band	ea.	80	1"-dia. main cable, ½"-dia. suspender
C4	Wire-rope clip	ea.	350	½"-dia. rope
	Suspender rope	750'-0"	1	½"-dia., 6x19, W. R. C.
	Tower guy	600'-0"	1	½"-dia., 6x19, W. R. C.
T10	Tower guy holdfast	ea.	12	Bar 1"-dia.x3'0"
	Spikes for tower saddle blocks	lbs.	64	60d. galv. steel
	Nails	lbs.	300	20d. galv. steel
T11	Dowel	ea.	20	Bar ¾"-dia.x1'0"

TABLE XV. *Lumber for light-equipment suspension bridge cut at site.*

Mark	Article	Number of Pieces Required		Size of Piece
		Per Article	For 300′ Span [1]	
T1	Tower post	15	66	2 x 10 x 10′ 0″
T2	" sill	8	18	2 x 10 x 10′ 0″
T3	" cross brace	4	9	2 x 10 x 10′ 0″
T4	" diagonals	2	18	2 x 10 x 10′ 0″
T5	" top cross piece	4	9	2 x 10 x 10′ 0″
T6	" saddle block	—	4	3 x 10 x 0′ 8″
T8	" back brace	29	40	2 x 10 x 10′ 0″
T9	" back-brace stop	4	9	2 x 10 x 1′ 0″
		Per Panel		
R1	Siderail	4	132	2 x 4 x 10′ 0″
R2	" post	2	66	2 x 6 x 3′ 10″
R3	Saw-tooth bracing	4	132	2 x 4 x 5′ 8″
R4	Knee bracing	2	66	2 x 4 x 4′ 1″
R6	Toeboard	2	66	2 x 6 x 10′ 0″
R7	" splice	2	66	1 x 6 x 1′ 6″
F1	Floor beam	1	33	6 x 6 x 10′ 0″
F2	Stringer	2	66	4 x 6 x 11′ 0″
F3	" cleat	4	132	2 x 4 x 0′ 3¼″
F4	Floor plank	18	57	2 x 6 x 5′ 10″
F5	Curb	2	66	4 x 4 x 10′ 0″
F6	" splice	4	132	1 x 4 x 1′ 6″
F7	Horizontal sway brace	1	33	2 x 6 x 11′ 6″
	Deadman	—	2	12″-min.-dia. log

Note [1] Includes spare pieces.

TABLE XVI. *Erection equipment for standard suspension bridges.*[1]

ARTICLE	UNIT	NO. REQ'D.
Adz, carpenter's, full-headed, 4½-in.-cut	Ea.	4
Air compressor, portable, and pneumatic tools[2]	Ea.	1 or 2
Ax, chopping, double-bit, 3½-lb.	Ea.	6
Bar, crow, pinchpoint, 60-in.	Ea.	4
Bar, wrecking, claw and pinchpoint, gooseneck, 30-in.	Ea.	2
Bit, auger, hand, ¾-in.	Ea.	1
Bit, auger, hand, ⅞-in.	Ea.	1
Blade, hacksaw, hand, 12-in., 14-teeth	Ea.	12
Block, ordinary, steel-shell, for manila rope, double with becket, ¾- x 6-in.	Ea.	1
Block, ordinary, steel-shell, for manila rope, single with becket, ¾- x 6-in.	Ea.	1
Block, snatch, steel-shell, for ¾-in. manila rope	Ea.	4
Block, snatch, steel-shell, steel-sheave, for ¾-in. wire rope	Ea.	6
Brace, ratchet	Ea.	1
Cap, blasting, commercial, electric, No. 8, instantaneous	Ea.	25
Carrier, timber	Ea.	4
Chain, coils, steel, proof, ¼-in.	Ft.	100
Cutter, cable, hammer-type, 1-in.-capacity	Ea.	4
Dynamite, ammonia-gelatin, 40-percent	Lb.	25
File, American standard, single, flat-bastard, 8-in.	Ea.	12
Frame, hacksaw, adjustable, 8- to 12-in., pistol-grip	Ea.	1
Grip, wire, come-along-type, ¾- to ¼-in. wire capacity	Ea.	4
Hammer, carpenter, nail, curved-claw, 1-lb.	Ea.	6
Hoist, chain, ratchet, 1½ to 3-ton-capacity	Ea.	4
Level and plumb, carpenter's wood, nonadjustable, 24-in.	Ea.	2
Machine, blasting, 10-cap-capacity	Ea.	1
Mattock, pick, 6-lb.	Ea.	6
Nippers, end-cutting, adjustable jaw, 14-in.	Pr.	4
Peavy	Ea.	6
Pick, railroad, 7-lb.	Ea.	12
Pliers, lineman's, side-cutting, 8-in.	Pr.	2
Radio set, receiver and transmitter, portable, SCR 536B	Set	2
Reel, wire, firing, 500-ft.	Ea.	1
Rope, manila, 3-strand, medium-laid, ⅝-in.	Ft.	1,000
Saw, chain, portable, gasoline, 24-in.-blade	Ea.	2
Saw, hand, crosscut, 26-in., 6 points	Ea.	4
Shovel, general-purpose, round-pointed, longhandled, No. 2	Ea.	12
Sledge, blacksmith, double-face, 8-lb.	Ea.	2

TABLE XVI. (*Continued*).

Stadia rod	Ea.	4
Steel, cold-rolled, bar, round, 2-in. (2 bars 2" x 4'0")	Lb.	86
Stone, sharpening, unmounted, artificial, combination	Ea.	4
Tape, measuring, woven metallic, U. S., 50-ft., with case	Ea.	2
Transit	Ea.	1
Winch, hand-operated, single-drum, 2-ton-capacity	Ea.	1
Wire, steel, carbon, annealed, bare, No. 16	Lb.	12
Wrench, crescent-type, single-end, 1⅛-in.	Ea.	8
Wrench, structural, offset, nominal-opening, 1⅛-in.	Ea.	6

NOTES: [1] Most of the equipment will be organic equipment issued to the engineer organization erecting the bridge.
[2] Under development. See paragraph 23.

WEIGHT AND STRENGTH OF WIRE ROPE AND CORDAGE

TABLE XVII. *Weight and breaking strength of 6 x 19 wire rope.*[1]

Size of Rope (Inches)	Breaking Strength (Tons) [2]	Weight Per 100 Feet (Pounds)
½	10.8	40
¾	23.7	90
1	42.0	160
1½	92.5	360

[1] For main cables use safety factor of 2.
[2] Improved plow steel.

TABLE XVIII. *Weight and breaking strength of cordage.*[1]

Size of Rope (Inches)	Breaking Strength (Tons) [2]	Weight Per 100 Feet (Pounds)
½	1.06	71.3
⅝	1.76	13.1
¾	2.16	16.4
1	3.60	26.5
1½	7.40	58.8

[1] Use safety factor of 3.5.
[2] Manila fiber. Sisal is 67 percent as strong.

WEIGHTS AND CUBAGES OF STANDARD SUSPENSION-BRIDGE MATERIALS

1 WEIGHTS AND CUBAGES OF DIMENSION LUMBER REQUIRED TO CONSTRUCT 300-FOOT STANDARD SUSPENSION FOOTBRIDGE.—

Part	Overall dimensions per part	Number required	Weight (lb.) [1]		Cubage (cu. ft.)	
			Per unit	Per span	Per unit	Per span
Tower post	2″ x 10″ x 10′ — 0″	44	41.7	1,835	1.39	61.0
Tower sill	2″ x 10″ x 10′ — 0″	16	41.7	667	1.39	22.2
Cross brace	2″ x 10″ x 10′ — 0″	5	41.7	208	1.39	7.0
Diagonal	2″ x 10″ x 10′ — 0″	18	41.7	751	1.39	25.0
Cross piece	2″ x 10″ x 10′ — 0″	5	41.7	208	1.39	7.0
Saddle block	3″ x 10″ x 0′ — 10″	4	5.2	21	0.17	0.7
Back brace	6″ x 6″ x 20′ — 0″	4	150.0	600	5.00	20.0
Back-brace stop	2″ x 10″ x 1′ — 0″	9	2.1	19	0.07	0.6
Siderail	2″ x 4″ x 10′ — 0″	66	16.7	1,103	0.56	36.7
Siderail splice	1″ x 4″ x 1′ — 6″	132	1.3	172	0.04	5.5
Saw-tooth bracing	1″ x 6″ x 7′ — 8″	132	9.6	1,268	0.32	42.2
Toe board	2″ x 6″ x 10′ — 0″	66	25.0	1,650	0.84	55.0
Toe-board splice	1″ x 6″ x 1′ — 6″	132	1.9	253	0.06	8.3
Siderail post	2″ x 4″ x 4′ — 3″	66	7.1	468	0.24	15.9
Knee brace	2″ x 4″ x 4′ — 8″	20	7.8	156	0.26	5.2
Knee-brace filler	2″ x 4″ x 4′ — 8″	20	7.8	156	0.26	5.2
Floor beam	4″ x 4″ x 11′ — 0″	25	36.7	918	1.25	31.2
Stringer	4″ x 4″ x 11′ — 0″	76	36.7	2,790	1.25	95.5
Floor beam	4″ x 4″ x 5′ — 0″	10	8.4	84	0.57	5.7
Floor plank	2″ x 6″ x 5′ — 0″	570	12.5	7,125	0.41	238.0
Rack stick	2″ x 2″ x 2′ — 0″	66	1.7	112	0.06	4.0

[1] Wood weight = 30 pounds per cubic foot.

2 WEIGHTS AND CUBAGES OF DIMENSION LUMBER REQUIRED TO CONSTRUCT A 300-FOOT STANDARD LIGHT-EQUIPMENT SUSPENSION BRIDGE.—

Part	Overall dimensions per part	Number required	Weight (lb.) [1]		Cubage (cu. ft.)	
			Per unit	Per span	Per unit	Per span
Tower post	2″ x 10″ x 10′ — 0″	66	41.7	2,750	1.39	92.0
Tower sill	2″ x 10″ x 10′ — 0″	18	41.7	751	1.39	25.0
Cross brace	2″ x 10″ x 10′ — 0″	9	41.7	375	1.39	12.5
Diagonal	2″ x 10″ x 10′ — 0″	18	41.7	751	1.39	25.0
Top cross piece	2″ x 10″ x 10′ — 0″	9	41.7	375	1.39	12.5
Saddle block	3″ x 10″ x 10″	4	5.2	21	0.17	0.7
Back brace	2″ x 10″ x 10′ — 0″	40	41.7	1,670	1.39	55.6
Back-brace stop	2″ x 10″ x 1′ — 0″	9	4.2	38	0.07	0.6
Siderail	2″ x 4″ x 10′ — 0″	132	16.7	2,200	0.56	74.0
Siderail post	2″ x 6″ x 3′ — 10″	66	9.6	634	0.33	21.8
Saw-tooth bracing	2″ x 4″ x 5′ — 8″	132	9.5	1,255	0.32	41.6
Knee brace	2″ x 4″ x 4′ — 1″	66	6.8	448	0.23	15.3
Toeboard	2″ x 6″ x 10′ — 0″	66	25.0	1,650	0.84	55.5
Toeboard splice	1″ x 6″ x 1′ — 6″	66	2.0	132	0.06	4.0
Floor beam	6″ x 6″ x 10′ — 0″	33	75.0	2,475	2.50	82.5
Stringer	4″ x 6″ x 11′ — 0″	66	55.0	3,630	1.88	124.0
Stringer cleat	2″ x 4″ x 3½″	132	0.5	66	0.02	0.3
Floor plank	2″ x 6″ x 5′ — 10″	570	14.6	8,320	0.49	279.0
Curb	4″ x 4″ x 10′ — 0″	66	33.4	2,200	1.12	74.0
Splice	1″ x 4″ x 1′ — 6″	132	2.0	264	0.04	5.2
Horizontal sway bracing	2″ x 6″ x 11′ — 6″	33	28.6	944	0.97	32.0
			Totals	30,852		1,033.1 [2]

[1] Wood weight = 30 pounds per cubic foot

[2] 1,033.1 cubic feet = 12,400 board feet
1,033.1 cubic feet = 25.8 ship tons

3 WEIGHTS AND CUBAGES OF HARDWARE AND CABLE.—**A** *Standard suspension footbridge.*—Cable and hardware weigh approximately 1 ton and have an approximate cubage of 275 cubic feet (6.9 ship tons).

B *Light-equipment suspension bridge.*—Cable and hardware weigh approximately 1.4 tons and have an approximate cubage of 295 cubic feet (7.4 ship tons).

C *Span length.*—Since the main cable is never cut and hardware is shipped as a set the weight and cubage do not vary for various span lengths.

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