Chapter 10.
Constructing Fixed Span Bridges From Floating Equipment

CONSTRUCTING FIXED SPANS FROM M4T6 EQUIPMENT

Characteristics of M4T6 Fixed Spans

Short freed spans erected with M4T6 components can provide tactical commanders with a rapid means of crossing narrow streams or dry gaps. The M4T6 freed spans can be built to cross gaps from 9 to 39 feet wide, without intermediate supports. Fixed spans over 45 feet long can be assembled using trestles or piers as intermediate supports.

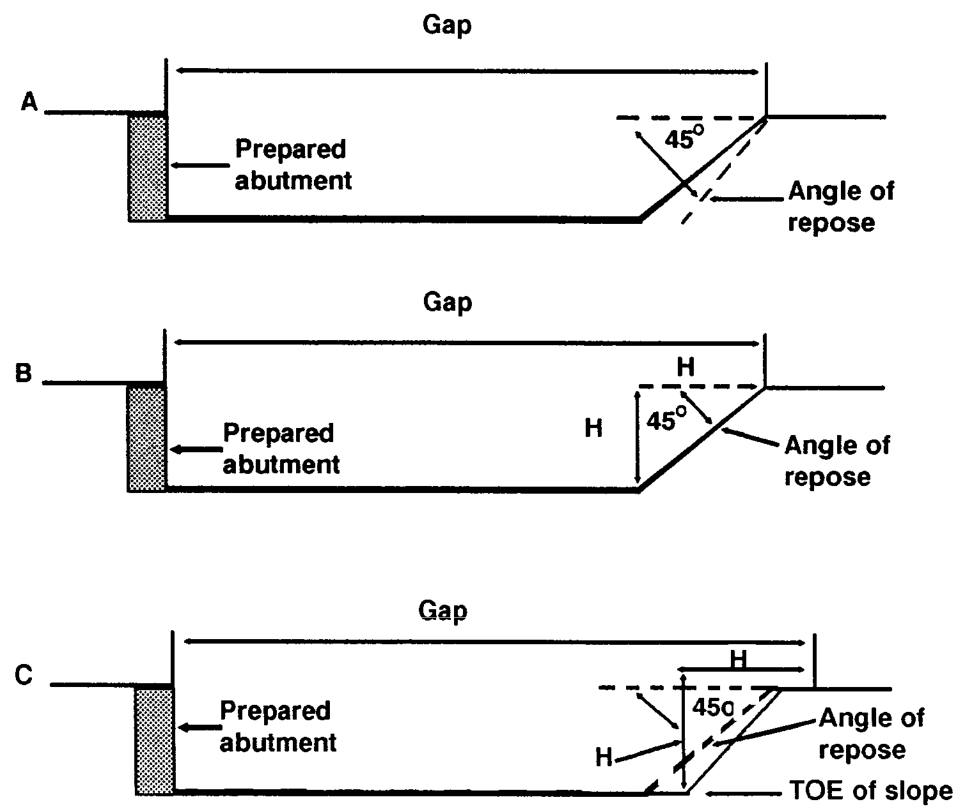
Components of M4T6

The components used for constructing M4T6 fixed spans are the same as those used for assembling M4T6 floating bridges with the exclusion of the pneumatic pontons and their associated saddle assemblies. For a detailed description of these components, refer to Chapter 5.

Capabilities of M4T6 Fixed Bridges

The M4T6 fixed spans can be constructed in the configurations shown in Table 48 as single span, unsupported bridges. Any combination of these spans may be built when supported by two or more trestle assemblies. Trestles assemblies can be constructed in Class 60 or Class 100 arrangements.

Gap measurement



Design of M4T6 Fixed Bridges

Initial design considerations

The desired load classification and the width of the gap are the two primary considerations when designing M4T6 freed span bridges. The desired classification is based upon the heaviest vehicle that is expected to cross the bridge. Determine the width of the gap by running a measuring tape across the gap along the proposed location of the bridge centerline. Ensure that the tape is run from a position on firm ground on one shore to another firm position on the other shore. Stake a line into position across the gap to mark the measured centerline.

Initial design

Step 1. Determine the required MLC of the bridge. This is normally designated in the mission statement of the operations order.

Step 2. Measure the gap. The gap is measured from firm ground on the near shore to firm ground on the far shore. For prepared abutments, firm ground is measured from the front face of the abutment. For unprepared abutments, the location of firm ground-depends on the slope and height of the banks and the angle of repose of the soil on the banks. When using the field method of determining firm ground, the angle of repose of the soil is assumed to be 45 degrees. If the slope of the banks does not exceed 45 degrees from the horizontal, then firm ground starts at the top of the banks. If the slope of the bank does exceed 45 degrees from the horizontal, then firm ground starts at a distance, H, from the toe of slope which is equal to the height of the bank at the toe of slope. (See figure on page 134.)

Table 48. M4T6 single span configurations

Classification (wheel/track) based upon span length and deck/roadway balk ratio

Span length	15 ft			23 ft 4 in		30 ft			38 ft 4 in				45 ft						
Deck/roadway	22/18	22/16	26/22	22/18	22/16	22/18	22/16	24/18	22/18	22/16	24/18	26/18	20/16	22/18	22/16	24/18	24/16	26/18	26/16
Type of crossing																			
Normal	100/100	100/100	100/100	100/100	100/100	85/65	90/70	90/70	45/35	50/40	55/45	65/50	24/25	24/25	30/30	30/30	40/35	40/35	45/40
Caution	100/100	100/100	100/100	100/100	100/100	100/80	100/80	100/85	70/51	70/51	75/55	82/60	40/35	46/40	46/40	51/43	51/43	56/46	56/46
Risk	100/100	100/100	100/100	100/100	100/100	100/90	100/90	100/95	78/57	78/57	85/62	90/67	47/40	54/45	54/45	60/49	60/49	66/53	66/53

Note.
The deck to roadway balk ratio provides the number of balk which make up the complete deck of the bridge over the number of balk which lie between the deck curbs (which make up the roadway). For example, a deck/roadway balk ratio of 22/18 would provide a deck which is 22 balk wide and a roadway which is 18 balk wide. See figure on page 134 .

Step 3. The bridge must have a minimum of 3 feet of bearing on both banks. This is a safety setback that is extended on both the near and far shore banks to ensure that the bridge is bearing on firm ground.

Step 4. Add the safety setback to the measured gap width to determine the required bridge length.

Gap width___ feet
Near shore bearing ____ + 3 feet
Far shore bearing ____ + 3 feet
Required bridge length = ____ feet

Step 5. Determine trestle requirements.

If the required bridge length is 45 feet or less, then a single span bridge may be adequate. Design a single span M4T6 bridge.

If the required bridge length is greater than 45 feet, intermediate supports must be used. If the required MLC of the bridge is Class 60 or less, design a freed span with a Class 60 trestle arrangement. If the required MLC of the bridge is greater than Class 60, but not greater than Class 100, design a fixed span with a Class 100 trestle arrangement.

Design of M4T6 single span bridges

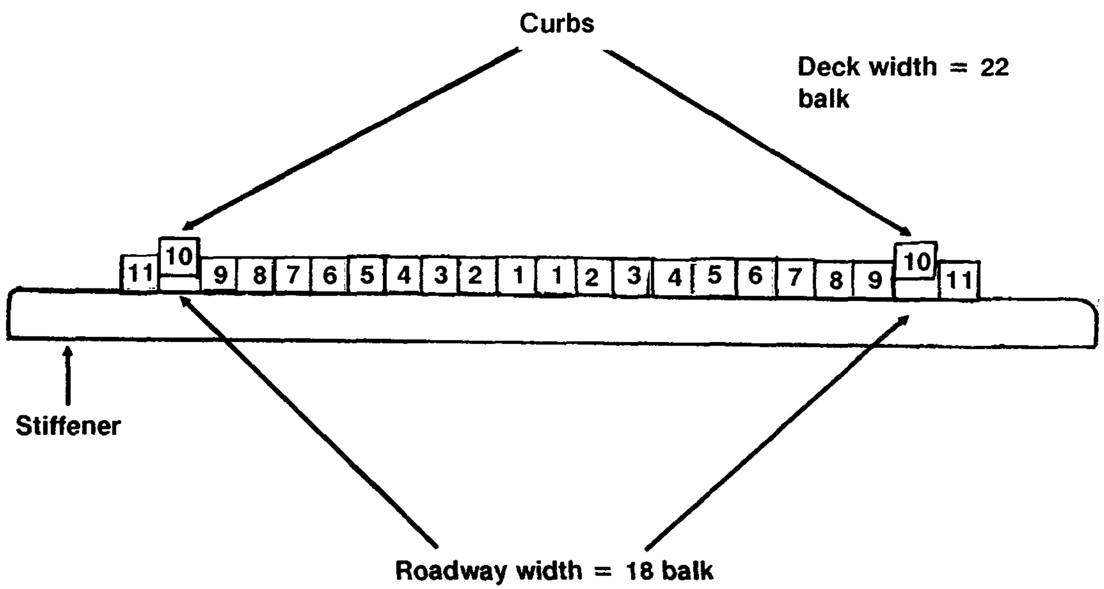
Steps 1-4. Complete steps 1 through 4 on the single span design work sheet provided in the figure on page 137. These steps are completed in the same manner as steps 1 through 4 shown above.

Step 5. After determining the required bridge length, refer to Table 48 on page 135. Select the shortest bridge configuration which is greater than or equal to the required bridge length.

Step 6. Determine the deck/roadway balk ratio for the bridge, refer to Table 48 and the figure above. Select a deck/roadway balk ratio for the bridge span length that was selected in step 5. The deck/roadway ratio must provide the required MLC for a normal crossing. If the desired MLC cannot be attained using the selected bridge span length, then a multiple span bridge must be used. Refer to the following paragraphs for design of multiple span bridges.

Step 7. If the desired load class is available, complete the design work sheet provided in the figure on page 137.

Deck/roadway balk ratio



M4T6 fixed span bridge design for 15′0″ to 45′0″ single span bridges	
1. Classification of bridge (designated in the mission statement).	**1. CL** ______
2. Gap as measured during reconnaissance (Chapter 10).	**2.** ______
3. Safety setback for NS and FS ia a constant of 3 feet for both prepared and unprepared abutments.	**3a. NS** +3′ ______ **3b. FS** +3′ ______
4. Initial bridge length (add steps 2, 3a, and 3b).	**4. =** ______
5. Round up to next highest standard H–frame configuration (Table 48).	**5.** ______
6. Determine deck/roadway ratio required to carry load (Table 48).	**6.** ______
7. Final design of bridge:	
a. H–frame (from step 5):	**7a.** ______
b. Deck/roadway ratio (from step 6):	**7b.** ______
c. Classification (Table 48).	**7c.** ______
Materials required: ______	

Design of M4T6 fixed spans with a Class 60 trestle arrangement

Complete the design work sheet provided in the figure on page 138. For steps 1 through 4, see initial design. The remainder of the work sheet is self-explanatory.

Design of M4T6 freed spans with a Class 100 trestle arrangement

Complete the design work sheet provided in the figure on page 139. For steps 1 through 4, see initial design. The remainder of the work sheet is self-explanatory.

M4T6 fixed span bridge design for support with Class 60 trestle arrangement (for Class 60 and below)

1. Classification of the bridge that needs to be built (obtained from the mission statement)
2. Gap as measured during reconnaissance
3. Safety setback for both the far shore and near shore is a constant of 3 feet for both prepared and unprepared abutments
4. Initial bridge length (add steps 2+3a+3b)
5. Initially, enter the "2 trestle assemblies" column and subtract 15 feet from the total bridge length obtained in step 4. (This distance must be accounted for as it will be part of the bridge road.)
6. Divide the value obtained in step 5b by 2 to determine the lengths of the two end span H frames.
   Notes:
   (1) If the value obtained in step 6b is greater than 45′0″, you must return to step 5. Enter the next column, and repeat the design sequence.
   (2) You are not limited to adding only 4 trestle assemblies as may be implied by step 5. Only 4 are shown due to space limitations on this form.
   (3) When the value obtained in step 6b is less than or equal to 45′0″, proceed to step 7.
7. Round up the value obtained in step 6b to the next highest standard H frame configuration as listed in Table 48.
8. Determine the deck/roadway (D/R) ratio required and corresponding MLC for the standard configuration obtained in step 7, Table 48. (Remember: 22 pieces of decking is the maximum which may be used with a trestle!)
   Notes:
   (1) This must meet or exceed the MLC requirements as stated in step 1 and is always based on a normal crossing unless otherwise directed by the tactical commander.
   (2) If the MLC requirement cannot be met or exceeded, you must return to step 5. Enter the next column, and repeat the design sequence, adding as many trestle assemblies as needed.
9. Final bridge design:

1. MLC________________

2.________________

3a. FS: +3 ____________

3b. NS: +3 ____________

4.___ = ____________

5.	2 trestle assemblies	3 trestle assemblies	4 trestle assemblies
5a.	−15′	−30′	−45′
5b.	=	=	=
6a.	÷ 2	÷ 2	÷ 2
6b.	=	=	=
7.			
8a.	D/R =	D/R =	D/R =
8b.	MLC =	MLC =	MLC =

M4T6 fixed span bridge design for support with Class 100 trestle arrangement (for Classes 61 to 100)

1. Classification of the bridge that needs to be built (obtained from the mission statement)
2. Gap as measured during reconnaisance
3. Safety setback for both the far shore and the near shore is a constant of 3 feet for both prepared and unprepared abutments
4. Initial bridge length (add steps 2+3a+3b)
5. Initially, enter the "1 trestle arrangement" column. You will not have to subtract any distance from step 4 because the end spans rest on the center of the trestle.
   Notes: One trestle arrangement consists of two trestle assemblies; two trestle arrangements consist of four trestle assemblies; etc.
6. Divide the value obtained in step 5b by 2 to determine the lengths of the two end span H frames.
   Notes:
   (1) If the value obtained in step 6b is greater than 30′0″, you must return to step 5, enter the next column, and repeat the design sequence.
   (2) You are not limited to adding only 3 trestle arrangements as may be implied by step 5. Only 3 are shown due to space limitations on this form.
   (3) When the value obtained in step 6b is less than or equal to 30′0″, proceed to step 7.
7. Round up the value obtained in step 6b to the next highest standard H-frame configuration as listed in Table 48.
8. Determine the deck/roadway (D/R) ratio required and corresponding MLC for the standard configuration obtained in step 7, from Table 48. (Remember: 22 pieces of decking is the maximum which may be used with a trestle!)
   Notes:
   (1) This must meet or exceed the MLC requirements as stated in step 1 and is always based on a normal crossing unless otherwise directed by the tactical commander.
   (2) If the MLC requirement cannot be met or exceeded, you must return to step 5, enter the next column, and repeat the design sequence, adding as many trestle arrangements as needed.
9. Final bridge design:
   a. H-frame end span configuration (from step 7)
   b. H-frame end span deck/roadway ratio (from step 8a)
   c. Number of trestle arrangement(s) required (from step 5)
   d. Bridge length(s) between trestle arrangement(s)
   Notes:
   (1) For 1 trestle arrangement, enter NA
   (2) For 2 trestle arrangements, enter: one 23′4″ span
   (3) For 3 trestle arrangements, enter: two 23′4″ spans
   (4) For 4 or more trestle arrangements, the number of 23′4″ spans that are required will be equal to the number of trestle arrangements, minus one.
   e. MLC of bridge length(s) between trestle arrangement(s)
   Notes:
   (1) For 1 trestle arrangement, enter: NA
   (2) For 2 or more trestle arrangements, use Table 7-26 on page 7-21, FM 5-34, to obtain the MLC. Use the same deck/ratio (D/R) as shown under step 9b.
   f. MLC of trestle(s) (constant of 100)
   g. MLC of end spans (from step 8b)
   h. MLC of entire bridge (compare the values of steps 9e, 9f, and 9g. Choose the smallest.)

Materials required: ____________________

____

1. MLC ____________________
2. ____________________
3a. FS: +3
3b. NS: +3
4. ___ = ___

5.	1 Trestle Arrangement	2 Trestle Arrangement	3 Trestle Arrangement
5a.	–0′0″	–23′4″	–46′8″
5b.	=	=	=
6a.	÷2	÷2	÷2
6b.	=	=	=
7.			
8a.	D/R =	D/R =	D/R =
8b.	MLC =	MLC =	MLC =
9a.			
9b.	D/R =		
9c.			
9d.			
9e.	MLC		
9f.	MLC 100		
9g.	MLC		
9h.	MLC		

Construction of Single Span Fixed Bridges

Step 1. Site preparation. The construction site must be cleared and leveled enough to assemble the required H-frame for the span.

Step 2. A line should be placed across the gap to mark the bridge centerline.

Step 3. Prepare the abutments and position the abutment sills to receive the ends of the bridge. To construct adequate abutments, check Table 49 to determine bank soil bearing capacity. If the soil bearing capacity is greater than 7 tons per square foot, the bearing plate can be placed directly on the ground. For soil bearing capacities of 1 ton per square foot or more, the maximum abutment size required is shown below. For detailed sill abutment design, refer to TM 5-312.

Note. Prepared abutments are not required for the M4T6 freed span bridge; however, if adequate abutments are not provided, the stiffeners and bearing plates at the ends of the bridge will sink into the ground.

Step 4. Construct the H-frame, as shown on pages 149 through 156, as appropriate for the span length desired. The stiffeners should be oriented so that the pin retainer clips attached to the stiffeners are facing toward the closest bank of the gap. Ensure that the H-frame balk is placed in the proper stiffener recesses as shown in the sketches. If the H-frame is constructed using erection girders, construct and launch the erection girder as shown on page 141. The H-frame is then built over the gap, resting on the erection girders. If a crane or vehicle with an A-frame is available to launch the H-frame, build the H-frame on flat ground. Ensure that every balk is pinned at all stiffeners before removing the erection girders or launching the H-frame.

Step 5. Place the curb adapters in the appropriate recesses on the stiffener as shown in Table 50 on page 142.

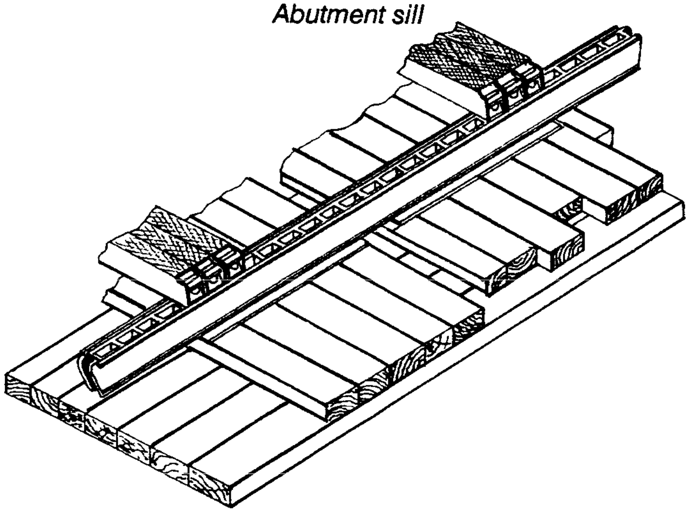
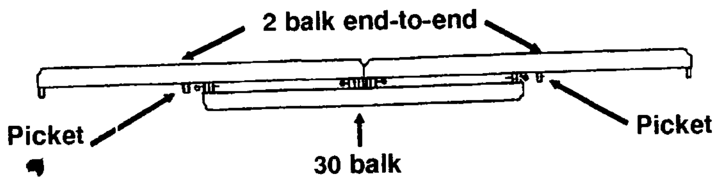


Table 49. Soil bearing capacity

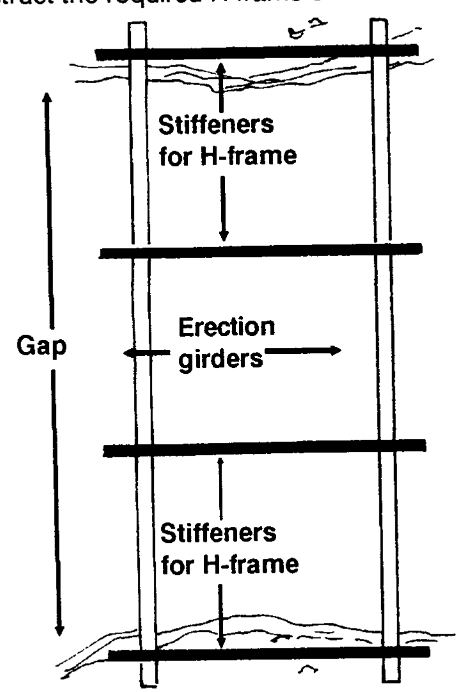
Soil description	Bearing values (tons per sq ft)
Hardpan overlying rock	12
Very compact sandy gravel	10
Loose gravel and sandy gravel, compact sand and gravelly sand; very compact sand, inorganic silt soils	6
Hard dry consolidated clay	5
Loose coarse–to–medium sand; medium–compact fine sand	4
Compact sand clay	3
Loose fine sand; medium–compact sand, inorganic silt soils	2
Firm or stiff clay	1.5
Loose saturated–sand clay soils; medium–soft clay	1

Construction and use of erection girders

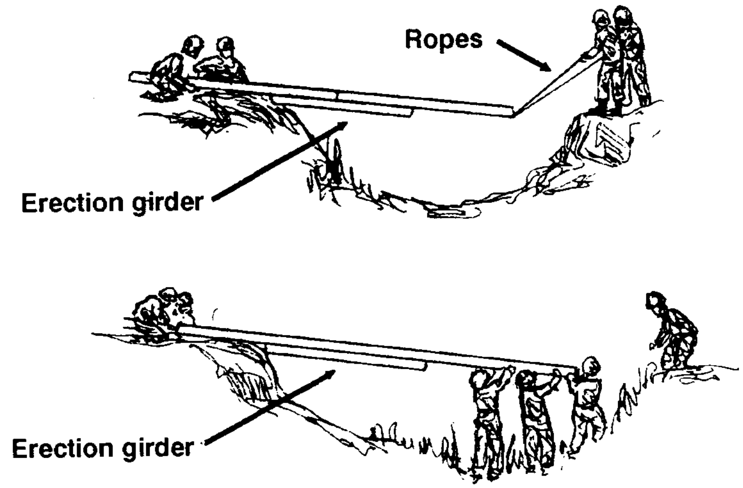
1. Assemble the erection girder using 3 normal balk, place two balk end-to-end, and the third on the lower side of the first two. Use D-handled pickets to connect the 3 balk. (This girder can be used for H-frames from 23′ 4″ to 30′. For larger H-frames use 5 normal balk. Place 3 balk end-to-end with 2 balk on the lower side.)



3. Construct the required H-frame on the erection girders.



2. Once two erection girders are constructed, place them across the gap.



4. Once the H-frame is completed, remove the erection girders, one at a time. This can be done as shown below.

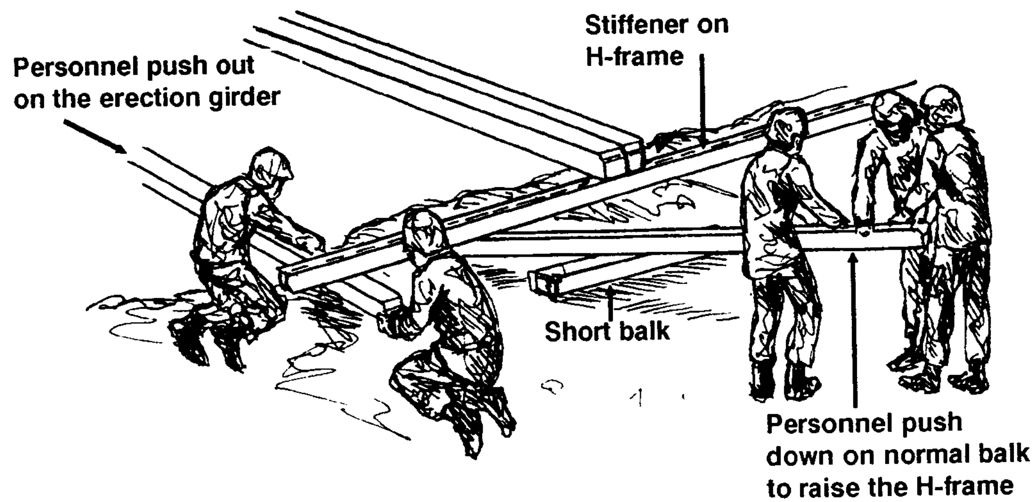
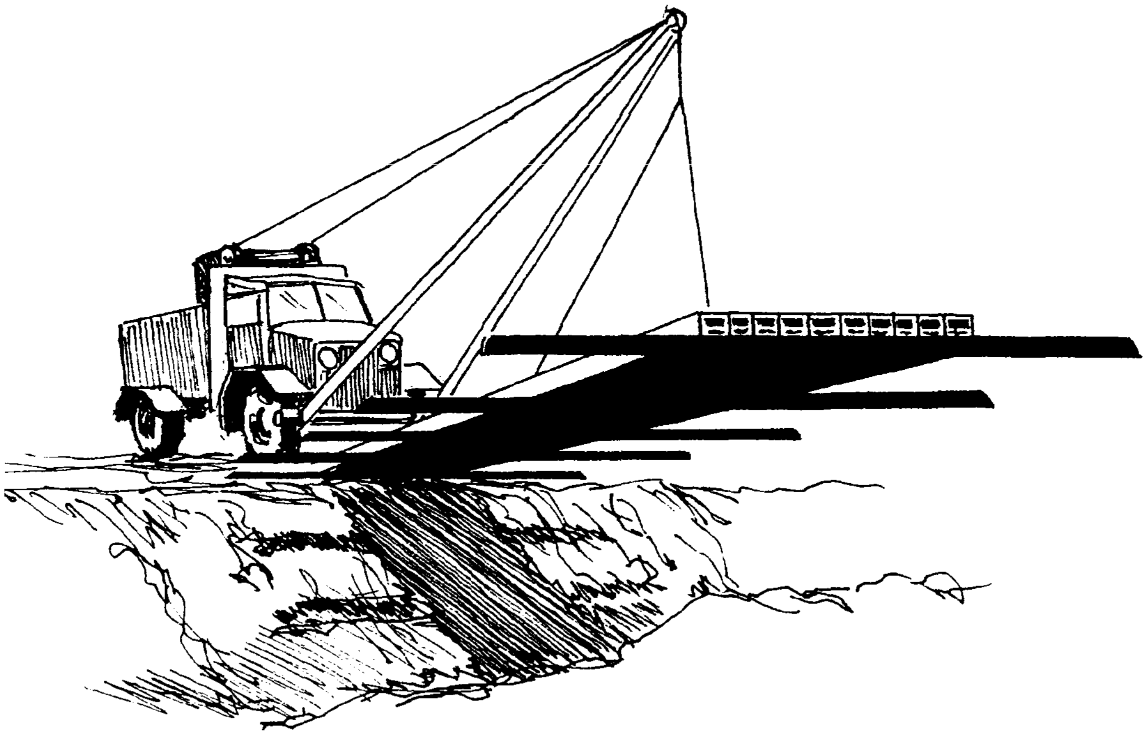


Table 50. Placement of curb adapters

Deck/roadway ratio	Placement of curb adapters
22/18	10th recess (left and right)
22/16	9th recess (left and right)
26/22	12th recess (left and right)

Use of a truck-mounted A-frame



Step 6. Launch the H-frame using a crane, erection girders, or a truck-mounted A-frame. Install two bearing plates on the underside of both end stiffeners prior to launching the bridge.

Note. This can be done prior to H-frame construction.

Cranes. It is possible to completely balk and launch 15-foot and 23-foot 4-inch spans when a crane is available. Longer spans must be balked after the H-frame is launched. When using a crane, Class 60 chains or wire rope lifting slings are attached to the ninth recesses (left and right) of the centermost stiffeners on the H-frame.

Erection girders. Erection girders can be constructed and used as described previously.

Truck-mounted A-frame. A truck-mounted A-frame provides an expedient method of launching an H-frame. (See figure at left.)

Step 7. Place the remaining balk on the stiffeners by starting at one side of the bridge and working towards the other side, or by starting at the centerline of the bridge and and working towards both sides. Pin the balk at all stiffeners except the stiffeners on the end of the span. Be sure to lay the reinforcing balk as shown in the sketches of the balk patterns on pages 149 through 156.

Step 8. Add 20 or 22 tapered balk (depending upon the deck width) to each end of the bridge to provide the ramps. Pin the balk in the end stiffeners. Place cover plates over the joint between the end of the bridge and the ramp.

Step 9. Anchor the ends of the bridge to prevent the span from moving.

Construction of multiple span M4T6 bridges using Class 60 trestle arrangements

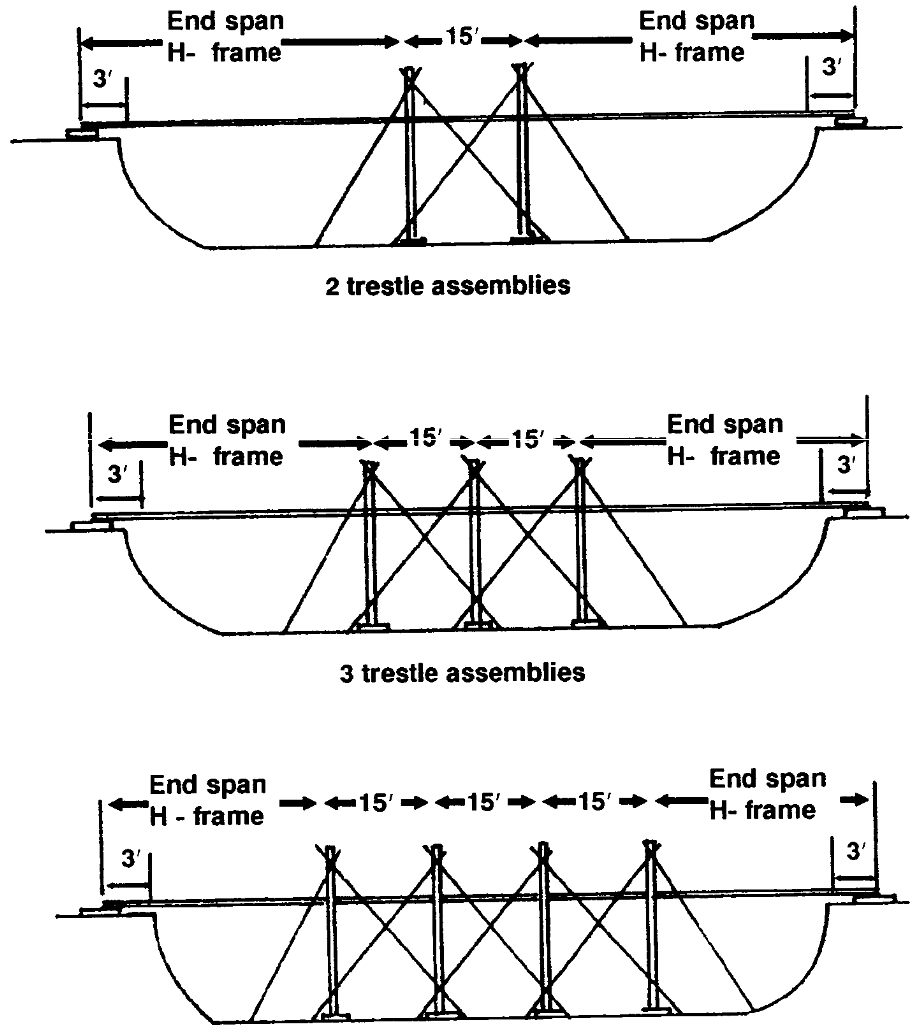
Step 1. Place a line across the gap to mark the bridge centerline.

Step 2. Accurately measure the gap and clearly mark the location for all trestles. Position trestles as shown in the figure at the right. Make provisions for a solid bearing surface for the trestle shoes. It may be necessary to either dig out or fill in the area in which the trestles will be placed.

Step 3. Construct the first trestle assembly as follows:

1. Place the trestle transom on cribbing to raise the trestle approximately 2.5 feet above the ground. This allows sufficient room to attach the trestle shoes.
2. Place a column in each end of the transom so that approximately 3 feet of each column

Class 60 trestle arrangement



2 trestle assemblies

3 trestle assemblies

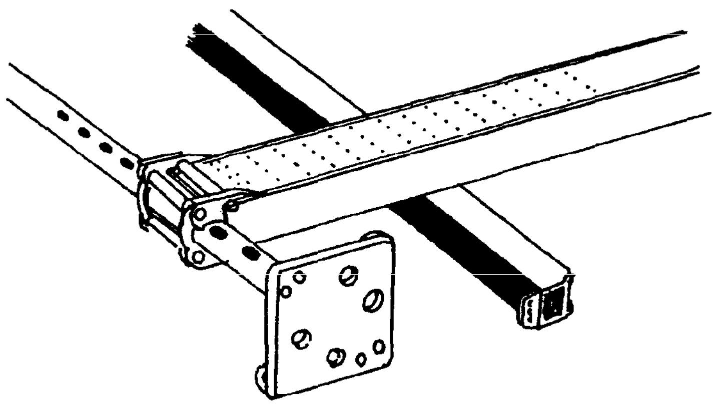
4 trestle assemblies

extends below the transom. This placement allows the trrestle to be raised with the least amount of effort and will prevent the trestle from sliding when raised.

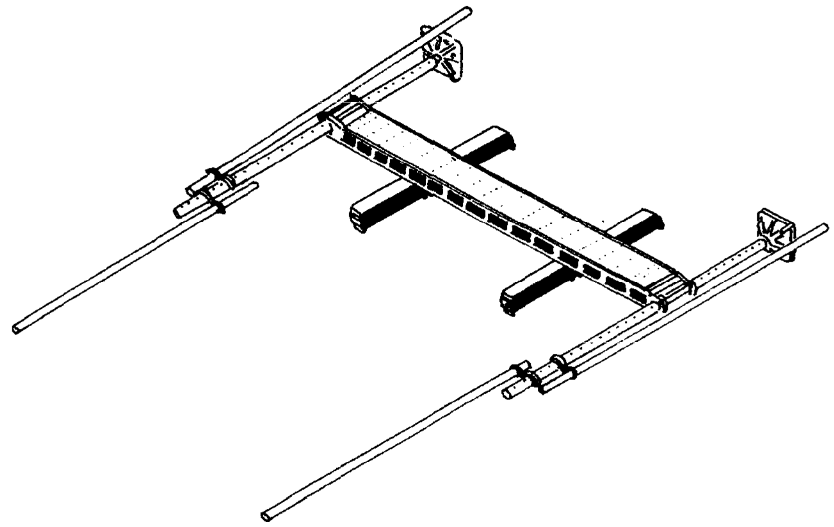
3. Attach the trestle shoes and secure them to the column using the special wrench provided.
4. Attach two bracing clamps to each column. Place the first clamp directly below the second hole in the top of the column. Place the second clamp directly below the fourth hole from the top of the column.
5. Place a bracing strut in each bracing clamp and tighten the clamp.
6. Raise the trestle by hand using the bracing struts, or with a crane. When raising the trestle assembly by crane, construct the trestle assembly with the transom placed about half way up the columns. Attach the crane's Class 60 chain hooks to stiffener pins placed in the seventh right and left recesses of the transom. Attach tag lines to each trestle shoe, each lifting eye on the transom, and each strut brace.
7. Adjust the bracing clamps so that the bracing struts form a 45-degree angle with the transom.
8. Pin the bottom of each bracing strut to a picket holdfast. Anchor the picket holdfasts using eight pickets per holdfast.
9. Place curb adapters in the recesses called for by the roadway width. (See Table 50.)
10. Raise the transom until it is 6 to 9 inches above the bank height. If the transom must be placed close to the top of the column, the bracing clamps may have to be removed and then replaced below the level of the transom. This will prevent the bracing struts from interfering with the positioning of the transom.

Step 4. Construct the near shore H-frame IAW the bridge design and steps 1 through 7 of the single span construction procedure. Omit the stiffener that would be placed over the trestle arrangement, as well as the short or tapered balk that connects into it, when constructing the H-frame.

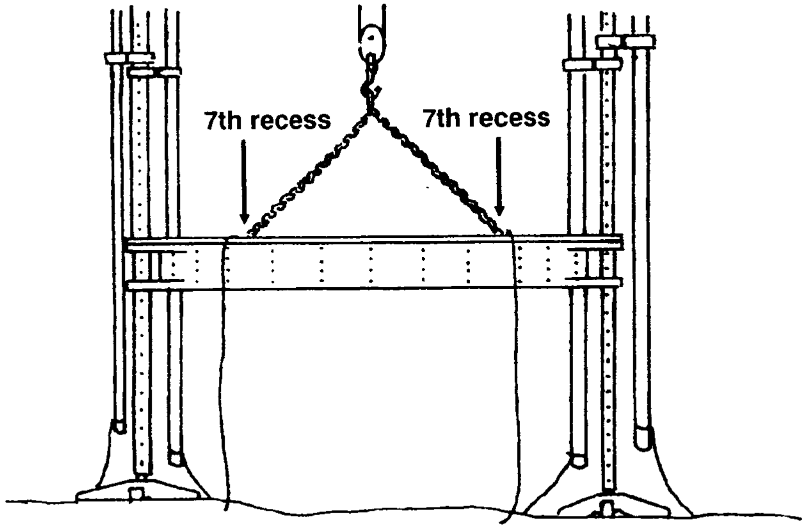
Initial construction of a trestle assembly



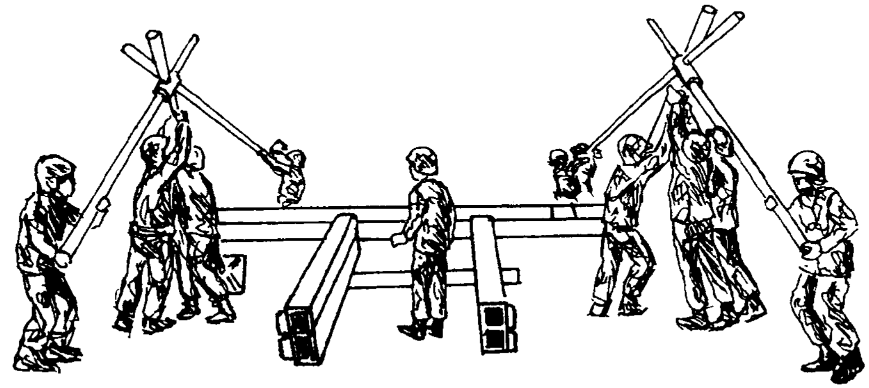
Placement of the bracing clasps on a trestle assembly



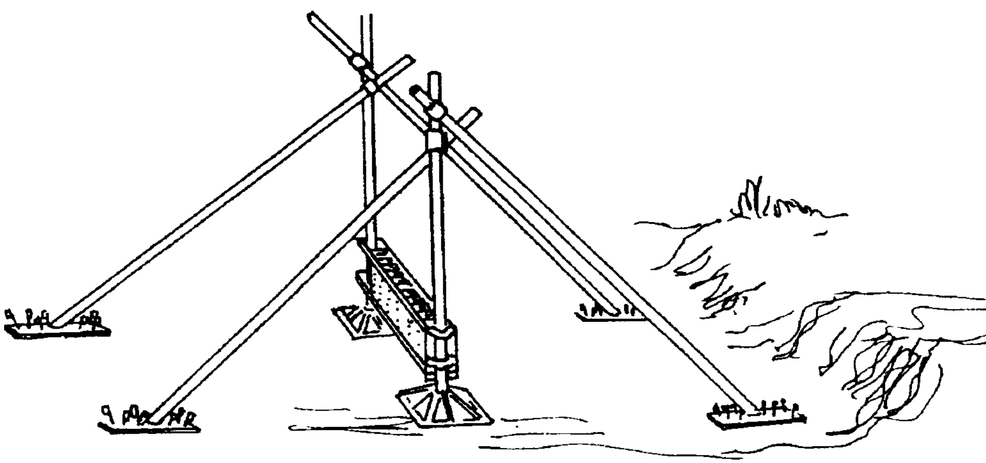
Raising a trestle using a crane



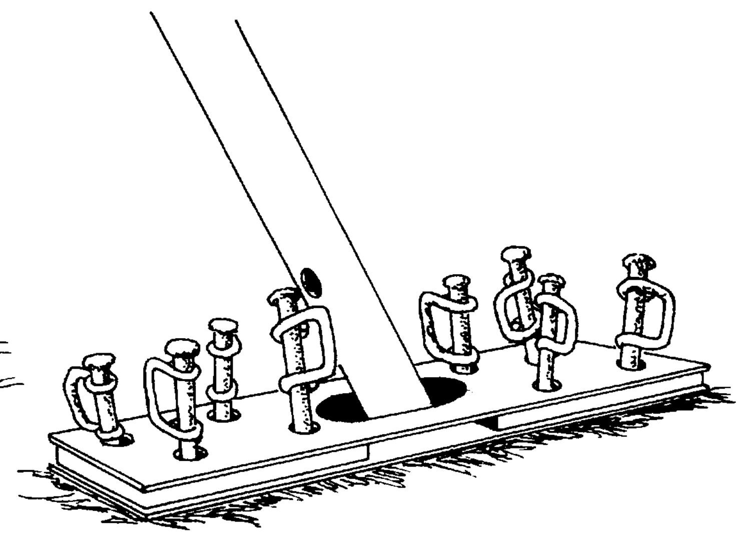
Raising a trestle assembly by hand, using the bracing struts



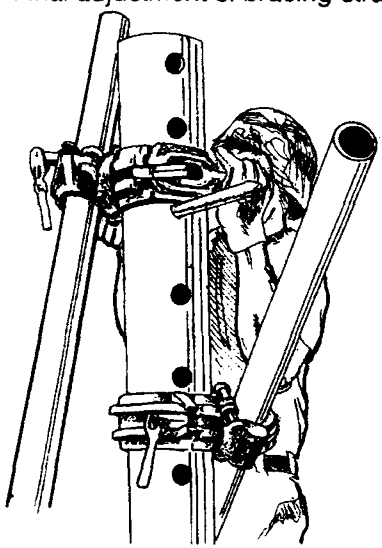
45° adjustment of bracing clasps



Anchoring the strut brace



Final adjustment of bracing struts



Step 5. Construct a second trestle IAW step 3. Construct this second trestle 15 feet center to center from the first trestle. Connect the two trestles with 22 normal balk to form a Class 60 trestle arrangement. Pin the balk in the first transom assembly. Reconfigure the bracing so the interior strut braces are connected to the adjacent trestle assembly and so the tops of the exterior strut braces do not interfere with traffic on the bridge. Install transverse bracing below the transom if space is available.

Step 6. Construct additional trestles as required by the bridge design IAW steps 3 and 5 above.

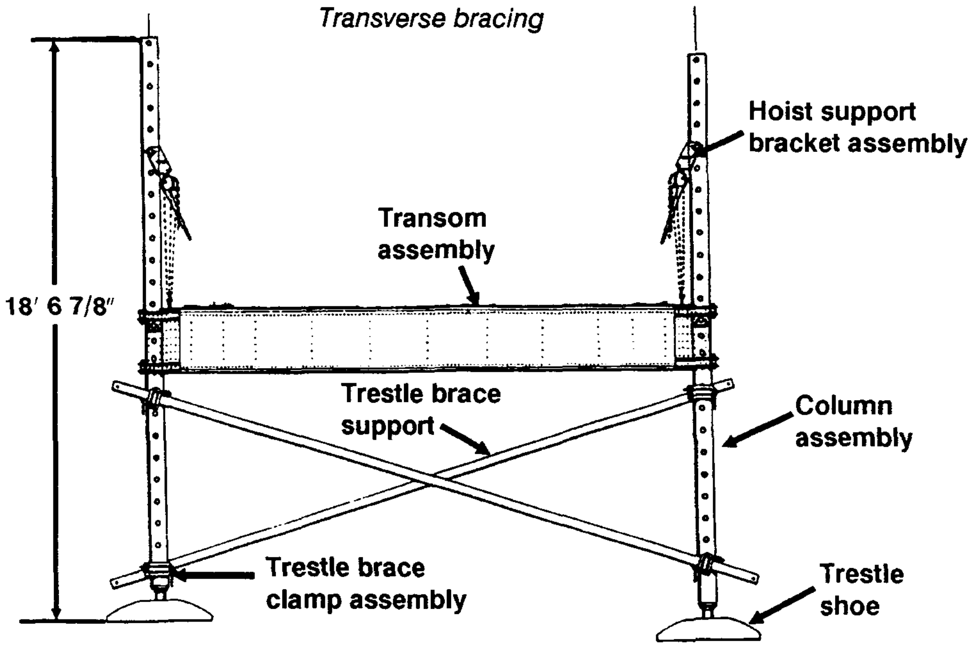
Step 7. When the last trestle is erected construct the far shore span IAW steps 1 through 7 of the single span construction procedure. Omit the end stiffener that is replaced by the trestle assembly transom and the short or tapered balk that connects into the transom, when assembling and launching the H–frame.

Step 8. Add 20 or 22 tapered balk (depending upon the deck width) to each end of the bridge to provide the ramps. Pin the balk in the end stiffeners. Place cover plates over the joint between the end of the bridge and the ramp.

Step 9. Anchor the ends of the bridge to prevent the span from moving.

Step 10. Once the bridge is completed, the trestle transoms may require adjustment to ensure that the bridge is as level as possible. Make these adjustments using a ratchet chain hoist.

Transverse bracing



Construction of multiple span M4T6 bridges using Class 100 trestles

Step 1. Place a line across the gap to mark the bridge centerline.

Step 2. Accurately measure the gap and clearly mark the location for all trestles. Position trestles as shown on page 147. Make provisions for a solid bearing surface for the trestle shoes. It may be necessary to either dig out or fill in the area in which the trestles will be placed.

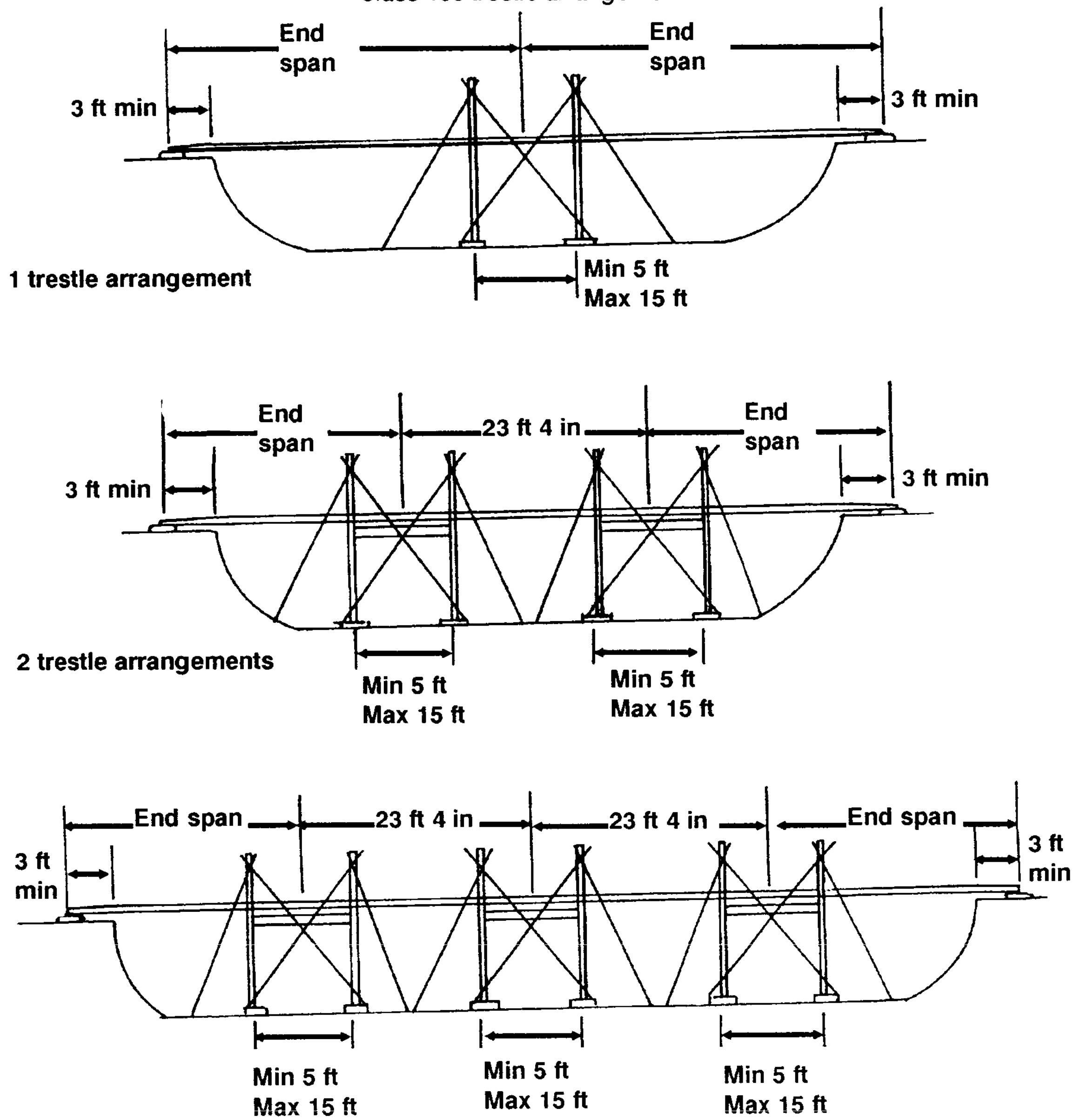
Step 3. Construct the first trestle arrangement as follows:

1. Place the trestle transom on cribbing to raise the trestle approximately 2.5 feet above the ground. This allows sufficient room to attach the trestle shoes.

2. Insert a full column in each end of the transom. Adjust the transom so it is as close to the cribbing as possible to prevent the trestle from sliding when it is raised upright.

3. Attach the trestle shoes and secure them to the column using the special wrench provided.
4. Attach two bracing clamps to each column. Place the first clamps directly below the second hole in the top of the column. Place the second clamps directly below the fourth hole from the top of the column.
5. Place a bracing strut in each bracing clamp and tighten the clamp.
6. Raise the trestle by hand using the bracing struts, or with a crane. When raising the trestle assembly by crane, construct the trestle assembly with the transom placed about half way up the columns. Attach the crane's Class 60 chain hooks to stiffener pins placed in the seventh right and left recesses of the transom. Attach tag lines to each trestle shoe, each lifting eye on the transom, and each strut brace.
7. Adjust the bracing clamps so that the bracing struts form a 45-degree angle with the transom.
8. Pin the bottom of each bracing strut to a picket holdfast. Anchor the picket holdfasts using eight pickets per holdfast.
9. Place curb adapters in the recesses called for by the roadway width. (See Table 50.)
10. Raise the transom until it is 6 to 9 inches below the bank height. If the transom must be placed close to the top of the column, the bracing clamps may have to be removed and then replaced below the level of the transom. This will prevent the bracing struts from interfering with positioning of the transom.

Class 100 trestle arrangement



11. Construct a second trestle, using the same procedures described above. Place this trestle between 5 and 15 feet from the first. Normally, place the trestles 8 feet 4 inches (center to center) or 15 feet apart.

12. Connect the two trestle assemblies by adding 11 short or normal balk so that the end lugs fit into the transom at every other recess. Timbers (12 x 12 inches) can also be used instead of balk to connect the trestle assemblies.

13. Reconfigure the bracing so the interior bracing struts are connected to the adjacent trestle assembly and so the tops of the exterior strut braces do not interfere with traffic on the bridge.

14. Install transverse bracing below the transom if space is available.

15. Place a stiffener with two bearing plates at the midpoints of the balk.

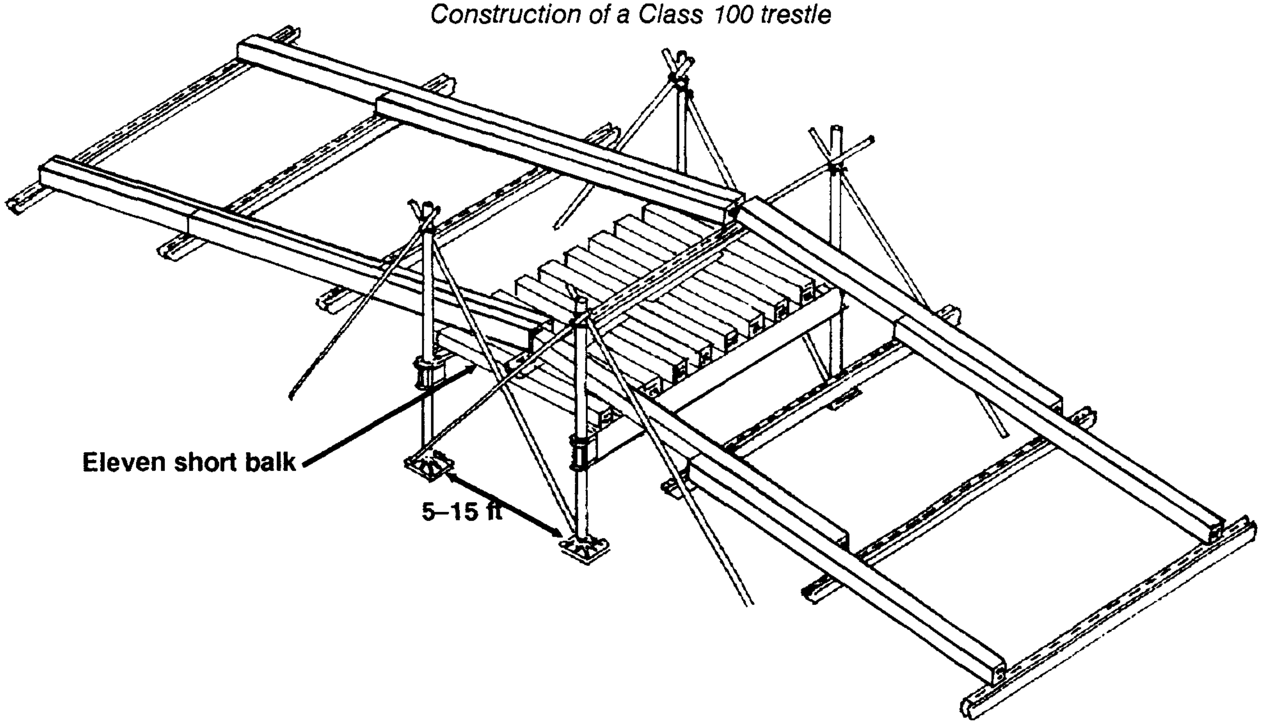
Step 4. Construct the near shore H-frame IAW the bridge design and steps 1 through 7 of the single span construction procedure. Omit the far shore stiffener and short or tapered balk that connects into it, when constructing the H-frame.

Step 5. If additional intermediate supports are required, continue to construct Class 100 trestle arrangements by following the procedure in step 3 above. Place the first trestle assembly in the next trestle arrangement 23 feet 4 inches (center to center) from the first trestle assembly in the previous trestle arrangement.

Note. If only a Class 90 wheeled / 70 tracked capacity is required, then the center to center spacing of the first trestle assemblies can be lengthened to 30 feet.

Step 6. Span the gap between trestle arrangements with either 23-foot 4-inch or 30-foot spans, as required by the bridge design. Assemble spans by following steps 3 through 7 of the single span construction procedure. Both of the end stiffeners and the short or tapered balk that connect into them should be omitted from the H-frame. Pin the balk in the stiffener on the

Construction of a Class 100 trestle

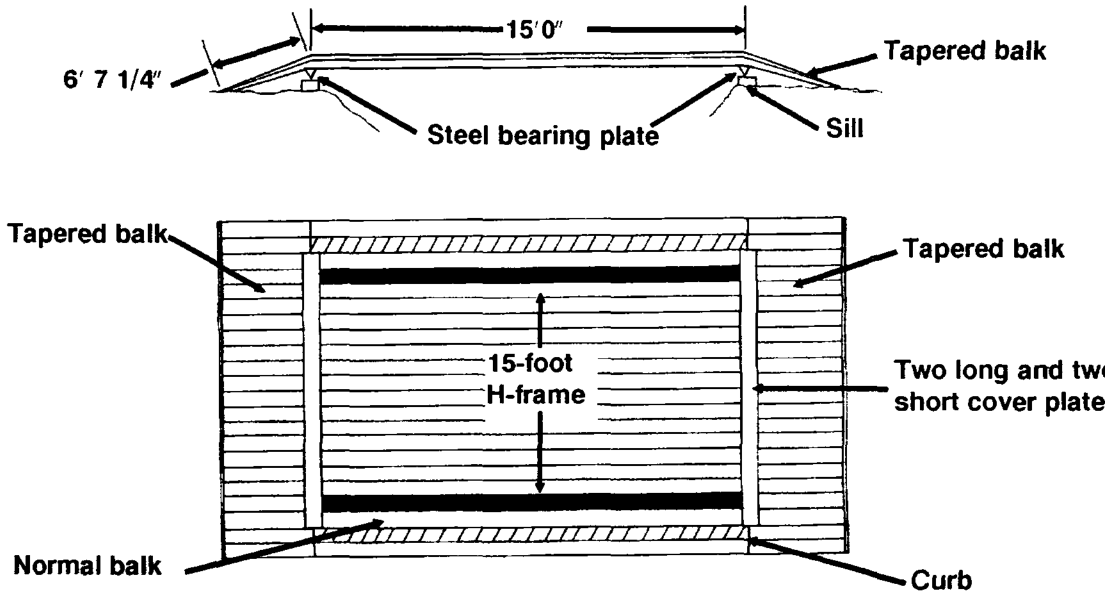


Class 100 trestle arrangement only when the second span's balk has been placed into it. Place cover plates at the joint between the two spans. Anchor the stiffener with cables or chains so that it cannot shift on the trestle arrangement when vehicles cross.

Step 7. Repeat steps 5 and 6 until all of the intermediate supports are completed.

Step 8. Construct the far shore span IAW steps 1 through 7 of the single span construction procedure. Omit the end stiffener that is replaced by the trestle assembly transom and the short or tapered balk that connects into the transom, when assembling and launching the H-frame. Pin the balk in the stiffener on the Class 100 trestle arrangement only when the final span's balk has been placed into it. Place cover plates at the joint between the two spans. Anchor the stiffener with cables or chains so that it cannot shift on the trestle arrangement when vehicles cross.

Balk pattern for 15-foot single span with 22-balk deck and 18-balk roadway

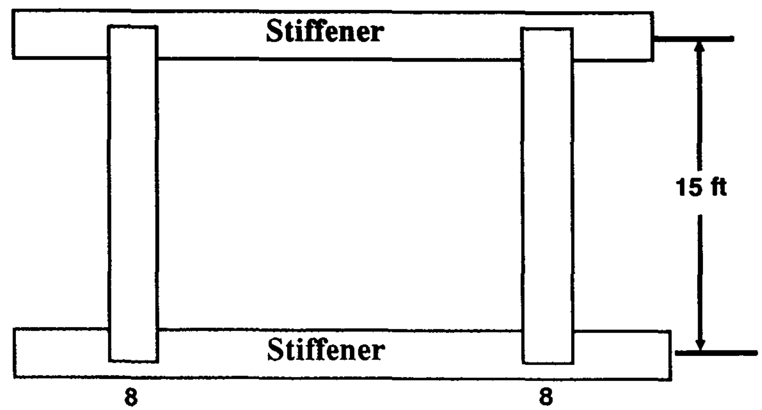


Components list

Length of span	15–foot single span		
Deck/roadway balk ratio	22/18	22/16	26/22
Component	Quantity		
Balk, normal	22	22	26
Balk, short	–	–	–
Balk, tapered*	44	44	52
Bearing plates	4	4	4
Cover plate, long	4	4	4
Cover plate, short	4	2	8
Curb adapters	4	4	4
Stiffeners	2	2	2
Stiffener pins	56	56	64

* The number of tapered balk may be reduced to the quantity needed to fill in the recesses between the curbs.

15–foot H–frame



Step 9. Add 22 tapered balk to each end of the bridge to provide ramps. Pin the balk in the abutment stiffeners. Place cover plates over the joint between the ends of the bridge and the bridge ramps. Anchor both ends of the bridge to prevent movement.

Step 10. Once the bridge is completed, the trestle transoms may require adjustment to ensure that the bridge is as level as possible. Make these adjustments using a ratchet chain hoist.

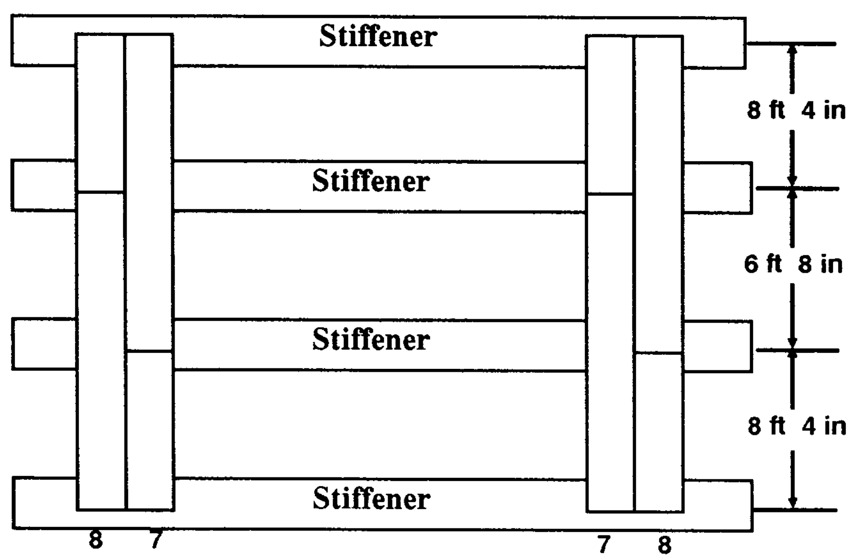
23-foot 4-inch and 21-foot 8-inch single span

Components list

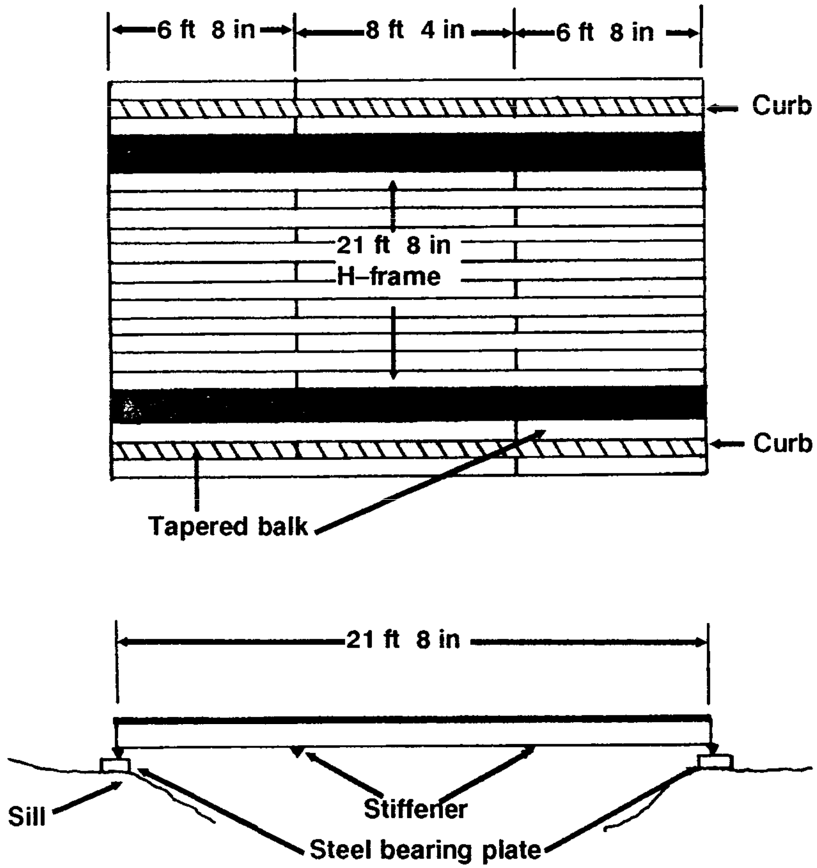
Length of span	23′ 4″		21′ 8″	
Deck/roadway balk ratio	22/18	22/16	22/18	22/16
Component	Quantity			
Balk, normal	22	22	22	22
Balk, short	22	22	–	–
Balk, tapered*	44	44	66	66
Bearing plates	4	4	4	4
Cover plate, long	4	4	4	4
Cover plate, short	4	2	4	2
Curb adapters	8	8	8	8
Stiffeners	4	4	4	4
Stiffener pins	104	104	104	104

* The number of tapered balk may be reduced to the quantity needed to fill in the recesses between the curbs.

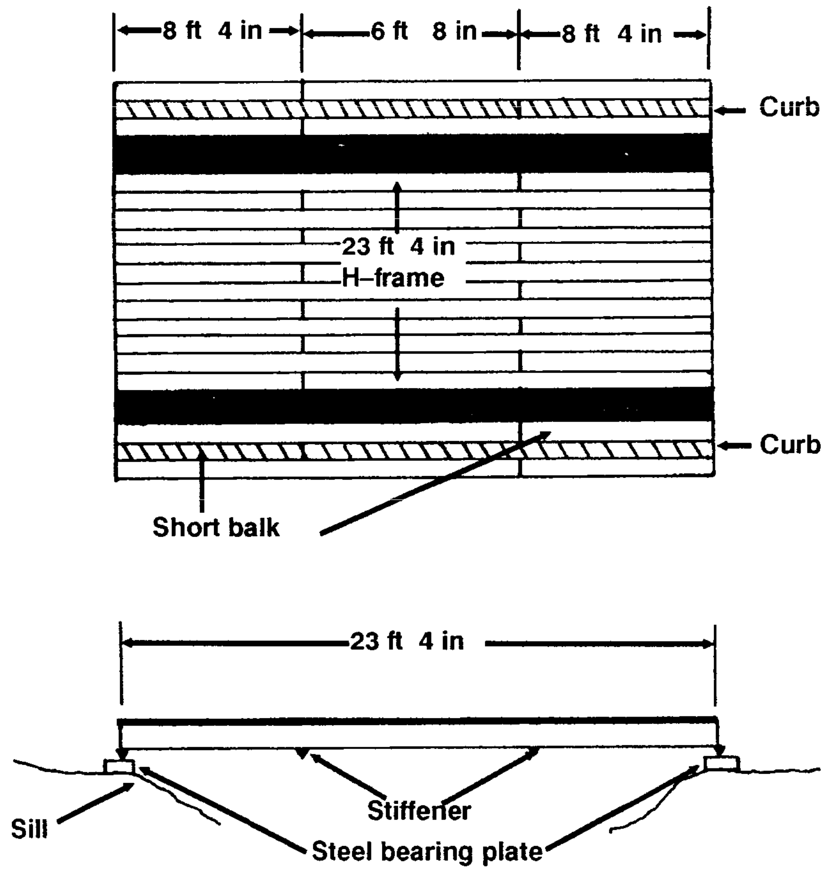
23-foot 4-inch H-frame



Balk pattern for 21-foot 8-inch single span with 22-balk deck and 18-balk roadway

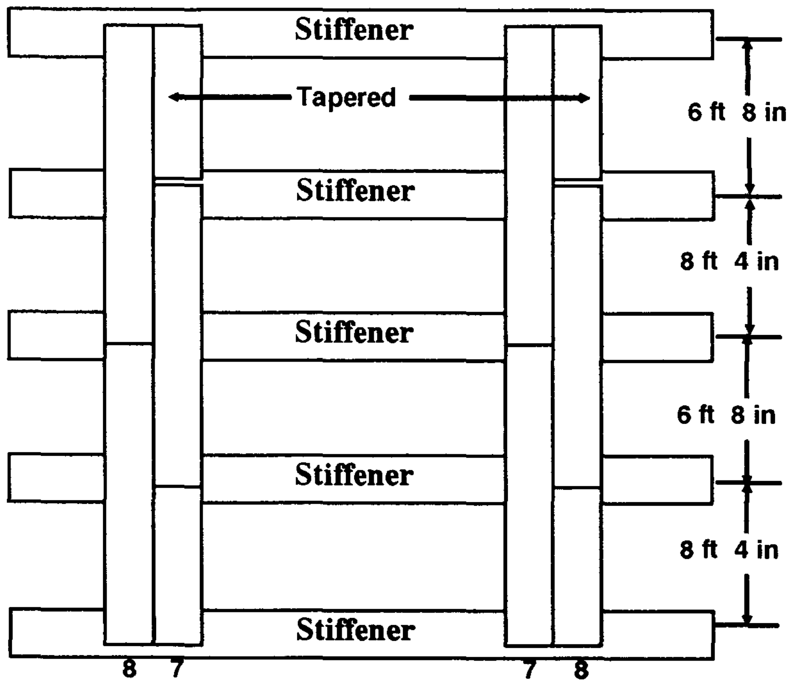


Balk pattern for 23-foot 4-inch single span with 22-balk deck and 18-balk roadway

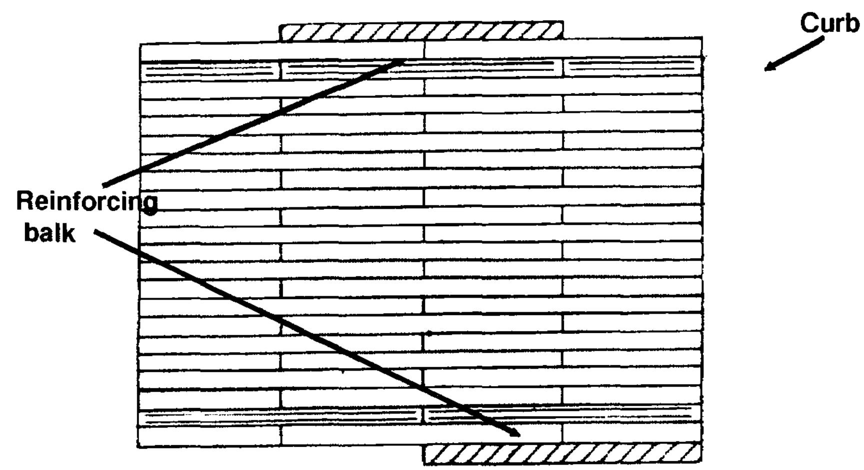


Note: Tapered balk approaches as with 15–ft span

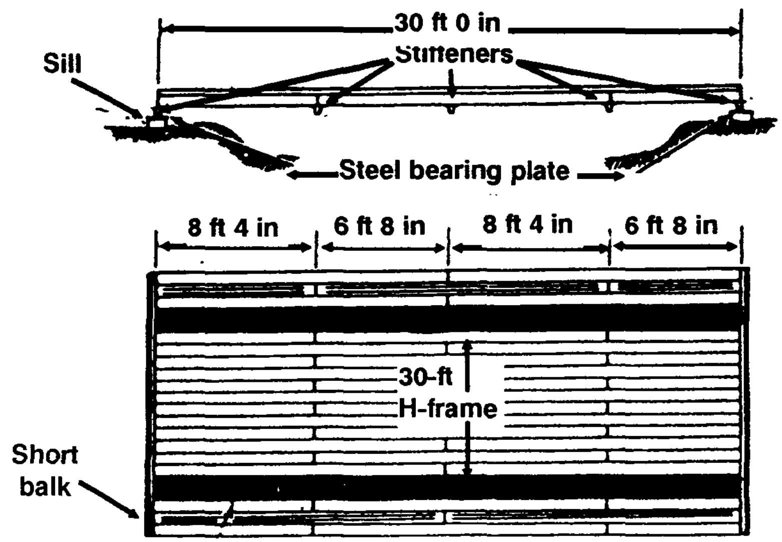
30–foot H-frame



Balk pattern for 30-foot single span with 24-balk deck and 18-balk roadway



Balk pattern for 30–foot single span with 22–balk deck and 18–balk roadway



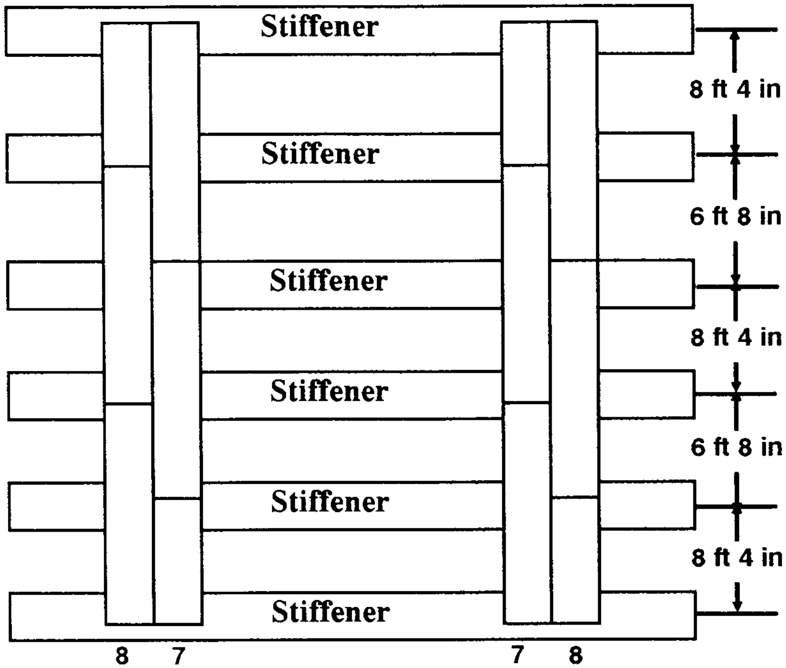
Note: Tapered balk approaches as in 15-ft span

Components list

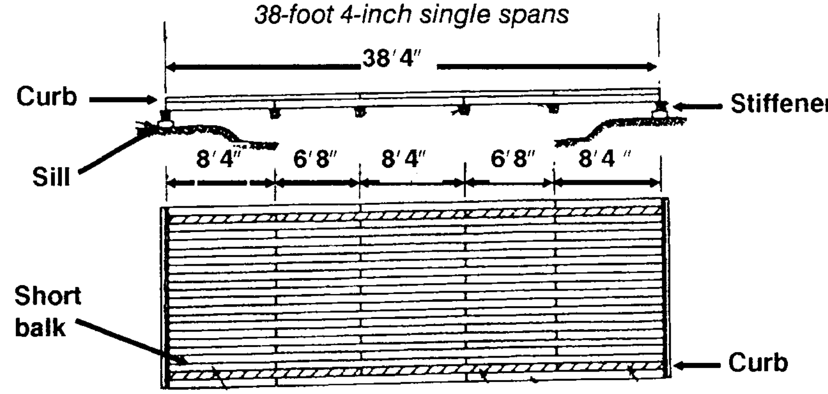
Length of span	30–foot single span		
Deck/roadway balk ratio	22/18	22/16	24/18
Component	Quantity		
Balk, normal	33	33	35
Balk, short	11	11	11
Balk, tapered*	55	55	55
Bearing plates	4	4	4
Cover plate, long	4	4	4
Cover plate, short	4	2	4
Curb adapters	10	10	10
Stiffeners	5	5	5
Stiffener pins	128	128	134

* The number of tapered balk may be reduced to the quantity needed to fill in the recesses between the curbs.

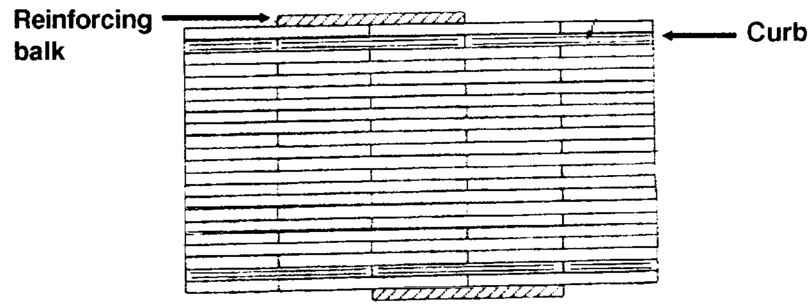
38-foot 4-inch H-frame



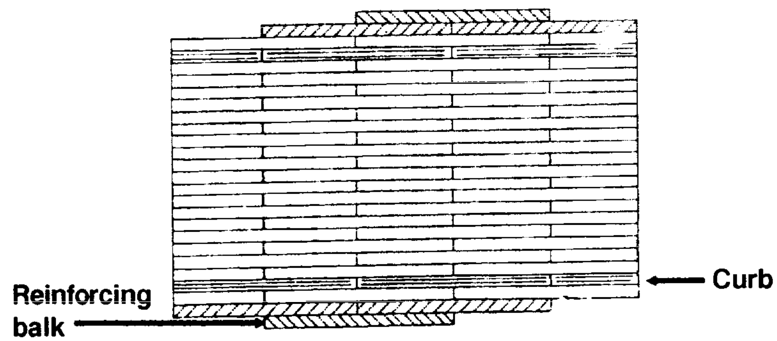
38-foot 4-inch single spans



Balk pattern for 38-foot 4-inch single span with 22-balk deck and 18-inch balk roadway



Balk pattern for 24-balk deck and 18-balk roadway



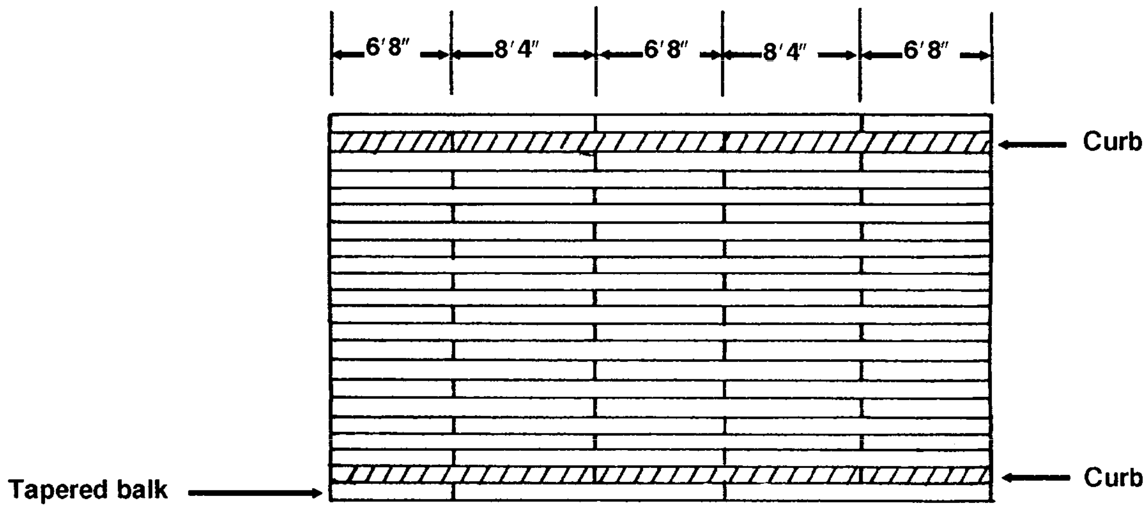
Balk pattern for 26-balk deck and 18-balk roadway

Components list

Length of span	38–foot 4–inch single span			
Deck/roadway balk ratio	22/18	22/16	24/18	26/18
Component	Quantity			
Balk, normal	44	44	46	50
Balk, short	22	22	22	22
Balk, tapered*	44	44	44	44
Bearing plates	4	4	4	4
Cover plate, long	4	4	4	4
Cover plate, short	4	2	4	4
Curb adapters	12	12	12	12
Stiffeners	6	6	6	6
Stiffener pins	152	152	158	168

* The number of tapered balk may be reduced to the quantity needed to fill in the recesses between the curbs.

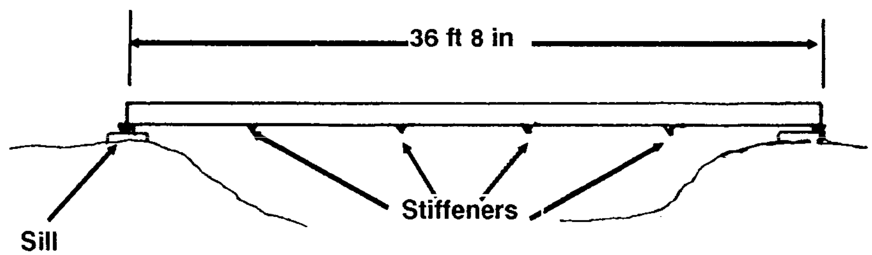
Balk pattern for 36-foot 8-inch single span with 22-balk deck and 18-balk roadway



Components list

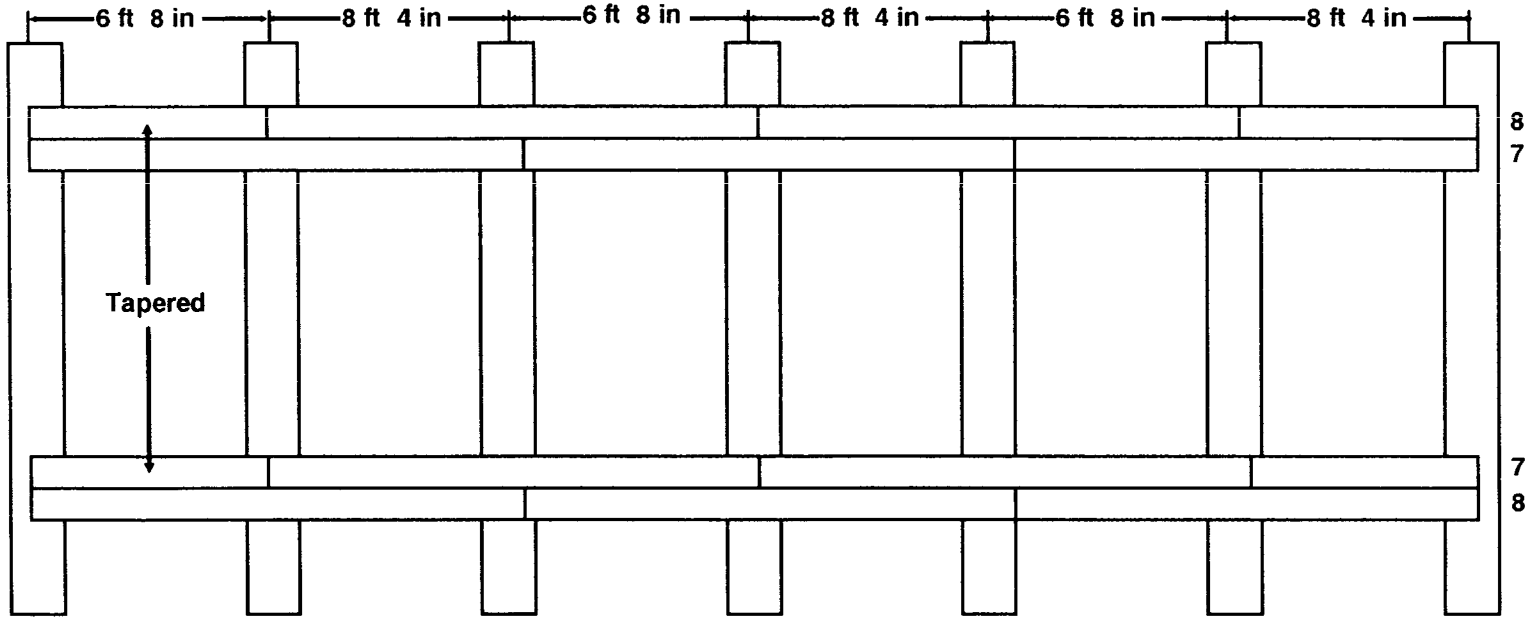
Length of span	36–foot 8–inch single span			
Deck/roadway balk ratio	22/18	22/16	24/18	26/18
Component	Quantity			
Balk, normal	44	44	46	50
Balk, short	0	0	–	–
Balk, tapered*	66	66	66	66
Bearing plates	4	4	4	4
Cover plate, long	4	4	4	4
Cover plate, short	4	2	4	4
Curb adapters	12	12	12	12
Stiffeners	6	6	6	6
Stiffener pins	152	152	158	168

* The number of tapered balk may be reduced to the quantity needed to fill in the recesses between the curbs.



Note: Tapered balk approaches as in 15-foot span

45–foot single spans

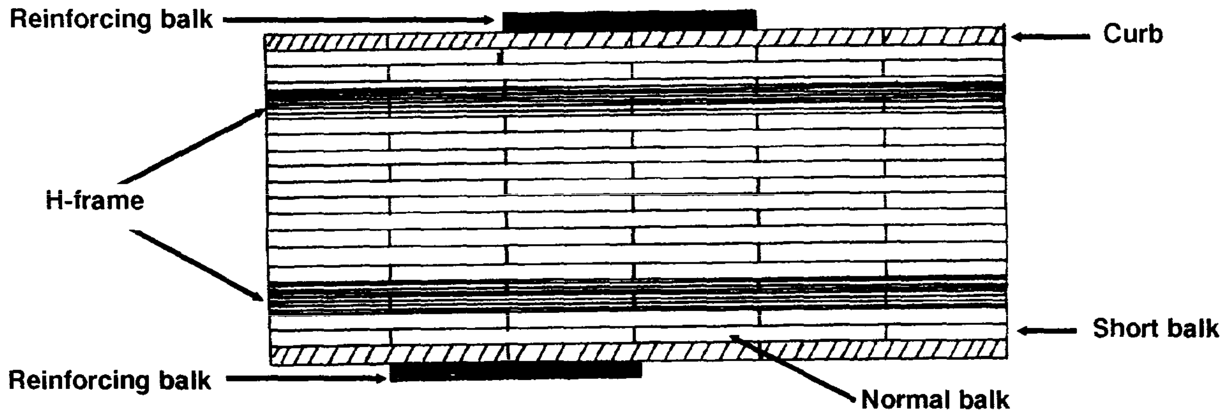


Components list

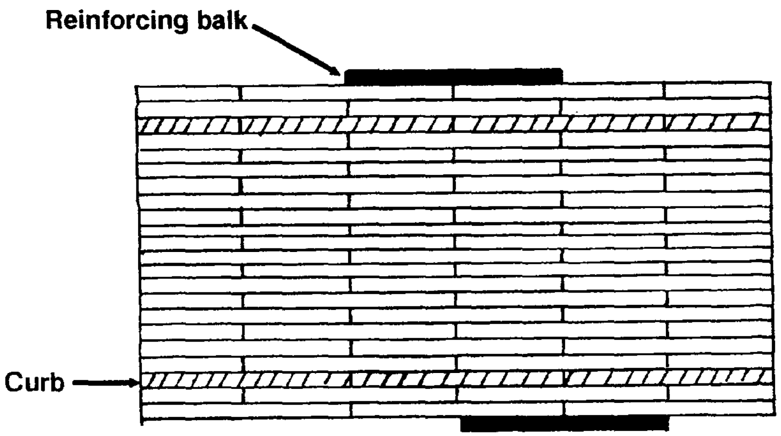
Length of span	45–foot single span						
Deck/roadway balk ratio	20/16	22/18	22/16	24/18	24/18	26/18	26/16
Component	Quantity						
Balk, normal	50	52	52	57	57	61	61
Balk, short	10	10	10	11	11	11	11
Balk, tapered*	50	50	50	55	55	55	55
Bearing plates	4	4	4	4	4	4	4
Cover plate, long	4	4	4	4	4	4	4
Cover plate, short	2	4	2	4	2	4	2
Curb adapters	14	14	14	14	14	14	14
Stiffeners	7	7	7	7	7	7	7
Stiffener pins	162	172	172	182	182	192	192

* The number of tapered balk may be reduced to the quantity needed to fill in the recesses between the curbs.

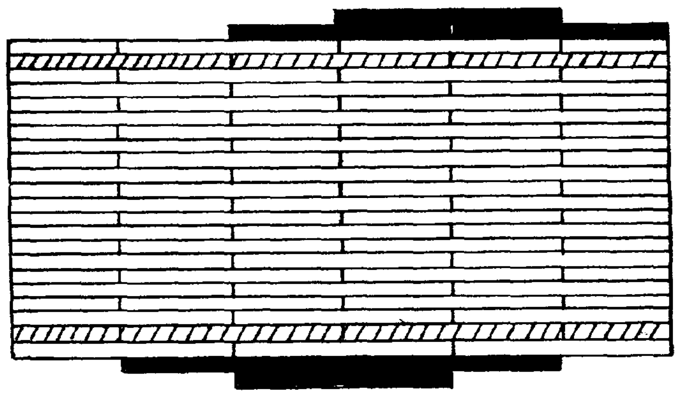
45-foot single span (continued)



Deck/balk ratio = 22/18
Balk pattern for 22-balk deck and 18-balk roadway



Deck/balk ratio = 24/16
Balk pattern for 24-balk deck and 16-balk roadway



Deck/balk ratio = 26/18
Balk pattern for 26-balk deck and 18-balk roadway

CONSTRUCTING FIXED SPANS FROM CLASS 60 EQUIPMENT

Characteristics of Class 60 Fixed Spans

Short fixed spans erected with Class 60 components can provide tactical commanders with a means of crossing narrow streams or dry gaps. Class 60 fixed spans can be built to cross gaps from 24 to 54 feet wide, without intermediate supports. Fixed spans over 54 feet long can be assembled using trestles or piers as intermediate supports. The roadway width for all Class 60 bridges is 13 feet 6 inches.

Components of Class 60 Equipment

The components required to construct Class 60 freed spans are the same as those used to assemble Class 60 floating bridges with the omission of the pneumatic floats and their associated saddle assemblies.

Design of Fixed Bridges Using Class 60 Equipment

Design considerations

The desired load classification and the width of the gap are the two primary considerations when designing Class 60 fixed span bridges. The desired classification is based upon the heaviest vehicle expected to cross the bridge. Determine the width of the gap by running a tape measure across the gap along the proposed location of the bridge centerline. Run the tape from a position on firm ground on one shore to another firm position on the other shore. Stake a line into position across the gap, to mark the measured centerline.

Initial design

Step 1. Determine the required MLC of the bridge. This is normally designated in the mission statement of the operations order.

Step 2. Measure the gap.

Step 3. The bridge must have a minimum of 3 feet of bearing on both banks. Add this bearing requirement to the measure gap width to determine the required bridge length.

Gap width ______feet
Near shore bearing ________+3 feet
Far shore bearing ________+3 feet
Required bridge length = ____feet

Step 4. If the required bridge length is greater than 56 feet, use at least one trestle assembly. If the required MLC of the bridge is Class 60 or less, design a fixed span with a Class 60 trestle arrangement. IF the required MLC of the bridge is greater than Class 60, but not greater than Class 100, design a fixed span with a Class 100 trestle arrangement.

Design of Single Span Bridges Using Class 60 Equipment

Types of single span fixed bridges

There are two types of Class 60 single span bridges. One type uses the bridge's ramp bays as an integral part of the bridge span. Build these bridges in the configurations shown in Table 51 and the figure on page 158. The second type of single span bridge does not use the ramps as part of the bridge span. Construct these bridges as described in Table 52 and shown in the figure on page 159. Build bridges which do not use ramp panels as an integral part of the bridge span with earthen or timber ramps. If Class 60 ramp panels are available, they can be used to provide ramps for these bridges as well. These ramps will rest completely on the ground and will not extend over the gap.

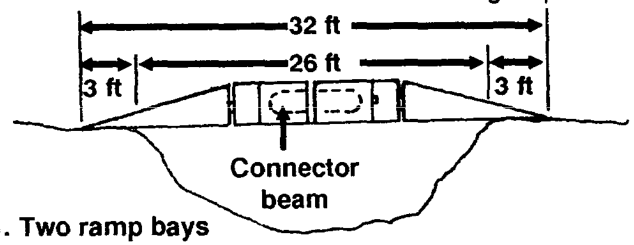
Step 1. Determine the required classification and the required length of the bridge.

Step 2. Refer to Tables 51 and 52. Select the smallest bridge span from each table which is greater than or equal to the required bridge length. Using both tables ensures that the designer considers both types of single span bridges during the design process.

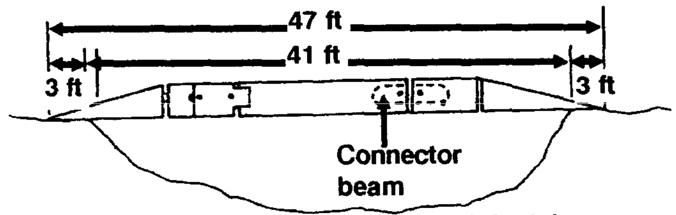
Table 51. Design of Class 60 single span bridges with ramp bays as part of the bridge span

Type of single span	Length of bridge (in feet)	Actual clear span (in feet)	Classification (wheel/track) Normal	Caution	Risk
2 ramp bays	32	24	120/100	120/100	120/100
		26	120/95	120/100	120/100
2 ramp bays plus 1 short deck bay	37.4	28	115/80	120/87	120/100
		30	105/65	110/65	120/90
2 ramp bays plus 1 normal deck bay	47	32	95/60	105/70	120/85
		34	85/55	90/63	110/75
		36	75/50	81/58	100/68
		38	65/45	75/53	90/65
		40	60/40	68/50	83/60
2 ramp bays plus 2 normal deck bays	62	50	30/30	36/36	50/45
		56	20/22	22/25	28/30

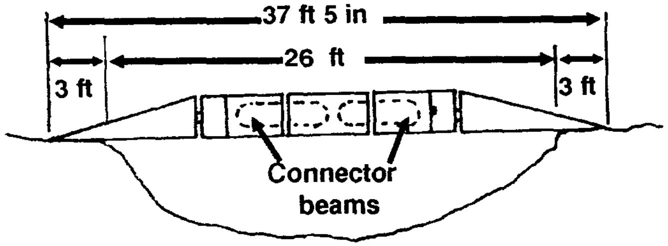
Class 60 single span bridges with ramp panels as part of the bridge span



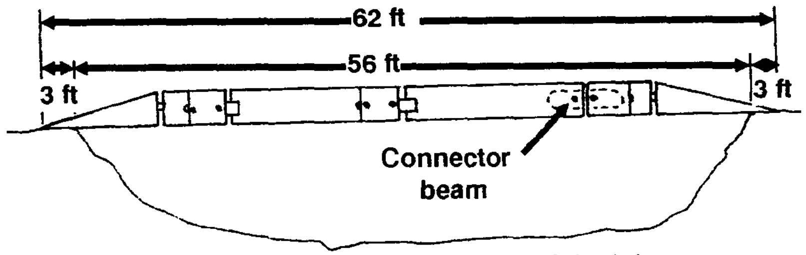
1. Two ramp bays



3. Two ramp bays plus one normal deck bay



2. Two ramp bays plus one short deck bay

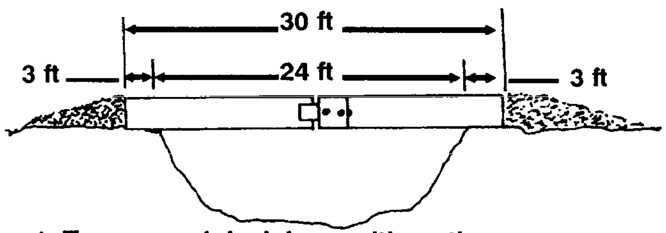


4. Two ramp bays plus two normal deck bays

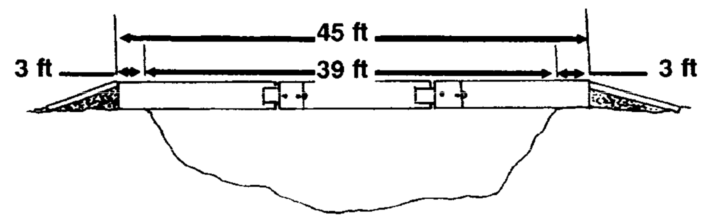
Table 52. Design of Class 60 single span bridges which do not use ramp bays as part of the bridge span

Type of single span	Length of bridge (in feet)	Actual clear span (in feet)	Classification (wheel/track) Normal	Caution	Risk
2 normal deck bays	30	24	120/100	120/100	120/100
3 normal deck bays	45	26	120/100	120/100	120/100
		28	120/85	120/92	120/100
		30	110/70	120/80	120/95
		32	95/60	105/70	120/85
		34	85/55	90/63	110/75
		36	75/50	81/58	100/68
		38	65/45	75/53	90/65
4 normal deck bays	60	40	60/40	68/56	83/60
		50	30/30	36/36	50/45
		54	20/22	22/25	28/30

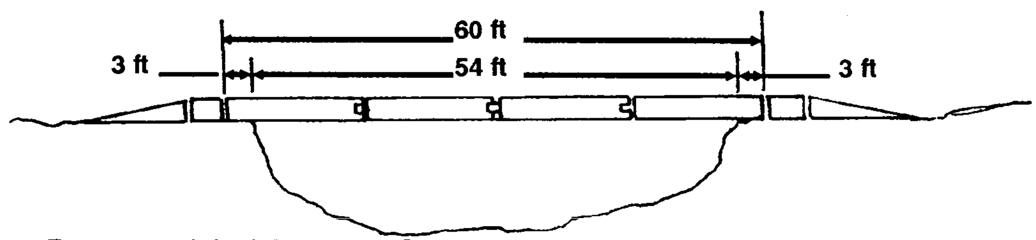
Class 60 single span bridges without ramp panels as part of the bridge span



1. Two normal deck bays with earthen ramps



2. Three normal deck bays with timber/earthen ramps



3. Four normal deck bays with Class 60 ramps. Note that the ramps are not part of the bridge span; that is, they rest completely on the ground.

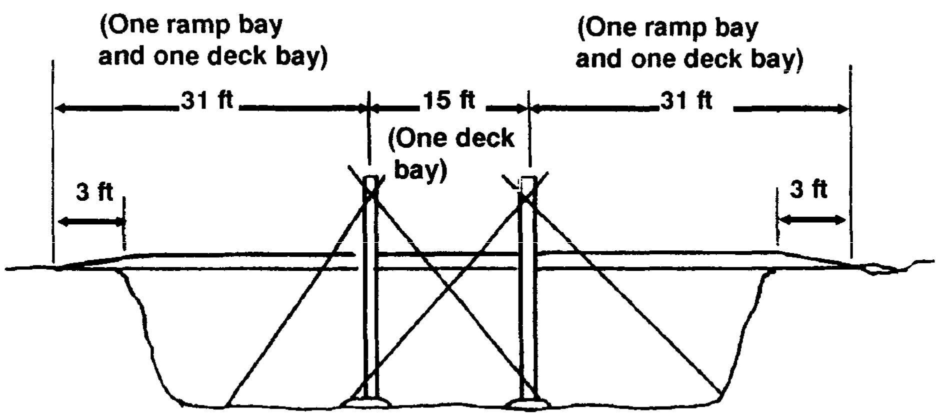
Table 53. Design of Class 60 multiple span bridges with ramp bays as part of the bridge span

Type of end span	Length of span	Classification (W/T)
1 ramp plus 1 short deck bay	21ft 3 in	120/100
1 ramp plus 1 deck bay	31ft	115/80
1 ramp plus 2 deck bays	46 ft	30/30
1 ramp plus 3 deck bays	61ft	20/22

Table 54. Design of Class 60 multiple span bridges which do not use ramp bays as part of the bridge span

Type of end span	Length of span	Classification (W/T)
2 normal deck bays	30 ft	115/80
3 normal deck bays	45 ft	30/30
4 normal deck bays	60 ft	20/20

Construction of a 77-foot multiple span bridge with one Class 60 trestle arrangement



Total length of span 77 ft
MLC Class 60 (based upon trestle classification)

Step 3. Determine the classification(s) of the bridge span(s) that were selected in step 2. Note that for bridge spans longer than 42 feet 10 inches, the classification is based not only on the type span constructed, but also on the actual gap width. This gap width was determined in the initial design.

Step 4. If neither of the single spans selected provide adequate bridge classification, a multiple span bridge using either a Class 60 or Class 100 trestle may be designed. (See the figure on page 161.)

Design of Multiple Span Bridges Using Class 60 Equipment

Like single span bridges, two types of multiple span bridges can be designed. In one type, the near and far shore end sections use ramp panels as an integral part of the bridge span. The second type does not. Bridges which do not use ramp panels as an integral part of the bridge span can be built with earthen or timber ramps. If Class 60 ramp panels are available, they can be used to provide ramps for these bridges as well. These ramps will rest completely on the ground and will not extend over the gap. Refer to the work sheet provided in the figure on page 162 for the design of Class 60 fixed bridges using Class 60 trestle arrangements. Refer to the work sheet provided in the figure on page 164 for the design of Class 60 fixed spans using Class 100 trestle arrangements. For positioning of Class 60 or Class 100 trestle assemblies, refer to the figures on pages 163 and 165, respectively.

Construction of Fixed Bridges Using Class 60 Equipment

The assembly of all Class 60 bridges is conducted in approximately the same manner. As an example, the assembly procedures for a 75–foot span, assembled with ramp panels as a part of the bridge span, is described below. Two Class 60 trestles are used for intermediate supports.

Step 1. Prior to constructing trestles, accurately measure the site and clearly mark the location for all trestles. Position trestles as shown in the figure on page 160.

Step 2. Construct a Class 60 trestle assembly. Refer to the construction of M4T6 multiple span bridges using Class 60 trestle arrangements, step 3. Raise the transom so that it is level with the bank.

Step 3. As the trestle is being braced, join a ramp panel to a normal deck panel using two connector beams. Position the male end of the deck panel to face the far shore. It is easier to assemble the decking when the male end of the panel extends over the transom of the trestle.

Step 4. Once the trestle is in place, use the crane to lift the two-panel section constructed in step 3. Place this section so that it runs from the abutment sill to the transom on the trestle. Take care to ensure that the end of the bottom flange of the panel is about 6 inches beyond the trestle transom so that another panel section can be joined to the first. Engage the sliding retainer assembly to hold the treadway in place on the transom.

Step 5. Construct a second two-panel section, consisting of a ramp panel and a normal deck panel. Place this section across the gap, parallel to the first section. Align the two sections using the panel pin holes. Take care to ensure that the stringer flanges of the two sections are butted against the outer retainer lugs on the trestle transom, so the filler panels can be placed without repositioning the deck panels.

Step 6. Emplace a ramp filler panel, a normal deck filler panel, and a short deck filler panel. Bolt these filler panels to the deck panels. Bolt two normal curbs and four short curbs to the outside flanges on the deck.

Class 60 single span design

1. Required bridge classification — 1. MLC ________

2. Gap width (measured IAW Chapter 10). — 2. ________ feet

3. Safety setback for near shore and far shore is 3 feet (for both prepared and unprepared abutments). — 3a. NEAR SHORE: + 3 ft; 3b. FAR SHORE: + 3 ft

4. Required bridge length (add steps 2, 3a, 3b). — 4. = ________

5. Refer to Tables 51 and 52. Select the shortest bridge span from both tables which meets or exceeds the required bridge length from step 4. — 5a. ________ (from Table 51); 5b. ________ (from Table 52)

6. Determine the classification of the bridge span(s) selected in step 5, using Tables 51 and 52. Compare the bridge span classification to the required classification in step 1. If both selected spans provide adequate classification, either span may be constructed. If neither span provides adequate classification, a multiple span bridge must be designed. — 6a. MLC ________ (from Table 51); 6b. MLC ________ (from Table 52)

7. Final Design:

Type of span ________

Span length ________

Military load class ________

Step 7. Assemble the second trestle arrangement, positioning it 15 feet from the first trestle (center to center). When the second trestle is in position, install and secure the trestle–to-trestle bracing and ground bracing (using the bracing struts).

Step 8. Next, the crane lifts a normal deck panel and backs onto the completed portion of the bridge. Pin the deck panel to the male end of one of the deck panels which are resting on the first transom. Remove the yoke pin and lower the deck panel onto the second trestle. The male end of this panel should extend approximately 6 inches beyond the second trestle. Removal of the yoke pin provides a hinge action over the transom.

Step 9. Connect and lower another 15–foot deck panel to the second transom. Remove the yoke pin to allow hinge action. Place a deck tread filler panel between the deck panels and bolt curbs to each side of the completed section.

Step 10. Construct a third two-panel section, consisting of one ramp panel and one deck panel. This time, the male end of the deck panel is connected to the ramp, so connector beams are not needed. The crane can now lift this two-panel section and back onto the newly constructed portion of the bridge.

Step ll. Pin the two-panel section to one of the deck panels which rests upon the second trestle arrangement. Lower the ramp panel onto the far shore abutment sill.

Step 12. Construct and emplace the final two-panel section. Place one deck filler panel, one short filler panel, and one ramp filler panel. Add two normal curbs and four short curbs to complete the far shore portion of the bridge.

Class 60 fixed span for support with Class 60 trestle arrangement

1. Required bridge classification.	1. MLC ______		
2. Measured gap width.	2. ______ ft		
3. Safety setback for both the near shore and far shore is a constant 3 feet (for prepared and unprepared abutments).	3a. Near shore +3 ft 3b. Far shore +3 ft		
	4. ______ ft		
4. Required bridge length (2+3a+3b).			
5. Initially enter the "2 trestle assemblies" column and subtract 15 ft from the required bridge length in step 4.	5. 2 trestle assemblies	3 trestle assemblies	4 trestle assemblies
	5a. -15 ft	-30 ft	-45 ft
6. Divide the value obtained in step 5b by 2 to determine the length of the 2 end spans.	5b. =	=	=
(1) If the value obtained in step 6b is greater than 60 feet, you must return to step 5 and enter the next column, repeating the design sequence.	6a. −2	−2	−2
	6b. =	=	=
(2) You are not limited to 4 trestles. Only 4 are shown because of space limitations on this form.			
(3) When the value obtained in 6b is less than 60 feet, proceed to step 7.			
7. Refer to Tables 53 and 54. Selcet the shortest end span which is greater than the value from 6b.	7a. ______ (from table 53)	______ (from Table 53)	______ (from Table 53)
8. Determine the classification of the end span(s) selected in step 7a and 7b.	7b. ______ (from Table 54)	______ (from Table 54)	______ (from Table 54)
(1) This classification must meet or exceed the MLC requirement from step 1.	8a. MLC ______	MLC ______	MLC ______
(2) If both values (7a and 7b) meet the MLC requirement, either end span can be selected.	(from Table 53)	(from Table 53)	(from Table 53)
(3) If neither classification meets the MLC requirement, return to step 5, enter the next column of the table, and repeat the design sequence.	8b. MLC ______ (from Table 54)	MLC ______ (from Table 54)	MLC ______ (from Table 54)

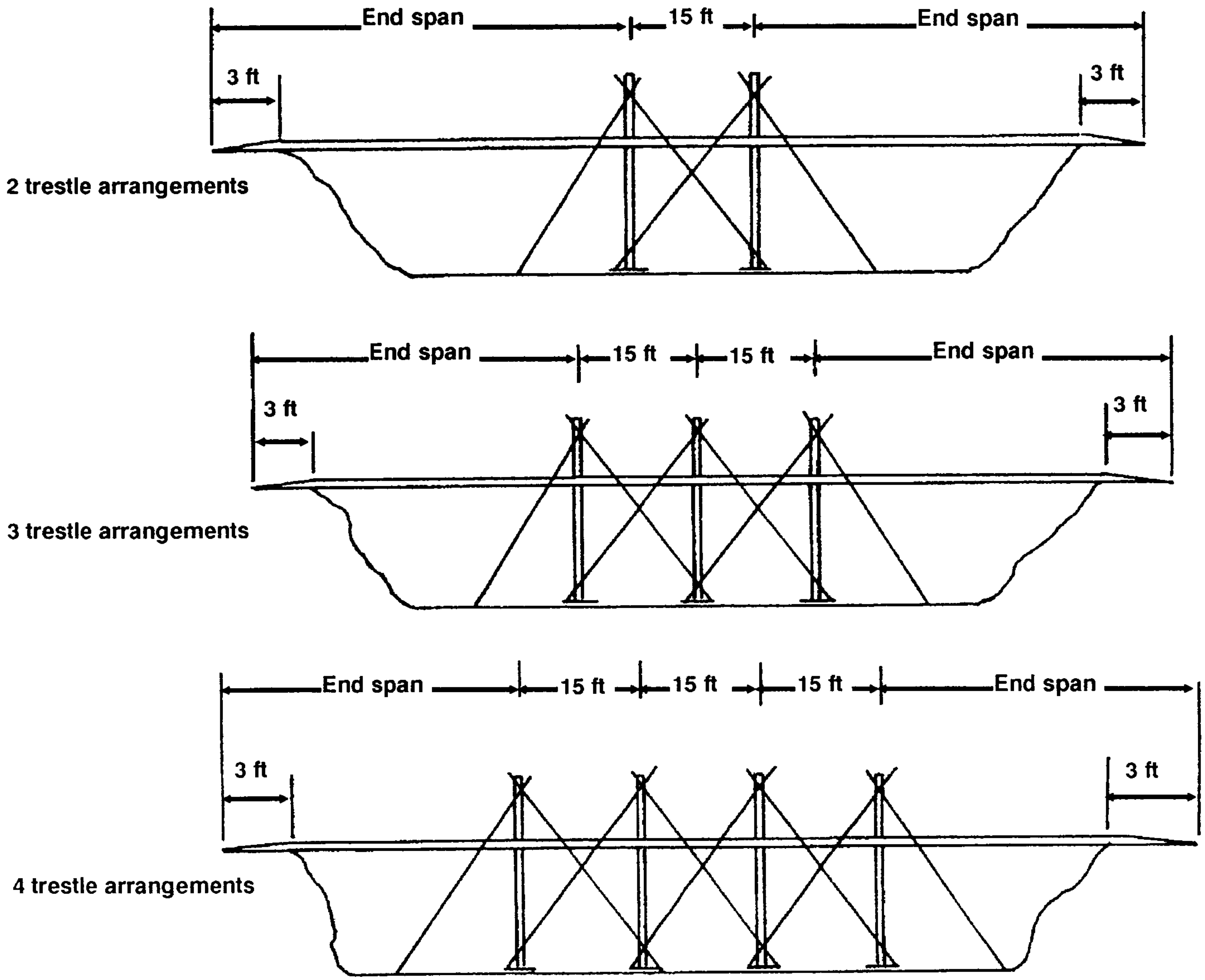
Selected end span______________

MLC______________

(cannot exceed Class 60)

Number of trestle assemblies required______

Class 60 trestle arrangements for Class 60 bridges



Class 60 fixed span for support with Class 100 trestle arrangement

1. Required bridge classification.	1. MLC ______		
2. Measured gap width.	2. ______ ft		
3. Safety setback for both the near shore and far shore is a constant 3 feet (for prepared and unprepared abutments).	3a. Near shore +3 ft		
	3b. Far shore +3 ft		
4. Required bridge length (2+3a+3b).	4. ______ ft		
5. Initially enter the "2 trestle assemblies" column. Do not subtract any distance from the required bridge length from step 4 because the end span rests on the center of the trestle.	5. 2 trestle assemblies	3 trestle assemblies	4 trestle assemblies
	5a. -0'0" ft	-30 ft	-60 ft
6. Divide the value obtained in step 5b by 2 to determine the length of the end spans.	5b. =	=	=
(1) If the value obtained in step 6b is greater than 60 feet, you must return to step 5 and enter the next column, repeating the design sequence.	6a. ÷2	÷2	÷2
(2) You are not limited to 4 trestles. Only 4 are shown because of space limitations on this form.	6b. =	=	=
(3) When the value obtained in 6b is less than 60 feet, proceed to step 7.			
7. Refer to Tables 53 and 54. Select the shortest end span which is greater than the value from 6b.	7a. ______ (from Table 53)	______ (from Table 53)	______ (from Table 53)
	7b. ______ (from Table 54)	______ (from Table 54)	______ (from Table 54)
8. Determine the classification of the end span(s) selected in step 7a and 7b.			
(1) This classification must meet or exceed the MLC requirement from step 1.	8a. MLC ______ (from Table 53)	MLC ______ (from Table 53)	MLC ______ (from Table 53)
(2) If both values (7a and 7b) meet the MLC requirement, either end span can be selected.			
(3) If neither classification meets the MLC requirement, return to step 5, enter the next column of the table, and repeat the design sequence.	8b. MLC ______ (from Table 54)	MLC ______ (from Table 54)	MLC ______ (from Table 54)

9. Final design:

Selected end span______

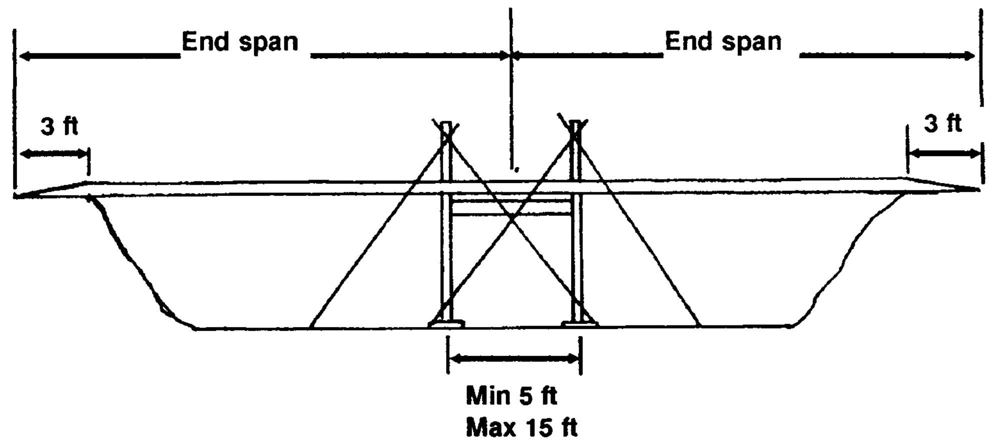
MLC______

(cannot exceed Class 100)

Number of trestle assemblies required______

Class 100 trestle arrangements for Class 60 bridges

1 trestle arrangement



2 trestle arrangements

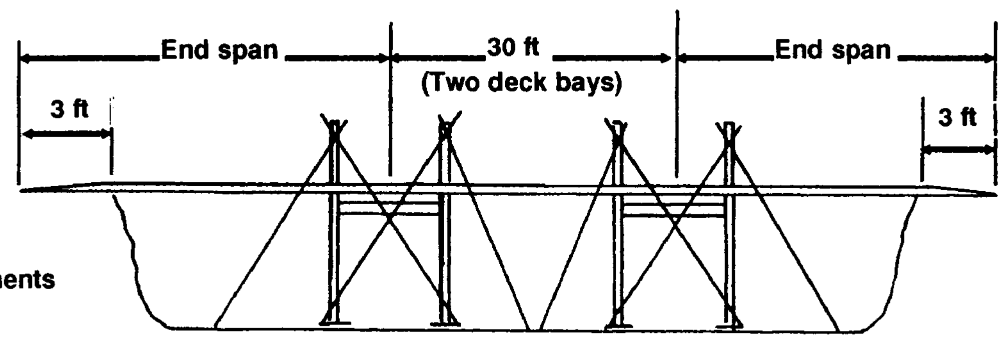


Table 55. Capabilities of LTR fixed spans

Type of crossing	Classification (wheel/track) based upon length of clear span									
	20 ft	22 ft	24 ft	26 ft	28 ft	30 ft	32 ft	34 ft	36 ft	38 ft
Normal	21/17	18/15	16/13	14/12	12/11	11/10	10/9	9/8	8/7	7/7
Caution	25/19	20/17	18/15	16/14	14/13	12/12	11/11	10/10	10/9	9/9
Risk	32/23	23/19	20/17	18/16	16/15	16/14	15/13	13/12	11/12	10/11

Notes.

1. A normal crossing is based upon a maximum vehicle speed of 25 mph on the bridge. Vehicle spacing is at least 100 feet and no sudden stopping or accelerating is allowed on the bridge.
2. A caution crossing is based upon a maximum vehicle speed of 8 mph on the bridge. Vehicle spacing is at least 150 feet and no stopping, accelerating, or shifting gears is allowed on the bridge. Vehicles must stay within 12 inches of the bridge centerline.
3. A risk crossing is based upon a maximum vehicle speed of 3 mph on the bridge. Only one vehicle is allowed on the bridge at a time and each vehicle must have a ground guide. No stopping, accelerating, or shifting gears is allowed. Vehicles must stay within 9 inches of the bridge centerline.
4. Classification is based upon length of clear span (gap width) not total span length (including bearing on both shores).

Step 13. Make final adjustments to the trestle transoms using the ratchet chain hoists, and ensuring that the bridge is as level as possible.

FIXED SPANS CONSTRUCTED FROM LTR

Characteristics of Fixed Spans Constructed from Light Tactical Floating Equipment

Expedient means can be used to erect freed bridges from the superstructure components of the LTR. After assembling sections of the bridge on rollers from the roller conveyor set, launch the bridge across the gap to provide up to 38 feet of bridge without intermediate supports. The roadway width of all light tactical bridges is 9 feet.

Capabilities of LTR Fixed Spans

Table 55 provides the load classifications of various span lengths which can be built from LTR components.