Chapter 5

M4T6 Floating Bridges And Rafts

The M4T6 floating bridges and rafts consist of a deck built of square, hollow aluminum sections (called balk) supported by pneumatic floats. The M4T6 equipment is hand erectable, air transportable, and can provide the crossing force commander with rafts and bridges capable of supporting MLC 70 traffic in river currents up to 8 FPS. The M4T6 was designed after World War II, combining the best characteristics of the older M4 and Class 60 bridges. Proper military nomenclature for this set is the *Bridge, Floating, Aluminum, Highway Type, Desk Balk Superstructure on Pneumatic Floats.* Until the advent of the ribbon equipment system in 1972, M4T6 equipment provided the state of the art means of conducting military river crossing operations.

COMPONENTS

The major components of one set of M4T6 are—

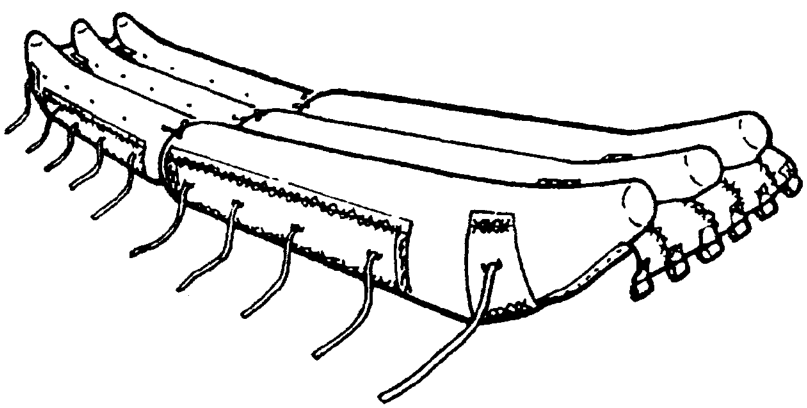
Floats

The pneumatic float which supports the M4T6 deck actually consists of two half-floats. Each half-float is 9 feet wide, 3 feet high, 22 feet long, and weighs 750 pounds. These half-floats are, in turn, made up of three tubes (called sausages) laced together side by side. These tubes are divided into four inflatable chambers, each fitted with a valve. The tapered noses, or bow ends, are upswept 40 degrees and covered with laced skirts. The skirts prevent debris from lodging between the tubes, improve the hydraulic characteristics of the float, and protect the tubes from puncture during launching.

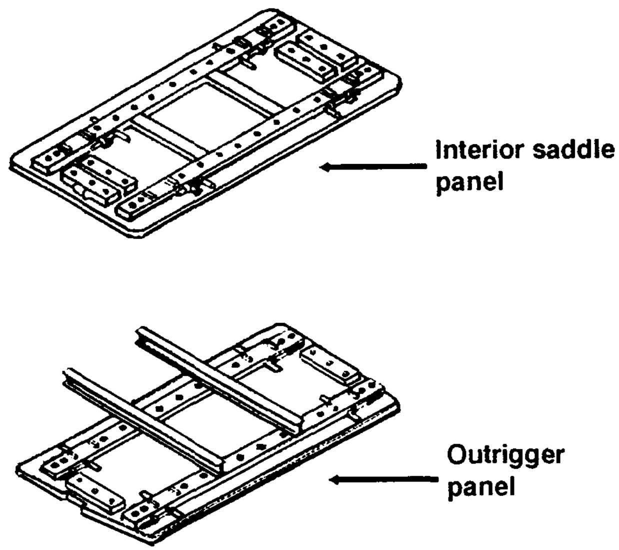
Saddle Assembly

The saddle assembly is placed upon the pneumatic float and bears the load of the bridge itself. The saddle assembly for a float includes eight interior saddle panels, two outrigger panels, and two saddle beams. Each saddle beam actually consists of five individual beams connected by double pinned joints. The weights

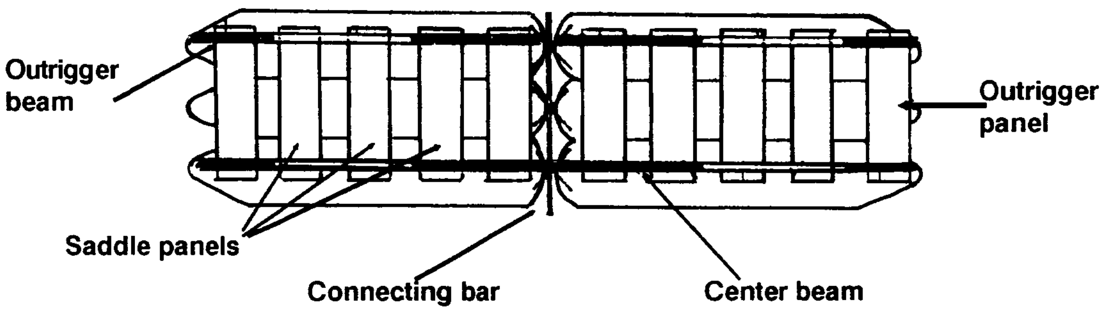
Two M4T6 half–floats

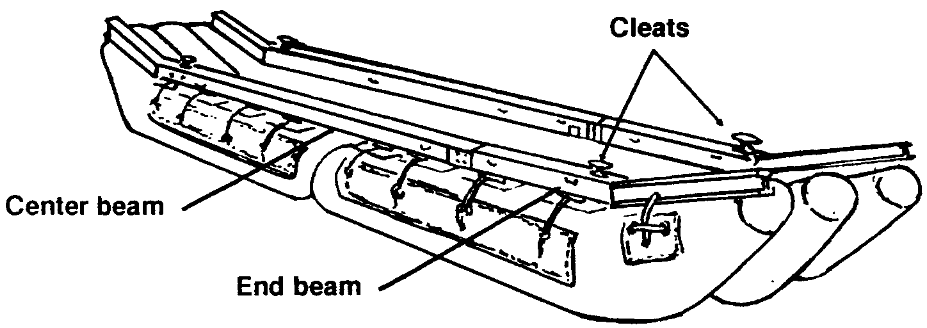


Interior saddle and outrigger panels



24–ton float and saddle assembly





Saddle panel dimensions

Interior saddle panel

Length: 7.5 ft
Width: 3 ft
Thickness: 2 in
Weight: 165 lb

Outrigger panel

Length: 7.33 ft
Width: 5.13 ft
Thickness: 5 in
Weight: 180 lb

Saddle beam dimensions

Center beam

Length: 16.5 ft
Weight: 465 lb

End beam

Length: 9.4 ft
Weight: 275 lb

Outrigger beam

Length: 6.6 ft
Weight: 96 lb

and dimensions of these items are provided in the figure.

The two center beams rest on four saddle panels. At each end of the center beam, a shorter beam, called an end beam extends to the end of the level length of the float and rests on two saddle panels. Each end beam is extended by a lighter, inclined outrigger beam which rests on an inclined outrigger panel. The saddle beams are equipped with cleats (on the end beams) for securing the towing lines and with handles designed to receive the float straps. The center beam is also equipped with retainer lugs for receiving the saddle adapters.

Saddle Adapters

The two types of saddle adapters are normal and offset. Their primary purpose is to provide a means to connect the deck balk superstructure to the saddle assembly, and to do this in such a way to provide sufficient work space between the two. Two like saddle adapters are used per bay of bridge (per pneumatic float). The saddle adapters are connected to the center saddle beams using the sliding retainer lugs located on these beams and their dimensions are given in the figure. In addition to providing work space between the saddle assembly and the balk, the offset saddle adapters permit floats to be placed closer together to allow for reinforced construction. To accomplish this, the beams which receive the balk-connecting stiffener have been shifted off-center approximately 14 inches.

Balk-Connecting Stiffener

Balk-connecting stiffeners are secured to the saddle adapters and are designed to receive the bridge's deck balk. The stiffener has 26 recesses, each spaced 9.25 inches apart. These recesses receive the lugs on the bottom of the deck balk. Each piece of deck balk is secured to the stiffener with a steel pin. This pin is the same type used to connect the stiffener to the saddle adapters.

Deck Balk

The three types of aluminum deck balk used in construction of M4T6 bridges and rafts are normal, short, and tapered balk.

Normal balk

Normal balk is the primary component of the bridge's deck. Normal deck balk is 15 feet long, 9.25 inches in depth, and 8.5 inches wide. Normal balk weighs 225 pounds and is usually carried by four soldiers. Lugs on the lower side of the balk enable it to be pinned to the balk-connetting stiffener.

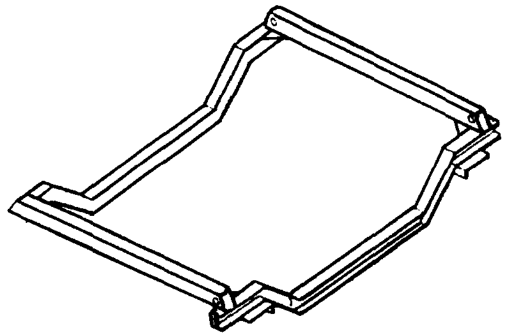
Short balk

Short balk is designed to fill gaps in the normal balk pattern. These gaps occur—

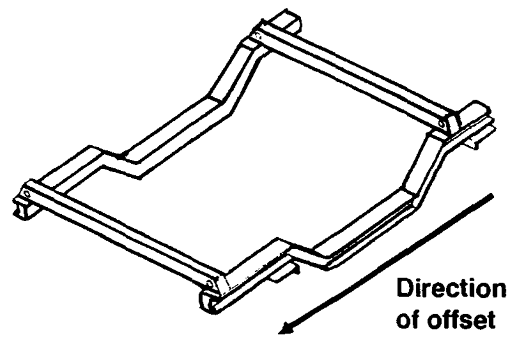
- At the end of any five-float reinforced raft with a 16-foot 7-inch overhang.
- At the end of any five-float normal raft with a 23-foot 4-inch overhang.
- At both ends of any 23-foot 4-inch or 38-foot, 4-inch M4T6 fixed span.
- At one end of any 30- or 45-foot M4T6 fixed span.

Short balk are 8 feet 4 inches long and have the same cross section as normal balk. Each piece of short balk weighs 122 pounds and can be carried by two soldiers.

Normal saddle adapter



Offset saddle adapter

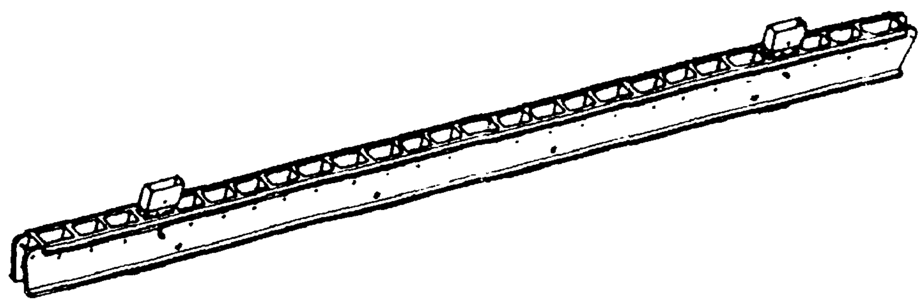


Saddle adapter dimensions

Normal saddle adapter	
Length:	7.2 ft
Width:	5.5 ft
Depth:	1.4 ft
Weight:	260 lb

Offset saddle adapter	
Length:	8.1 ft
Width:	5.5 ft
Depth:	1.4 ft
Weight:	275 lb

Balk–connecting stiffener



Tapered balk

Tapered deck balk are used to create a sloping approach to the bridge deck and to fill gaps between the ends of normal balk. These gaps occur —

- At the end of any normal floating bridge that has a 21-foot 8-inch end span.
- At the end of a four-float reinforced raft with a 21-foot 8-inch overhang.
- At both ends of any 21-foot 8-inch M4T6 freed span.
- At one end of any 30- or 45-foot M4T6 fixed span.

Tapered deck balk are 6 feet 8 inches long and have the same cross section and fittings as normal balk at one end. The other end is tapered and ends in a hinged plate. Each piece of tapered balk weighs about 100 pounds and can be carried by two soldiers.

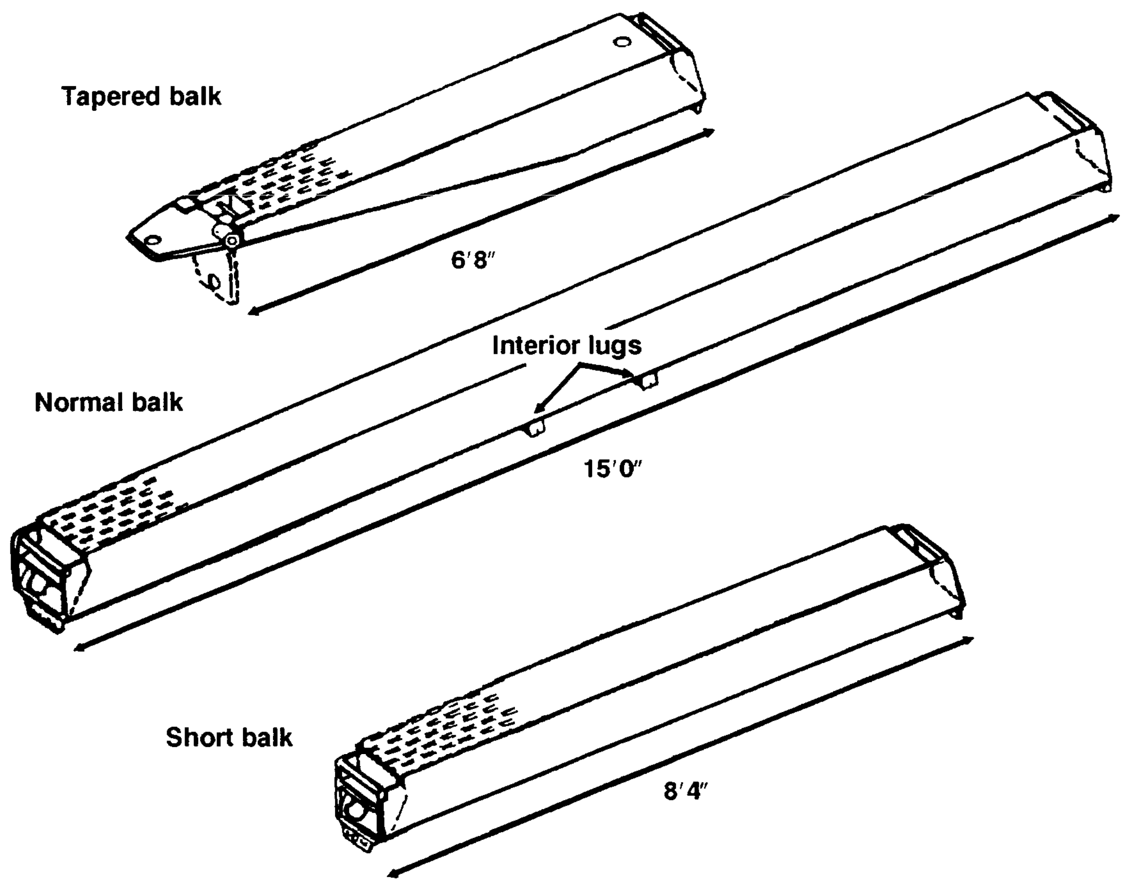
Curb Adapters

Steel curb adapters are used to raise normal deck balk 6 inches above the level of the roadway to provide curbing for a bridge or raft. These adapters are attached by pins to the balk-connecting stiffeners. Each adapter weighs about 15 pounds.

Ramps

Four aluminum alloy raft ramps are used at each end of a raft to provide a sloping approach. Raft ramps are a little over 3 feet wide and have an effective length of 3 feet. They weigh 235 pounds and are normally carried by three soldiers. Each ramp is connected to the end of the raft by one horizontal pin and two vertical pins.

Deck balk



Abutment Plates

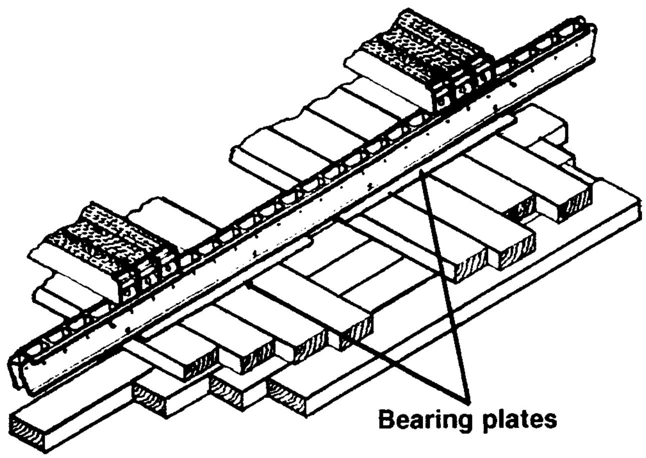
Bearing plates

Abutment bearing plates are 5 feet 9.75 inches long, 1 foot wide, 3.75 inches high, and weigh 165 pounds. This plate is fastened to the last balk-connecting stiffener on M4T6 bridges to distribute the load of the bridge on the shore.

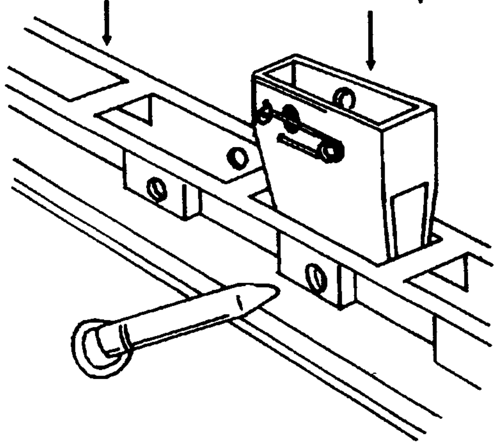
Cover plates

Aluminum alloy cover plates are used over joints in the deck and at abutments and trestles to protect balk handles from being damaged by vehicles crossing the bridge. Two short cover plates (1.5 feet long) and two long cover plates (5.3 feet long) are required to cover the normal width of the bridge deck. The short cover plate weighs 28 pounds while the long plate weighs 97 pounds.

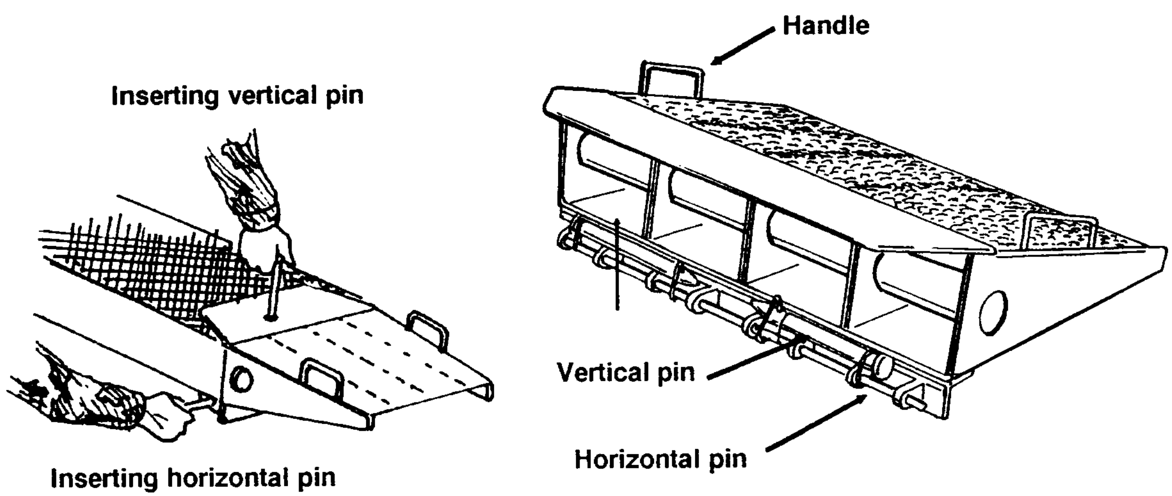
Abutment sill



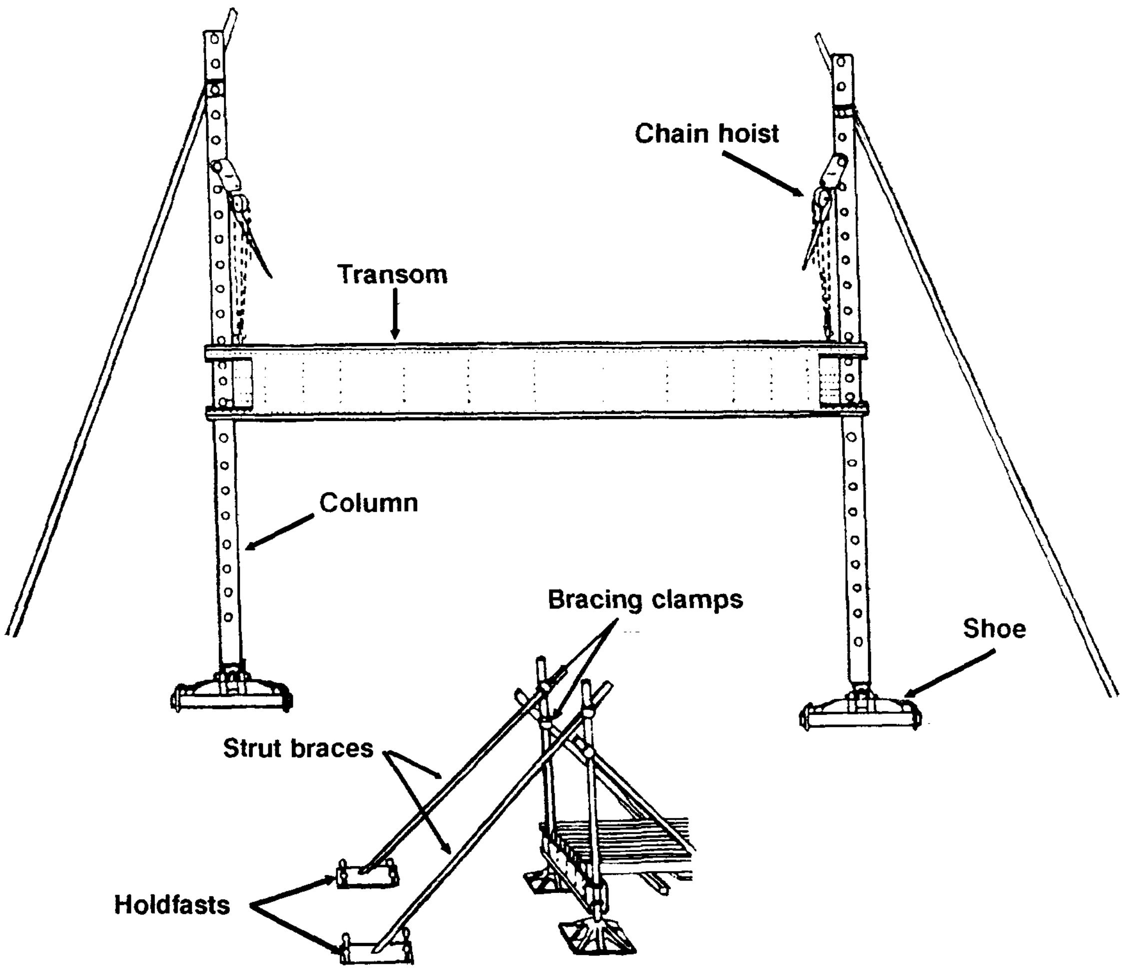
Curb adapter



Raft ramps



Universal trestle arrangement



Trestle and Bracing

Universal trestle

The universal trestle consists of one transom, two columns, two shoes, and two chain hoists. The top of the transom is fitted with recesses to accept 22 pieces of balk. The transom is pinned to each column. Each column has holes spaced every 6 inches to accommodate the transom. Three holes in the transom are spaced 9 inches apart to permit adjustments in transom height. These adjustments are made using chain hoists.

Trestle (strut) bracing

Trestle bracing gives lateral and longitudinal stability to the trestles. The following trestle bracing equipment is issued with each trestle: four strut braces, weighing 145 pounds each; eight bracing clamps, weighing 50 pounds each; two wrenches, weighing 13 pounds each; and four holdfasts (with pickets), weighing 68 pounds each.

Other accessories

Other accessories issued with the bridge include handrail posts (used on each side of the roadway), standard 100-pound kedge anchors, prefabricated holdfasts, a bicycle traveler for ferrying operations, an inflatable craft repair kit, and a bridge erection set.

ALLOCATION OF M4T6 EQUIPMENT

Currently, all active duty float bridge companies are equipped with ribbon float bridge equipment rather than M4T6. Some US Army Reserve and National Guard float bridge companies still maintain M4T6. Those companies which retain M4T6 are authorized five sets, providing about 700 feet of normal bridge or 540 feet of reinforced bridge. All other M4T6 equipment is maintained in depot stocks. One set of M4T6 can be used to construct any one of the following:

- One 141-foot 8-inch normal bridge
- One 108-foot reinforced bridge
- One four-float normal raft
- One five-float normal raft
- One four-float reinforced and one five-float reinforced raft
- One six-float reinforced raft
- Three short fixed span bridges

TRANSPORTATION AND LOADING OF M4T6

The M4T6 can be carried on any standard military cargo truck or trailer having a rated capacity of 2 1/2 tons or more. Standard bridge trucks include the older M821(diesel) and M139 (gasoline) bridge trucks as well as the M812 bridge transporter. The M812 chasis has been modified to safely accommodate bridge loads in excess of 5 tons. Components of the set may also be airlifted using medium or heavy lift helicopters LAW Appendix B.

Normal Loading of M4T6 Equipment

One set of M4T6 can be transported on 12 bridge trucks. Of these trucks, 5 trucks are used to carry normal bridge bay loads, 4 trucks carry offset bridge loads, 1 truck carries the trestle load, 1 truck transports the anchorage load, and 1 truck hauls the tools and rigging equipment. More specifically, each truck is normally loaded as shown in Table 12a, b, c, and d.

Table 12a.
Transportation of M4T6

Normal bay loads (5 per M4T6 set)	
Component	**Quantity per load**
Half pontons (connected w/connecting bar)	**2 ea**
Saddle assembly (with normal saddle adapters)	**1 ea**
Normal balk	**26 ea**
Tapered balk	**8 ea**
Raft ramps	**4 ea**
Anchors	**4 ea**
Handrail posts	**2 ea**
Tag line, manila rope	**50 ft**
Offset bay loads (4 per M4T6 set)	
Component	**Quantity per load**
Half pontons (connected w/connecting bar)	**2 ea**
Saddle assembly (with offset saddle adapters)	**1 ea**
Normal balk	**22 ea**
Short balk	**12 ea**
Raft ramps	**0**
Anchors	**1 ea**
Handrail posts	**4 ea**
Tag line, manila rope	**50 ft**

Table 12b.
Trestle load (1 per M4T6 set)

Component	**Quantity**
Trestle assembly, universal type, consisting of:	**2 ea**
Adapter, pin assembly	**44 ea**
Bolt, column–shoe, connecting	**4 ea**
Bracket assembly, chain hoist	**4 ea**
Clamp assembly, trestle bracing	**20 ea**
Column assembly	**4 ea**
Holdfast	**8 ea**
Pin, lock	**52 ea**
Pin, lock	**4 ea**
Pin, transom	**4 ea**
Retainer assembly, sliding	**8 ea**
Shoe assembly, trestle	**4 ea**
Strut, bracing, trestle	**12 ea**
Transom assembly	**2**
Adapter, pin assembly	**8 ea**
Bag, Bailey brg, parts and tools	**4 ea**
Balk, deck, normal	**2 ea**
Balk, deck, short	**18 ea**
Stiffener, balk–connecting w/30 pins	**2 ea**
Adapter, curb	**4 ea**
Pin assembly, transom	**2 ea**
Plate, bearing, balk–connecting stiffener	**12 ea**
Plate, cover, long	**8 ea**
Plate, cover, short	**8 ea**
Rope, manila, 1/2–inch dia	**100 ft**
Rope, manila, 1–inch dia	**400 ft**

Table 12c.
Anchorage load (1 per M4T6 set)

Component	Quanitiy
Bracket, outboard motor	4 ea
Lumber, footing, softwood	48 ea
Sandbag, burlap	500 ea
Picket, steel	72 ea
Holdfast, chain, w/9 ea picket steel	16 ea
Bag, Bailey, parts and tools	1 ea
Connector, bridle, sheave	9 ea
Base, anchor tower	2 ea
Cap adapter, anchor tower	2 ea
Cap assembly, anchor tower	2 ea
Frame, hinge, anchor tower	2 ea
Pivot unit, anchor tower	2 ea
Tower unit, anchor tower	4 ea
Wire rope, steel 5/8-inch dia	1,200 ft
Wire rope, steel 3/4-inch dia	1,200 ft

Table 12d.
Tool and rigging load (1 per M4T6 set)

Component	Quantity
Erection set, dual purpose, compl	1 set
Bag, Bailey, parts and tools	7 ea
Chest, chain hoist	2 ea
Clip wire rope for 5/8 inch dia wire rope	100 ea
Clip wire rope for 3/4 inch dia wire rope	100 ea
Compressor, rotary, power driven	2 ea
Depressor, hydraulic balk, assembly	1 ea
Gage, air, low pressure	2 ea
Hammer, hand, machinist's	2 ea
Hoist, chain, 5–ton	4 ea
Hook, boat, 10–foot long	8 ea
Light marker, ground obstruction	100 ea
Pin assembly, balk stiffener	120 ea
Repair kit, inflatable craft	1 ea
Rope, manila, 1/2–inch dia	1,200 ft
Thimble, for 5/8–inch dia wire rope	24 ea
Thimble, for 3/4–inch dia wire rope	24 ea
Tape, luminous, plastic, 50–yard roll	2 rolls

CONSIDERATIONS FOR TACTICAL EMPLOYMENT

Because of the considerable time and number of personnel required to construct M4T6 rafts and bridges, this equipment will probably not perform a major role in the rafting phase or even in the early stages of the bridging phase of a deliberate river crossing operation. The M4T6 rafts may be needed in situations where insufficient ribbon assets are available to swiftly cross the desired number of armored vehicles. Additionally, as the crossing force commander secures the bridgehead area and prepares to move forward, he will consider removing his ribbon bridges to deploy them with the advancing forces. These ribbon bridges must be replaced with more permanent bridges to sustain lines of communications. The M4T6 bridges, placed along MSRs, will normally serve in this capacity. The major consideration in determining the location of such a bridge is the existence of a well-defined road network leading both to and from the bridge site. Other considerations include the availability of adequate assembly sites, sufficient water depth, as well as the need for specialized equipment, such as air compressors, cranes, and BEBs. A discussion of these requirements is provided in this chapter.

GENERAL CONSTRUCTION

The M4T6 floats (bays) maybe constructed by hand at the bridge site, or they maybe partially preassembled in rear areas and then completed upon arrival at the launch site. When bays are preassembled, a crane or some comparable lifting device must be available to complete final assembly of the float. The two types of M4T6 bays are normal bays and offset bays. The difference between the two is determined by the type of saddle adapters attached to the bay's saddle assembly. Normal and offset bays are constructed in exactly the same manner.

Assembly and Launching of Floats by Hand

1. Two deflated half-floats are laid out stem to stern. These half-floats are connected by threading a connecting bar through the flaps on the bottom of each float, and buckling the crisscross straps at the top of one half-float to the D-rings of the other. One-inch manila rope may also be used in place of the connector bar.

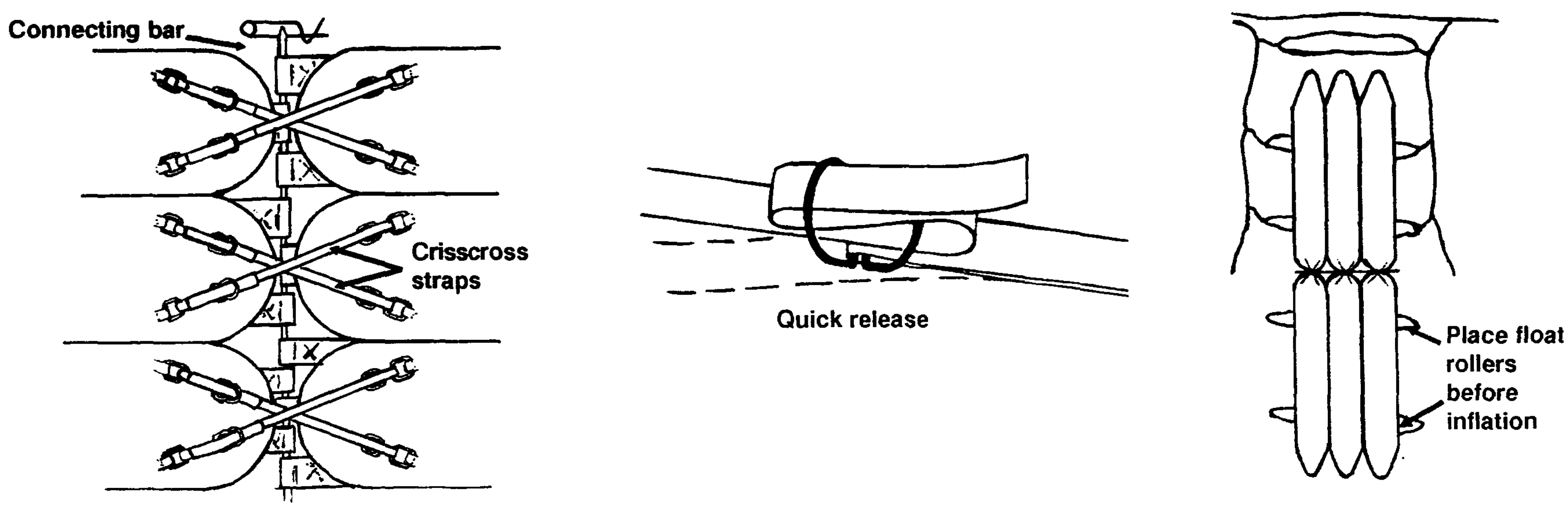
2. Float rollers can be used to launch M4T6 bays when the bays are constructed by hand and no crane or other lifting device is available. Each float roller is equipped with two air valves (one at each end). Float rollers are placed beneath the uninflated M4T6 float prior to the construction of the remainder of its substructure. The proper method of positioning the float rollers is to place the first float roller beneath the position where the first interior saddle panel will be placed. The additional float rollers are then spaced evenly beneath the remainder of the float.

3. Once the rollers are in position, the retrieving lines are attached to each float roller. One rope should be run through the end of each roller and secured to D-handled pickets until the float is ready for launch.

4. The float is then inflated, working from the stern to the bow. There are four compartments in each of the three tubes which make up each half-float. Each compartment should be filled to a pressure of 2 psi, using a 250 cubic feet per minute (CFM) air compressor.

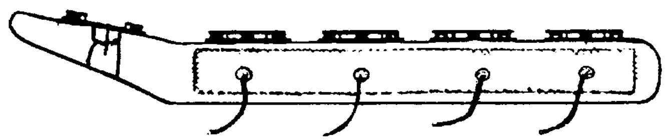
5. Once the floats are inflated, the saddle assembly crew can construct the remainder of the substructure. The 10 saddle panels are placed on the top of the floats. These panels are placed so that the handles on the panels are in line with the tie-down straps on the outside of the floats. Do not tie the panels

Assembly of floats by hand

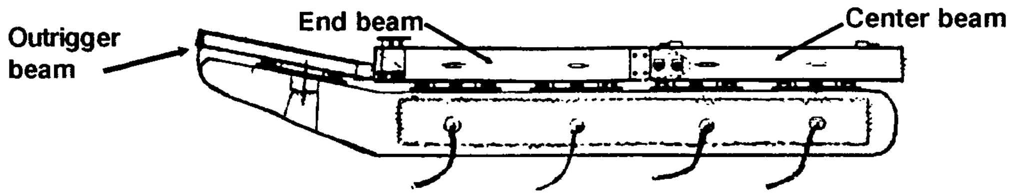


Assembly of floats by hand (continued)

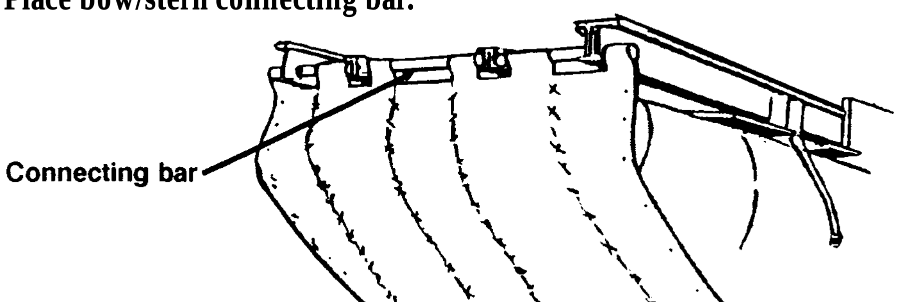
1. Position saddle panels so that handles are in line with tie-down straps.



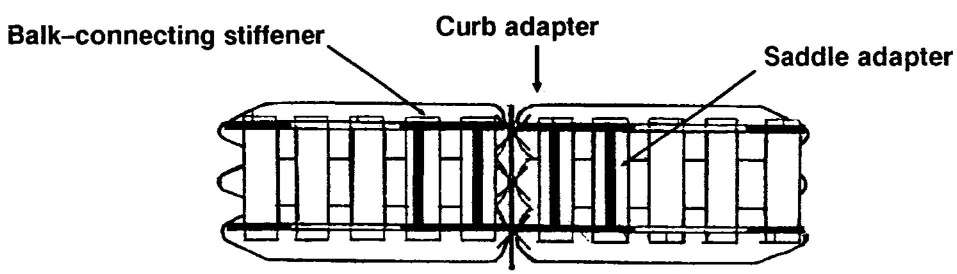
2. Place saddle beams on panels. Lock into place.



3. Place bow/stern connecting bar.



4. Place saddle adapters and balk-connecting stiffeners.



down until assembly of the substructure is completed.

6. Next, the saddle beams are placed on top of the panels. The two center beams are placed on the four center panels. These beams are locked into place using the spring-actuated catches on the panels. The four end beams should be attached once the center beams are in place. One end beam is attached to the end of each center beam using two connecting pins. The end beams are placed so that the tie-off cleat is located on the top of the beam. These beams are not attached to the panels until the float is almost completed. The last beams connected are the outrigger beams. These beams are connected in the same manner as the end beams.

7. Once the saddle beams are in place, the two connecting bars are installed. Prior to installing one connecting bar to each end of the float, remove the guide pins from each of the outrigger beams. This will allow the beam to be raised or lowered as needed without great difficulty. The connecting bars should be threaded through the outrigger beams and the holes provided in the skirt at the bow end of the float. Pushup on the ends of the float to reinstall the guide pins. All panel should be attached to the saddle beams at this time.

8. The saddle adapters are added next. The two adapters rest on the top of the center beams. Each adapter is held in place by the sliding retainer lugs on the beam. A safety pin is placed on each retainer lug to prevent it from accidentally disengaging from the saddle adapter.

9. The balk-connecting stiffeners are next placed on top of the saddle adapters. These stiffeners are fixed to the saddle adapters by four stiffener pins (four pins are placed on each stiffener). Curb adapters should be pinned into the 10th recess on both the left and right side of the stiffener. The substructure is now complete.

10. Secure all panels to the float. Run the straps attached to the outside of the float through the handle on the panel above it. If possible, the straps should also be run through the handle on the saddle beam above the panel. The straps below the outrigger panels are attached to the outrigger beam. Next, fold the strap in half and run it back through the D-ring to provide a quick release.

11. Once the float is completely assembled, and two tag lines (ropes) are attached to the float, the float rollers may be inflated. Inflation should begin with the roller closest to the water and worked towards the rear of the float. Each roller is filled to a pressure of 2 psi, using an air compressor. Members of the saddle assembly crew should man the tag lines during float roller inflation.

12. Once roller inflation is completed, the float can be pushed into the water, either by hand or by the bridge truck. When the float is in the water, the saddle assembly crew can retrieve the rollers and position them for the next assembly and launch.

Preassembly of Bays

To decrease the assembly time along the river line, bays may be preassembled in rear areas and driven forward on 5-ton bridge trucks or trailers. Normally, bays will be only partially preassembled, although it is possible to completely preassemble floats and transport them to the river. In either case, a crane is needed both at the preassembly site and at the launch site.

Partial preassembly (prepack assembly)

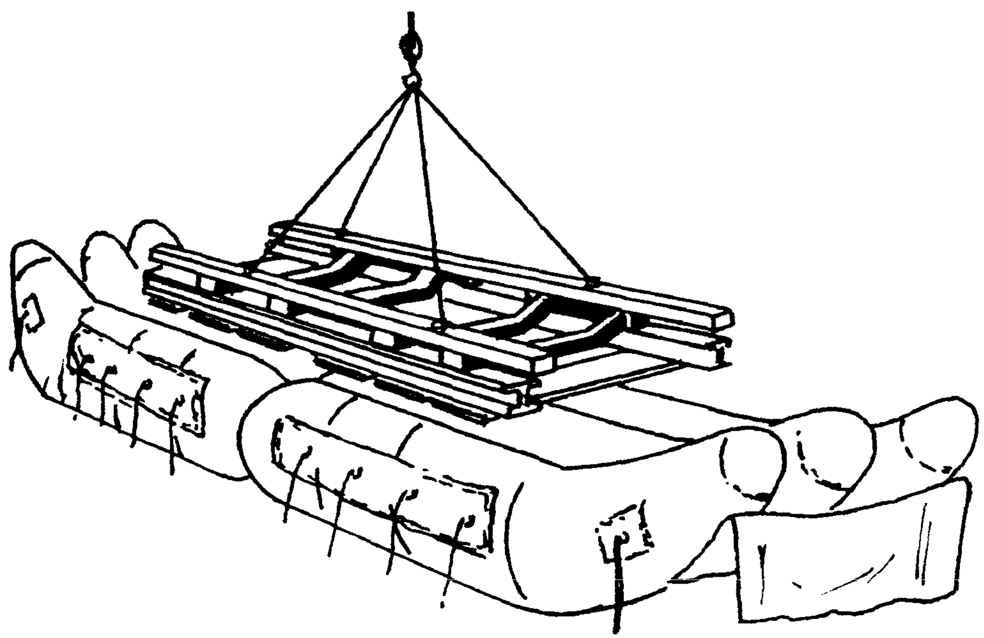
1. Construction of a prepack basically involves the preassembly of the center section of the saddle assembly. The four saddle panels are connected to the two center beams with the two saddle adapters and balk-connecting stiffeners attached. The remaining panels and beams are loaded on top of this prepack. This allows a crane to off-load the entire saddle assembly and place it directly onto the inflated float.

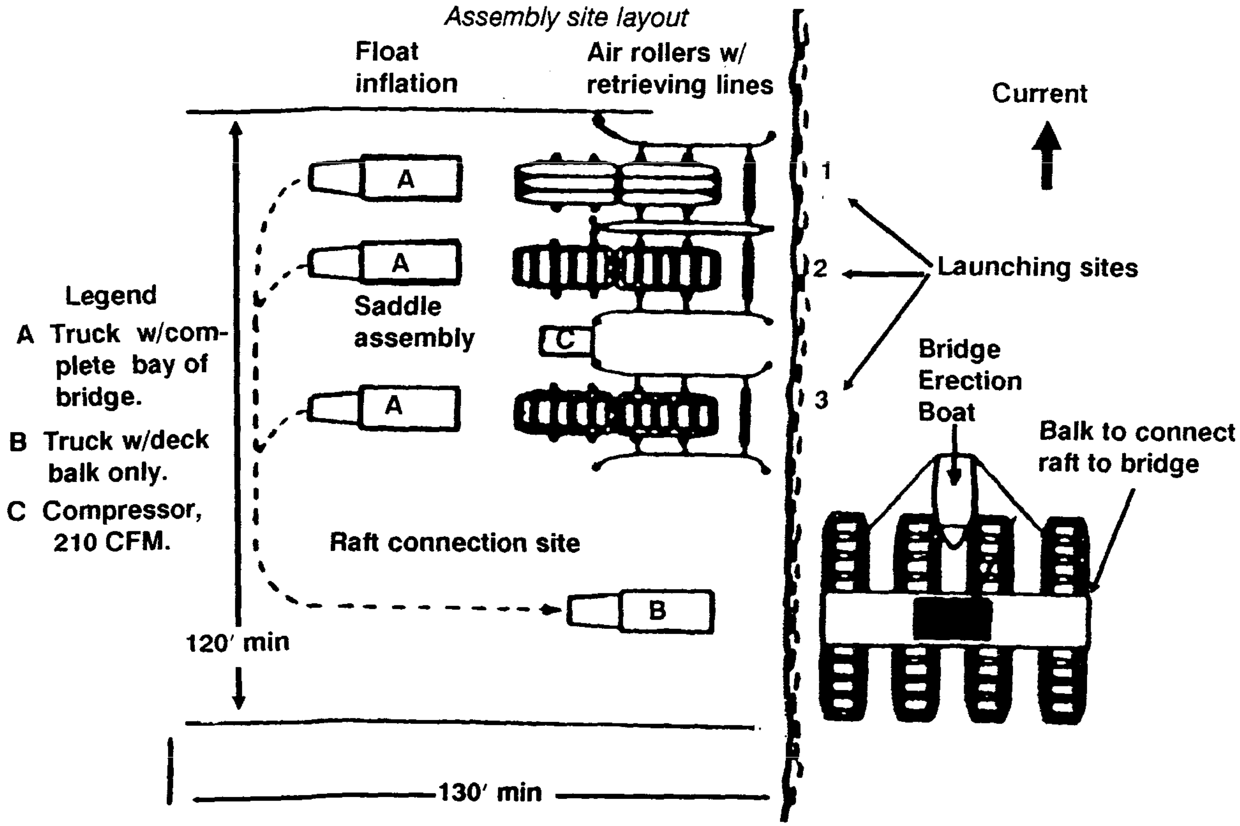
2. Prior to assembly and launching of floats, the assembly/launch site should be set up as shown on page 48.
Note. The crane should be placed as close as possible to the water's edge. The air compressor is positioned in front of the crane and the bridge trucks are placed on either side of the air compressor(s).

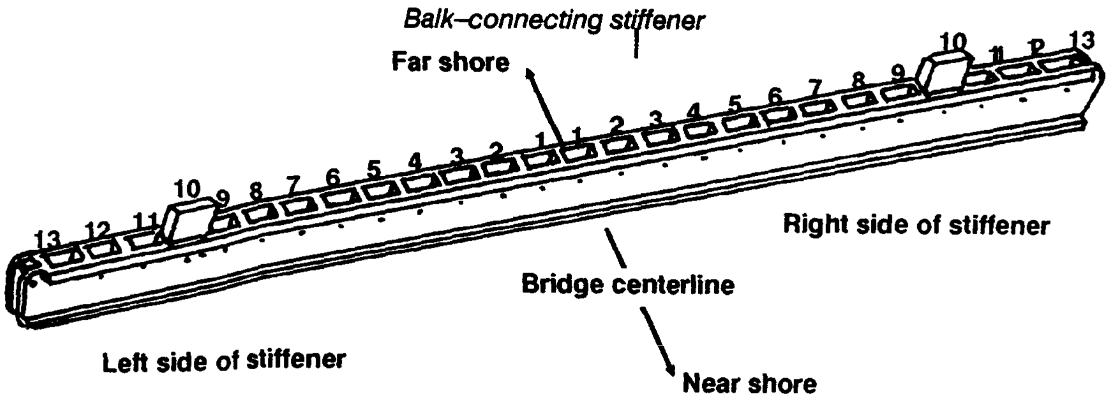
3. Once the half-floats are connected and positioned on the ground beside the crane, the float inflation crew can inflate the floats.

4. While the floats are being inflated, the saddle assembly crew places the hooks of the crane's lifting chains in the eighth recess of both stiffeners on the prepack. Two tag lines should also be attached to the prepack to allow for better control during lifting.

Placement of a prepack on the 24–ton pneumatic float







5. Once the floats are inflated, the saddle assembly crew secures the tag lines to help control the placement of the prepack onto the float. The NCOIC of this crew directs the crane operator to place the prepack onto the center of the inflated float using standard hand signals. The float can now be completely assembled as previously described in the discussion of manual assembly.
6. When assembly is complete, the saddle assembly crew places the hooks on the lifting chains in the eighth recesses on the stiffeners once again. Tag lines are attached to the cleats on the float's end beams and the saddle assembly crew secures these lines. The NCOIC can now direct the crane operator to lift the entire float and place it into the water.

Establishing a Balk Pattern

Normal deck balk is used to provide the roadway decking for M4T6 rafts and bridges. The placement of this balk provides the only means of connecting one float to another. Twenty-two pieces of normal balk are placed on each floating bay to accomplish this task. The correct placement of this balk is essential in providing adequate roadway and correct bay to bay connections. To establish this correct balk pattern, it is first necessary to understand the terms surrounding the balk-connecting stiffeners to which the balk is attached.

Balk-connecting stiffeners

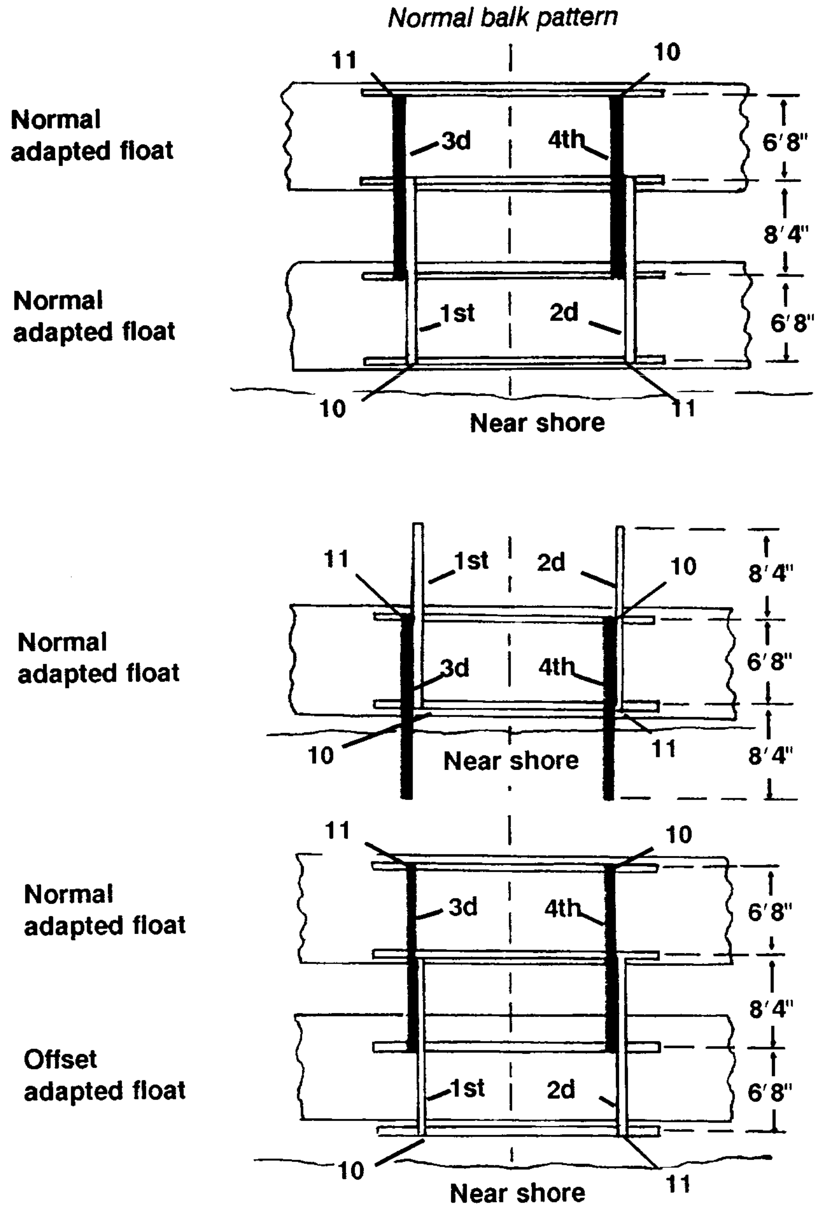
As stated previously, each balk-connecting stiffener has 26 recesses, spaced 9.25 inches apart. These recesses are designed to receive the lugs on the bottom of the deck balk. Each of these recesses is assigned an identifying number as shown in the figure on page 48.

The outside recess on each end of the stiffener is given the number 13. The next recess, on the inside of recess 13, is assigned the number 12. This continues to the center of the stiffener where the two center recesses are assigned the number 1.

Balk patterns

The two types of balk patterns are normal and reinforced. Both patterns provide a deck which is 22 balk wide with 18 pieces of balk resting between the curbs. (Curb adapters are placed in the 10th recess on both the left and right side of the bridge.)

Normal. When constructing M4T6 normal rafts and bridges, a normal balk pattern is used to maintain a spacing of 8 feet 4 inches between the last stiffener on one float and the nearest stiffener on the next float (regardless of the type of saddle adapter). The figure at the right shows the methods of starting a normal balk pattern on various float combinations. When starting a normal balk pattern, place the near shore ends of the first two normal balk into the 11th recess on the left of and the 10th recess on the right of the stiffener closest to the shore. The next two normal balk are placed into the 10th recess on the left of and the 11th recess on the right of the second stiffener as shown in the figure. Once the first four pieces of normal balk are placed and every lug is pinned as shown the remainder can be put into place (or placed on



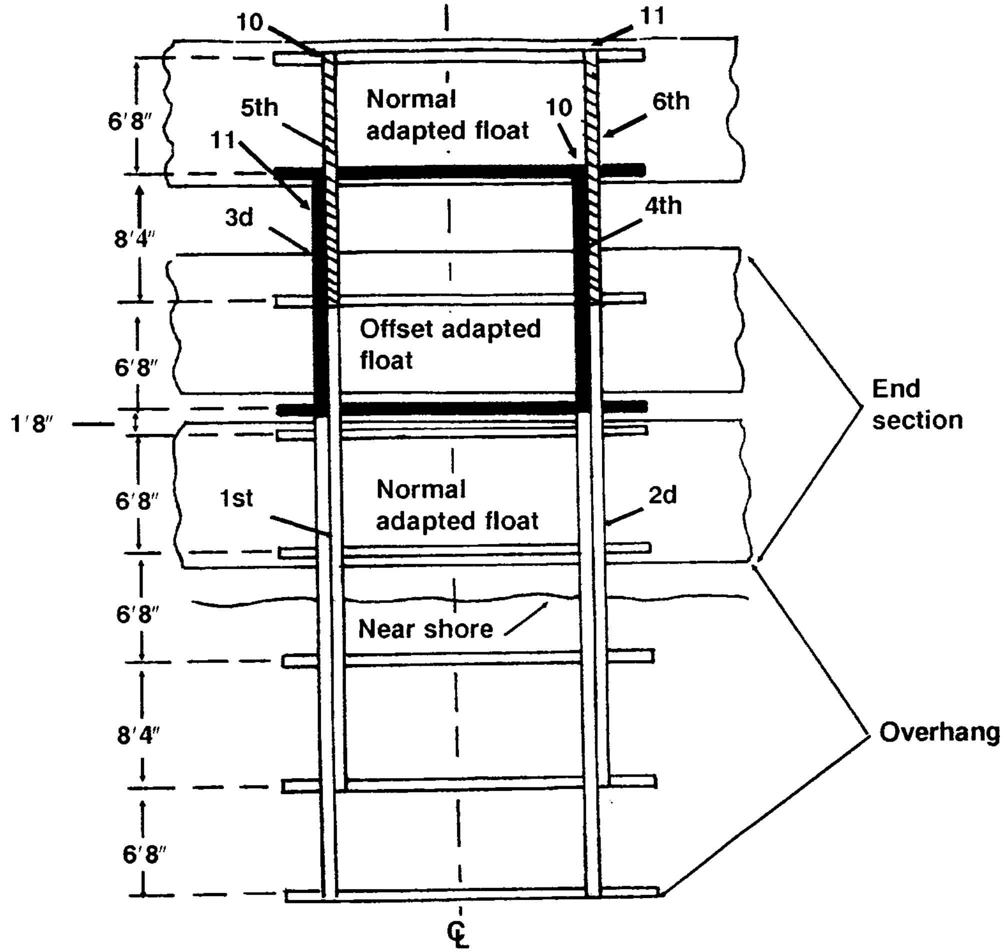
top of the float until the float has been moved upstream to where a bridge or raft is to be completed). When placing the remainder of the balk, be sure to maintain the staggered pattern initiated with the first four pieces of balk. Pin the center lugs of all normal balk as they are placed into a stiffener recess. The end lugs are pinned only when two pieces of balk meet in the same recess. The exceptions to this rule are—

- When constructing an H-frame for a freed bridge
- When initiating a balk pattern
- When adding a stiffener to a raft overhang

In these situations, the end lugs on the balk are pinned temporarily until adjacent balk is placed and pinned. At that time, the temporary pins are removed, filler balk placed, and pins reinserted.

Reinforced. Offset saddle adapters are used to establish reinforced balk patterns. Reinforced patterns are designed to reduce the float spacing when constructing reinforced end sections for normal bridges, or when building reinforced rafts and bridges. The procedures used to initiate a reinforced end section are shown in the figure at the right. Note that the second float is equipped with offset saddle adapters and that the adapters are positioned so that the stiffeners are offset toward the near shore. As shown in the figure, the first two normal balk are placed in the 10th recess on the left of and the 11th recess on the right of the stiffener closest to the near shore. These two balk connect all four stiffeners on both floats. If the third float has not arrived on the centerline by this time, the next nine pieces of balk can be placed in every other recess between the first two. When the third float, equipped with normal saddle adapters, arrives at the bridge centerline, it will be joined to the second float by two normal balk. These two pieces of balk are placed in recesses 11 left and 10 right and two additional pieces will be placed into recesses 10 left and 11 right. The remainder of the bridge will be constructed using a normal balk pattern (except for the reinforced end section on the far shore). The figure below illustrates the reinforced balk pattern extended through a 21-foot 8-inch overhang.

Reinforced balk pattern

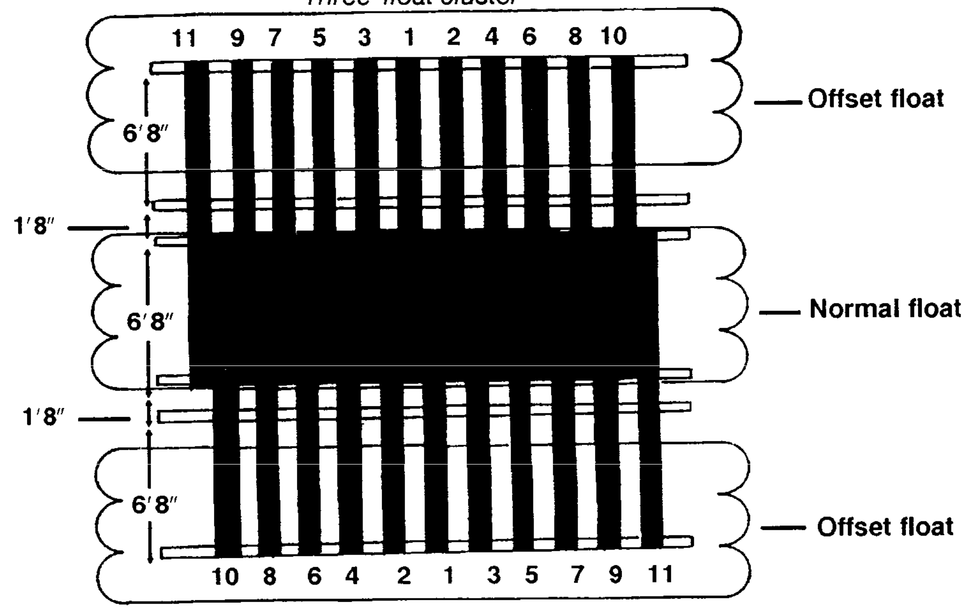


Constructing a Three-Float Cluster

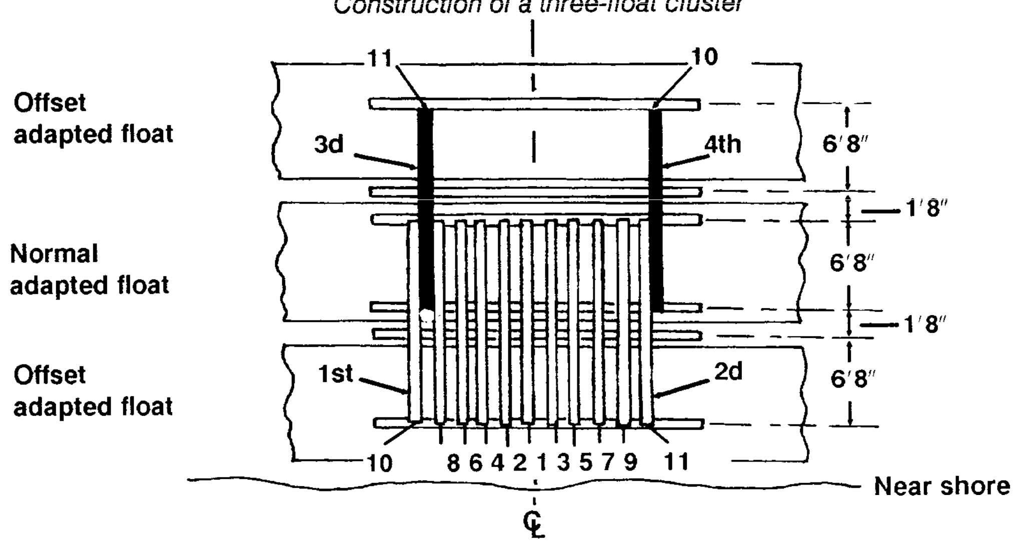
A three-float cluster consists of one normal bay (float) surrounded by two offset bays. Because this three-float cluster is used as the basis for all reinforced bridges and as the basis for five- and six-float reinforced rafts, it is discussed here under General Construction and is referred to in the paragraphs explaining the assembly of those rafts and bridges. Construction of a three-float cluster is accomplished as follows:

1. The first float constructed is an offset float. Once constructed and launched, this bay should be secured to the near shore so that the stiffeners are offset towards the far shore.
2. Next, a normal bay is assembled and launched. This bay is placed as close as possible to the far shore side of the first float.
3. Two pieces of normal balk are then placed to connect these floats. As shown in the figure, these balk are placed in recesses 10 left and 11 right (as seen from a position on the near shore), connecting all four stiffeners on both floats. This establishes the reinforced balk pattern.
4. If the third float has not arrived on the centerline by this time, the next nine pieces of balk can be placed in every other recess between the first two. Pin all center lugs as the balk are placed.
5. When the third float, equipped with offset saddle adapters, arrives on site, it is positioned on the far shore side of the second float. This float is placed with its stiffeners offset towards the near shore.
6. Normal balk are now placed so that the lugs on the balk will engage the two stiffeners on the normal (center float) and the two

Three–float cluster



Construction of a three-float cluster



stiffeners on the offset third float. Pin all center lugs as the balk are placed.

Use of Balk Depressors

There are two basic types of balk depressors: manual and hydraulic. These balk depressors are furnished with the M4T6 bridge erection set and are used when the balk lugs will not fit easily into the recesses on the balk-connecting stiffeners. Balk depressors force the balk down into the stiffener and, at the same time, raise the stiffener up towards the balk.

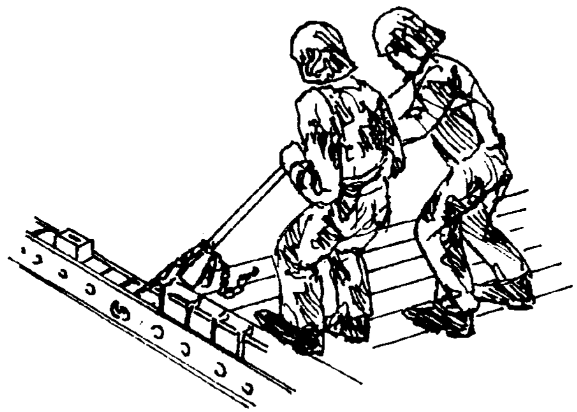
To use the manual balk depressor-

1. Place the foot of the balk depressor on the top of the piece of balk that needs to be depressed.
2. Lock the hook at the end of the chain into the stiffener, using a steel stiffener pin.
3. Pull the chain taut and lock it into the chain lock at the foot of the depressor.
4. Two soldiers grasp the handle of the depressor and pull down and away from the balk,

To use the hydraulic balk depressor-

1. Place the jack over the center lugs of the piece of balk that needs to be depressed.
2. Center the depressor assembly over the jack.
3. Attach the hooks on the depressor assembly's chains to the lifting handles of the two adjacent balk.
4. Pump the jack handle, depressing the balk and raising the stiffener to a point where the balk can be properly pinned.

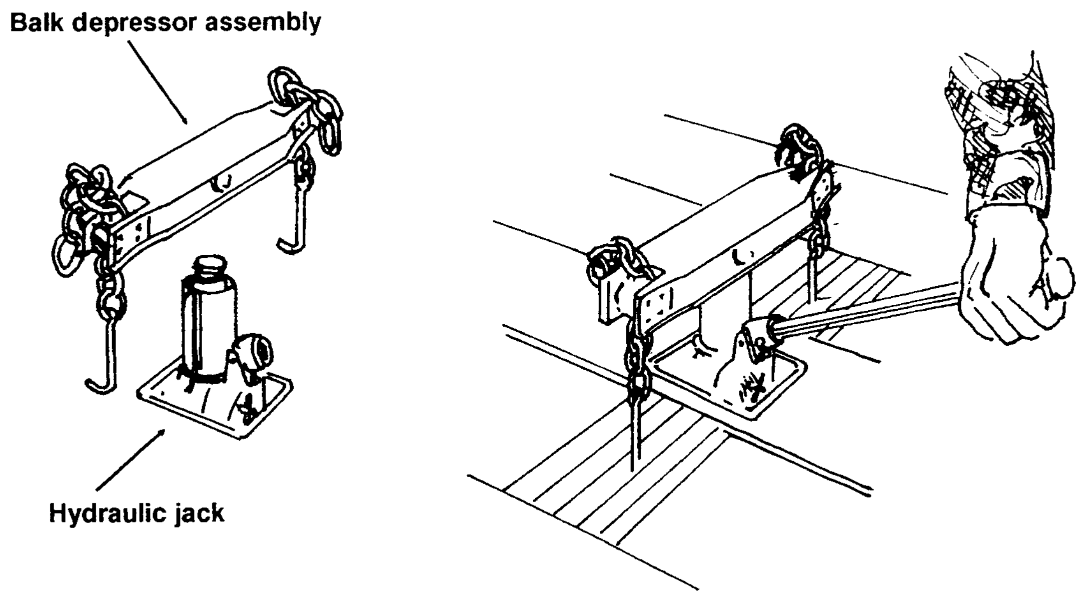
Use of the manual balk depressor



Warning!

The pressure exerted by the depressor is too great for one person to handle safely. Use of the balk depressor by one individual may reault in serious injury or death.

Use of the hydraulic balk depressor



M4T6 RAFTING OPERATIONS

M4T6 Raft Design Criteria

The M4T6 rafts are constructed using either a normal or reinforced configuration. Each raft provides a roadway width of 13 feet 10 inches. When fully loaded, an M4T6 raft has a draft of 29 inches.

The primary considerations when deciding upon the type of raft to build include the desired MLC of the raft and the required load space of the raft. Also the number of rafts needed versus the availability of M4T6 equipment should be considered. One set of M4T6 can provide the commander with either one four-float normal raft, one five-float normal raft, one four- and five-float reinforced raft, or one six-float reinforced raft. The capabilities of these rafts are given in Table 13.

Raft Assembly Times

Table 13 shows the amount of time required to construct four-, five-, and six-float M4T6 rafts. The construction times given are for assembly by hand with an experienced platoon under daylight conditions. Assembly times increase by 50 percent at night.

EXAMPLE: What is the assembly time for the construction of a five-float reinforced M4T6 raft at night?

SOLUTION: Refer to Table 13. Three platoon hours are required for the construction of a five-float raft during the day. Adding 50 percent for night assembly, the planned assembly time is 4.5 hours.

Table 13. M4T6 raft design

Type of raft	Assembly time (hr)	Load space (ft)	Classification (wheeled/tracked) based upon current velocity				
			0–5 FPS	7 FPS	8 FPS	9 FPS	11 FPS
Four–float normal	2.25	51.6	50/55	45/50	40/45	35/40	30/35
Four–float reinforced	2.25	38.3	55/60	50/55	45/50	40/45	35/40
Five–float normal	3	66.6	55/60	50/55	45/50	40/45	35/40
Five–float reinforced	3	50	60/65	60/65	55/60	55/60	45/50
Six–float reinforced	3.75	53.3	65/70	65/70	65/70	60/65	45/50

Load Space

The available load space on each type of M4T6 raft is shown in Table 13. Rafts are loaded only in the space between the raft's outside floats. The raft overhangs are not loaded.

EXAMPLE: How much load space is available on a six-float reinforced M4T6 raft?

SOLUTION: Refer to Table 13. The six-float reinforced M4T6 raft has approximately 53.3 feet of available load space.

Classification of M4T6 Rafts

The classification of M4T6 rafts is based upon the current velocity of the river at the rafting site. Table 13 provides the wheel and track classification of each type of M4T6 raft.

EXAMPLE: What is the classification of a four-float reinforced M4T6 raft operating in a current velocity of 5 FPS?

SOLUTION: Refer to Table 13. An M4T6 four-float reinforced raft can carry wheeled vehicles with an MLC of 50 or less and tracked vehicles with a classification of 55 or less (in a current of 5 FPS).

Equipment Requirements

Construction

All assembly sites for the construction of M4T6 rafts should be equipped with at least one 250 CFM air compressor, two BEBs, and either float rollers or a 20-ton capacity crane. Additional equipment requirements for specific rafts are shown in Table 14.

Rafting

The M4T6 rafts are always propelled with BEBs tied off in a conventional configuration, as shown below. The number of boats needed to propel these rafts is based upon the velocity of the river. Table 15 shows the number of 27-foot BEBs required to push M4T6 rafts under varying current conditions. No formal tests have been conducted using the BEB-SD under fast water conditions.

Attachment of boats to M4T6 rafts

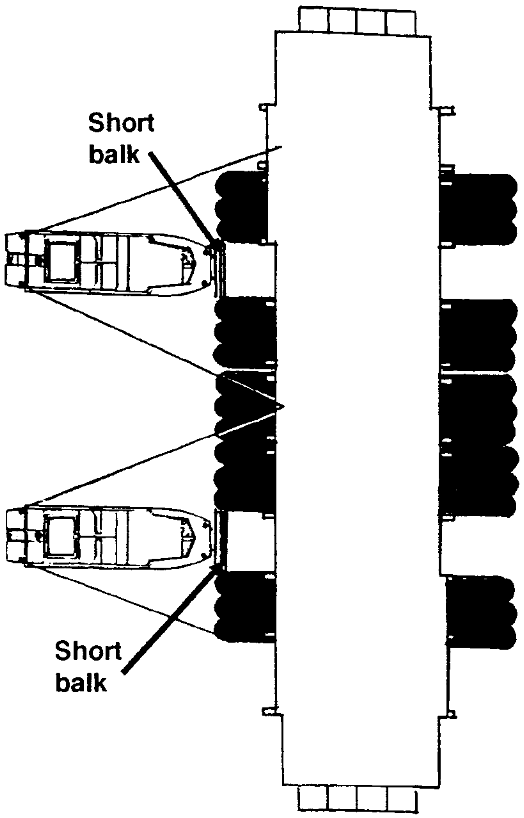


Table 14. Equipment requirements for M4T6 raft construction

Equipment	Four–float rafts	Five–float rafts	Six–float rafts
Bridge trucks	5	6	7
Cranes[1]	1	1	1
250 CFM Air Compressors	1	1	1
Bridge erection boats[2]	2	2	2

Notes.
1. One crane is required when floats are partially preassembled.
2. Two boats are needed for construction. An additional boat may be required to perform duties as a safety boat.

Table 15. Bridge erection boats required for M4T6 rafting operations

Type of raft	Number of boats required for rafting (based upon current velocity)				
	0–5 FPS	7 FPS	8 FPS	9 FPS	11 FPS
Four–float normal	1	2	2	3	4
Four–float reinforced	1	2	2	3	4
Five–float normal	1	2	3	3	5
Five–float reinforced	1	2	3	3	5
Six–float reinforced	1	2	3	3	5

Notes.
1. This table is based upon the use of 27–foot BEBs.
2. The number given is the number of boats needed to propel the raft. An additional boat or boats may be required to act as a safety boat at the raft centerline.

Organization for the Construction of M4T6 Rafts

Under normal conditions, one combat engineer platoon can construct one M4T6 raft, under the supervision of at least one bridge sergeant. Personnel should be assigned to assembly parties as shown in Table 16. The float assembly crew is responsible for float inflation, saddle assembly, and launch. The duties of this crew, as well as those of the raft assembly crew, are described as follows:

Table 16. M4T6 raft assembly crews

Assembly site crews	Number of crews	Crew size	
		NCO	EM
Float assembly	2	1	8
Raft assembly	1	1	14

Inflation

Inflation crews unload the half-floats from the truck. They remove the carrying case, position the deflated float rollers (when used), inflate the floats, connect the float straps, and thread the connecting bar between the floats.

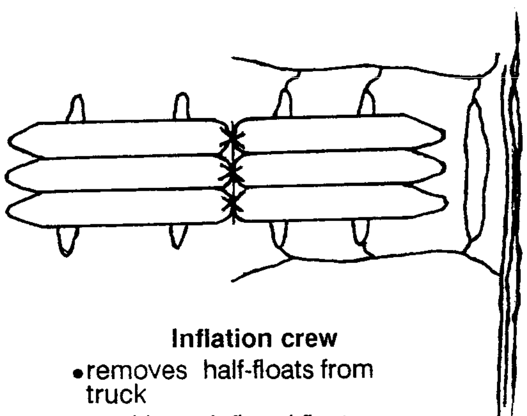
Saddle assembly

Two members from each saddle assembly crew assist in removing the saddle assembly from the truck. The other crew members place the panels on the inflated float, place and connect the saddle beams, thread the bow and stern connecting bars, place the saddle adapters, and connect the stiffeners.

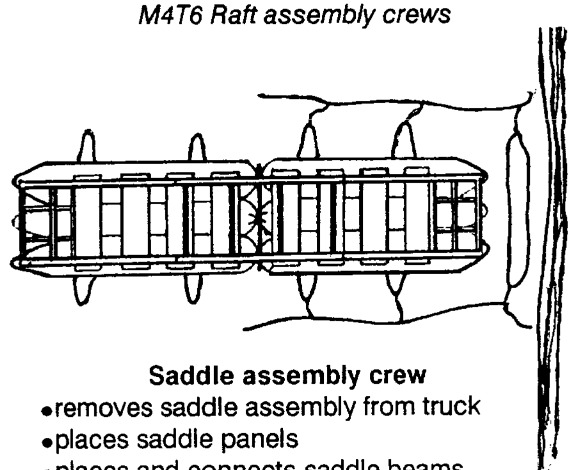
Raft assembly

The raft assembly crew positions the truck containing the balk and then places the balk on the floating supports.

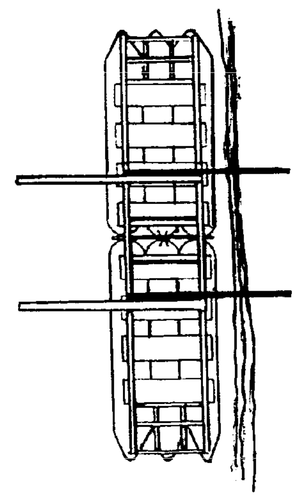
M4T6 Raft assembly crews



Inflation crew
- removes half-floats from truck
- positions deflated float rollers
- inflates floats
- connects float straps
- inserts connecting bar



Saddle assembly crew
- removes saddle assembly from truck
- places saddle panels
- places and connects saddle beams
- places bow and stern connecting bars
- places saddle adapters
- connects balk stiffeners
- inflates rollers



Raft assembly crew
- positions truck containing balk
- places balk on raft

Construction of an M4T6 Four-Float Normal Raft

A four-float normal raft consists of four normal bays spaced approximately 15 feet apart. This raft is almost always built with two 15-foot overhangs, but can be built with 23-foot 4-inch overhangs. The construction sequence is generally described as follows:

1. Assemble and launch the first two floats. Both of these floats should be equipped with normal saddle adapters.

2. Once the first floats are in the water, the raft assembly crew can begin placing balk. Since normal construction is used, the balk is placed in recesses 11 left and 10 right, as previously described. Balk should be placed so that the lugs rest in two stiffeners on one float and one on the other.

3. While the raft assembly crew continues to balk the first two floats, the third and fourth floats can be inflated and the saddle assemblies placed on them. These are also normal floats.

4. When the third float is constructed, it is placed on the far shore side of the two floats already in the water. The raft assembly crew can attach this float with balk, continuing the initial balk pattern. Balk should be pinned in the center recesses only, and at points where two pieces of balk meet end to end.

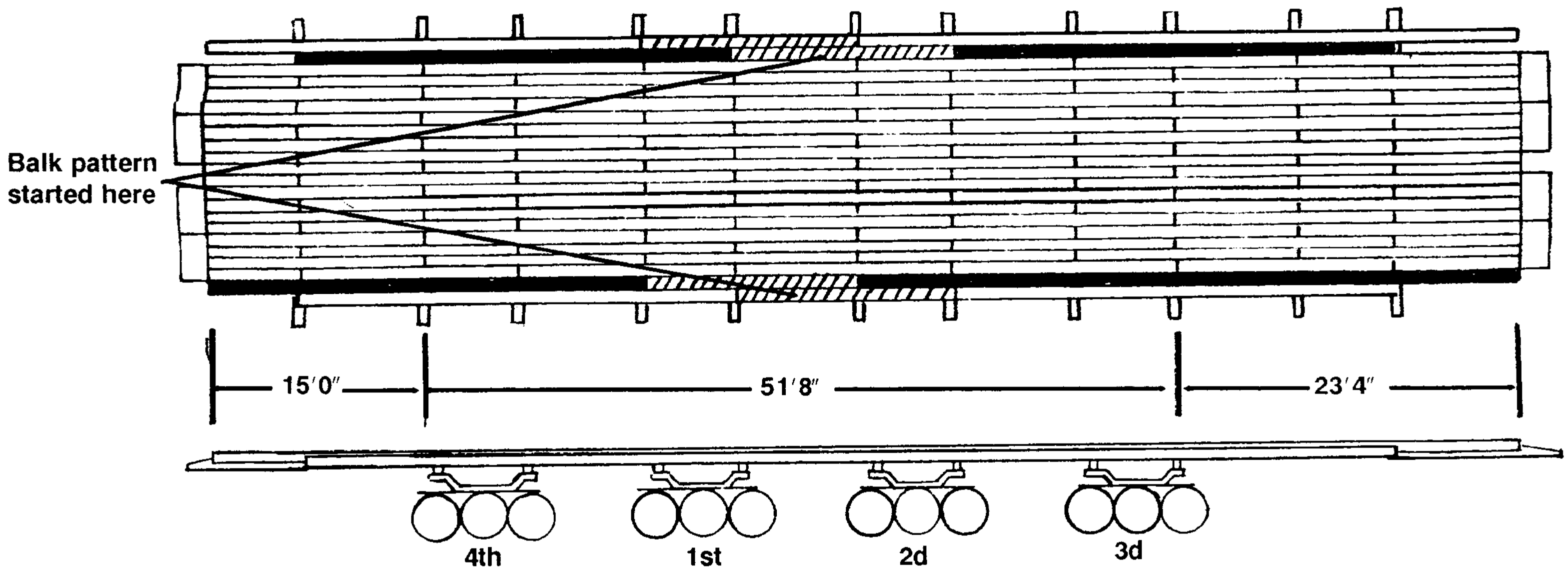
5. The fourth float is added to the near shore side of the raft in the same manner as the other floats.

6. When all four floats are connected and completely balked, the near shore overhang can be built. This is normally a 15-foot overhang. To construct this overhang, add a stiffener to the ends of the balk that are suspended from the near shore end of the raft.

7. Add 11 pieces of normal balk, maintaining the pattern already established. Place eight pieces of tapered balk in the remaining recesses, with the tapered end connected to the last stiffener. Work from inside the curbs toward the center of the raft. This will leave the center of the raft open. Add four raft ramps to complete the overhang.

8. Spin the raft around and construct the second overhang. This overhang is normally a 15-foot overhang and is constructed in the same manner as the first.

Four–float normal raft



Construction of an M4T6 Four-float Reinforced Raft

A four-float reinforced raft is constructed by placing a pair of side-by-side floats in the water. It is normally equipped with a 15-foot overhang at one end and a 21-foot 8-inch overhang on the other. The raft is constructed as follows:

1. Assemble and launch the first two floats. One of these floats is equipped with normal saddle adapters, the other with offset saddle adapters.

2. Once these bays are launched, the normal bay is placed closest to the near shore. The offset bay is placed on the far side of the normal float with the stiffeners offset towards the near shore.

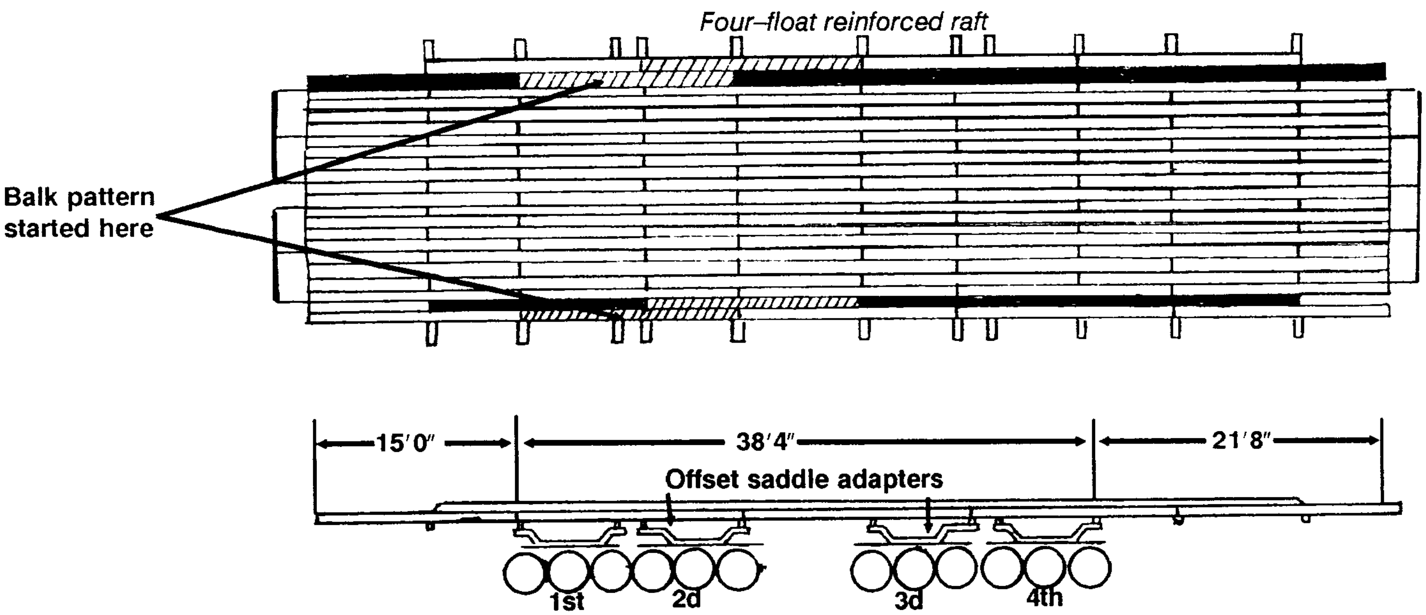
3. The two floats are joined using a reinforced balk pattern. The first 11 balk should be placed so that the lugs rest in all four stiffeners. Pin all center lugs.

4. While the raft assembly crew is connecting the first two floats, the float inflation crew will inflate the third and fourth floats. The saddle assembly crews can then emplace the saddle assemblies on these floats. Like the first pair of floats, one of these floats is a normal bay, the other is offset.

5. The third float launched should be the offset float. It is placed on the far shore side of the two floats already in the water. The stiffeners on this float should be offset towards the far shore. Initiate a staggered balk pattern by placing the frost two pieces of balk in recesses 10 right and 11 left. These two balk should start in the first stiffener of the second float and reach across to the first stiffener of the third float, providing an 8-foot, 4-inch gap between the second and third floats. Now place two pieces of normal balk one recess to the right of these two balk. These balk should start in the second stiffener on the second float and reach across to the last stiffener on the third float. Pin all center lugs and all end lugs where two pieces of balk meet end to end.

6. The last float, a normal float, should be moved to the far side of the three connected floats. Continue the reinforced balk pattern already established and fill in the remaining recesses.

7. Once the raft is completely balked, the first overhang can be built. This is normally the 15-foot overhang. To construct the 15-foot overhang, attach a stiffener to the ends of the balk suspended from the near shore side of



the raft. Fill in the recesses with 11 more normal balk. Add eight pieces of short balk, working from inside the curbs toward the center of the raft. Add four raft ramps to complete the overhang.

8. When the first overhang is completed, spin the raft and construct the second overhang (normally a 21-foot 8-inch overhang). To build this overhang, frost add a stiffener to the ends of the balk suspended from the raft. Add 11 more normal balk.
9. Add another stiffener to the ends of the balk just placed. Fill in the remaining recesses on this stiffener with normal balk.
10. Complete by adding eight tapered balk, pinning the tapered end to the last stiffener. Work from inside the curbs toward the center of the raft. Add four raft ramps.

Construction of an M4T6 Five-float Normal Raft

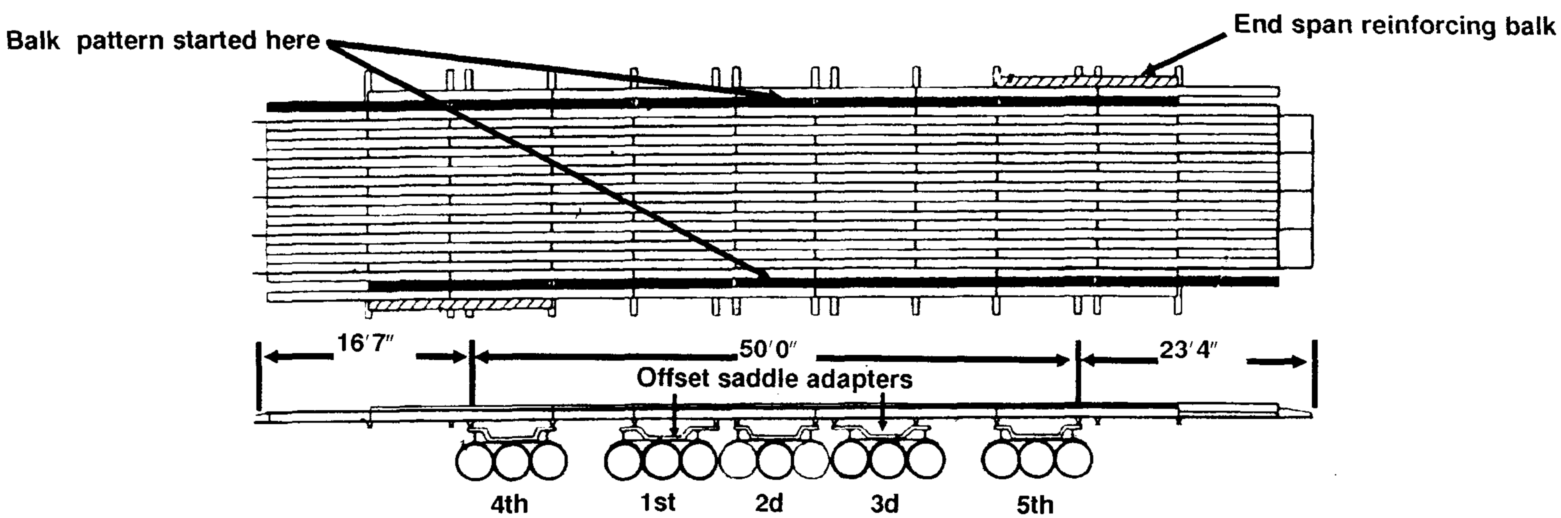
The five-float normal raft is constructed in the same manner as the four-float normal raft except that a fifth float is added. (See figure.) The fifth float is normally positioned on the far side of the raft after the fourth float is connected. Either 15-foot or 23-foot 4-inch overhangs may be used.

Construction of an M4T6 Five-float Reinforced Raft

The five-float reinforced raft is a three-float cluster with one normal bay attached to each side. Normally a 16-foot 7-inch overhang and a 23-foot 4-inch overhang will be constructed for this raft. Construction sequence is as follows:

1. Construct a three-float cluster. This cluster should be balked with 22 pieces of normal balk. Refer to the figure on page 51.
2. While the raft assembly crew is balking the three-float cluster, the next two floats can be inflated and the saddle asemblies emplaced. These floats are equipped with normal saddle adapters.
3. Upon launching the fourth float, it is placed on the far shore side of the three-float cluster. This float is first connected to the cluster with two pieces of normal balk following the balk pattern already established. These balk start at the ends of the balk in the fourth stiffener (from the shore) and run to the first stiffener on the fourth float. These balk are placed in stiffener recesses 11 left and 10 right.
4. Place two more pieces of normal balk running from the sixth stiffener from the shore. These balk will overhang 19 inches off

Five–float reinforced raft



the last stiffener on the fourth float. These balk are placed in stiffener recesses 10 left and 11 right.

5. Add 18 normal balk, following the established balk pattern.
6. Add the fifth float to the near shore side of the raft. Connect this float in exactly the same manner as the fourth float.
7. Construct a 16-foot 7-inch overhang from the near shore float. This overhang is built by first adding a stiffener to the ends of the suspended balk. Fill in the remaining recesses on this stiffener with 11 more normal balk.
8. Add a stiffener to the ends of the suspended normal balk (just added) and fill in the recesses on this stiffener by adding 11 more normal balk.
9. Complete the overhang by adding eight pieces of short balk, working from inside the curbs to the center of the raft. Add four raft ramps.
10. Spin the raft and construct a 23-foot 4-inch overhang. This is done by adding a stiffener to the ends of the suspended balk, and filling in the recesses with 11 normal balk. Add a stiffener to these balk and fill in the recesses with 11 more normal balk. Add one more stiffener and fill the recesses with 11 additional normal balk. Add eight tapered balk, pinning the tapered end to the stiffener. Work from inside the curbs to the center of the raft. Complete the overhang by adding four raft ramps.
11. Add three pieces of reinforcing balk as shown on page 57,

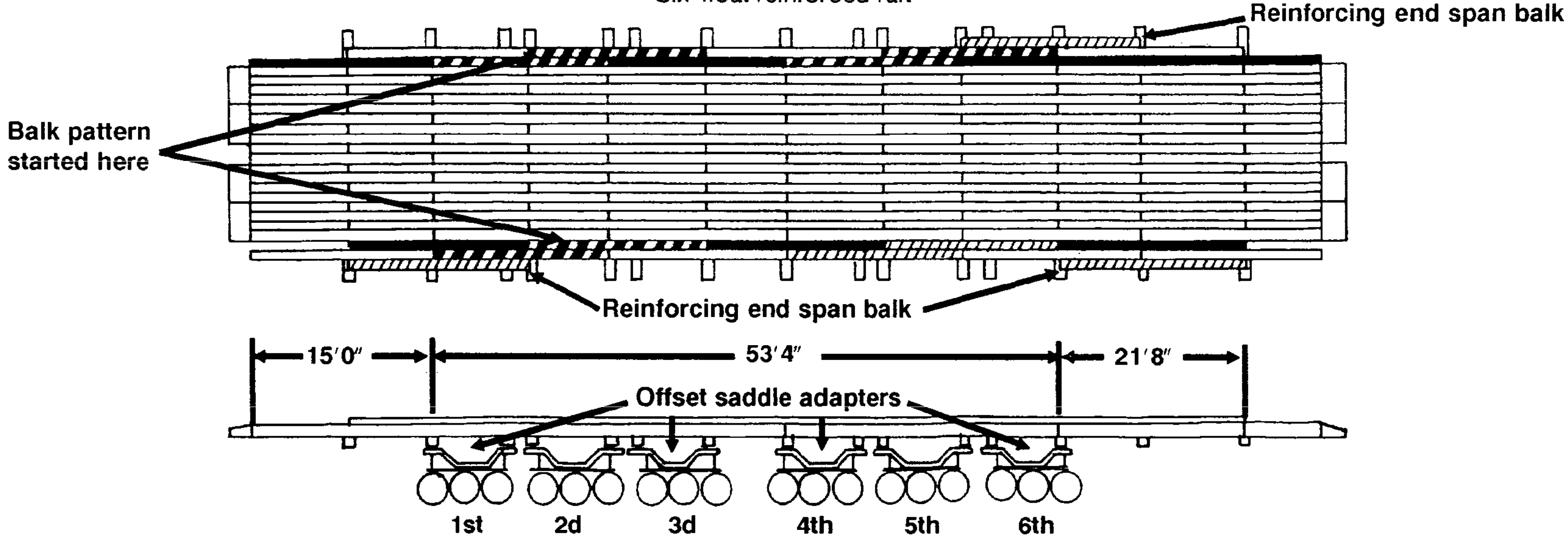
Note. If two 16-foot 7-inch overhangs are used then only two reinforcing balk are needed. If two 23-foot 4-inch overhangs are built then four reinforcing balk are required.

Construction of an M4T6 Six-float Reinforced Raft

A six-float reinforced raft is constructed by connecting a pair of three-float clusters. The space between the two clusters is 6 feet 8 inches. This raft is built as follows:

1. Construct a three-float cluster.
2. Construct a second three-float cluster.
3. Connect the second three-float cluster to the first using 11 pieces of normal balk. These balk are placed on the fourth stiffener (from the shore) and extend to the near shore stiffener on the fourth float.

Six–float reinforced raft



4. Place 11 more normal balk. These balk are placed on the sixth stiffener (from the shore) and extend to the near shore stiffener on the fifth float.

5. Fill all remaining recesses with normal balk.

6. Normally a 15-foot and a 21-foot 8-inch overhang will be constructed for this raft. The 15-foot overhang is constructed first by adding a stiffener to the balk suspended toward the near shore. Fill in the remaining recesses with 11 more normal balk. Complete the overhang with eight pieces of short balk, working from inside the curbs toward the center of the raft. Add four raft ramps.

7. Spin the raft and construct the 21-foot 8-inch overhang. Add a stiffener to the suspended balk. Fill in the recesses with 11 more normal balk. Add another stiffener to the ends of these balk. Fill in the recesses with 11 additional normal balk. Complete the overhang with eight pieces of tapered balk and four raft ramps.

8. Add three pieces of reinforcing balk as shown on page 59.

Note. If two 15-foot overhangs are built, only two reinforcing balk are needed. If two 21-foot 8-inch overhangs are used, four reinforcing balk are required.

M4T6 BRIDGING OPERATIONS

M4T6 Bridge Design Criteria

The M4T6 bridges can be constructed in either a normal or reinforced configuration. Reinforced bridging is generally preferred because of the increased classification afforded by this type of construction. Reinforced bridges are built using the successive raft method of assembly. Normal bridges can be built either using the successive bay or successive raft method. When designing M4T6 bridges, the required classification of the bridge and the quantity of M4T6 equipment available are critical considerations. Additional considerations include the required assembly time, the number of assembly sites needed, and the crew size required for construction of the bridge.

Determining the number of floats required

The number of floats needed to construct a bridge will vary with the width of the gap and the type of bridge (normal or reinforced) to be constructed.

For *normal construction*, the number of floats needed is determined using the following formula:

Number of floats

$$= \frac{Gap(ft) + 2}{15} \times 1.1$$

OR

Number of floats

$$= \frac{Gap(m) + 2}{4.6} \times 1.1$$

EXAMPLE:

How many floats are required to construct an M4T6 normal bridge across a 500-foot gap?

SOLUTION

Number of floats

$$= \frac{500 + 2}{15} \times 1.1$$

Number of floats = 38.86 so round up to 39 floats

For *reinforced construction*, the number of floats needed is determined using the following formula:

Number of floats

$$= \frac{Gap(ft)}{10} \times 1.1$$

OR

Number of floats

$$= \frac{Gap(m)}{3} \times 1.1$$

Because reinforced construction involves the assembly of a series of three-float clusters, the total number of floats must be rounded up to a number divisible by 3.

EXAMPLE:

How many floats are required to construct an M4T6 reinforced bridge across a 500-foot gap?

SOLUTION:

Number of floats

$$= \frac{500}{10} \times 1.1 = 55 \text{ floats}$$

Note. This number must be rounded up to a number divisible by 3. Therefore, the total number of floats needed is 57. Of these 57 floats, one-third will be normal floats and two-thirds will be offset floats since there is one normal float and two reinforced floats in every three-float cluster. Of the total 57 floats, 19 must be normal floats and 38 will be offset floats.

Table 17 shows the personnel and equipment required for construction of normal and reinforced bridges of varied lengths.

Bridge Assembly Times

The time needed to assemble a floating bridge may be effected by any number of factors.

Generally, M4T6 floating bridges can be constructed by one company at a rate of 150 feet every 4 hours, during the day. Table 18 gives the assembly times and recommended crew size for varying lengths of M4T6 bridges. The times shown are for daylight construction with experienced crews. Construction times should be increased by 50 percent for assembly at night.

EXAMPLE: What size unit is needed to construct an M4T6 normal bridge across a 500-foot gap and how long would construction of this bridge take at night?

SOLUTION Refer to Table 18. Two companies should be used to construct this bridge. The construction time given is 6 hours, but this is for daylight construction. Adding 50 percent for night assembly, the required construction time is 9 hours.

Classification of M4T6 Bridges

Bridge classifications are based upon the type of bridge constructed and the current velocity. Table 19 on page 62 shows the classification of M4T6 normal and reinforced bridges for varying currents and for normal, caution, and risk crossings.

Construction of M4T6 Normal Bridges

Assembly crews

The crews shown in Table 20 on page 63 are required for M4T6 construction using either method of assembly. The duties of the crews do not differ between the two methods of assembly, except for those personnel in the raft assembly crews. When building bridges using the successive raft method, these personnel construct two-, three-, or four-bay floating supports rather than single bays. Otherwise, the duties of these crews are as follows:

Table 17. Manpower and equipment for bridge construction

Required	Normal					Reinforced				
Assets	141′8″	276′8″	411′8″	546′8″	68′8″	96′8″	156′8″	216′8″	276′8″	336′8″
Platoons	2	4	6	8	10	2	3	4	5	5
Assembly sites	1–2	3	4	5–6	6	1	2	2–3	2–3	3–4
Air compressors	1	3	4	5	6–7	1	2	2	3	4
Cranes[1]	1	3	4	5	6–7	1	2	2	3	4
BEBs[2]	2	4	6	8	10	2	3	4	5	6
M4T6 sets	1	2	3	4	5	1	2	3	4	5

Notes.
1. This is the number of cranes needed if the bays are partially preassembled.
2. The number of boats does not include safety boat requirements.

Table 18. Assembly times and recommended crew sizes for M4T6 bridge construction

Bridge length (ft)	Recommended crew size (companies)	Assembly time (hr)
150	1	4
200	1	5
250	1	6
300	2	4
400	2	5
500	2	5.5
600	2	6
700	3	4
800	3	5–7
1,000	3	7–10
1,200	3	8–12

Float assembly. The float assembly crew is divided into a float inflation crew and a saddle assembly crew.

Float inflation. This crew inflates the prepositioned half-floats. Upon completion of the saddle assembly, the inflation crew inflates the float rollers and retrieves and repositions them for the next float inflation (if float rollers are used). This crew assists the air compressor operator in setting up for float inflation.

Saddle assembly. This crew unloads the two half-floats from the bridge truck, removes the carrying cases when floats are not loaded in preassembled form and places the floats over the float rollers and connects them. While floats are being inflated, the saddle assembly crew unloads the saddle assembly from the truck and, after inflation places the saddle assembly, saddle adapters, and stiffeners with curb adapters on the float. After assembly they launch the float.

Float delivery. This crew delivers completed floating supports to the bridge centerline, using a BEB.

Balk carrying. This crew unloads and carries balk for each end section. When end sections are complete, all carriers unload and carry balk for each bay of bridge.

Balk laying. This crew constructs the near shore end section, using one half of the balk carrying crew. After the end section is complete, the crew places and pins balk in the floating supports as they are added to the bridge.

Table 19. Bridge classifications

M4T6 Normal bridge classification (wheel/track)

Type crossing	0–3 FPS	5 FPS	7 FPS	8 FPS	9 FPS	11 FPS
Normal[1]	50/55	45/55	40/50	35/45	30/40	25/30
Caution[2]	60/61	58/59	54/55	49/51	45/47	35/37
Risk[3]	68/69	66/67	62/63	59/60	54/56	43/45

M4T6 Reinforced bridge classification (wheel/track)

Type crossing	0–5 FPS	7 FPS	8 FPS	9 FPS	11 FPS
Normal	75/75	70/75	65/70	55/60	27/30
Caution	80/80	79/79	73/73	66/67	43/45
Risk	90/90	90/90	87/87	81/81	59/60

Notes.

1. For normal crossings:
   Maximum speed on the bridge is 25 mph.
   Vehicle spacing (front to back) is 100 feet.
   No sudden stopping or acceleration is allowed on the bridge.

2. For caution crossings:
   Maximum speed on the bridge is 8 mph.
   Vehicle spacing is 150 feet.
   No stopping, accelerating, or shifting gears is allowed on the bridge.
   Center of vehicles must remain within 12 inches of the bridge centerline.

3. For risk crossings:
   Maximum speed on the bridge is 3 mph.
   Only one is allowed on the bridge at a time.
   No stopping, accelerating, or shifting gears allowed on the bridge.
   Center of vehicles must stay within 9 inches of the bridge centerline.
   A ground guide is required for each vehicle.

Anchorage. This crew installs anchorage cables, bridle lines, anchor towers, deadmen, and approach guys as needed.

Near shore abutment crew. This crew prepares the near shore abutment and assembles the 21-foot 8-inch end span on the near shore. This crew also places handrail posts and attaches handrail lines.

Far shore abutment crew. This crew constructs the far shore end section with the assistance of one half of the balk carrying crew. They prepare the far shore abutment and complete the assembly of the far shore end section.

Abutment preparation in construction of normal bridges

Near shore. The near shore abutment must be prepared as soon as possible to allow for the construction of this end section. Only the work needed to position the abutment sill in its final position should be initially performed, since the abutment may need to be repositioned prior to final bridge closure.

Far shore. The far shore abutment crew and one half of the balk carrying crew construct the far shore end section, using the first, second, and third floating supports constructed at the assembly site. The next three floats constructed are used in the assembly of the near shore end section.

Table 20. Assembly crews for M4T6 bridges

Type crew	Number of crews	Crew size	
		NCO	EM
Assembly crews for successive rafts			
Assembly site crews:			
Float assembly	2	1	8
Raft assembly	1	1	16
Delivery crew	1	1	4
Centerline crews:			
Anchorage	1	2	12
Far shore construction	1	1	14
Near shore construction	1	1	14
Assembly by successive bays			
Assembly site crews:			
Float assembly	2	1	10
Delivery crew	1	1	2
Centerline site crews:			
Balk carrying	1	2	20
Balk laying	1	1	12
Anchorage	1	2	12
Near abutment	1	1	4
Far abutment	1	1	4

Note.
These numbers do not include the requirements for boat and crane operators/assistant operators.

Constriction of a reinforced end section

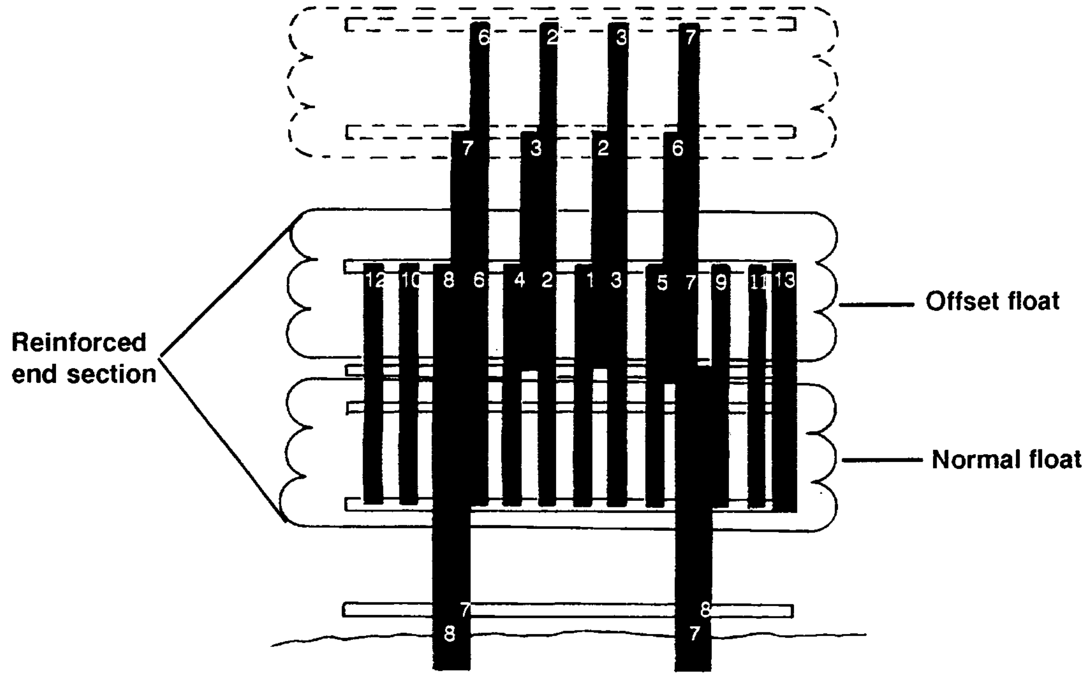
All normal bridges are constructed with two reinforced end sections.

1. Two floats are placed at the float assembly site and lined up on their centerlines. These floats are spaced as close together as possible. The near shore float is equipped with normal saddle adapters. The second float is equipped with offset saddle adapters and is positioned so that the stiffeners are offset towards the near shore. Two normal balk are placed so that they extend across all four stiffeners. These balk are placed in the number 11 recess to the right of the bridge centerline and in the number 10 recess to the left. The balk are pinned at the center. If the third float has not arrived on the centerline, the next nine balk are placed in every other recess between the first two.

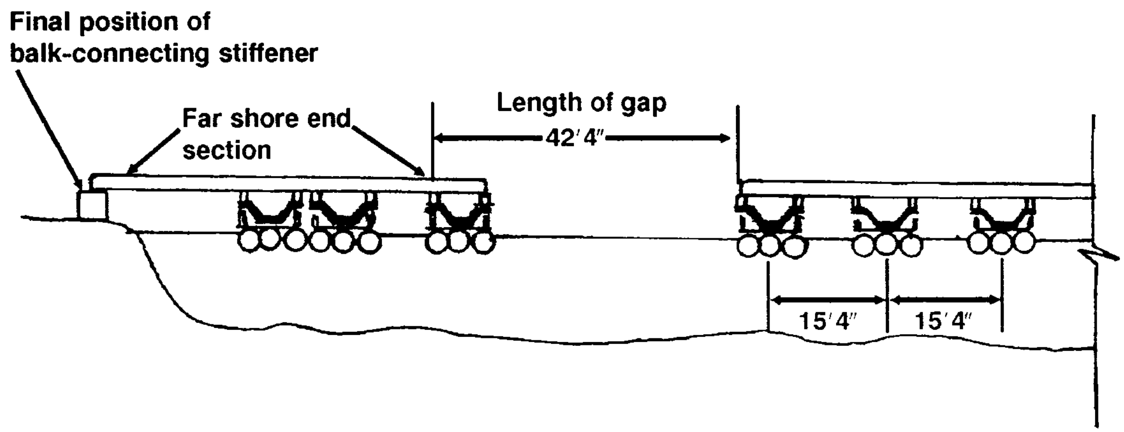
2. The third float is a normal float and is moved into position on the far shore side of the first two. Two pieces of balk should be used to connect this third float to the second float. These balk are placed in the number 10 recess to the right and the number 11 recess to the left of the bridge centerline. These balk should engage both stiffeners on the second float and should run to the first stiffener on the third float. Pin these balk in the center lugs only.

3. Place two normal balk in the number 11 recess on the right and the number 10 recess on the left of the bridge centerline. These two balk should engage both stiffeners on the third float and should run to the second stiffener on the second float. Pin these balk in the center recesses.

Construction of a reinforced end section



Determining final stiffener position and measuring gap



4. Now the balk needed to complete the deck are carried forward, placed, and pinned IAW the balk pattern established. A reinforced end section is constructed with a deck width of 26 balk. When constructing the bridge using the successive raft method, balk are placed on the third float for use in the connection of the first raft to the end section.

Bridge connection

Normal bridges can be built using either the successive bay or successive raft method.

Successive bays. After the end sections are completed, single floating supports are brought upstream to the bridge site where they are connected into the bridge. These connections are exactly the same as the connection of the third float to the reinforced end section. The balk are unloaded from the trucks at the bridge centerline by the balk carrying crew and brought out to the balk laying crew which places the balk, connecting the floating supports. As bridge construction continues, the vehicle loaded with balk can be backed onto the partially completed bridge to reduce the distance that the balk must be carried. To ensure that an 18 balk roadway width is maintained, curb adapters are placed in the 10th recesses (left and right) of all stiffeners.

Successive rafts. When constructing a bridge using the successive raft method, two-, three-, or four-float rafts are assembled and moved to the bridge centerline. A four-float raft is assembled using the same method as described on page 56. Obviously, the overhangs are not attached to these floating sections. After completion of the raft, 20 normal balk are loaded on the floating section. These balk are used to connect the raft to the bridge. Two additional balk are placed onto the raft, extending 8 feet 4 inches beyond the last stiffener. These two balk are pinned only at one end to allow them to be raised and connected into the bridge.

Overhang assembly

The 21-foot 8-inch overhang is normally assembled by extending the balk pattern established by the near and far shore end sections. The end stiffener is equipped with two abutment bearing plates. The spaces are filled in with normal and tapered balk. The tapered balk are placed with the tapered end toward the bridge. A 15-foot noncontinuous approach span extending beyond this abutment stiffener is desired. Eighteen tapered balk, placed side by side, are used for this approach from the ground to the overhang.

Adjusting the gap

As soon as the gap is narrow enough to be measured accurately, the final position of the near shore abutment is determined by measuring the distance between corresponding stiffeners on the assembled portion of the bridge. To close the bridge, this gap must be adjusted to a multiple of 15 feet. The measured distance is subtracted from the closest multiple of 15 feet to find the distance that the abutment stiffener must be moved, considering the fact that there must be 40 inches of water under the float closest to the shore and that the abutment sill should be 30 inches above the water level. This distance is measured back from the abutment stiffener and pickets are driven on either side of the centerline to mark the stiffener's final position.

EXAMPLE: If the distance measured between the far shore stiffeners on both ends of the bridge is 82 feet 4 inches, how far must the near shore abutment be moved to allow for final connection of the bridge?

SOLUTION: Since the measured gap is 82 feet 4 inches, the next higher multiple of 15 is 90 feet. Subtracting 82 feet 4 inches from 90 feet, the distance the near shore end section must be moved is 7 feet 8 inches. Measure 7 feet 8 inches back from the current position and drive pickets to mark the new location.

Closing the gap

The near shore end section should be raised and moved as previously stated. A crane or bulldozer can be used to perform this task. While final adjustments are made to the abutments, the remaining floats are added to the bridge. The near shore stiffener, with bearing plates attached, should be lowered into its final position onto the abutment sill. Balk can now be laid across the closing span. All balk should be pinned at both the interior and end lugs. Once all adjustments are complete, tapered balk can be laid, providing the approach span.

Construction of Reinforced M4T6 Bridges

When constructing reinforced bridges, successive three-float clusters are used for each 30 feet of bridge length. Assembly crews are the same as those given for the construction of normal bridges using the successive raft assembly method. The method of construction is also exactly the same with two exceptions:

- Three-float clusters are built instead of four-float rafts.
- The end sections are further reinforced to match the capacity of the three-float clusters used to construct the bridge. Note. The end sections on reinforced bridges are also constructed from three-float clusters.

The method of constructing this end section is described as follows:

1. The abutment sill is reinforced to support a 100-ton load. The level of the abutment may range from the level of the bridge deck to 30 inches above the level of the bridge deck. Refer to *TM 5-312* for additional guidance in constructing a reinforced abutment sill.
2. Construct a 21-foot 8-inch overhang, as previously described and move the end section into position on the abutment sill. No curbs should be placed on this end section. The raised curb would interfere with the construction of the superimposed end section.
3. Place seven stiffeners on the deck of the three-float end section, starting about one foot from the shore end of the end section. Space these stiffeners alternately at 8-foot 4-inch and 6-foot 8-inch intervals.
4. Construct a reinforced abutment sill 8 feet 4 inches (on center) from the first of these seven stiffeners. A stiffener with abutment bearing plates attached is centered on this sill. The span constructed between this abutment sill and the first stiffener on top of the bridge is called the transition span. If normal balk is used in this transition span, this span should be constructed 15 feet (on center) from the shoreward stiffener on the bridge.
5. Lay the balk, beginning at the bridge centerline and working from the center of the bridge toward both sides. Pin each lug as the balk is placed.

Eighteen tapered balk are laid for the *shore approach span*. A sill is placed under the shoreward end of these balk.

Twenty-two balk (either short or normal) are laid for the *shore transition span*.

Twenty-two short balk and 44 normal balk are laid in a normal staggered pattern to form a 38-foot, 4-inch *superimposed deck*. This superimposed deck runs from the first to the sixth stiffener placed on top of the bridge.

Twenty-two balk (either short or normal) are laid for the *deck transition span. This* span runs from the sixth to the seventh stiffener placed on top of the bridge.

Eighteen tapered balk are laid as an *approach to the deck transition span*.

6. Check all lugs to ensure they are securely pinned. Place cover plates at all hinged joints.
7. Fasten wire rope lashings to the ends of the stiffeners placed on top of the bridge to hold the superimposed deck in place.

OPERATIONAL MAINTENANCE

Maintenance of Floats

Protection

When the bank is on a gradual slope and the water is shallow, the pneumatic floats at the ends of the bridge or raft may be grounded. During rafting operations. there is little that can be done to prevent this grounding, but the raft commander can take care to ease the raft into and away from the shore to minimize possible damage. When bridge end sections are grounded, the floats are particularly vulnerable to wear from contact with the riverbed. Unless the bottom is protected, the float will wear through in 12 to 18 hours of continuous use. One method of protection is to lash a timber frame to the bottom of the pontons. This frame can be constructed of 2- by 12-inch timbers. Place three 15-foot timbers along the length of the float and four 8-foot timbers along the width of the float.

Repair

The air pressure in pneumatic floats changes with the temperature and the weather. Floats should be inspected frequently to ensure a constant pressure of 2 psi is maintained. Temporary repairs to floats are limited. Small holes may be plugged with the tapered plugs supplied in the emergency repair kit. If a float is damaged to the extent that the hole or tear cannot be repaired, the float will have to be removed from the bridge. Once removed, this float should be inflated and the extent of the damage should be determined. It maybe necessary to replace one or more of the tubes which make up the float if damage is severe. A severely damaged float may be removed from the bridge and another float may be installed without breaking the bridge connection. This may be accomplished by—

- Retracting the retainers holding the superstructure to the saddle beams and withdrawing the damaged float.

- Pulling a partially inflated float (with a complete saddle assembly), beneath the bridge. This is done after the damaged float is removed.
- Working the saddle beams on the new float into position under the superstructure and replacing the retainer lugs.
- Completely inflating the new float.

Storage of floats

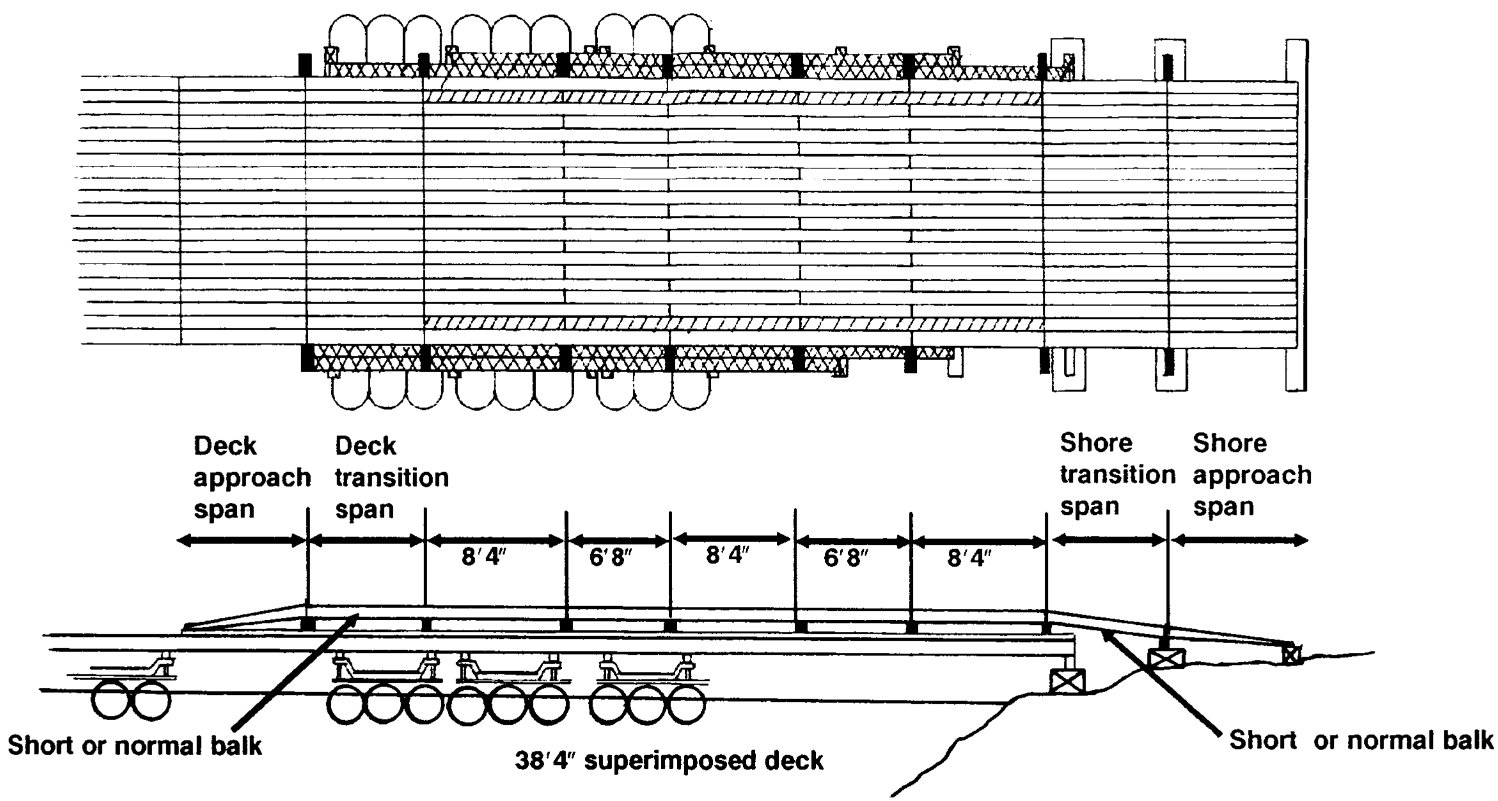
If floats are to be removed from the water for an extended period of time, the following actions are recommended

1. Deflate and remove all water from the float using the inflator-deflator valve on the 250 CFM air compressor.

2. Reinflate the float and allow it to stand. This lets the float dry completely and provides a means to ensure that the float has no leaks.

3. Deflate the float completely. Powder the float and store it in a cool, dry place. It is best to store floats in an area where they can be stacked flat (neither rolled nor folded). When this is not possible, it is preferable to roll the floats rather than fold them.

Construction of a superimposed deck span for reinforced bridges



Bridge Maintenance

Inspections

The M4T6 bridges should be inspected frequently to ensure the bridge remains in safe, operational condition. Particularly ensure that connecting pins and safety pins are in their required locations and are serviceable. Decks must remain clean and inspect balk for signs of cracks or undue wear.

End spans

Continuous deck end spans frequently rise off the abutments. This tendency can be overcome by raising the height of the abutment and by ensuring that there is adequate bearing surface on the abutment.

Trestles

Transoms should be raised whenever a trestle shoe does not settle. Additional trestle bracing is usually needed after the initial settlement. The bracing clamps should be adjusted and tightened to compensate for the bending caused by settlement. Use sandbags, wire netting, landing mats, or rocks to protect footings from the undercutting action of the current.

Abutments and approaches

Check abutment shoes and sills for settlement. When they settle, use gravel, additional footing material, or cribbing to provide the necessary bearing area. Bank revetting must be checked frequently and, when necessary, the banks should be stabilized with riprap or sandbags. Every effort should be made to anticipate water level changes which may necessitate lengthening the bridge or adding trestles. Bridge approaches require continuous maintenance to avoid traffic delays caused by impassable approach conditions. Stockpile road materials to aid in repairs and improvements.