CHAPTER 12

TIMBER BRIDGE FABRICATION AND CONSTRUCTION

12.1 INTRODUCTION

The performance and serviceability of any bridge depend on the accuracy and quality of fabrication and construction. When correct procedures are followed, the bridge can be economically built and can provide many years of service. When improper or negligent practices dominate, both the economics and long-term serviceability of the bridge will be adversely affected. Timber bridges are especially suited to economical fabrication and construction because they can be completely prefabricated at a shop facility and shipped to the project site for assembly. Components are lightweight compared to those using other bridge materials and can be quickly installed without highly skilled labor or specialized equipment.

This chapter addresses proper techniques and procedures for timber bridge fabrication and construction. Topics include the preparation of engineering drawings, bridge fabrication, handling, transportation, storage, and construction. Discussions are general in nature and are applicable to most timber bridge types. Because construction specifications and administrative procedures vary for different projects and jurisdictions, details related to these two areas are not included.

12.2 ENGINEERING DRAWINGS

Successful bridge fabrication and construction depend on the accuracy and completeness of the engineering drawings. Two types of drawings are normally used: design drawings and shop drawings. Design drawings show the structure configuration and provide information necessary for field assembly. Shop drawings provide more detailed information for the fabrication of individual components. Design drawings are prepared by the organization responsible for the design of the structure. The same organization may also prepare shop drawings, or the fabricator may prepare them from the design drawings. In some cases, the design drawings are completed in sufficient detail to serve as both design drawings and shop drawings.

This chapter was coauthored by Michael A. Ritter and Charles B. Schmokel, Bridge Systems Manager, Western Wood Structures, Inc.

Engineering drawings are usually the only means of communicating design and fabrication information to the material fabricator and construction crew. They must be complete, legible, and accurate, and must contain all necessary information, including material specifications and material lists. Individual components and assembly details should be laid out clearly with all dimensions, hole sizes, and assembly locations accurately shown. When laying out the drawings it is desirable to assign mark numbers to individual timber members. These numbers can be placed on the components during fabrication where they will help identify material during erection. Some common symbols and abbreviations used for detailing timber structures are shown in Table 12-1.

The drawings should include material specifications that are referenced to standard specifications discussed in previous chapters (AITC, AWA, AASHTO, or ASTM) and should include specific information related to timber grades, surfacing, preservative treatments, steel and hardware grades, and corrosion protection. Material information should be summarized in a materials list that includes the required number, size, and weight for all components and hardware. Such lists are important because they often serve as the basis for competitive bidding, transportation estimates, and checklists of material quantities delivered to the project site. In addition, drawings should include any special assembly instructions or requirements for transportation, handling, or storage. Complete, accurate drawings increase the likelihood that correct materials and quantities will arrive at the jobsite. An example of a good-quality engineering drawing for a timber bridge is shown in Figure 12-1.

Drawing preparation is an integral part of the design process. As such, the attention given to detailing can have a substantial effect on both the economy and long-term performance of the structure. When preparing drawings, consideration should be given to material selection, ease of assembly, fabrication and erection tolerances, and details that affect bridge performance. Some of the important points related to detailing and specifications discussed in previous chapters are reiterated as follows:

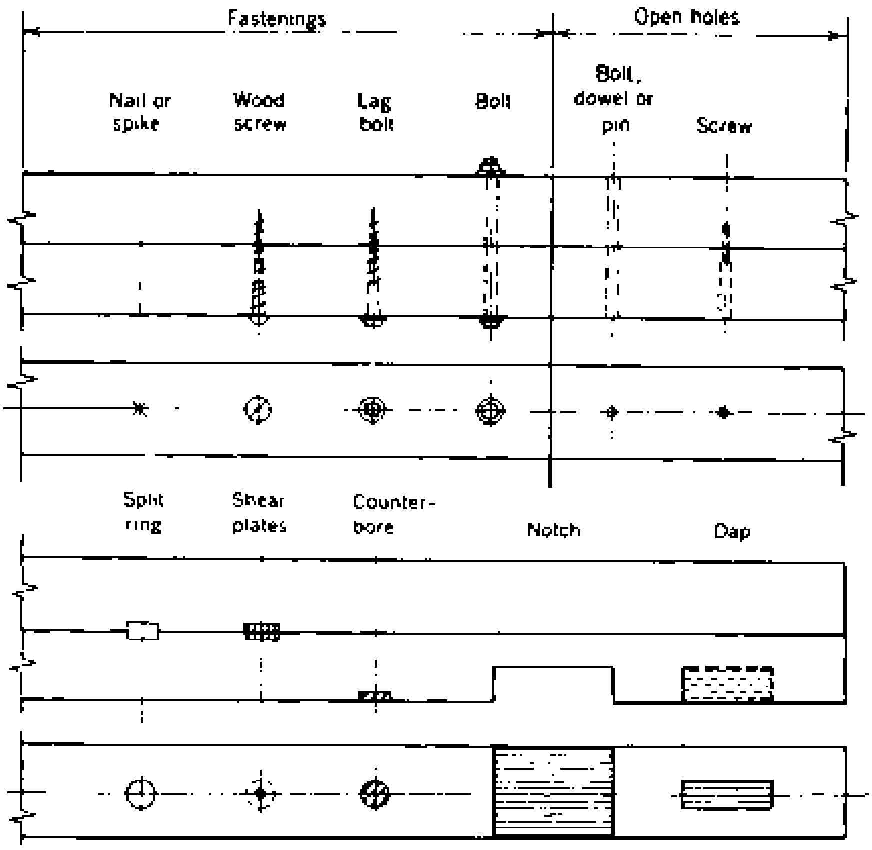
1. Use standard material sizes and grades for glulam and sawn lumber (Chapter 3).

2. Use timber species that are readily treatable with preservatives (Chapter 4).

3. Specify appropriate wood preservatives for the intended application (Chapter 4). Oil-type preservatives, such as creosote, pentachlorophenol, or copper naphthenate in heavy oil, provide the best protection for bridge components. When members are subject to human contact, waterborne preservatives or oil-type preservatives in light petroleum solvents should be used.

Table 12-1. - Typical detailing symbols and abbreviations for timber.

Detailing symbols[a]



Detailing abbreviations[b]

Angle(s) (metal section)	∠, ∠s	Malleable iron washer	M.I.
Both sides	B.S.	Mark(ed)	MK
Carriage bolt	C.B.	Mold loft	ML
Centerline	℄	Near side	N.S.
Center-to-center	c–c	Ogee (cast) washer	O.G.
Chamfer	chfr	On centers	o.c.
Channel(s) (metal section)	[, [s	Plate	⅊
Counterbore	cbr	Radius	R, rad
Countersink	csk	Steel section	S
Cut washer	C.W.	Shear plate	Sh. Pl.
Diameter	ϕ	Split ring	S.R.
Each side	E.S.	Threaded rod	thrd
Far side	F.S.	Turnbuckle	tbkl
Lag bolt	L.B.	Steel section	W
Lamination	lam	Wrought washer	W.W.
Machine bolt	M.B.		

[a] Symbols are intended for large-scale details only. For all symbols, the sizes and quantities required must be indicated on the drawings. If sizes are mixed, or if these symbols do not provide a clear explanation of the connection, a detail showing the hardware arrangement should be included.

[b] Additional abbreviations are given in Chapter 16.

From *Timber Construction Manual*;[2] American Institute of Timber Construction; ©1974, John Wiley & Sons, Inc. Reprinted by permission.

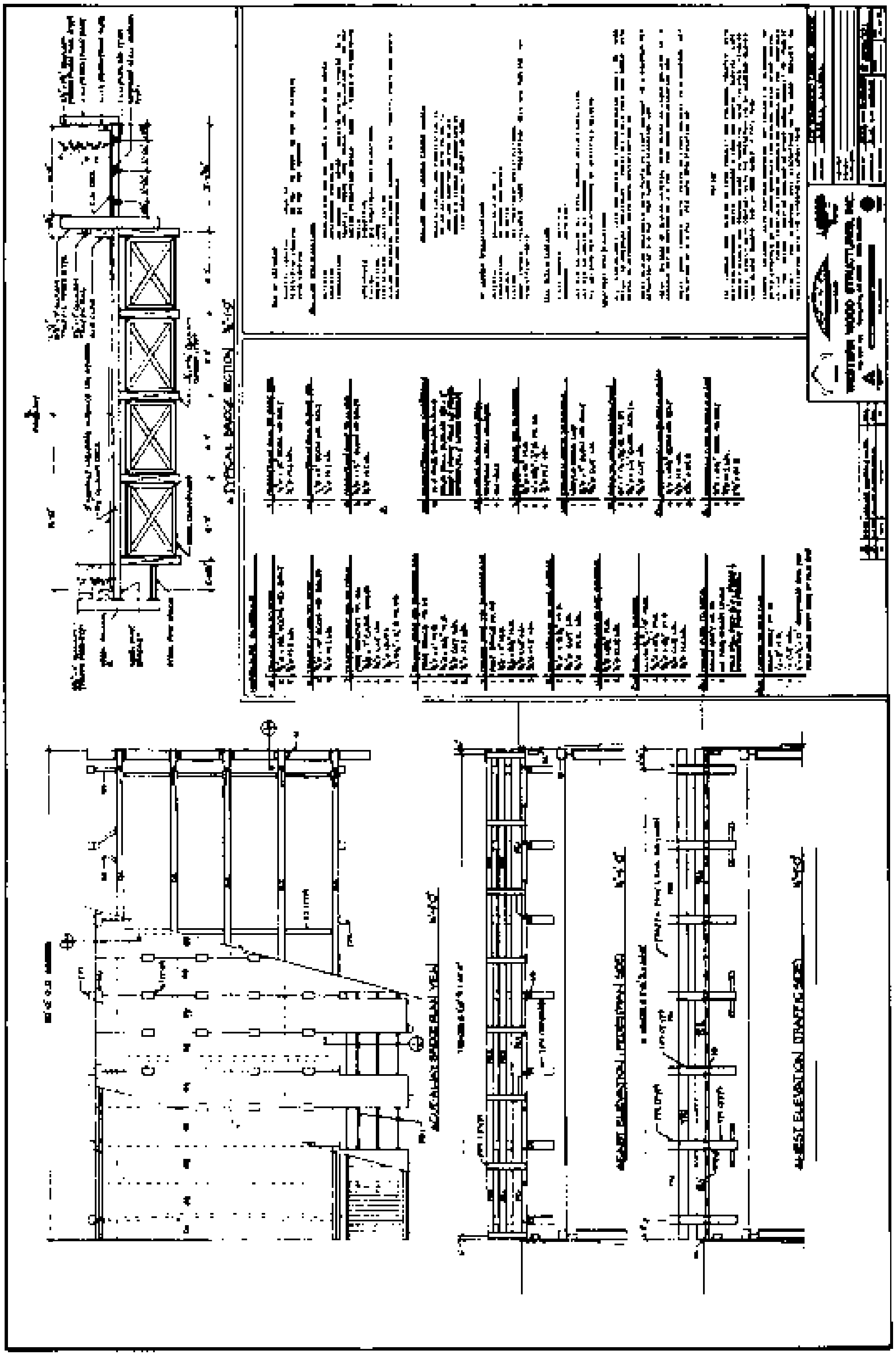


Figure 12-1.—Example of an engineering drawing for a timber bridge (photo courtesy of Western Wood Structures, Inc.).

4. Detail members so that fabrication can be completed before pressure treatment with preservatives.

5. Use standardized members in a repetitious arrangement, especially for glulam deck panels.

6. Avoid details that trap water, debris, or other material.

7. Use standard connection details whenever practical. Typical connection details are given in *AITC 104 - Typical Construction Details.*[2]

As a final step in drawing preparation, it is important that all work be independently checked for completeness and accuracy before putting an order into production. Do not depend on the fabricator or contractor to check the accuracy of dimensions, quantities, or specifications. A few hours of checking in the office can save thousands of dollars in field expenses.

Familiarity of the design engineer and draftsperson with material availability, cost, and common fabrication and construction practices can greatly improve economy and ease of construction. It is beneficial for design personnel to visit fabrication facilities and construction sites to observe procedures. This is also a good opportunity to discuss processes with fabrication and construction personnel and solicit comments on methods for improving the fabrication and installation of future timber bridges.

12.3 BRIDGE FABRICATION

Accurate fabrication is essential for the quick installation of a timber bridge. It is more economical to accomplish as much work as possible at the fabrication plant since costs are normally lower there than in the field. Also, plant equipment is generally faster and more accurate (Figure 12-2).

Glulam and dressed lumber is initially manufactured to the dimensions discussed in Chapter 3. The expected tolerance for the holes and cuts made during fabrication is approximately 1/16 inch. In some cases, tolerances may be slightly greater depending on the type of component and the condition of the timber at the time of fabrication. A member that is precisely fabricated at a shop facility may undergo slight dimensional changes because of variations in moisture content during treatment, transportation, and storage. Therefore, minor dimensional changes may occur before the material reaches the construction site.

Figure 12-2.- Shop fabrication of timber bridge components, such as these nail-laminated lumber deck panels, is more accurate and more cost effective than field fabrication (photo courtesy of Wheeler Consolidated, Inc.).

Most glulam and sawn lumber manufacturers provide fabrication services such as trimming, drilling, counter boring, notching, tapering, and in some cases, incising. Some glulam manufacturers also have layout areas where they can pattern fabrication templates for more accurate fabrication of multiple members (Figure 12-3). Many treating plants offer fabrication services comparable to those of material suppliers and manufacturers, including incising. A number of businesses deal strictly in timber fabrication. These operations have fabrication capabilities similar to those of sawn lumber manufacturers or treating plants and can usually cut, bore, and incise timber components, as well as package units ready for pressure treatment with preservatives. This results in reduced handling requirements at the treating plant, and can lower treating costs. Some manufacturers and fabricators will also preassemble bridge components to ensure proper fit; however, this service can be relatively expensive.

Most timber bridges require fabricated steel and fastening hardware. Fabrication procedures and tolerances for steel are just as critical as those for wood, and a reputable steel fabricator should be used to ensure that correct fabrication procedures are used. Steel bearing shoes, hangers, or saddles should be manufactured approximately 1/4 inch larger than the member over which they will fit. Holes should be 1/16 inch oversized, or slotted where provisions for movement or field adjustment are required. Weldments or other protrusions that may conflict with other bridge components should be ground smooth. Bolts, nuts, washers, and other

Figure 12-3. - Template production area at a glulam manufacturing plant. Plywood templates shown in the background are used to ensure consistent, accurate, and complete fabrication of multiple glulam members.

hardware can be purchased from hardware manufacturers and suppliers. Most hardware required for bridge construction is standard and often readily available. When special hardware is required, additional time should be allowed for manufacturing. All steel components should be hot-dip galvanized or painted for corrosion protection and longevity.

Several businesses currently sell complete timber bridge packages. These packages, which may include structural design at the option of the purchaser, provide all fabricated bridge materials including treated sawn lumber or glulam, steel components, and hardware. The materials are packaged for a specific project and shipped to the construction site in bundles and containers, ready for construction. In many cases, packages of this type are the most economical source of bridge material.

12.4 TRANSPORTATION, HANDLING, AND STORAGE

Timber is a naturally durable material that can withstand moderate abuse without damage. However, it is necessary that reasonable care be exercised in transportation, handling, and storage to ensure that good quality is maintained.

TRANSPORTATION

Bridge materials can be transported from the plant to the jobsite by trucks, rail cars, or barges. Highway trucks are the most common method of transportation and are capable of hauling between 45,000 and 60,000 pounds (maxi-trucks). It may be necessary to obtain special equipment to haul long lengths (over 50 feet), wide loads (over 8 feet), and members with a large amount of curvature. Long material may also require pilot cars or steering trailers. In most States, there are curfews, permits, or other regulatory laws that must be considered. Some States have length limitations that may not permit hauling long material. In addition, roads to the project site may have limited vertical clearance and could have hairpin turns, which require special equipment or handling.

Many manufacturing and treating plants have rail sidings, but most jobsites do not. This means that material must be taken off the rail cars at some point and transported by truck to final destinations. Rail cars have width, length, and other restrictions, including minimum weight limits that may increase costs. Some water-locked sites may only be accessible by barge. The same types of length, width, and weight restrictions that apply to rail transport may apply to barges and should be considered.

Timber components are normally stacked in units for easy loading and transportation. It is common and accepted practice to bundle a number of pieces and band them together with steel straps. When steel straps are used, corner guards must be placed to prevent damage to the wood (Figure 12-4). It is advisable to place a piece of nominal 2-inch lumber across the bundle, under the band, to protect the material and provide access for lifting when bundles are stacked. In most cases, members are handled and transported flat. Short members can be transported on a flatbed truck, while loads over 75 feet may require a log truck or other specialized vehicle (Figure 12-5). If more than one member is being trucked at a time, they should be strapped together with nylon binders.

With competitive prices and the ability to haul materials directly to the jobsite, truck delivery is normally most economical. Bridge members can be hauled hundreds or even thousands of miles to a jobsite and still be competitive. For example, it is not uncommon for glulam bridges manufactured in Oregon to win competitive bids for projects in Virginia or Florida. Therefore, transportation distance should not be a limiting factor in soliciting project bids.

HANDLING

Treated sawn lumber and glulam must be handled with reasonable care to avoid breaking the material or the preservative treatment envelope. Minor scuffs usually do not affect the end use of the material unless they cause an appearance problem. More severe damage, such as cuts or breaks in the tension laminations of glulam beams, can have adverse effects on structural capacity. It is recommended that timber members be handled with nylon slings to prevent damage. The sling is placed around the member

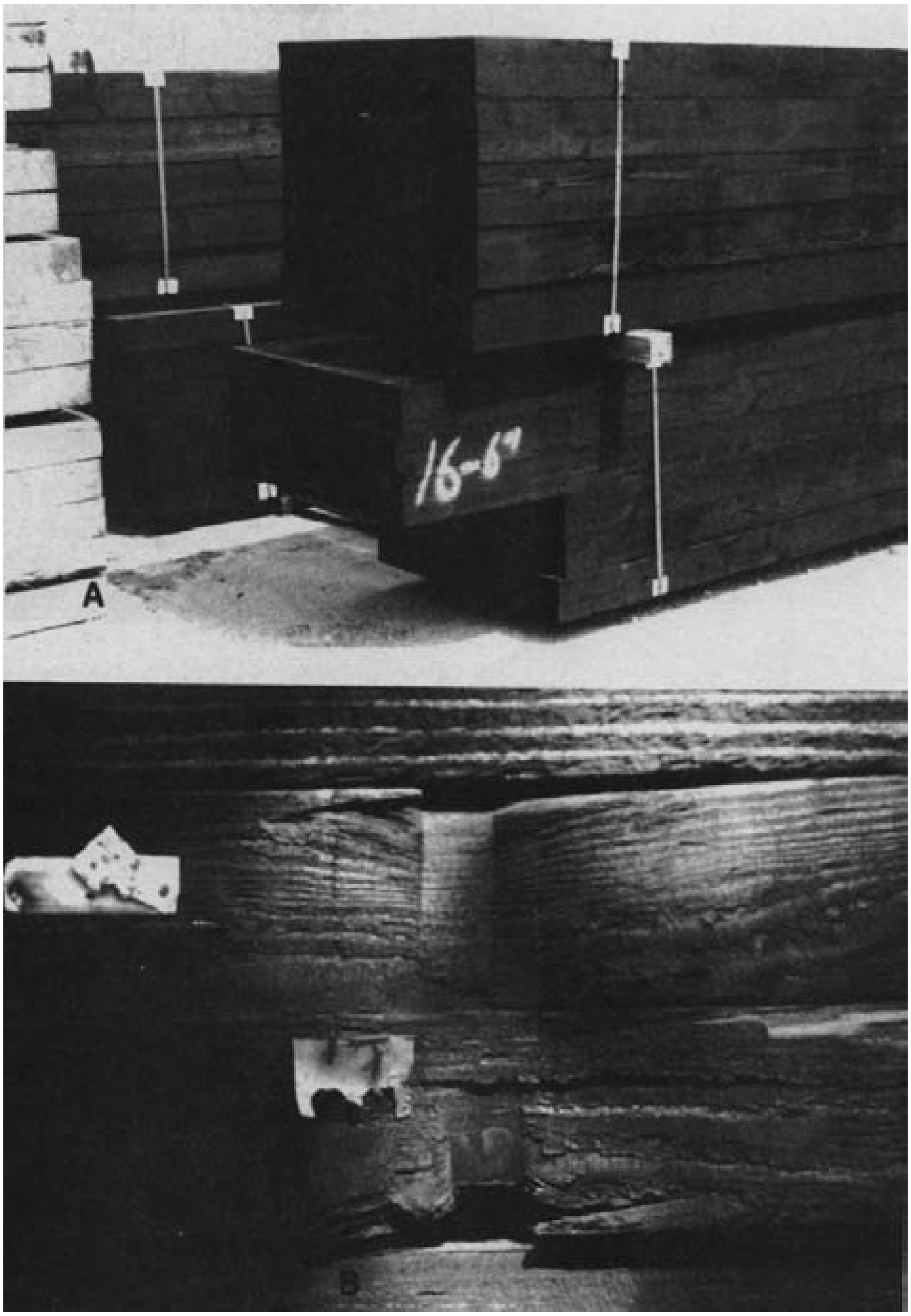


Figure 12-4. - (A) Properly placed corner guards prevent wood damage from steel straps (photo courtesy of Western Wood Structures, Inc.). (B) Wood damage resulting from steel straps when corner guards are not used.

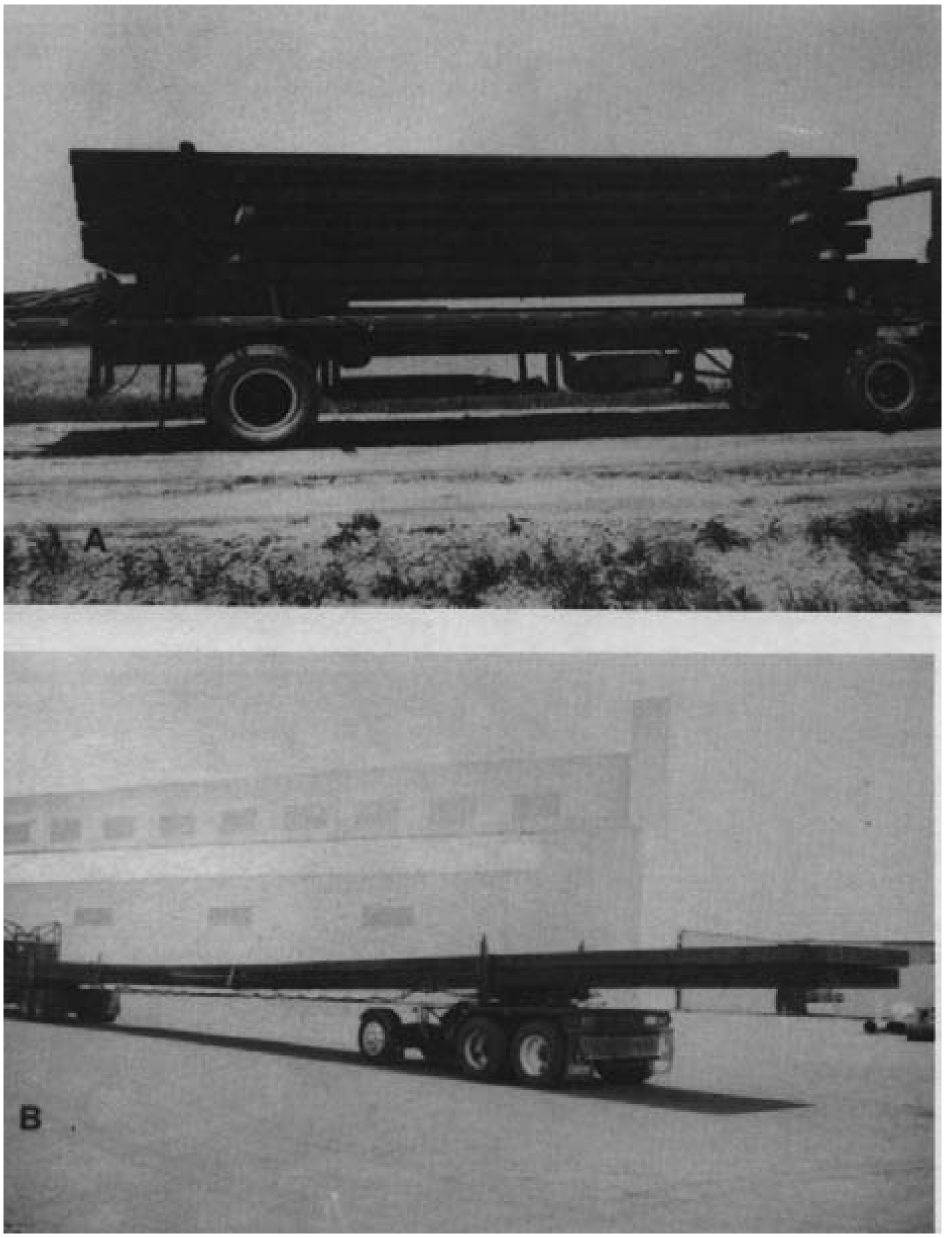


Figure 12-5. - Truck transportation of timber bridge components. (A) Short members, such as these nail-laminated lumber deck panels, can be transported on a flatbed truck (photo courtesy of Wheeler Consolidated, Inc.). (B) Long glulam beams require specialized vehicles such as this log truck and dolly (photo courtesy of Western Wood Structures, Inc.).

with the loop at a corner (choke position) so the member rides vertically (Figure 12-6). Chains or cables are not recommended because they can cut into the wood surface. If they are the only rigging available, steel corner protectors must be used to protect the wood members.

Figure 12-6. - Proper placement of a nylon sling on a glulam beam, with the loop in the sling at the corner of the beam.

Because of their relatively light weight, lifting timber components can be done with a variety of equipment, depending on what is available near the project site. Cranes are usually the most desirable, but forklifts, front-end loaders, backhoes, or other equipment can be used, depending on the size and type of component. Short glulam members can be picked up and moved in the flat position while longer beams must be tipped and lifted on edge (Figure 12-7). When glulam deck panels or beams are lifted flatwise, they should not be lifted by the edges parallel to the wide face of the laminations. This can induce high bending stress perpendicular to grain and may cause structural damage. Members of this type should be lifted in a vertical position, with the laminations horizontal (supports placed across the wide face of the lamination) or with fabricated steel C-shaped brackets that fit over the member ends (Figure 12-8).

Figure 12-7. - A large glulam bridge beam is tipped from its horizontal storage position before being lifted into place on edge (photo courtesy of Tim Chittenden, USDA Forest Service).

Handling preservative-treated timber is generally not hazardous to construction workers. However, a few common-sense procedures should be followed. Workers should use chemically impervious gloves and wear long-sleeved shirts and long pants when working with treated materials. Eye protection (goggles and face masks) should be used when sawing or machining treated lumber. After handling treated wood, workers should wash exposed skin areas carefully before eating, drinking, or using tobacco products. By law, all shipments of pressure-treated wood must be accompanied by an EPA Consumer Information Sheet (copies are included in Chapter 16). All workers should read and understand these sheets before construction begins.

STORAGE

For short- or long-term storage, timber should be neatly stacked in dry, level areas that are clear of plant growth and debris (Figure 12-9). The bottom layer of material should be approximately 8 inches above ground level and be supported on spacer blocks placed 10 to 15 feet apart, de-

Figure 12-8. - Lifting a glulam deck panel from steel C-brackets that fit over the panel ends.

pending on the material. If sagging is evident, additional supports should be added. Layers in the stack are added on 2-inch nominal sawn-lumber spacers (stickers) that extend across the full width of the stack. The stickers separate the layers to allow free air circulation and provide access for lifting equipment. It is important that all stickers be aligned vertically and be spaced at regular intervals. Otherwise, stacked members may be subjected to bending stress and might twist or warp during extended storage.

When properly stacked, it is normally not necessary to cover timber that has been treated with oil-type preservatives. Free air circulation is all that is required. If dried sawn lumber treated with waterborne preservatives is stored, a cover may be desirable for protection during inclement weather conditions, depending on the anticipated length of storage. When covers are necessary, impervious membranes such as polyethylene film should not be left in place during dry weather because they trap moisture that evaporates from the ground or from the timber members.

12.5 BRIDGE PRECONSTRUCTION

Before the arrival of bridge materials, a thorough job of preconstruction engineering at the bridge site can save time and money during construction. The first step is to review all drawings and specifications to understand the sequence of construction and any special handling or equipment that might be required. If there are questions, the bridge designer or

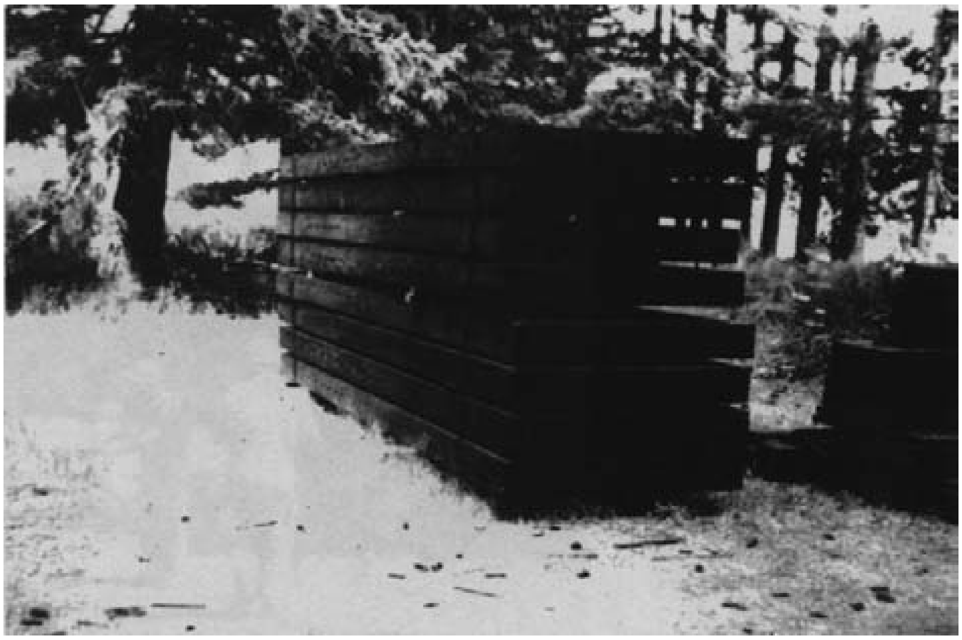


Figure 12-9. - Glulam deck panels stacked for storage.

supplier should be contacted for clarification. Personnel and equipment should not be kept idle while drawings are being interpreted. After drawings are reviewed, the bridge substructure should be inspected for correct placement. Sills must be spaced the correct distance apart and at the correct elevations shown on the drawings. Holes for the bridge bearing anchor bolts must be in their correct positions, both longitudinally and transversely. The substructures should be measured corner to corner to verify squareness (Figure 12-10). Many of the problems that develop in timber bridge construction can be eliminated by doing this preliminary review and inspection before actual receipt of materials for construction of the bridge superstructure.

To efficiently construct a timber bridge, proper lifting equipment and tools must be available at the jobsite. A crane is usually most practical for large components such as glulam beams or large, prefabricated bridge sections (Figure 12-11), while other types of equipment such as forklifts, front-end loaders, or backhoes can be used for smaller components. When determining required equipment capacity, the weights of bridge components are normally on the drawings or can be calculated from member dimensions. If this is not possible, weights can be obtained from the bridge designer or supplier. When possible, lifting equipment should be provided with two nylon slings that are long enough to be used in the choke position and strong enough to lift at least half the weight of the largest member. Deck-lifting brackets should also be available when glulam panels are a part of the project.

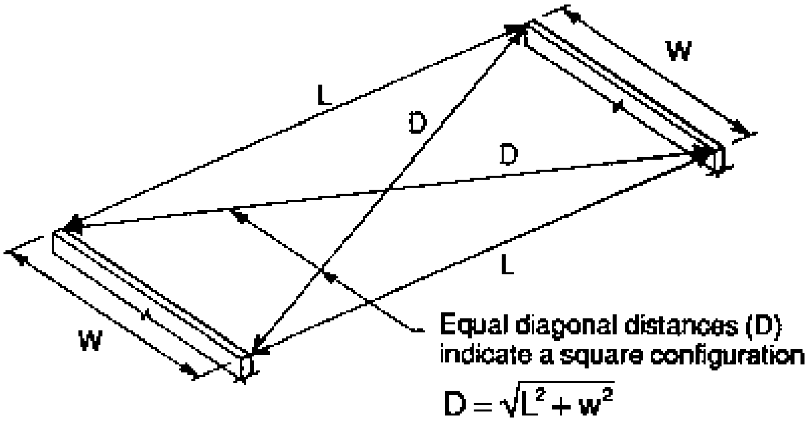


Figure 12-10. -- Verifying squareness and alignment of substructures by measurement of diagonals.

Figure 12-11. - One-half of a stress-laminated parallel-chord bridge is lifted into place by a crane.

It is helpful in bridge construction to have a power source or generator for electric tools. Even though bridges are usually totally prefabricated, field construction and adjustment tools such as drills, reamers, and power saws should be available. Cutting torches and welders may also be required, in unusual cases, to modify steel members. A supply of wood preservative (which may be shipped with the bridge) and galvanizing paint should be available for field touchup during construction. Other tools, including impact wrenches, sockets, pry bars, come-a-longs, sledge hammers, and spud wrenches are helpful. For most types of timber bridges, access to the bridge underside is necessary for placement of transverse bracing and fasteners. A tall ladder may be sufficient for small structures, but for most bridges a scaffold system is required. Scaffolding should be movable from the top of the bridge using staffpower or available equipment (Figure 12-12).

Before material delivery, survey the site to make sure there is adequate access for delivery trucks and equipment. Most trucking companies allow an hour of free unloading time and then charge an hourly standby fee, so prompt truck unloading is important. Locate adequate material storage sites before unloading begins. When selecting storage locations, consider lifting equipment access to various stacks.

When bridge materials are delivered to the site, immediately make an initial visual inspection and inventory of materials. Any items that are obviously damaged or missing should be noted on the bill of lading accompanying the shipment. If the damages appear serious, notify the supplier at once. Next, all material should be carefully sorted to make sure the proper sizes and quantities are present. Verify dimensions of all fabricated components as soon as possible after delivery. It is better to find incorrect sizes or fabrication errors when the material arrives than to wait until construction has started.

12.6 BRIDGE ASSEMBLY

The methods and techniques of bridge assembly differ slightly among bridge types and materials. This section discusses bridge assembly for glulam beam bridges with transverse glulam deck panels. These general procedures also apply to longitudinal deck bridges or to bridges with sawn lumber beams or decking. More specific assembly procedures are presented in case histories in Chapter 15.

For beam-type glulam bridges, assembly is normally started with one of the outside beams. The beam is lifted upright from the storage stack using two nylon slings in the choke positions, placed approximately at the beam one-third points. When available, a spreader beam is normally used for long members. When the beam is upright, shop drawings should be checked to ensure that the beam has the correct mark number and is standing with the top mark up. In some designs, beam fabrication may not be symmetrical so it is important that the member is properly orientated. At this point, it is desirable to attach some of the steel components, such as bearing shoes, steel cross-frames, and railing brackets, to the beams. It is easier and safer to attach these components while the beam is on the ground and readily accessible. After steel components are in place, the

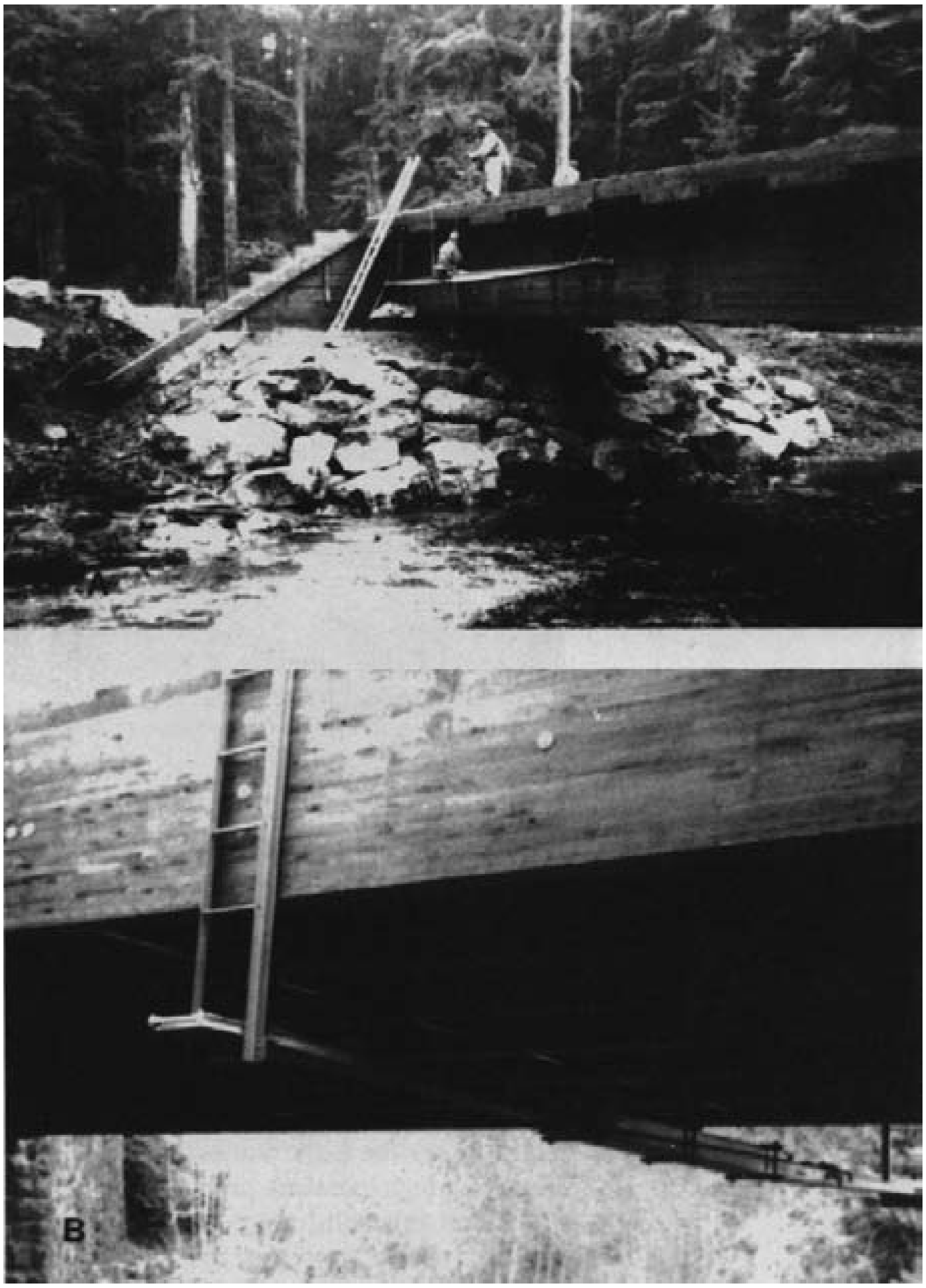


Figure 12-12. - Typical scaffolding configurations for accessing the underside of a glulam beam bridge. (A) Along the deck overhang (photo courtesy of Tim Chittenden, USDA Forest Service). (B) Between beams (photo courtesy of Western Wood Structures, Inc.).

beam is lifted into position (Figure 12-13). Ropes should be tied at each end of the beam so personnel can keep it aligned as it is moved. The beam is positioned on the substructure, and anchor bolts are placed and finger-tightened. Nuts should not be tightened until the bridge is completely assembled to allow for adjustment during the course of construction. After the first beam is in place, the remainder of the glulam beams are correctly orientated and lifted into place in the same manner (Figure 12-14).

Figure 12-13. - Glulam beam is lifted into position with steel components in place. Note the use of a spreader beam and nylon straps for lifting (photo courtesy of Western Wood Structures, Inc.).

After all beams are in place, deck panels can be placed. Again, it is important to check the mark numbers on the deck panels against those on the shop drawings to ensure proper placement and sequence. If the panels are not interchangeable, or are not symmetrical, panel size and fabrication should be visually verified against the shop drawings. Panels should also be checked to be sure they are not upside down; however, some deck panel layouts require that the last panel at the bridge ends be turned upside down to match bolt spacing. Deck panels can be picked up and set easily with a backhoe, forklift, or crane using deck-lifting brackets (Figure 12-15). As panels are placed, a mastic sealer is usually applied to the panel interface (Chapter 7). To aid in panel placement, it is beneficial to tack a piece of colored flagging at the center of each panel to assist in visually aligning the panels on the beams. Once the panels are in place they can be easily adjusted with a pry bar. When all deck panels are on the bridge, the crane (if used) may be discharged and other, less expensive equipment may be used to finish the bridge construction.

Figure 12-14. - Glulam beams for this bridge are placed from left to right, starting with the outside beam. As the beams are placed in position, bolts are inserted through bearings and steel cross-frames (photo courtesy of Western Wood Structures, Inc.).

Figure 12-15. - Glulam deck panels are sequentially lifted into place with a backhoe, using C-brackets over the panel ends.

If load-transferring devices, such as dowels, are used between the deck panels, they are installed progressively as the panels are placed. For dowels, the first deck panel should be placed in position and attached to supporting beams. This panel then serves as a starting point for installing the balance of the deck panels. Dowels are partially inserted into the stationary deck panel, the next panel is moved into position, and the dowels are inserted into the corresponding dowel holes. The deck panels are then either pulled together with come-a-longs or pushed together with equipment or jacks (Figure 12-16). For a complete description of the installation procedures for a doweled glulam deck, refer to *Erection Procedure for Glued Laminated Timber Bridge Decks With Dowel Connector*.[9]

If the deck panels are attached to beams with brackets or clips, the bolt holes in the panels must match the routed grooves in the beams. The deck connection bolts are placed through the deck panels and the brackets or clips are loosely attached to the beams. Next, the curbs are set into place and fastened to the deck with connecting bolts. If some of the holes do not line up, a spud wrench, pry bar, or sledgehammer (with a softening device) may be used to slightly adjust the deck or curb so holes align (Figure 12-17). From time to time, some components may not fit perfectly because of minor misfabrication, and some adjustments may be required. Twisting or tapping a bolt may help solve the problem. It may be necessary in some cases to ream or enlarge holes so that the bolt will slide through. Before reaming, the engineer should determine if enlarging the

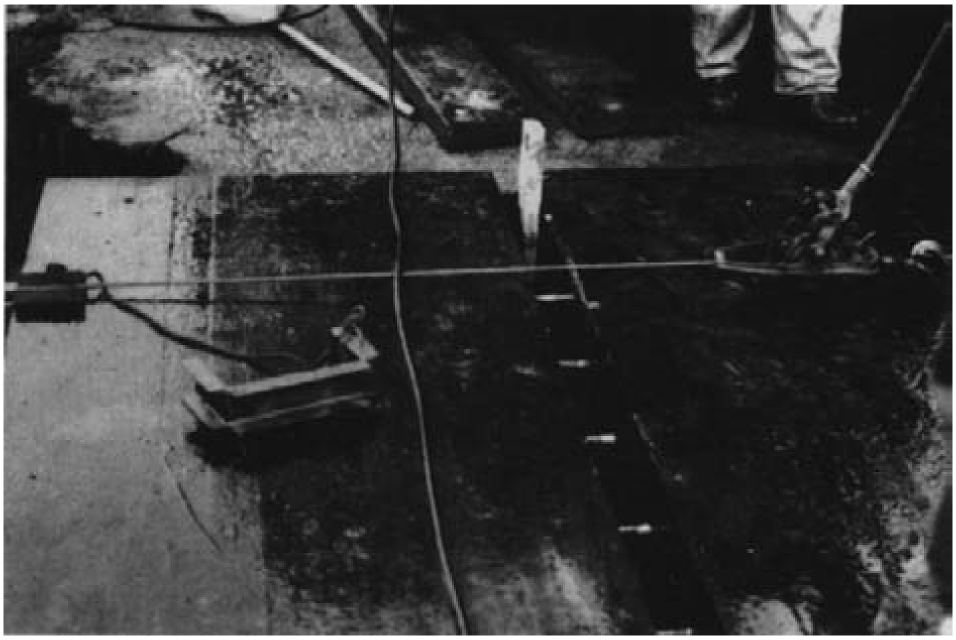


Figure 12-16. - Doweled glulam deck panels are pulled together with a come-a-long. Note the steel C-brackets that are placed over the panel edges to prevent damage during jacking.

Figure 12-17. - Workers use a pry bar to align the curb for deck attachment.

hole will alter the strength of the connection. This type of reaming will usually not expose untreated wood, and field treatment will not be necessary; however, if new holes are drilled or members are cut, field treating should be done in accordance with procedures discussed later in this chapter.

Once the curbs are in place, rail posts and railing are installed using the same procedures as those used in bolt alignment. Alignment and appearance are important on the curbs and railings, and the system must be level and straight. Once this is done, all bolts on the bridge can be tightened. The quickest way to tighten nuts is to use an air or electric impact wrench and sockets. A torque ratchet is desirable to ensure that bolts are tightened to approximately 50 ft-lb of torque. This can be noted visually when the washers begin to pull into the treated wood. It is necessary to go under the bridge to tighten most types of deck-attachment hardware, and a ladder or scaffolding will be required for access.

After the bridge is assembled, and all connections are tightened, the substructure backwalls can be placed and the approach roadway can be backfilled. Backfill should be placed from both sides at approximately the same rate to prevent the bridge from being pushed out of line by the uneven backfill loads. Once backfilling is complete, and the roadway approaches are in place, the wearing surface is placed over the bridge deck.

Most contractors are surprised at how quickly a glulam bridge can be erected if the bridge shop drawings are accurate, if the bridge is properly fabricated, and if the preconstruction techniques and reviews are followed. Cases have been documented where 60-foot glulam beam bridges have been completely assembled in 60 work hours. Once a crew has gained experience, the bridge construction time and cost can be reduced even further, thus making a glulam bridge one of the fastest, easiest, and least expensive bridges to install.

12.7 FIELD TREATMENTS

Occasionally, treated timber bridges may be damaged or require field modification during installation. This can expose untreated wood that must be field treated to protect the member from future decay and deterioration. Field treatment procedures are outlined in AWPA Standard M4-84,[4] which requires that all cuts, holes, and injuries to treated wood be protected by brushing, spraying, dipping, or soaking in an approved preservative. Field application is not nearly as effective as pressure treating, so field fabrication and field treatment should be kept at a minimum.

Most timber bridges are pressure treated with such oil-type preservatives as creosote, creosote solutions, pentachlorophenol, and occasionally, waterborne salts. In the past, these treating solutions could be purchased over the counter from a number of sources and then applied by construction crews as necessary, but because of recent EPA rulings, a state applicator's license is required for the purchase and application of most wood preservatives. Even with an applicator's license, it can be very difficult to locate and obtain common wood preservative solutions. The most widely available and approved field treatment solution is copper naphthenate in an oil solvent. This product is available over the counter and does not require an applicator's license. AWPA Standard M4 states that copper naphthenate solutions may be used to field treat wood that was originally treated with creosote, creosote solutions, pentachlorophenol, or waterborne preservatives. The preservative solution is prepared with a solvent conforming to AWPA Standard P9 and must have a minimum concentration of 2 percent copper metal. When available to licensed applicators, other wood preservatives can be used in accordance with the guidelines in AWPA Standard M4.

Preservatives for field treating are usually applied by brushing, dipping, or squirting (Figure 12-18). For each method, the surface of the wood must be saturated with the preservative to provide adequate protection. Even small openings in the preservative can provide an avenue for decay entry. In order to adequately protect wood, all wood preservatives must be toxic to intended targets such as fungi and insects. Workers applying field treatments must wear protective clothing, gloves, and eye protection.

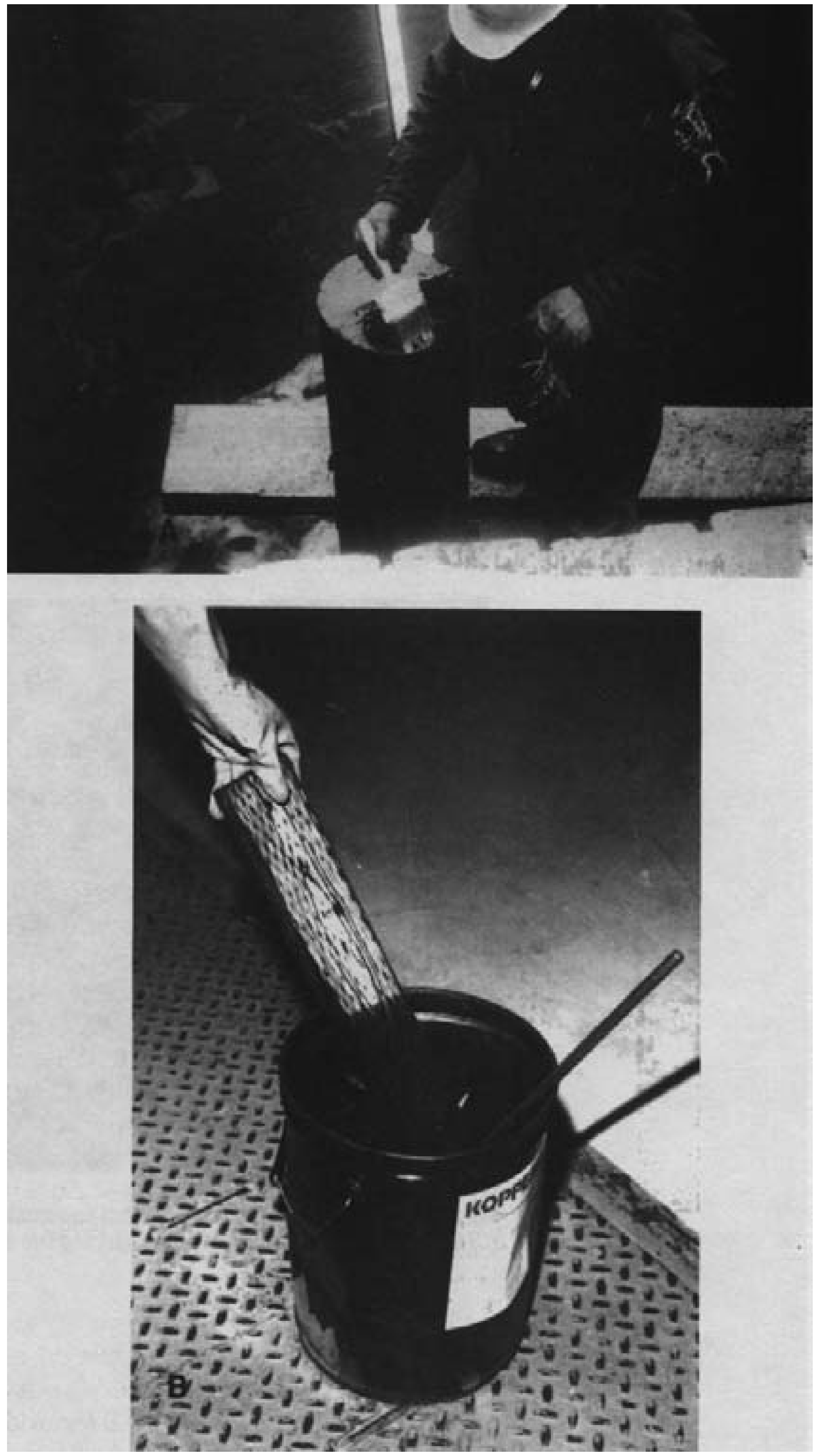


Figure 12-18. - Commonly used methods of field treating timber members. (A) Brushing. (B) Dipping.

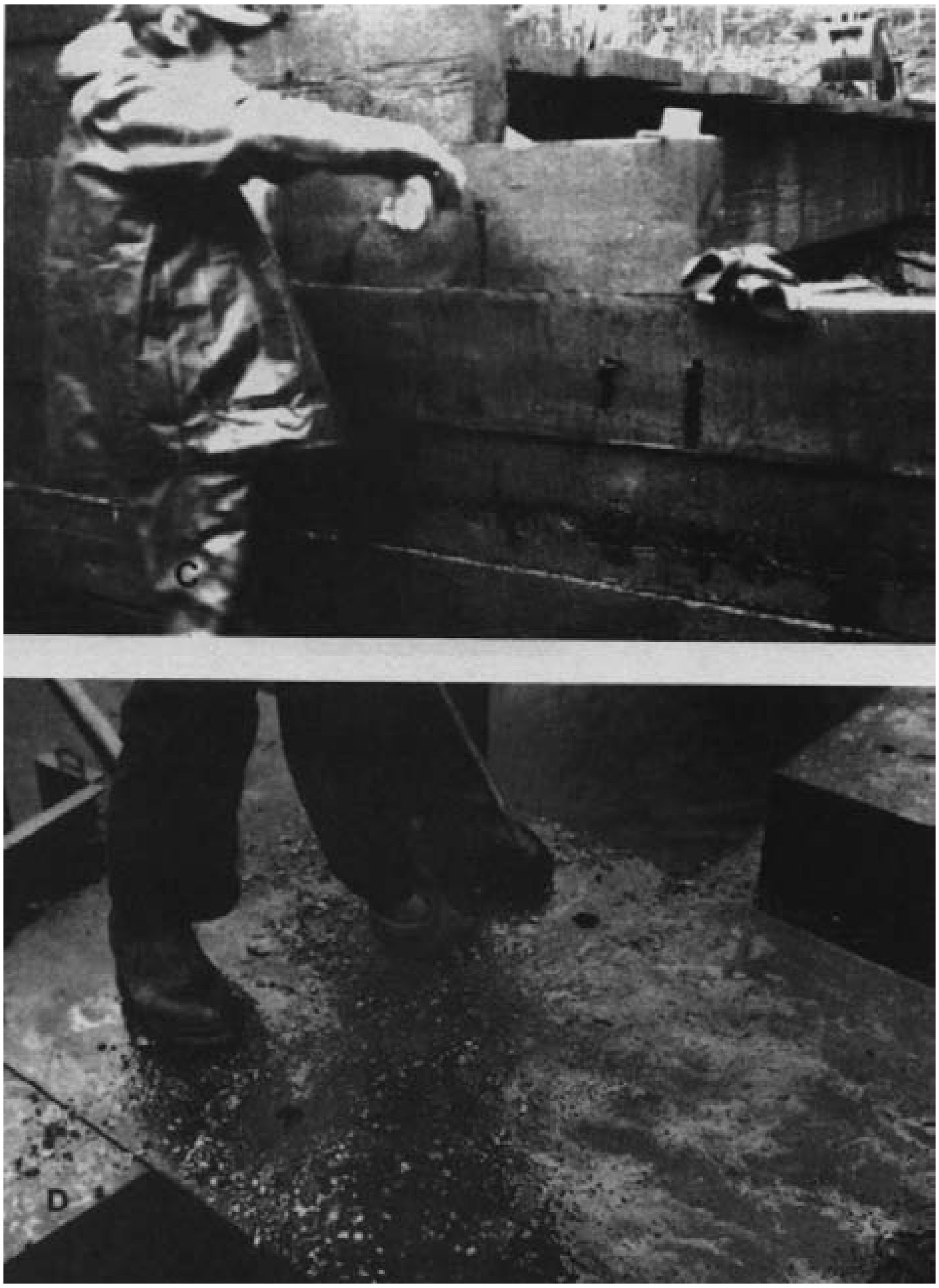


Figure 12-18. - Commonly used methods of field treating timber members (continued). (C) Squirting into a horizontal hole. (D) Squirting into a vertical hole.

Methods of applying preservatives for field treating depend on the type and orientation of the area to be treated. When members can be moved, the best method of field treating is dipping or soaking. The area with exposed untreated wood is immersed in the preservative solution for 3 to 5 minutes, or longer. This completely saturates the wood surface and allows some preservative absorption into the wood. Unfortunately, most field treatments must be made when members are a part of the structure, and then soaking or dipping is impractical.

When treating in-place members with field cuts, abrasions, or breaks in the wood surface, the preservative is normally brushed over the surface. For horizontal surfaces, the area can be saturated with preservative solution, with time allowed for the preservative to soak into the wood. On vertical surfaces, excess preservative will run off and the amount that can be applied in one application will be limited. In such a case, three or four successive brushings must be applied with adequate time allowed between each brushing for the preservative to soak in.

Through-holes, whether horizontal or vertical, are more difficult to treat than exposed cuts because access to the untreated wood is limited. It is generally necessary to squirt or spray preservative to one end and catch the excess preservative coming out the other end. Holes can also be treated by plugging one hole end, treating the other end, and then reversing the procedure. When the plug is removed, the excess preservative must be collected in a container to avoid spillage.

Bore holes that do not go through the member, such as those for lag screws and spikes, are field treated by filling the hole with preservative. This is done with an oil can or plastic squeeze bottle that allows a controlled amount of the liquid to be inserted directly into the hole. After the preservative is applied, time must be allowed for the preservative to soak into the wood before fasteners are placed. All preservative will not be absorbed into the wood, and fasteners must be placed with caution to prevent the preservative from being squirted out of the hole. It is beneficial to place a rag around the fastener to contain any preservative that may be forced out as the fastener is driven or screwed.

12.8 INSPECTION AND CERTIFICATION

Owners and specifiers of timber bridges are often concerned as to whether quality requirements for material, treatments, and construction methods are being met or exceeded. This is especially true in bid situations where the lowest bid must be accepted. Quality control and material compliance can be ensured in a number of ways. Many large organizations, such as government agencies, utilities, and railroads, maintain their own inspection personnel. These inspectors visit manufacturing or fabrication facilities and conduct quality control inspections and tests to ensure specification compliance. For most purchasers, however, maintaining a full-time inspection staff is impractical. An alternative is to hire an independent third-party inspection agency. There are numerous agencies of this type located across the United States that have many years of experience as well as good reputations. Several specialize in wood products, including sawn lumber, glulam, and preservative treatments. These inspection firms charge a fee for their services, which varies with the amount and type of inspection required. In some cases, material manufacturers and suppliers will charge a fee for third-party inspection to compensate for the extra handling and the potential for material rejection that inspectors may cause.

For most timber bridge projects, acceptable quality control is achieved by industry material-certification programs discussed in previous chapters. Certificates of conformance issued through such programs provide written documentation that the material was manufactured in accordance with the applicable specifications and standards established by that organization. Examples of these programs include a grading-stamp certification program for sawn lumber administered by various grading rules agencies (Chapter 3), a glulam certification program administered by the American Institute of Timber Construction (Chapter 3), and a preservative treatment certification program administered by the American Wood Preservers Bureau (Chapter 4). Under these programs, participating manufacturers, treaters, and inspection agencies are routinely checked for quality control and compliance by the administering association. If they comply, the producer is authorized to use quality stamps and/or issue certifications of material conformance (Figure 12-19). If they are found deficient, corrective action must be taken immediately or the producer will lose the quality certification. There is a small charge for these association certification programs, which is normally absorbed by the manufacturer or treater and included in material prices.

In addition to material certification by industry associations, quality certification may be indicated by mill certificates. Mill certificates are material certifications issued by individual manufacturers or suppliers, rather than industry quality control associations. Thus, their validity is usually based solely on the word of the manufacturer. Many reputable firms issue mill certificates based on extensive in-house testing and quality control programs. Other firms may have few or no quality control programs. Before accepting mill certificates as proof of material compliance, it is a good idea to verify the reputation of the manufacturer and check on the extent and depth of its quality control and testing programs.

CERTIFICATE OF CONFORMANCE

THE UNDERSIGNED, COMPANY A AND COMPANY B, hereby make the following certifications:

(1) Both Companies A and B certify that all the products identified below and on the attached sheets Nos. ________ were manufactured, in part, in the plant of Company A at ________ and, in part, in the plant of Company B at ________

(2) Company A certifies that the said products so made by it were manufactured in conformance with the applicable provisions of American National Standard ANSI/AITC A190.1–1983, Structural Glued Laminated Timber, at its said plant, which plant operates under a quality control system approved by the Inspection Bureau of the AMERICAN INSTITUTE OF TIMBER CONSTRUCTION and is inspected periodically by such Bureau; and

(3) Company B certifies that the said products made by it were manufactured in conformance with the applicable provisions of American National Standard ANSI/AITC A190.1–1983, Structural Glued Laminated Timber, at its said plant, which plant operates under a quality control system approved by the Inspection Bureau of the AMERICAN INSTITUTE OF TIMBER CONSTRUCTION and is inspected periodically by such Bureau.

The manufacture of these members complies with the manufacturing and fabricating provisions of Chapter 25 of the Uniform Building Code. ☐ Not applicable.

JOB NAME: ________

JOB LOCATION: ________

CUSTOMER'S ORDER NO. ________ DATE ________ MFGR'S ORDER NO. ________

SIGNATURE ________ COMPANY A ________

TITLE ________ ADDRESS ________ DATE ________

CUSTOMER'S ORDER NO. ________ DATE ________ MFGR'S ORDER NO. ________

SIGNATURE ________ COMPANY B ________

TITLE ________ ADDRESS ________ DATE ________

AITC HEREBY CERTIFIES that Companies A and B, at their respective plants, are licensed by the AMERICAN INSTITUTE OF TIMBER CONSTRUCTION to use the AITC Collective Mark in respect of products which comply with the applicable provisions of said Standard, that the adequacy of the quality control system in effect at each said plant is periodically inspected and verified by the Inspection Bureau of the AMERICAN INSTITUTE OF TIMBER CONSTRUCTION, and that, in the judgment of AITC, said Companies A and B are capable of complying with the applicable manufacturing and testing provisions of said Standard in respect of products manufactured at said plants. Conformance with the Standard with respect to any specific or particular product is the sole responsibility of said manufacturer. AITC's guarantee hereunder being that said Companies A and B are qualified to produce products meeting the said Standard and that each of said plants is periodically inspected and verified by the AITC Inspection Bureau.

AITC FORM IBCC

AITC *Certificate No.* 00021 C

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION

Figure 12-19. - Certificate of material conformance for glulam issued through the AITC Quality Control Program (photo courtesy of the American Institute of Timber Construction).

12.9 SELECTED REFERENCES

1. American Association of State Highway Officials. 1973. Construction manual for highway bridges and incidental structures. Washington, DC: American Association of State Highway Officials. 66 p.
2. American Institute of Timber Construction. 1985. Timber construction manual. 3d ed. New York: John Wiley and Sons, Inc. 836 p.
3. American Institute of Timber Construction. 1984. Typical construction details. AITC 104-84. Englewood, CO: American Institute of Timber Construction. 32 p.
4. American Wood-Preservers' Association. 1987. Book of standards. Stevensville, MD: American Wood-Preservers' Association. [240 p.]
5. Canadian Wood Council. 1985. Canadian wood construction. Storage and handling. CWC datafile CW-1. Ottawa, Can.: Canadian Wood Council. 4 p.
6. Morrell, J. J.; Helsing, G.G.; Graham, R.D. 1984. Marine wood maintenance manual: a guide for proper use of Douglas fir in marine exposure. Res. Bull. 48. Corvallis, OR: Oregon State University, Forest Research Laboratory. 62 p.
7. Muchmore, F.W. 1986. Designing timber bridges for long life. GPO 693-017. Missoula, MT: U.S. Department of Agriculture, Forest Service, Northern Region. 15 p.
8. Nagy, M.M.; Trebett, J.T.; Wellburn, G.V. 1980. Log bridge construction handbook. Vancouver, Can.: Forest Engineering Research Institute of Canada. 421 p.
9. Tuomi, R.L. 1976. Erection procedure for glued-laminated timber bridge decks with dowel connectors. Res. Pap. FPL 263. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 15 p.
10. U.S. Department of Agriculture, Forest Service, Northern Region. 1985. Bridge design manual. Missoula, MT: U.S. Department of Agriculture, Forest Service, Northern Region. 299 p.
11. U.S. Department of Agriculture, Forest Service. 1985. Forest Service specifications for construction of bridges & other major drainage structures. EM-7720-100B. Washington, DC: U.S. Department of Agriculture, Forest Service. 241 p.
12. Western Wood Products Association. 1973. Storage of lumber. WWPA tech. guide TG-5. Portland, OR: Western Wood Products Association. 1 p.
13. Weyerhaeuser Company. 1980. Weyerhaeuser glulam wood bridge systems. Tacoma, WA: Weyerhaeuser Co. 114 p.