

Portable Bridges For Forest Road Stream Crossings

Stream crossings on forest roads frequently create problems for loggers and many landowners. Stream crossings are costly to build and time-consuming to install. They are also subject to failure during storms, and soil erosion from stream crossings is a major source of pollution in our streams. The best approach to a stream crossing is to avoid the crossing by selecting a route that does not require crossing the stream. However, there are times when crossing a stream cannot be avoided and a structure that will fit the site and accommodate the required traffic must be designed and installed. Selecting the appropriate structure is a critical step towards insuring that a crossing is both usable and cost effective, and that pollution of the stream is minimized.

Stream Crossing Structures

Ford Crossing

The most basic stream crossing structure is the *ford*. If you are fortunate enough to have a gravelly or sandy stream bottom with good bearing strength, the natural ford requires the least amount of improvement to allow vehicles to cross and is therefore the least costly approach initially. If the stream bottom is of less stable material such as a silty or clayey soil, a ford can be constructed of rock and man-made retaining materials. Installation costs for a man-made ford can approach several thousand dollars per crossing.

Culvert Crossing

The most common type of stream crossing structure is the *culvert crossing*. Most commonly constructed of corrugated metal pipes, culverts must be properly sized and installed to allow passage of water generated by storm events of 10, 25, or 50 year recurrence intervals. The culvert should also be stabilized with rock, grass or other soil stabilizing material to minimize erosion and sediment movement into the stream. Finally, the culvert crossing requires frequent maintenance to insure that debris does not clog the culvert inlet and reduce the water flow through the culvert, which may result in additional erosion around the culvert. In extreme cases, the culvert may be washed out if not properly designed or maintained.

Bridge Crossing

Generally, the most costly type of stream crossing structure is the *bridge*. A properly designed and constructed bridge can afford the passage of vehicular traffic with the least amount of sedimentation placed in the stream. However, this type of crossing can also be the most costly to construct and requires periodic maintenance.

Types Of Bridges

Permanent Bridges

A permanent bridge installation requires abutments or piers to be installed at each end of the bridge to support the structure. The most common type of bridge consists of girders or stringers that span the stream. A deck is placed on top of the girders to support the vehicle loads. Stringers or girders can consist of logs, preservative-treated sawn timbers or glued-laminated timbers, or steel beams.

Decking is placed perpendicular to the girders and can consist of sawn lumber planks, glued-laminated timber deck panels, precast concrete panels, or even a poured concrete slab. When wood decks are used, timber running planks are typically placed over the decking to serve as a replaceable wearing surface. While building a permanent timber bridge for a forest road is not necessarily complex, it is neither simple nor inexpensive for a landowner to construct.

A bridge structure may need to be designed to carry heavy vehicle loads such as log trucks weighing up to 88,000 pounds, which is the maximum legal allowable weight in Alabama. To achieve this requirement, the bridge may be the most costly per use of any of the three basic stream crossing structures. Many bridges may only be used for log truck traffic once every 5 to 10 years, making the cost per use even greater. However, it may be the only alternative at the specific stream crossing site chosen.

Portable Bridges

When permanent access to a site is not needed, an alternative to the permanent bridge installation is the use of a *portable bridge* for temporary stream crossings. In this case, a portable bridge can be installed and used during logging operations, then removed after operations are finished and moved to another location. In some situations, there may already be an existing crossing structure that is suitable for light vehicle traffic, but not strong enough to carry heavy truck traffic. In this case, a portable bridge may be placed temporarily on top of the existing structure while heavy traffic is present, then removed when the activity is finished.

Portable bridging materials have been used in military applications for many years, but use in forestry applications is more recent. In the past, the lower cost approaches to temporary stream crossings, like log crossings, fords, and culverts, were preferred over portable bridges because of the bridge's relatively high initial cost. However, these low cost techniques frequently involved the use of large quantities of earth fill in the stream crossing and they resulted in excessive erosion and sedimentation of the stream. As a result of the Clean Water Act of 1987, most temporary crossings that required the use of soil fill have fallen into disfa-

vor as they frequently cause sedimentation and pollution problems. Since portable bridges can be installed and used with a minimal impact on water quality, they have become a more feasible alternative for temporary stream crossings on forest roads.

Portable Glulam Panel Bridges

Portable bridges can be made of various materials. Steel or concrete panels, engineered modular steel girder bridges, non-engineered timber mats, and even worn-out rail cars and flat-bed trailers have been used for portable bridge applications. Each one of these bridge types has its own set of advantages and disadvantages, yet all of these systems can be effectively used as portable bridging structures in the right situation. A relatively new type of engineered design that incorporates treated, glued-laminated timber (glulam) deck panels has shown promise as a single-span bridge that can be moved from site to site relatively quickly and easily.

Glulam deck panels are constructed of different sizes of southern pine dimension lumber (2 by 8 through 2 by 12) that is finger-jointed and face-glued into a solid bridge deck panel or bridge girder. Modern glulam manufacturing plants can produce timbers in virtually any size and shape. However, for these types of bridge decks, panels are typically 4 to 6 feet wide and 6¾ to 10½ inches thick. Lengths of these panels can range from 15 to 40 feet, with the longer lengths requiring the greatest panel thickness. A typical glulam deck panel is shown in Figure 1.



Figure 1. Typical glulam bridge deck panel.

As with any wood product used outdoors, these bridge components are treated with preservatives. Typically creosote is the best preservative for this type of product because it forms a water resistant envelope around the wood. In addition to preventing decay, it reduces the amount of checking in the wood.

Through research at Auburn University, several variations of these types of bridges have been designed and tested. These include bridges for off-highway vehicles such as log skidders as well as several different types of bridges for log truck traffic. The lengths of these bridges range from 26 feet for the skidder bridge up to 40 feet for the largest truck bridge. The skidder bridge is the simplest design and consists of two glulam panels 4 feet wide by 26 feet long by 8½ inches thick. The two panels are laid side-by-side directly on the stream banks with a gap approximately 2 feet wide between the panels. To simplify the installation and removal, the panels are not connected to each other. The panels are skidded to the stream crossing site by the skidder and then they can be easily set in place using the skidder grapple as shown in Figure 2.



Figure 2. Use of grapple skidder to place glulam bridge

Steel plating is attached to the ends of the panels to prevent damage from the grapple and steel lifting loops are attached at the center of the bridge to facilitate lifting onto a truck using the typical knuckleboom loader.

A larger version of this design has been built for use by log truck traffic. This bridge is 35 feet long and consists of two panels 5 feet wide by 35 feet long by 10½ inches thick. The two panels are again placed side-by-side with a small gap between them. This design has a curb installed along the sides of the bridge to help delineate the edge of the bridge. Steel lifting loops are installed at each corner and along the sides of the panels for use in loading and unloading. Since this bridge is only 10 feet wide, it is mainly suited for a site with straight road approaches and for lower traffic volumes where access is restricted. If the bridge is going to be used at a site with curved road approaches or with higher traffic volumes, a wider bridge may be necessary.

Description Of Portable Glulam Bridge For Truck Traffic

This glulam bridge consists of two or more creosote-treated panels. Each panel is constructed of panels that are 4 feet wide, 10½ inches thick and 30 feet long. Panels can be used in a combination of 2, 3 or 4 panels joined together, depending on the type of traffic load required and the condition of the road approaches. As a temporary installation, construction of abutments to support the bridge ends is not required. In most cases, the panels can be placed on a mud sill, which sits approximately 4 feet away from the edge of the stream bank. The sill can be virtually any type of flat panel or mat that distributes the bridge load to the stream bank and provides a flat surface on which to place the bridge panels. One sill that has been used is a 3 inch thick by 15 inch wide glulam beam that is 16 feet long. If the soil conditions are soft, a wider sill can be used to support the panel ends.

In this bridge design, the panels are held together by one or more stiffener beams that are bolted on the underside of the bridge. Although not absolutely necessary, these stiffener beams, shown in Figure 3, add rigidity and improve weight distribution when a vehicle is on the bridge.



Figure 3. Transverse stiffener beams attached to bridge deck panels.

The stiffener beams are also made of creosote treated glulam beam 6¾ inches wide by 5½ inches thick by 16 feet long.

To keep vehicles on the bridge panels, glulam curb rails, 8¼ inches wide by 5 inches thick by 30 feet long are placed on top of 5 inch high risers on the edges of the bridge. Once attached to the outside panel, these curbs remain on the panel and do not need to be removed when the bridge is transported from site to site.

In 1994, the total cost of these materials was approximately \$15,500. It is important to note that even though this initial cost is higher than that of the typical ford or culvert crossing, when the bridge is used on many sites, the cost per site becomes competitive with what would be spent on the traditional types of crossings.

The use of this type of engineered bridge overcomes the need for guesswork or field estimates of how much support is required to safely carry a vehicle load. This bridge was designed for an AASHTO HS20 truck load, which is what most highway bridges are currently designed for, and which is going to be sufficient for carrying the weight of fully loaded log trucks.

Bridge Installation

It is a good practice to place any bridge at least 3 feet above the high water mark of the stream. This increases the use of the bridge, and also reduces the possibility of the bridge being washed away during a storm. However, for locations where the bridge will be installed for a short time period or where excessive fill is necessary, it may be possible to place the bridge closer to the stream level. In this case, additional care must be taken to keep the bridge from washing away in a flood.

Installation of the bridge usually requires some site work with a bulldozer or excavator. You want to try to get the floor of the bridge as level as possible, so it is best to use a construction or engineer's level to insure that the sills are at the same elevation before you set the first panel in place. The panels can then be lifted into place with a knuckleboom loader, backhoe, or crane truck using nylon slings, chains, or wire rope as shown in Figure 4.



Figure 4. Placing bridge deck panels.

The use of appropriate rigging hardware such as steel eye bolts or lifting loops is important to prevent damage to the bridge panels. These panels can also be winched into place with a skidder or crawler tractor, but the use of a boom type loader is much quicker, less damaging to the stream banks, and safer.

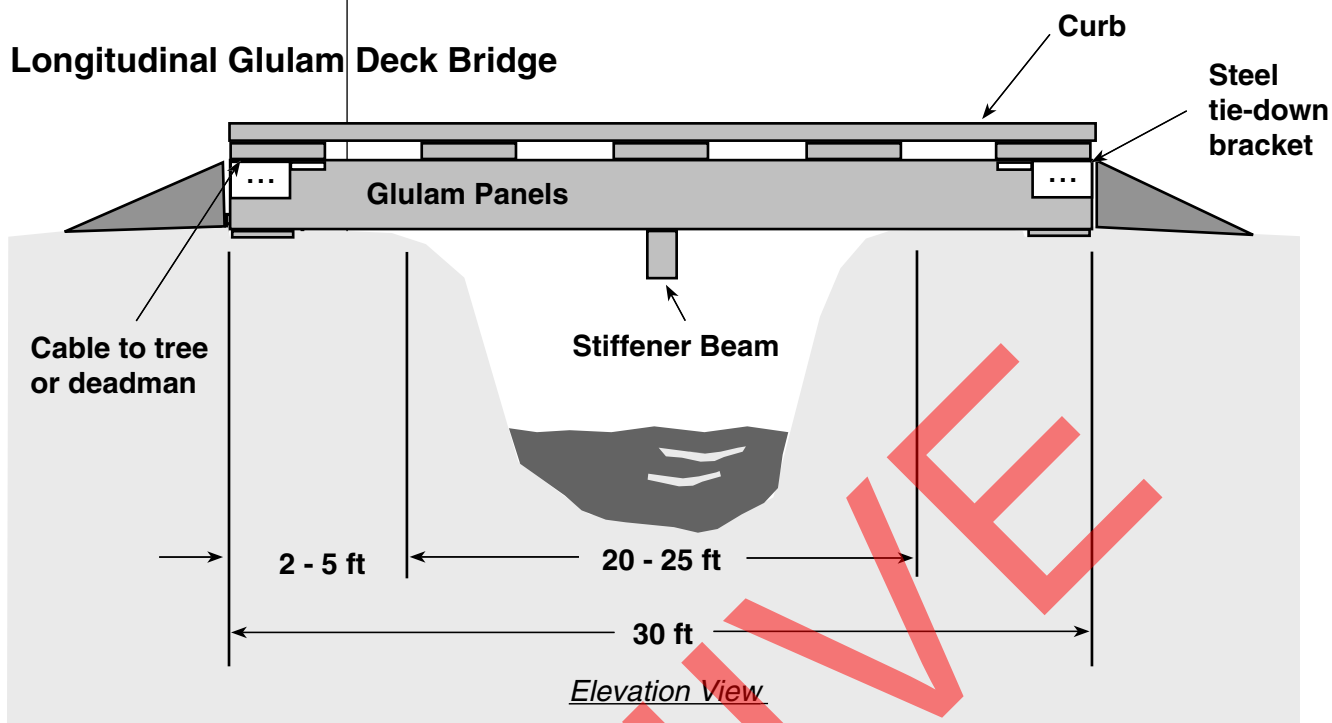


Figure 5. Using wire rope to secure bridge.

After the first panel is in place, the stiffener beams (if used) are bolted to the underside and the remaining panels are lowered onto the stiffener beams and bolted to these beams. No additional decking or running planks are required for the glulam bridge. The thickness of the glulam panel satisfies this requirement.

To reduce the possibility of the bridge being washed away during a heavy storm, wire rope should be connected from lifting loops or brackets on the corners of the bridge to a large tree upstream on each bank of the stream as shown in Figure 5.

This will provide added assurance that the bridge will survive flood water levels. To complete the installation, the roadway should be built up to the same elevation as the bridge floor, and some surfacing material such as crushed rock applied to the road surface to reduce the potential for sediment being washed into the stream (Figure 6).

The time required to install the glulam bridge is about 6 hours. After the crossing is no longer needed, the bridge can be removed in reverse order of the installation. Removal time is approximately 3 hours. There may be some



Figure 6. Finished bridge installation.

minor remediation required on the stream banks after the bridge has been removed. Revegetation with a quick-germinating grass selected for the season combined with the application of a hay or straw mulch will usually prevent most polluting sediment from entering the stream. For further information on grass species selection and time of planting you can obtain the publication, by the Natural Resources Conservation Service, Erosion Control & Wildlife Plantings for Forestry Operations, from your county Extension agent.

Conclusion

The use of a portable bridge has been shown to be an environmentally sensitive method to cross streams. Currently, designs for portable glulam deck bridges are available for spans up to 40 feet with additional designs under development. Although the cost of the bridge if used for a one-time installation may be excessive, it is engineered to carry the weight of fully loaded log trucks and it is designed to be used on many different sites. When amortized over ten or more sites, the cost per site becomes much more reasonable as compared to construction of a permanent bridge and it is even competitive with the cost of installing culverts or man-made fords. Additionally, the timber bridge is aesthetically pleasing and environmentally sensitive since it minimizes site disturbance and sedimentation in the stream. If you would like additional information on this type of stream crossing, please contact the authors.

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Richard W. Brinker, *Extension Forester*, Associate Professor, Forestry, and Steven E. Taylor, Associate Professor, Agricultural Engineering, both at Auburn University.

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