Timber As A Bridge Material

Modern timber bridges are expected to last more than 50 years.

Wood was probably the first material used by humans to construct a bridge. Although in the 20th century concrete and steel replaced wood as the major materials for bridge construction, wood is still widely used for short- and medium-span bridges. Of the bridges in the United States with spans longer than 20 feet, approximately 12 percent of them, or 71,200 bridges are made of timber. In the USDA Forest Service alone, approximately 7,500 timber bridges are in use, and more are built each year. The railroads have more than 1,300 miles of...continued on p. 2
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timber bridges and trestles in service. In addition, timber bridges have recently attracted the attention of international organizations and foreign countries, including the United Nations, Canada, Japan, and Australia. Timber's strength, light weight, and energy-absorbing properties furnish features desirable for bridge construction. Timber is capable of supporting short-term overloads without adverse affects. Contrary to popular belief, large wood members provide good fire resistance qualities that meet or exceed those of other materials in severe fire exposures. From an economic standpoint, wood is competitive with other materials on a first-cost basis and shows advantages when life cycle costs are compared. Timber bridges can be constructed in virtually any weather conditions, without detriment to the material. Wood is not damaged by continuous freezing and thawing and resists harmful effects of decaying agents, which cause deterioration in other bridge materials. Timber bridges do not require special equipment for installation and can normally be constructed without highly skilled labor. They also present a natural and esthetically pleasing appearance, particularly in natural surroundings.

The misconception that wood provides a short service life has plagued timber as a construction material. Although wood is susceptible to decay or insect attack under specific conditions, it is inherently a very durable material when protected from moisture. Many covered bridges built during the 19th century have lasted over 100 years because they were protected from direct exposure to the elements. In modern application, it is seldom practical or economical to cover bridges; however, the use of wood preservatives has extended the life of wood used in exposed bridge applications. Using modern application techniques and preservation chemicals, wood can now be effectively protected from deterioration for periods of 50 years or longer. In addition, wood treated with preservatives requires little maintenance and no painting.

Another misconception about wood as a bridge material is that its use is limited to minor structures of no appreciable size. This belief is probably based on the fact that trees for commercial timber are limited in size and are normally harvested before they reach maximum size. Although tree diameter limits the size of sawn lumber, the advent of glued-laminated timber (glulam) some 40 years ago provides designers with several compensating alternatives.

Glulam, which is the most widely used modern timber bridge material, is manufactured by bonding sawn lumber laminates together with waterproof structural adhesives. Thus, glulam members are virtually unlimited in depth, width, and length and can be manufactured in a wide range of shapes. Glulam provides higher design strengths than sawn lumber and provides better utilization of the available timber resource by permitting the manufacture of large wood structural elements from smaller lumber sizes. Technological advances in laminating over the past four decades have further increased the suitability and performance of wood for modern highway bridge applications.

Sign Vandalism

... If You Can't Beat Them Try This

We've all seen them: signs that have been vandalized - ones full of holes, covered with spray paint, intentionally altered or run down or completely missing. What to do about the problem has plagued road departments for years and is a real source of frustration to local officials. Every road department knows how expensive it is to repair or replace signs. Since penalties for the crimes are rarely enforced, there is no real deterrent. Unfortunately, for those in charge of replacing the signs, many young people feel it's worth the gamble to have one of those signs displayed in their rooms or apartments.

A County in the state of Ohio has taken a different approach to the problem and so far it is succeeding in reducing vandalism to their road signs. Their approach combines education along with free replicas of road signs. Officials in Franklin County, Ohio, introduced a public awareness program that included news releases, presentations to local groups, and displays. Schools also were targeted. Students were told of the seriousness of sign vandalism and the costs associated with repair and replacement. One of the facets that has been instrumental in the program's success is the distribution of eight miniature replicas of road signs. These replicas have been reproduced in color on heavy paper.

A Franklin County official estimates that the program has reduced vandalism and its associated costs by as much as 40 percent. Maybe it's worth a try in New Hampshire. If anyone decides to give it a try, let us know the outcome so we can pass the word along.


Total Cost Bidding

You have tight budgets to manage. Essential services to provide. And when you need new equipment, a big cash outlay to justify.

From where you stand now, the lowest bid may look like the best buy. But look again. How much will that low-bid machine cost you in the long run? If it isn't dependable, your initial savings could be wiped out fast-in downtime, high maintenance costs, rental fees and standby equipment. If it doesn't hold its value, you'll lose again when you sell or trade.

GUARANTEED COST CONTROL

Total Cost Bidding can guarantee one or more of the following factors:

Minimum repurchase value: At the end of your contract period, your agency is guaranteed a minimum value for your machine by the supplier. You can sell elsewhere if you're offered a better price, but you're assured of resale value-in writing-before you buy.

Maximum repair costs: Your Total Cost Bid guarantee can cover parts and labor. If your repair costs exceed the specified maximum during your contract period, your supplier covers the difference.

Maximum scheduled maintenance: You won't pay more than your specified amount for periodic lubrication and maintenance costs during your contract time. This means you can project your maintenance costs exactly.

When requesting bids, consider asking suppliers for total cost guarantees on maintenance and repairs...and guaranteed resale value. Then compare and see why low ownership costs can mean a great deal more than low initial price.

Reprinted from KUTC Newsletter, Vol. 12, No. 2. The information was excerpted from a Caterpillar brochure on Total Cost Bidding. (Caterpillar also makes available a pocket sized daily Work and Cost Record Book and a monthly Time and Cost Record Book for aiding in figuring total cost on your individual machines. Contact your Caterpillar dealer if you are interested.)

The above was selectively excerpted from Timber Bridges: Design, Construction, Inspection, and Maintenance published by the US Department of Agriculture, Forest Service, June, 1990, EM 7700-8.
500 Attend The 1990 Road Agent Association
Mountain of Demonstrations
R.A.A. Mountain of Demonstrations
Questions 'N' Answers
From Cornell Local Roads Program - April 1990

QUESTION:

We built a one-inch hot-mix overlay on a road that showed moderately deep, narrow ruts in the wheelpaths. After a few months of summer traffic the ruts came right back again. What causes this to happen?

ANSWER:

There are a variety of factors that could contribute to wheelpath rutting, but the ruts came so quickly, I would say it was because you did not put down a leveling course to begin with.

A leveling course (also called a T&L course or a scratch coat) is a thin layer of sand-asphalt mix which is placed on top of the old road surface just deep enough to fill the ruts. It is compacted immediately, using a pneumatic rubber tired roller (a steel drum roller would bridge across the ruts and not properly compact the mix). Because the leveling course is so thin, you must place it on a very hot day in the middle of the summer, and get the roller on it quickly, if you hope to compact it well. It is usually a good idea to let traffic run on it for a few days to help compact it, before placing the overlay on top.

The leveling course helps to eliminate the return of the wheelpath ruts. An overlay that is placed above the leveling course will be of uniform thickness across the lane (Figure 1). When it is compacted (typically by a steel drum roller) the density is uniform. If good density is achieved, traffic will not have much effect on it. If the leveling course is omitted, then when the overlay is placed it is thicker in the wheelpaths by the amount of the rut depth (Figure 2). When the overlay is compacted, the material between the wheelpaths gets more compaction effort because it is thinner than the material in the wheelpaths. Traffic gradually compacts the material in the wheelpaths, and the ruts reappear.

There are several other possible, but less likely, causes. The overlay material or the old road surface could be unstable. Low stability is usually caused by having too much asphalt in the mix. This condition will sometimes be accompanied by flashing of excess liquid asphalt to the surface, initially just in the wheelpaths and later across the entire surface. Often materials of low stability will exhibit transverse ripples (corrugations) as well as wheelpath ruts.

Another possible cause could be a weak base course or subgrade. Ruts due to base failure are usually wider and deeper than ruts due to surface failure. Ruts due to subgrade failure are usually very wide, each being perhaps half a lane or more in width. Since you describe your ruts as being narrow, this is not likely to be applicable in your situation.

In recent years wheelpath ruts have become an increasing problem on roads that serve large trucks. Although axle loads and gross vehicle weights are regulated according to law, tire pressures are not. This posed no problem when trucks were using tire pressures of 65 to 85 pounds per square inch (psi). But today truck tire pressures commonly run from 100 to 125 psi, which often leads to rutting on hot summer days. If you have a large number of trucks on the road in question, they could be aggravating the problem.

Overlay of uniform thickness on top of leveling course.

With both tire pressures and the number of trucks using the roads steadily increasing, it is more important today than ever before to use a leveling course to fill in the ruts as part of the construction of an overlay. To get better performance in the future, specify a high stability hot-mix. And be sure to construct when the weather is very hot, to help you get good compaction of the new layer.

Overlay of non-uniform thickness on top of the old road surface. Material in the wheelpaths does not compact properly. Ruts reappear due to compaction under traffic.

Figure 1. Overlay of uniform thickness on top of leveling course

Figure 2. Overlay of non-uniform thickness on top of old road surface. Material in the wheelpaths does not compact properly. Ruts reappear due to compaction under traffic.
Glued-Laminated Timber Bridges

Glulam designs are the most commonly used modern timber bridge designs

The first glulam bridges were built in the mid-1940's. Since that time, they have become the most common type of timber bridge in both single and multi-span configurations. Glulam beam bridges are completely prefabricated in modular components and are treated with preservatives after fabrication. When properly designed and fabricated, no field cutting or boring is required, resulting in a service life of 50 years or more.

GLULAM BEAM SYSTEMS

Glulam beam bridges consist of a series of transverse glulam deck panels supported on straight or slightly curved beams (Figure 1). They are the most practical for clear spans of 20 to 100 feet and are widely used on all size roads and highways. Glulam has proved to be an excellent material for beam bridges because members are available in a range of sizes and grades and are easily adaptable to a modular or systems concept of design and construction. Although glulam can be custom fabricated in many shapes and sizes, the most economical structure uses standardized components in a repetitive arrangement, an approach that is particularly adaptable to bridges.

DESIGN OF GLULAM DECKS

Glulam decks are constructed of panels manufactured of vertically laminated lumber. The panels are placed transverse to the supporting beams and loads act parallel to the wide face of the laminations. The two basic types of glulam decks are the non-interconnected deck and the dowelled deck (Figure 2). Noninterconnected decks have no mechanical connection between adjacent panels. Dowelled decks are interconnected with steel dowels to distribute loads between adjacent panels. Both deck types are stronger and stiffer than conventional nail-laminated lumber or plank decks, resulting in longer deck spans, increased spacing of supporting beams, and reduced live load deflection. Additionally, glulam panels can be placed to provide a watertight deck, protecting the structure from the deteriorating effects of rain and snow.

Glulam decks are generally 5-1/8 inches (5 inches for Southern Pine) or 6-3/4 inches thick. Increased thickness up to 14-1/4 inches are available but are seldom

Figure 1: Typical glulam beam bridge configuration
required. Panel width is a multiple of 1-1/2 inches, the net width of the individual lumber laminations. The practical width of the panel ranges from approximately 30 to 55 inches; however, the designer should check local manufacturing and treating limitations before specifying widths over 48 inches. Panels can be manufactured in any specified length to be continuous across the structure. It is common practice to vary adjacent panel lengths to provide a drainage opening under curbs (Figure 3).

The performance and economy of glulam deck panels can be significantly affected by the configuration and materials specified in design. The most economical design is the one that uses a modular-type system with two or three standardized panels in a repetitious arrangement. Panel width and configuration are usually based on criteria for curb or railing systems. When the bridge length is not evenly divisible by the selected panel width, odd-width panels are placed on the approach ends of the deck.

**NONINTERCONNECTED GLULAM DECKS**

Noninterconnected glulam decks are the most widely used type of glulam deck in modern timber bridge construction. They are economical, require little fabrication, and are easy to install with unskilled labor and without special equipment. Because the panels are not connected to one another, each panel acts individually to resist the stresses and deflection from applied loads.

**DOWELED GLULAM DECKS**

Doweled glulam decks consist of a series of glulam deck panels interconnected at the panel joints with steel dowels (Figure 4). The dowels transfer loads between panels and reduce relative displacements and rotations between adjacent panels. As a result, doweled decks generally have lower live load deflections and may result in longer deck spans or thinner panels than noninterconnected decks. These advantages can be significant in some cases but may not be sufficient to offset the increased costs required for dowel installation.

The suitability of a doweled deck for a specific application depends on the design requirements of the structure and the economics of fabrication and construction. Doweled panels are more expensive than noninterconnected decks because they require precise fabrication for proper installation and performance. As a general

...continued on p. 8
Rule, they are the most practical when an asphalt wearing surface is used and the deflection at the panel joints must be limited to prevent cracking. However, it may be more cost effective to use a noninterconnected deck and limit deflections by using a thicker deck or decreased deck span. When paving is not planned, noninterconnected panels will generally provide the most economical deck.

The above was selectively excerpted from Timber Bridges: Design, Construction, Inspection, and Maintenance published by the US Department of Agriculture, Forest Service, June, 1990, EM 7700-8. For a copy of this very comprehensive manual contact the Technology Transfer Center at 1-800-423-0060.

Figure 3: The length of glulam deck panels may be varied between adjacent panels to provide a drainage opening under the curb

Figure 4: Primary and secondary directions for doweled glulam deck panels
The Construction Of Two Timber Bridges
In New Hampton, New Hampshire
Did You Know?

You could save your town some money if you can decide on generic type signs. Instead of using signs such as "Men At Work," "Road Work One Mile," Road work 1500 Feet," or "Men In Road" try using one sign that says it all - "Road Work Ahead."

Signs are expensive to buy and to replace. The less number of signs you need the more money you can save.

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The Technology Transfer Center can either loan you a copy of these tapes for two weeks or you can purchase them on an extended play tape for $16.50. All video purchases will be sent to you within a one week period.

For more information please contact the T^2 Center at 1-800-423-0060.

Road Business...

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