RAPID BRIDGE CONSTRUCTION USING TIMBER COMPONENTS

ABSTRACT

Prefabricated timber components provide for rapid bridge construction. Used as the primary material or in conjunction with steel and reinforced concrete there are many proven applications for timber.

Pre-engineered solutions utilize demonstrated details ensuring ease of construction and long term durability. Shop manufactured kits provide enhanced quality control, reduce on-site construction and speed installation.

INTRODUCTION

Build bridges faster, to last longer, for less money and with aesthetic appeal. This motive has lead to the quest for the perfect bridge material. High strength steel, form liners for concrete, new coatings for reinforcing bars, plastic composites all enter the discussion. One material with a proven track record is often overlooked – treated timber.

Developed from years of monitored installations, innovations in materials and advances in design and construction, treated timber provides all the attributes of a quality bridge material. Used primarily for the farm to market low volume road system it will also appear in temporary bridges on some of the largest projects.

Advances in engineered lumber and pressure treating practices provide low energy renewable sources of raw material that respect the environment at both the manufacturing facility and bridge site.

PROVEN SYSTEMS

Properly designed and detailed, treated timber bridges have demonstrated durability with installations in service for more than fifty years. Many pre-engineered, prefabricated concepts find their origins in the late 1960's. These concepts have been refined over the last forty years into the modern timber bridges of today.

Pre-manufactured kits allow for bridges to be built quickly under a variety of circumstances. Controlled shop conditions improve quality and reduce the need for site inspection. Treated timber is not temperature sensitive and does not require controlled site conditions for proper curing. Partially assembled components are installed in days instead of weeks.

Most timber bridge decks are finished with an asphalt wear surface. Enhanced details have improved asphalt performance on the bridge deck.

QUALITY MATERIALS

Timber Sources

Most timber used for bridges is either Coastal Region Douglas Fir or Southern Yellow Pine. Both species can be used as solid-sawn, glued-laminated or dowel-laminated engineered lumber. Established design values, grading procedures and source of supply have made these

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the species of choice. Most lumber is sourced through managed forest initiatives making it a renewable raw material.

Advances in Pressure Treating

Treated timber has experienced changes in preservatives and treating practices. General use preservatives such as copper naphthenate are replacing restricted use preservatives like creosote. Best Management Practices for treating and handling of wood have been developed by the Western Wood Preservers Institute. They are being adopted nationwide. This greatly reduces the impact of treated wood on the environment by limiting excess preservative from leaving the wood.

Low Energy Material

When compared to the production of steel and reinforced concrete, the energy required to produce and transport treated wood is far less.

COMMON BRIDGE TYPES

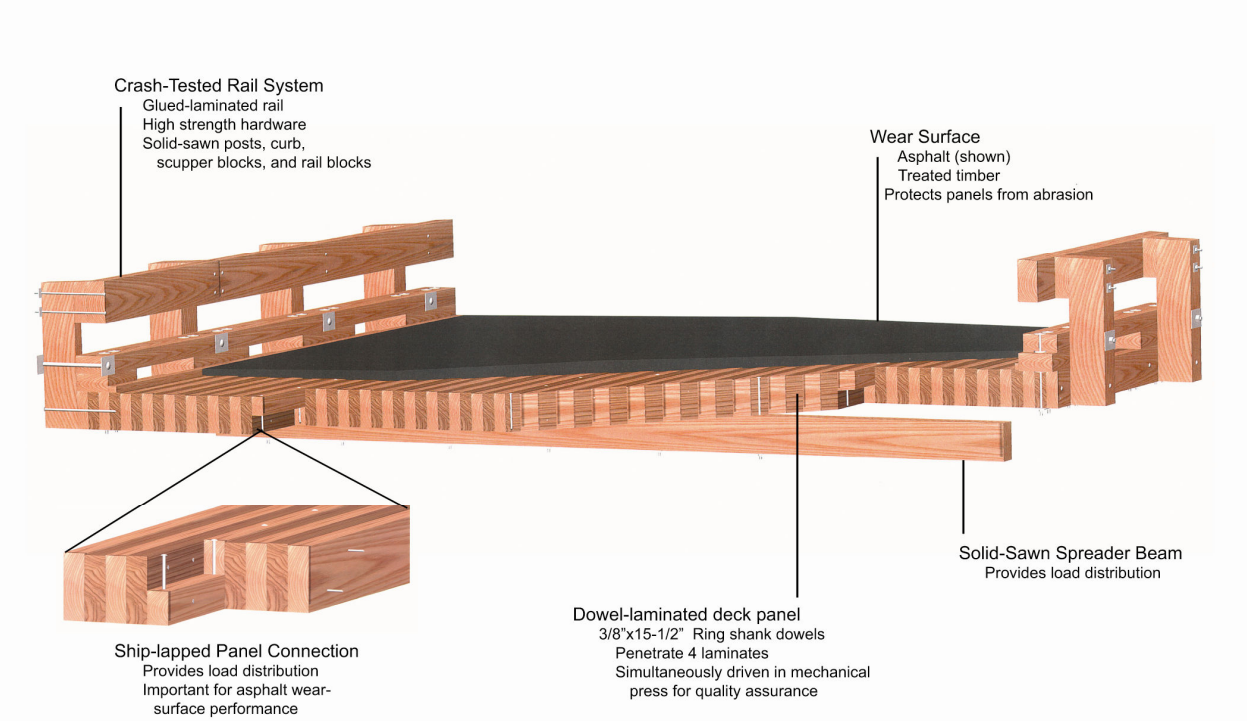
Timber Slab Span

The timber slab span is primarily intended for short to medium span bridges. It can be used in single or multiple span configurations. Comprised of pre-manufactured panels it is one of the fastest ways to build a modern bridge.

Evolved from designs dating back to the 1940's the timber slab span design incorporates dowel-laminated panels as the primary superstructure component. It has been continuously upgraded to increase durability, safety and economy. Its biggest contribution advanced the timber bridge from loose lumber requiring extensive on site labor to a shop manufactured kit.

The panels start as individual sawn timbers, sized, pre-drilled and treated before fabrication. These laminates are placed on edge and then simultaneously doweled together with large ring shank nails in a mechanical press forming a pre-fabricated panel. Individual panels are typically less than eight feet wide to minimize shipping expense and to facilitate handling at the jobsite. The panels are then shipped to the site as a kit. Spanning between substructures, multiple panels are longitudinally interconnected. Overall bridge deck width is unlimited. More panels can be added to expand the width and panels are custom detailed for each project. As panels are placed they are fastened to each other via a longitudinal ship-lapped joint. This provides load transfer between individual panels and increased redundancy.

Figure 1. Typical Timber Slab Span Superstructure



The depth of panel is a function of span length and loading. For typical highway applications this can range from twelve inches for a twenty foot span to eighteen inches for a forty foot span. Because it does not require additional beams, this is the overall depth of the structure. A big advantage when clearance is important.

The dowel-laminated system can be used in single or multiple span applications. When used as multiple spans each is designed as a simple span. Foundations are detailed to accommodate bearing of each span and panels are connected longitudinally over the pier joint via steel straps fastened to the panels with drive spikes.

Under highway traffic conditions it is important to protect the deck panels over the life of the bridge. Although treated timber plank can be used as a wear course, an asphalt overlay is often preferred. Experience has shown care must be taken when detailing the panels to maximize the asphalt performance. Properly interconnected panels and improved panel stiffness provide decks with asphalt lasting as long as the bridge approaches.

Numerous railing systems can be fastened directly to the outside panels. Crash-tested systems are available and have become the standard. Pedestrian railing can be added when sidewalks are separated from the driving lanes.

As span lengths extend beyond forty feet the economy of the dowel-laminated system is stretched. Bridges spanning up to seventy-five feet have been built with panels consisting of glued-laminated laminae where the depth of section was critical.

Longitudinal Beams with Transverse Timber Deck Panels

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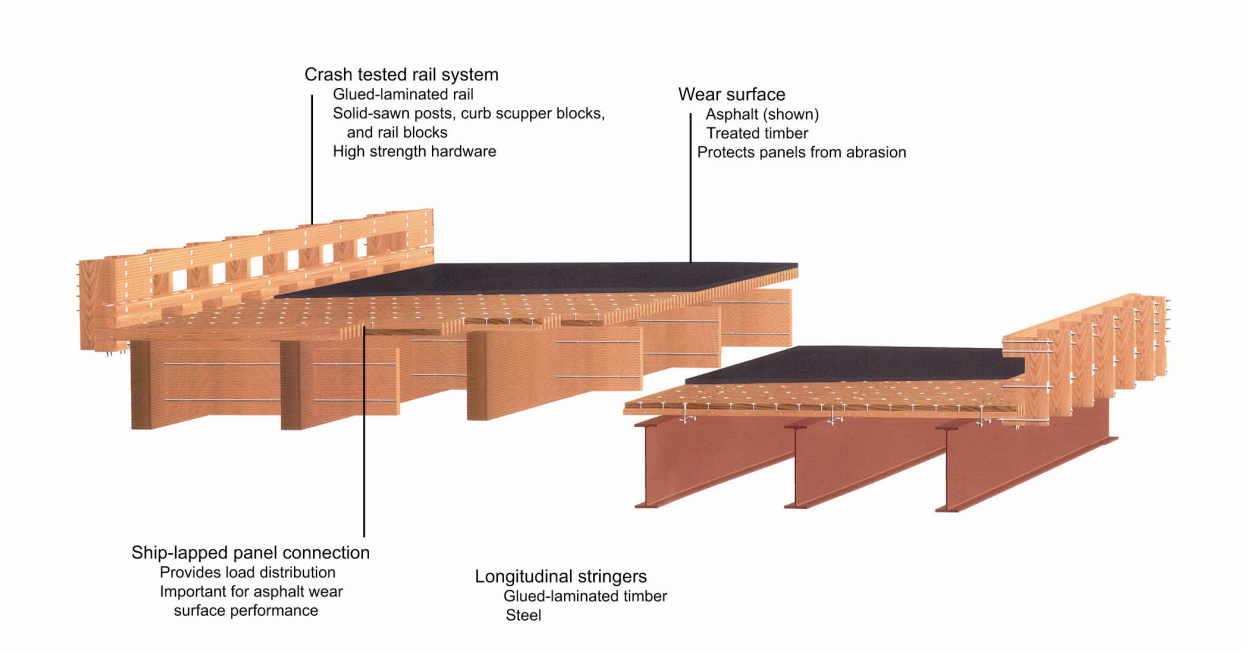
For span lengths of forty to eighty feet where a deeper cross section is expected, timber bridges can be designed with longitudinal beams and transverse timber deck panels. This is accomplished by placing glued-laminated longitudinal beams at some spacing, typically five to six feet. Dowel-laminated panels oriented perpendicular to the beams form the deck by spanning over the beams. The panels are scaled down to six or eight inches in thickness based on the span between beams and design loadings. The deck panels are again interconnected with ship-lapped joints to provide a continuous deck ready for an asphalt overlay. The design includes provisions for crash-tested timber railings. In this span range the beam and deck design is more efficient and uses less material than the slab span.

Figure 2. Typical Transverse Timber Deck Superstructure



Steel beams can be substituted for the glued-laminated beams. This may provide for a thinner depth of section or span lengths in excess of eighty feet. The steel beams can be used with any appropriate finish. Weathering steel has become popular. While there are many ways to attach the panels to the steel beams, bolted clips are most common.

Steel beams with transverse timber deck panels and precast concrete barriers provide an effective temporary bridge. The bridge decks are finished with an asphalt overlay. Many major interstate highway projects have used this design for temporary by-pass bridges. All the components can be disassembled for future use. Some states have standard designs and maintain their own inventory of timber panels to be installed by the contractor.

Long Span Bridges

Treated timber has been used for many long span applications. Glued-laminated arches and trusses provide for landmark structures. Long span covered bridges have seen resurgence for both their nostalgia and durability. Many long span bridges become a combination of treated timber and steel components. Treated timber panels can serve as a lightweight deck replacement on older bridges.

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CRASH-TESTED TIMBER RAILING

Industry sponsored crash-testing was originally performed in the 1980's to develop timber railing systems to be used with timber decks. Many designs are available for varying performance levels. All timber bridge designs can incorporate crash-tested railing systems.

In the 1990's additional testing was sponsored by Federal Highway Administration and the USDA Forest Service to include timber railings for concrete deck systems. Standard plans for various test levels were then published. Bridge owners are increasingly specifying treated timber railings for concrete bridges. The pre-manufactured railings are easy to install, easy to fix if damaged and stand up to deicing chemicals. But the primary reason is the added aesthetics the timber provides, especially for rural bridges.

INSTALLATION

Designed and delivered as a kit, treated timber bridges have provided accelerated bridge construction for many decades. Components are detailed at the shop and certified prior to shipment. No material testing is required at the site, reducing construction inspection expense.

For slab span designs the components are handled by small cranes or large backhoes. The connections do not require skilled labor. The average crew is comprised of four to five people.

Treated timber is not temperature sensitive. In colder climates timber bridges are often installed in the winter when cast-in-place concrete becomes more difficult.

SUMMARY

Treated timber bridges are built in days not weeks. This reduces detour times and construction inspection expense. Components are shop manufactured under controlled conditions to maintain quality. Materials are low energy, certified, reusable and renewable.

Accelerated bridge construction has long been an attribute of treated timber bridges. Design details have been refined for over forty years. They are proven and remain relevant. While the quest continues for the prefect bridge material, treated timber already provides many of the advantages desired of new materials and construction techniques.

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