DESIGN CONCEPTS

GLULAM IN RAILROAD CONSTRUCTION

ENGINEERED WOOD SYSTEMS

APA EWS

Glued laminated timber or "glulam" is one of the strongest and most resource efficient members of today's family of glued engineered wood products. Its dimensional stability, strength, availability, and quality make it an ideal product for railroad bridge components, including ties, stringers, and deck panels.

Glulam has been used in construction in the United States since 1934. A significant development in the glulam industry was the introduction of fully water-proof adhesives in the mid 1940s. This allowed glulam to be used in exposed exterior environments without concern of glueline degradation. Exterior uses include electric utility structures, marinas and pedestrian, highway and railroad bridges.

The Glulam Advantage for Railroads

Dimensional Stability – Glulam is manufactured from kiln dried lumber and has an average moisture content of approximately 12%. This means that glulam is highly dimensionally stable and that members will remain straight and true in section.

Minimal Checking and Splitting – Because glulam is manufactured at a relatively low moisture content, it has much less tendency to exhibit surface checking and splitting as compared to sawn timbers which typically undergo a significant degree of checking and splitting as they dry.

Higher Fastener Values – Another advantage of using a dry wood member such as glulam is that it allows the use of higher fastener design values. And, fasteners have less tendency to work out of the member as may occur with green sawn timbers.

Greater Strength – The use of dry lumber combined with the selective positioning of laminations throughout the depth of the member allows the assignment of much higher stresses to glulam as compared to sawn timbers. In addition, the coefficient of variability for glulam is much lower than for sawn lumber products, resulting in highly predictable structural performance. Glulam is well-suited as a structural material to carry the heavy E-90 railroad design loads. As with all wood products, glulam has excellent dynamic performance characteristics and is an ideal material to resist the repetitive dynamic loads induced by railroad train loading.

Pre-fabrication – Glulam can be pre-fabricated with holes and cuts made at the manufacturing plant prior to treating. This will save valuable labor time in the field and ensure the integrity of the preservative treatment.

Availability – Whereas large dimension sawn timbers having free of heart center (FOHC) characteristics are virtually unattainable today, glulams are readily available throughout North America in virtually any size from a large number of independent manufacturers, all producing to the same high level of quality. Also, the availability is not seasonal, meaning glulams are available year-round, with "on time" deliveries. Long lead times are not necessary as with sawn timbers.

Unlimited Sizes – The glulam manufacturing process allows the manufacturer to produce glulam members in virtually any size and shape and in sizes that match existing construction, such as replacement stringers for railroad bridges or long lengths, curved shapes, and very deep beams. Since glulam is manufactured from dimension lumber, the most efficient widths are 3-1/8", 5-1/8", 6-3/4", 8-3/4" or 10-3/4". For wider widths, multiple laminations are placed side by side within each layer of the beam using a staggered configuration that eliminates any continuous vertical joints. These multiple piece laminations are not required to be edge-glued unless required for specific loading conditions. Depths are typically specified in lamination multiples of 1-3/8" for southern pine and 1-1/2" for western species although any depth is possible.

Quality – Glulam is produced in accordance with the requirements of ANSI Standard A190.1 *Structural Glued Laminated Timber.* All Engineered Wood Systems (EWS) member manufacturers are entitled to apply the *APA EWS* trademark, signifying conformance with this standard. This trademark is the end user's assurance that these members have been produced to the highest industry quality standards and have consistent quality from one beam to the next and from one EWS manufacturer to another.

Environmentally Friendly – Because glulam is manufactured from smaller pieces of dimension lumber and can use a wide variety of species and grades, it places less dependency on high quality old growth timber. Glulam can be manufactured using a wide variety of species harvested from second growth and managed forest lands.

Glulam Manufacturing

Glulam is manufactured by bonding individual lumber laminations together with adhesives. Shorter lengths of lumber are structurally end-jointed to produce longer laminations in the desired length. The wide faces of these full length laminations are then bonded together with adhesives to achieve the desired shape and size of the finished member. Glulam is manufactured with the strongest lumber positioned where the maximum in-service stresses will occur in the member such as in the outer tension and compression zones of a bending member.

Glulam beams are manufactured in both unbalanced and balanced layups. Unbalanced beams are primarily intended for use in simple span applications with the quality of the lumber used on the tension side being higher than the lumber used on the corresponding compression side. These beams, which optimize the utilization of lumber resources and are typically the most economical, are clearly marked with the word TOP to assure their proper installation.

Balanced members are symmetrical in lumber quality about the mid-depth. Thus, they have the same bending stress values assigned to the top and bottom of the beam. Balanced members can be used in continuous span applications or other situations where maximum tension stresses could occur on either face of the beam. For most railroad applications such as multiple-span stringers, pile caps and crossties, a balanced layup is recommended.

Railroad Bridge Components

Typical Bridge Configurations – Figure 1 shows open deck and ballasted deck timber railroad bridges using the traditional four-stringer system. Use of a ballasted deck system provides a more effective distribution of loads through the timber system, resulting in enhanced performance and lower maintenance costs. By converting existing open deck bridges to ballasted systems and incorporating glulam replacement or helper stringers, it should be possible to upgrade many existing timber bridges to carry Heavy Axle Load (HAL) traffic.

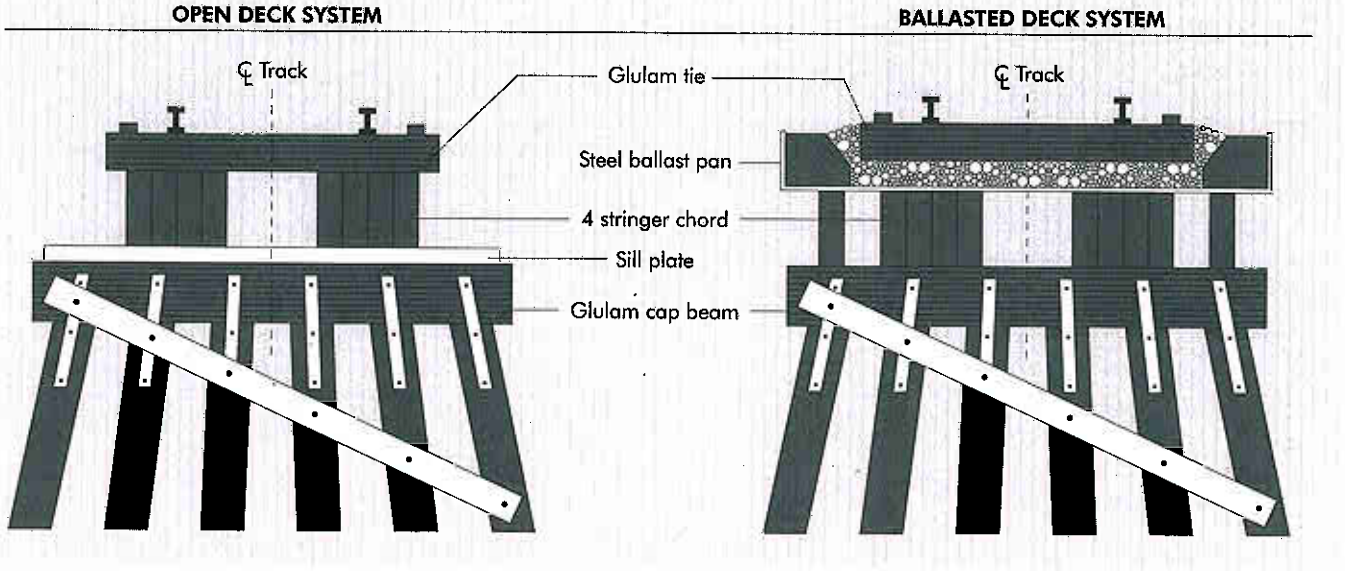
Glulam is a superior alternative material to traditional sawn timber elements, whether it be for stringers, pile caps, or, in some instances, for ties.

Ties – Wood has long been the material of choice for crossties, switch ties and bridge ties. With new innovations in construction technology such as the use of elastic fastener systems and tie preservative pads, the future looks good for timber ties. However, the availability of sawn timber ties in the sizes and quality demanded by the railroad industry is uncertain, whereas glulam is readily available in the sizes and quality needed.

Since glulam timbers perform in essentially the same manner as sawn timber ties, they can be interchanged in tie replacement projects where it is desirable to maintain the use of wood ties but sawn ties are not available. Glulam ties offer the best alternative with the following advantages over sawn timbers and other materials such as concrete:

- Ready availability
- No need for long periods of costly air drying
- Just in time inventory procedures are possible
- Install with normal installation equipment used for sawn timber ties
- Higher resistance for impact loading
- Better electrical insulation for power signaling
- Virtually any length available for switch or crossing applications
- High degree of chemical resistance
- Potential for secondary use or recovery is very high
- No need for anti-splitting plates
- Better fastener support with more uniform density
- Better resistance to "spike kill" due to laminating effect reducing splitting

FIGURE 1



It is important to emphasize that any of the grades shown in Table 2 can be used for any stringer application as long as their structural performance is consistent with the end use demands. Although other structural grades of glulam are available, the three grades tabulated have been identified for ease of specifying for railroad stringer applications.

Pile Caps – Glulam is also ideally suited for use as pile caps since virtually any size section can be produced. Length is also unlimited. Since dense outer laminations can be used in the layup of the member, maximum bearing capacity can be provided to resist the high compressive loads transferred from the stringers above.

Deck Panels

Glulam is often manufactured in relatively thin depths (3-1/8 to 12-1/4 in.), wide widths (45 to 52 in.) and long lengths (24 to 34 ft) to create deck panels for highway bridge construction. In highway bridge construction the panels can be positioned transverse to the traffic flow across intermediate stringers or parallel to the traffic flow spanning from support to support, thus eliminating the need for stringers.

One possibilty for using these panels in railroad bridge construction is to span longitudinally from pier to pier when relatively short spans are involved. A highly efficient system uses steel pre-stressing rods inserted through the width of the deck system at mid-depth of the glulam deck panels. These rods are stressed to very high forces which creates a post-tensioned deck system with a high degree of friction between the deck panel edges. This allows the deck system to function with greater structural efficiency to carry higher loads and reduce deck deflection.

Another potential railroad application for these glulam panels is to use relatively thin panels (2-1/2 in. thick) to form the ballast pan in ballasted deck bridges, eliminating the costly steel ballast pan or other wood ballast systems. This has the potential for reducing the structural system costs and further reducing maintenance costs.

Preservative Treatment of Glulam

Regardless of the application, all glulam exposed to the environment must be pressure preservative treated in accordance with industry standards. AWPA Standard C-28 *Treatment of Glued Laminated Timber* provides the basic requirements for the preservative treatment of glulam.

For railroad applications, either creosote or pentachlorophenol in oil treatments applied after gluing are recommended. In addition to providing protection from insect attack and decay, these oil-based treatments also provide a surface barrier which restricts moisture migration in the member, thus minimizing dimensional changes and surface checking.

Since glulam is typically treated after gluing, as much cutting and hole drilling as is practical should be done prior to treating to assure that all surfaces are properly treated. However, when it is necessary to do some field fabrication, all cut or drilled surfaces should be field-treated with a heavy coating of copper napthanate or other approved field treatment.

In order to assure maximum penetration of the preservative treatment, some species are often incised prior to treating. This incising provides a path for the treatment to better penetrate the wood cells and helps to assure an effective treatment membrane. Check with the glulam supplier and treater to determine if incising is recommended for a specific species and treatment.

Summary

Whatever the end use, glulam is the ideal wood material for railroad bridge construction whether it be for stringers, ties, pile caps or other uses. Some of the many features and advantages of glulam have been identified in this brochure.

For additional information on glued laminated timber for use in railroad construction, contact Engineered Wood Systems or one of the member manufacturers. A Source List of EWS glulam producers can be sent by fax on request to EWS.

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We have field representatives in most major U.S. cities and in Canada who can help answer questions involving APA and APA EWS trademarked products. For additional assistance in specifying APA engineered wood products, get in touch with your nearest APA regional office. Call or write:

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