PDHonline Course C479 (3 PDH)

FHWA Bridge Inspector's Manual
Section 6--Timber Superstructures

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Section 6

Inspection and Evaluation of Common Timber Superstructures

Topic 6.1 Solid Sawn Timber Bridges

6.1.1 Introduction

Timber bridges are gaining a resurgence in popularity throughout the United States. There are two basic classifications in timber construction: solid sawn and glued-laminated (glulam). A solid sawn beam is a section of tree cut to the desired size at a saw mill. Solid sawn multi-beam bridges are the simplest type of timber bridge (see Figure 6.1.1).

Figure 6.1.1 Elevation View of a Solid Sawn Multi-Beam Bridge

6.1.2 Design Characteristics

Multi-beam Bridges

Solid sawn multi-beam bridges consist of multiple solid sawn beams spanning between substructure units (see Figure 6.1.2). The deck is typically comprised of transversely laid timber planks, and longitudinally laid planks called runners which are supported by the beams. Sometimes a bituminous wearing surface is placed on the deck planks to provide a skid resistant riding surface for vehicles, as well as a protective surface for the planks. Beam sizes typically range from about 150 mm by 300 mm (6 inches by 12 inches) to 200 mm by 400 mm (8 inches by 16 inches), and the beams are usually spaced about 600 mm (24 inches) on center.

Figure 6.1.2 Underside View of a Solid Sawn Multi-Beam Bridge

This bridge type is generally used in older, shorter span bridges, spanning up to 8 m (25 feet). Shorter spans are sometimes combined to form longer multiple span bridges and trestles. Many older timber trestles were built for railroads and trolley lines. Solid sawn timbers have become obsolete for most modern bridge members due to the development of high quality glulam members (see Topic 6.2).

Covered Bridges

Covered bridges are generally found along rural roads and get their name from the walls and roof which protect the bridge superstructure (see Figures 6.1.3 and 6.1.4). Covered bridges are usually owned by local municipalities, although some are owned by states or private individuals. Some still carry highway traffic, but many are only open to pedestrians or light weight vehicles. While most covered bridges were built during the 1800's and early 1900's, there are a number of covered bridges being built today as historic reconstruction projects.

Figure 6.1.3 Elevation View of Covered Bridge

Figure 6.1.4 Inside View of Covered Bridge Showing King Post Truss Design

Trusses

The majority of covered bridges are essentially truss bridges (see Figure 6.1.5). Solid sawn timber members make up the trusses of these historic structures. The covers on the bridges prevent decay of the truss and are responsible for their longevity. Typical truss types for covered bridges include the king post, queen post, Town, Warren, and Howe (see Figure 6.1.6). The floor system consists of timber deck planks, stringers, and floorbeams. The span lengths of covered bridges generally range from 15 to 30 m (50 to 100 feet), although many are well over 30 m (100 feet) and some span over 61 m (200 feet).

Figure 6.1.5 Town Truss Covered Bridge

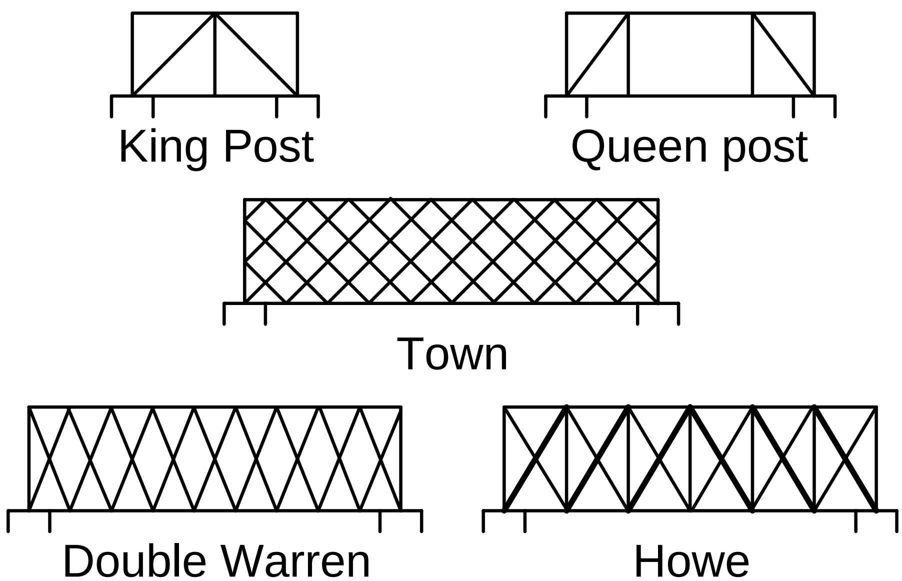

Figure 6.1.6 Common Covered Bridge Trusses

Arches

Timber arches were first used in covered bridges by Theodore Burr to strengthen the series of truss configurations normally used in covered bridges. These became known as Burr arch-trusses (see Figures 6.1.7, 6.1.8 and 6.1.9). The arch served as the main supporting element, and the king posts simply strengthened the arch. The span lengths for Burr-arch truss bridges generally range from 15 to 53 m (50 to 175 feet). Because of their greater strength, many of these structures still exist today.

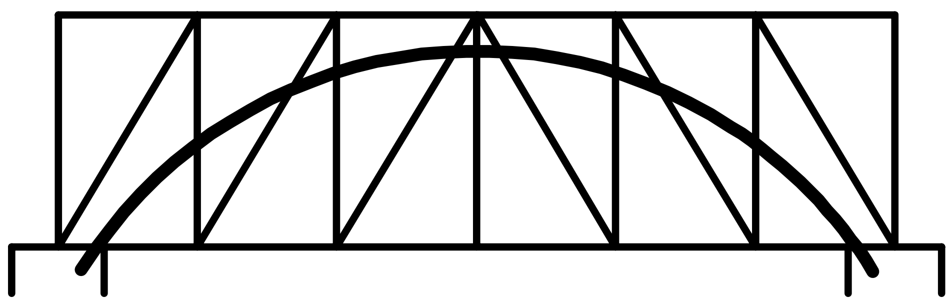

Figure 6.1.7   Schematic of Burr Arch-truss Covered Bridge

Figure 6.1.8   Burr Arch-truss Covered Bridge

Figure 6.1.9 Inside View of Covered Bridge with Burr Arch-truss Design

Primary and Secondary Members

The primary members of solid sawn multi-beam bridges are the beams, and the secondary members are the diaphragms or cross bracing if present (see Figure 6.1.2). These bridges usually have timber diaphragms or cross bracing between beams at several locations along the span.

The primary members in truss and arch structures are the truss members (chords, diagonals, and verticals), arch ribs, stringers, and floorbeams (see Figures 6.1.9 and 6.1.10). The secondary members are the diaphragms and cross bracing between stringers, the upper and lower lateral bracing, sway bracing, and the covers on the roof and sides when present.

Figure 6.1.10 Town Truss Design

6.1.3 Overview of Common Defects

Common defects that occur on solid sawn timber beams include:

- Checks, splits, shakes, and knots
- Decay by fungi
- Damage by insects and borers
- Damage from impact/collisions
- Damage from wear, abrasion, and mechanical wear
- Damage from weathering/warping
- Damage from overstress
- Damage from fire
- Loose connections
- Failure of protective system

A less common defect that may be encountered by the inspector includes damage from chemical attack. Refer to Topic 2.1 for a more detailed presentation of the properties of timber, types and causes of timber deterioration, and the examination of timber.

6.1.4 Inspection Procedures and Locations

Inspection procedures to determine other causes of timber deterioration are discussed in detail in Topic 2.1.7.

Procedures

Visual

The inspection of timber splits, cracks, shakes, fungus decay, deflections, crushing, delaminations, and loose connections is primarily a visual activity.

Physical

The physical examination of a timber member can be conducted with a hammer or pick. The hammer is used to sound the members to detect hollow areas or internal decay. Picks are used to determine the condition of the surface.

Advanced Inspection Techniques

Several advanced techniques are available for timber inspection. Nondestructive methods, described in Topic 13.1.2, include:

- Pol-Tek
- Spectral analysis
- Ultrasonic testing
- Vibration

Other methods, described in Topic 13.1.3, include:

- Boring or drilling
- Moisture content
- Probing
- Shigometer

Locations

Bearing Areas

Check the bearing areas for crushing of the beams near the bearing seat (see Figure 6.1.11). Investigate for decay and insect damage by visual inspection and sounding and/or probing at the ends of the beams where dirt, debris, and moisture tend to accumulate. Also verify the condition and operation of the bearing devices, if they are present (see Topic 9.1).

Figure 6.1.11 Bearing Area of Typical Solid Sawn Beam

Shear Zones

As discussed in Topic P.2, maximum shear occurs near supports. A horizontal shear force of equal magnitude accompanies the vertical shear component of this force. Because of timber's orthotropic cell structure, it has excellent resistance against vertical shear but low resistance against horizontal shear. The failure of a solid sawn timber member due to load is generally preceded by horizontal shear cracking along the grain. A horizontal shear "crack" is effectively a longitudinal split.

Investigate the area near the supports for the presence of horizontal shear cracking. The presence of transverse cracks on the underside of the girders or horizontal cracks on the sides of the girders indicate the onset of shear failure. These cracks can propagate quickly toward midspan and represent lost moment capacity of up to 75% (see Figure 6.1.12). Measure these cracks carefully for length, width, and if possible, the depth.

Figure 6.1.12   Horizontal Shear Crack in a Timber Beam

Tension Zones

Examine the zones of maximum tension for signs of structural distress. The maximum tension generally occurs at the bottom half of the middle third of the beam span. Investigate for section loss due to decay or fire, especially near mid-span. Examine beams for excessive deflection or sagging.   Tension cracks in timber break the cell structure perpendicular to the grain and are typically preceded by the appearance of horizontal shear cracks.

Solid sawn beams with sloping grain that intersects the surface in the tension zone are particularly susceptible to flexure cracking because the tensile stress and horizontal shear stress combine to split the grain apart.

Areas Exposed to Drainage

Timber bridges with plank decks are exposed to drainage throughout the length of the span. Plank decks with asphalt overlays in good condition offer some protection. In these cases, deck joint areas at span ends are candidates for drainage exposure.

Investigate for signs of decay along the full length of the beam but especially where the beam is subjected to continual wetness and areas that trap moisture. These include member interfaces between deck planks and stringers, deck planks and beams, beams and bearing seats, stringers and floorbeams, floorbeams and trusses, truss member connections, arch connections, and all fastener locations. (see Figure 6.1.13).

Decay and chemical attack may be evidenced by discolored wood, brown and white rot, the formation of fruiting bodies (the result of fungal attacks, which produce disc-shaped bodies that distribute reproductive spores), “sunken” faces in the wood, or soft “punky” texture of the wood. When surface probing for expected decay is inconclusive, the next step is to drill the suspect area. If this has been done in a previous inspection, the drill hole area should be examined carefully for proper preservation treatment and dowel plug installations.

Figure 6.1.13 Decay in a Timber Beam

Areas of Insect Infestation

Insect infestation can be detected in various ways. Carpenter ants generally leave piles of sawdust; powder-post beetles leave small holes in the surface of the wood; and termites can often be readily seen. Another indication of insect infestation is hollow sounding wood. Further probing or drilling should be performed in suspect areas.

Areas Exposed to Traffic

For overhead and through structures, check for collision damage from vehicles passing below or adjacent to structural members.

Areas Previously Repaired

Thoroughly examine any repairs that have been previously made. Determine if repaired areas are sound and functioning properly.

Secondary Members

Inspect bracing members for decay and fire damage. Examine connections of bracing to beams for tightness, cracked or split members, and corroded, loose, or missing fasteners (see Figure 6.1.14). Deteriorated secondary members may indicate problems in the primary members.

Figure 6.1.14 Typical Timber End Diaphragm

Fasteners and Connectors

Check all fasteners (e.g., nails, screws, bolts, and deck clips) for corrosion. Also inspect for loose or missing fasteners. Check for moisture and decay around the holes.

6.1.5 Evaluation

State and federal rating guideline systems have been developed to aid in the inspection of timber bridges. The two major rating guideline systems currently in use are the FHWA's *Recording and Coding Guide for the Structural Inventory and Appraisal of the Nation's Bridges* used for the National Bridge Inventory (NBI) component rating method and the *AASHTO Guide for Commonly Recognized (CoRe) Structural Elements* used for element level condition state assessment.

NBI Rating Guidelines

Using NBI rating guidelines, a 1-digit code on the Federal Structure Inventory and Appraisal (SI&A) sheet indicates the condition of the superstructure. Rating codes range from 9 to 0, where 9 is the best rating possible. See Topic 4.2 (Item 59) for additional details about the NBI rating guidelines.

The previous inspection data should be used along with current inspection findings to determine the correct rating.

Element Level Condition State Assessment

In an element level condition state assessment of a solid sawn timber bridge, the AASHTO CoRe elements are:

Element No.	Description
111	Open Girder/Beam
117	Stringer
135	Truss/Arch
156	Floorbeam

The unit quantity for the timber superstructures is in meters or feet, and the total length must be distributed among the four available condition states depending on the extent and severity of deterioration. The sum of all condition states must equal the total quantity of the CoRe element. Condition state 1 is the best possible rating. See the *AASHTO Guide for Commonly Recognized (CoRe) Structural Elements* for condition state descriptions.

A Smart Flag is used when a specific condition exists, which is not described in the CoRe element condition state. The severity of the damage is captured by coding the appropriate Smart Flag condition state. The Smart Flag quantities are measured as each, with only one each of any given Smart Flag per bridge.

For damage due to traffic impact, the “Traffic Impact” Smart Flag, Element No. 362, can be used. There are three condition states for the “Traffic Impact” Smart Flag, with condition state 1 being the best.

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Topic 6.2 Glulam Timber Bridges

6.2.1 Introduction

A glued-laminated (glulam) member is made by gluing strips of wood together to form a structural member of the desired size. An advantage of glulam members is that they allow for a higher utilization of the wood, since a lower grade of material can be used in of lower stress. Many strength reducing characteristics of wood, such as knots and checks, are minimized due to relatively small laminate dimensions. Also, the size and length of a glulam member is not limited by the size or length of a tree. Strips of wood used in glulam members are generally 20 to 40 mm (3/4 to 1-1/2 inches) thick (see Figures 6.2.1 and 6.2.2).

Figure 6.2.1 Elevation View of a Glulam Multi-beam Bridge

Figure 6.2.2 Underside View of a Glulam Multi-beam Bridge

6.2.2 Design Characteristics

Multi-beam Bridges

Glulam multi-beam bridges are very similar to solid sawn multi-beam bridges, but they generally use larger members to span greater distances. Glulam multi-beam bridges are typically simple span designs (see Figure 6.2.1). They usually support a deck consisting of glulam panels with a bituminous wearing surface. Beam sizes typically range from 150 mm by 610 mm (6 inches by 24 inches) to 310 mm by 1525 mm (12-1/4 inches by 60 inches), and the beams are usually spaced 1.7 m to 2.0 m (5'-6" to 6'-6") on center (see Figure 6.2.2).

These more modern multi-beam bridges can typically be used in spans of up to 24 m (80 feet), although some span as long as 46 m (150 feet). These too can be used to form longer multiple span structures. They are generally found on local and secondary roads, as well as in park settings.

Truss Bridges

Trusses may be of the through-type or of the deck-type. Usually the floor system consists of a timber deck supported by timber stringers and floorbeams, all of which are supported by the trusses (see Figures 6.2.3 and 6.2.4). Timber trusses are generally used for spans that are not economically feasible for timber multi-beam bridges. Timber trusses are practical for spans that range from 46 to 76 m (150 to 250 feet) (see Figure 6.2.5).

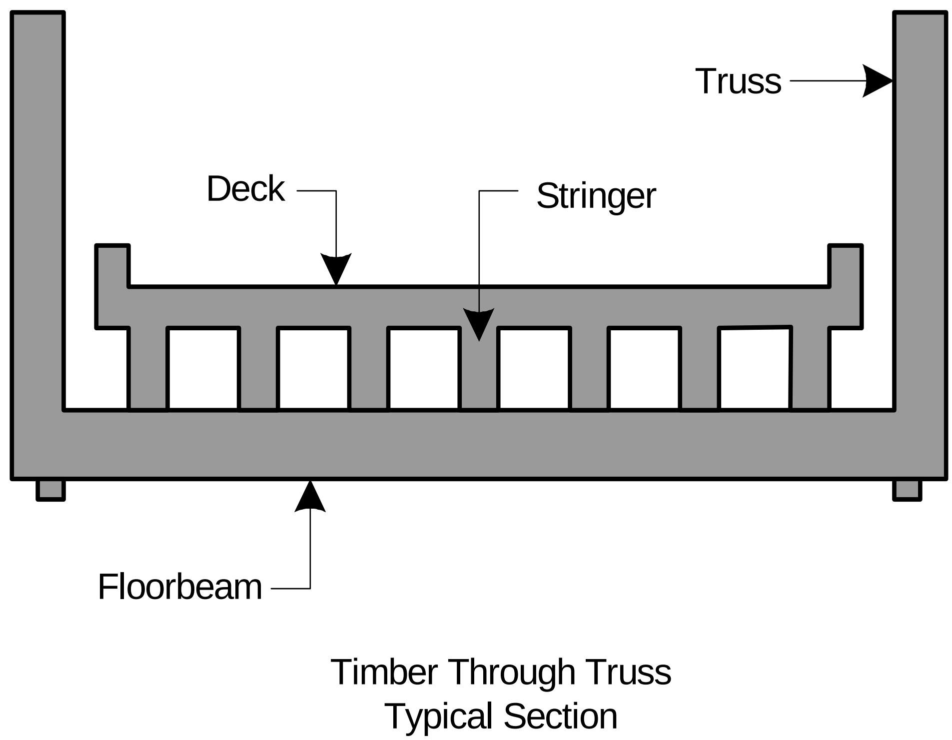

Figure 6.2.3 Timber Through Truss Typical Section

Figure 6.2.4 Bowstring Truss Pedestrian Bridge

Figure 6.2.5 Parallel Chord Truss Pedestrian Bridge (Eagle River, Alaska)

Arch Bridges

Glulam arch bridges usually consist of two- or three-hinged deck arches, which support a glulam deck and floor system (see Figures 6.2.6 and 6.2.7). Glulam arches are practical for spans of up to about 91 m (300 feet). Although they are not widely used for highway bridges, they are frequently used for pedestrian overpasses and in locations such as parks where aesthetics is important.

Figure 6.2.6 Glulam Arch Bridge over Glulam Multi-beam Bridge (Keystone Wye interchange, South Dakota)

Figure 6.2.7 Glulam Arch Bridge (West Virginia)

Primary and Secondary Members

The primary members of glulam multi-beam bridges are the beams, and the secondary members are the diaphragms or cross bracing (see Figure 6.2.8). Due to the larger depth of the glulam beams, diaphragms or cross bracing should always be present. Diaphragms are usually constructed of short glulam members, and cross bracing is usually constructed of steel angles.

The primary members of glulam arch and truss structures are the arch, truss, stringers, and floorbeams, spandrel bents and hangers. The secondary members are the diaphragms and cross bracing between the stringers and the lateral bracing between the arch or truss.

Figure 6.2.8 Typical Glulam Diaphragm

Recent technology has also produced glulam timber materials which are reinforced with fibers such as aramids, carbon, and fiberglass. These fiber reinforced glulam beams help increase the strength and mechanical properties of timber bridges.

6.2.3 Overview of Common Defects

Common defects that occur on glulam timber beams include:

- Checks, splits, shakes
- Decay by fungi
- Damage by insects and borers
- Damage from impact/collisions
- Damage from wear, abrasion, and mechanical wear
- Damage from weathering/warping

- Damage from overstress
- Damage from fire
- Loose connections
- Failure of protective system

A less common defect that may be encountered by the inspector includes damage from chemical attack. Refer to Topic 2.1 for a more detailed presentation of the properties of timber, types and causes of timber deterioration, and the examination of timber.

6.2.4 Inspection Procedures and Locations

Inspection procedures to determine other causes of timber deterioration are discussed in detail in Topic 2.1.7. The inspection locations and procedures for glulam bridges are similar to those for solid sawn bridges.

Procedures

Visual

The inspection of timber splits, cracks, shakes, fungus decay, deflections, crushing, delaminations, and loose connections is primarily a visual activity.

Physical

The physical examination of a timber member can be conducted with a hammer or pick. The hammer is used to sound the members to detect hollow areas or internal decay. Picks are used to determine the condition of the surface.

Advanced Inspection Techniques

Several advanced techniques are available for timber inspection. Nondestructive methods, described in Topic 13.1.2, include:

- Pol-Tek
- Spectral analysis
- Ultrasonic testing
- Vibration

Other methods, described in Topic 13.1.3, include:

- Boring or drilling
- Moisture content
- Probing
- Shigometer

Locations

Bearing Areas

Inspect the bearing areas for crushing of the beams (see Figure 6.2.9). Investigate for decay and insect damage by visual inspection, sounding, and/or probing at the ends of the beams. Also check the condition and operation of the bearing devices if they are present (see Topic 9.1).

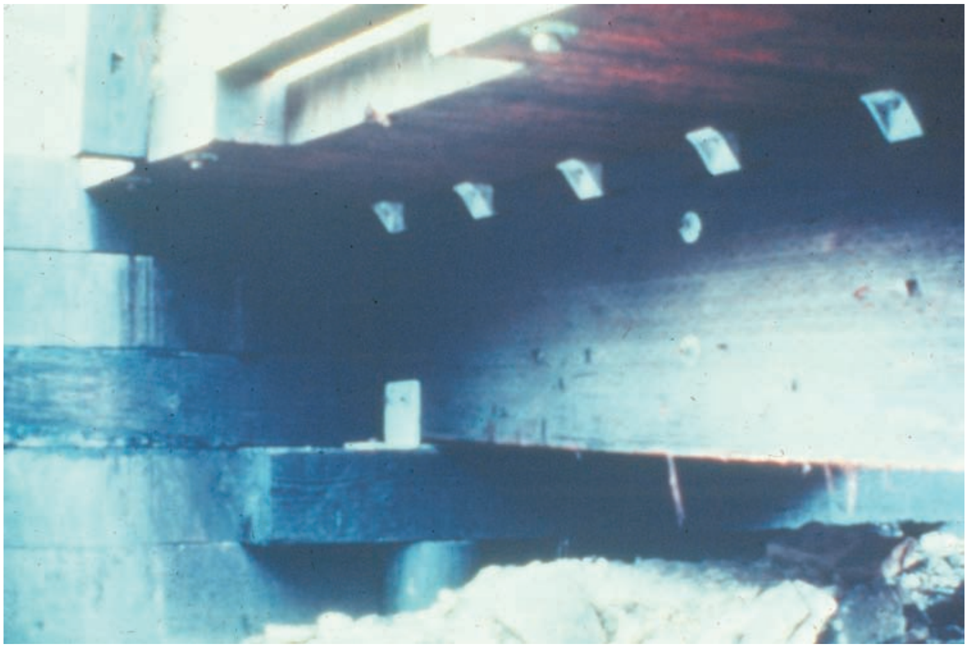

Figure 6.2.9 Bearing Area of Typical Glulam Beam

Shear Zones

Examine for horizontal shear cracks and delaminations near the ends of the beam. Delaminations (i.e., separations in the laminations) can occur due to either failure of the glue or failure at the bond between the glue and the lamination (see Figure 6.2.10). Delaminations that extend completely through the cross section of the member are the most serious since this makes the member act as two smaller members. Delaminations that are located near the center of the cross section are more serious than those near the top or bottom of the beam. Delaminations directly through a connector are also undesirable.

Figure 6.2.10 Close-up View of Glulam Bridge Showing Laminations

Tension Zones

Examine the zone of maximum tension for signs of structural distress (see Figure 6.2.11). The maximum tension generally occurs at the bottom half of the middle third of the beam span. Investigate for section loss due to decay or fire, especially near mid-span. Inspect for excessive deflection or sagging in the beams.

Figure 6.2.11 Elevation View of Beam of Glulam Multi-beam Bridge

Areas Exposed to Drainage

Investigate for signs of decay along the full length of the member but especially where the beam is subjected to continual wetness or prolonged exposure to moisture (see Figure 6.2.12). Decay and chemical attack may be evidenced by discolored wood, brown and white rot, the formation of fruiting bodies (the result of fungal attacks, which produce disc-shaped bodies that distribute reproductive spores), "sunken" faces in the wood, or the soft “punky” texture of the wood.

Figure 6.2.12 Decay on Glulam Beam

Areas of Insect Infestation

Insect infestation can be detected in various ways. Carpenter ants generally leave piles of sawdust; powder-post beetles leave small holes in the surface of the wood; and termites can often be readily seen. Another indication of insect infestation is hollow sounding wood. Further probing or drilling should be performed in suspect areas.

Areas Exposed to Traffic

For overhead and through structures, check for collision damage from vehicles passing below or adjacent to structural members.

Areas Previously Repaired

Thoroughly examine any repairs that have been previously made. Determine if repaired areas are sound and functioning properly.

Secondary Members

Examine diaphragms for decay, fire damage, and insect damage (see Figure 6.2.13). Check steel cross bracing for corrosion, bowing, or buckling (see Figure

6.2.14). Examine connections for tightness, cracks and splits, and corroded, loose, or missing fasteners. Deteriorated secondary members may indicate problems in the primary members.

Figure 6.2.13 Typical Diaphragm for a Glulam Multi-beam Bridge

Fasteners and connectors

Inspect all fasteners for corrosion, tightness, and missing parts (see Figure 6.2.13).

Figure 6.2.14 Glulam Beams with Numerous Fastener Locations

6.2.5 Evaluation

State and federal rating guideline systems have been developed to aid in the inspection of timber bridges. The two major rating guideline systems currently in use are the FHWA's *Recording and Coding Guide for the Structural Inventory and Appraisal of the Nation's Bridges* used for the National Bridge Inventory (NBI) component rating method and the *AASHTO Guide for Commonly Recognized (CoRe) Structural Elements* used for element level condition state assessment.

NBI Rating Guidelines

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Element Level Condition State Assessment

In an element level condition state assessment of a glulam timber bridge, the AASHTO CoRe elements are:

Element No.	Description
111	Open Girder/Beam
117	Stringer
135	Truss/Arch
156	Floorbeam

The unit quantity for the timber superstructures is in meters or feet, and the total length must be distributed among the four available condition states depending on the extent and severity of deterioration. The sum of all condition states must equal the total quantity of the CoRe element. Condition state 1 is the best possible rating. See the *AASHTO Guide for Commonly Recognized (CoRe) Structural Elements* for condition state descriptions.

A Smart Flag is used when a specific condition exists, which is not described in the CoRe element condition state. The severity of the damage is captured by coding the appropriate Smart Flag condition state. The Smart Flag quantities are measured as each, with only one each of any given Smart Flag per bridge.

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Topic 6.3 Stress-Laminated Timber Bridges

6.3.1 Introduction

Stress-laminated timber bridges were first developed in Canada, in 1976, by the Ontario Ministry of Transportation and Communications. These bridges consist of multiple planks mechanically clamped together using metal rods to perform as one unit (see Figure 6.3.1). The compression induced frictional resistance within the timber laminations is the mechanism that makes this structural system effective.

Figure 6.3.1 Stress-Laminated Timber Slab Bridge Carrying a 90,000-Pound Logging Truck (Source: Barry Dickson, West Virginia University)

6.3.2 Design Characteristics

Stress-Laminated Timber Slab Bridges

Stress-laminated timber slab bridges can be used for simple spans of up to 15 m (50 feet) and are capable of carrying modern highway loadings (see Figures 6.3.1 and 6.3.3). Stressed deck bridges have also been constructed using glulam members. Combining glulam technology with stress-lamination increases practical span lengths to 19 m (63 feet) (see Figure 6.3.4).

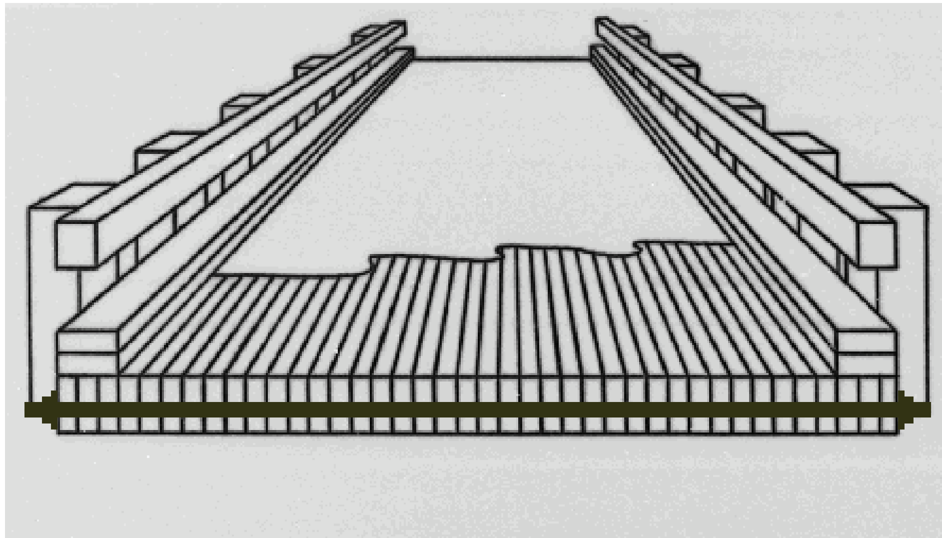

Figure 6.3.2 Typical Section of a Stress-Laminated Timber Slab Bridge

Figure 6.3.3 Stress-Laminated Timber Slab Bridge

Figure 6.3.4 Glulam Stress-Laminated Timber Slab Bridge

Stress-Laminated Timber Tee Beam Bridges

The idea for stress-laminated timber tee beam bridges was developed at West Virginia University. These bridges consist of a stress-laminated deck and glulam beams (see Figure 6.3.5). High strength steel rods are used to join the stress-laminated deck and glulam beams together to form stress-laminated timber tee beams. The first structure of this type was built in 1988, near Charleston, West Virginia. It is 23 m (75 feet) long and has stressing rods spaced at two feet. It has performed well, and stressed tee beams will likely be used in the future to achieve even longer span lengths (see Figure 6.3.6).

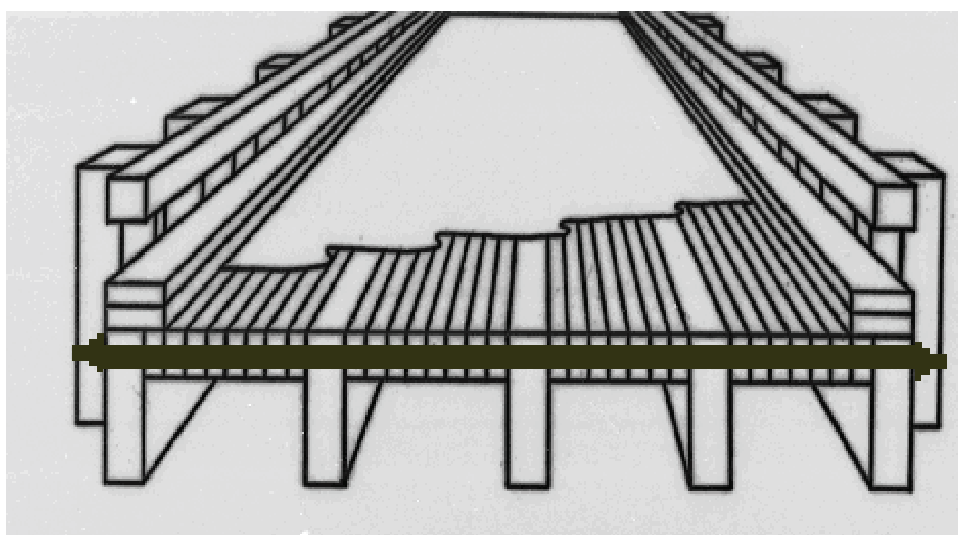

Figure 6.3.5 Typical Section of a Stress-Laminated Timber Tee Beam Bridge (Source: Barry Dickson, West Virginia University)

Figure 6.3.6 Elevation View of Stress-Laminated Timber Tee Beam Bridge (West Virginia)

Stress-Laminated Timber Box Beam Bridges

Stress-laminated timber box beam bridges represent further development of timber bridges by West Virginia University. These bridges consist of adjacent box beam panels individually comprised of stress-laminated flanges and glulam beam webs (see Figure 6.3.7). This bridge type is also known as a cellular stressed deck. Span lengths of up to 18 m (60 feet) have been designed, and there is a potential for longer spans (see Figure 6.3.8).

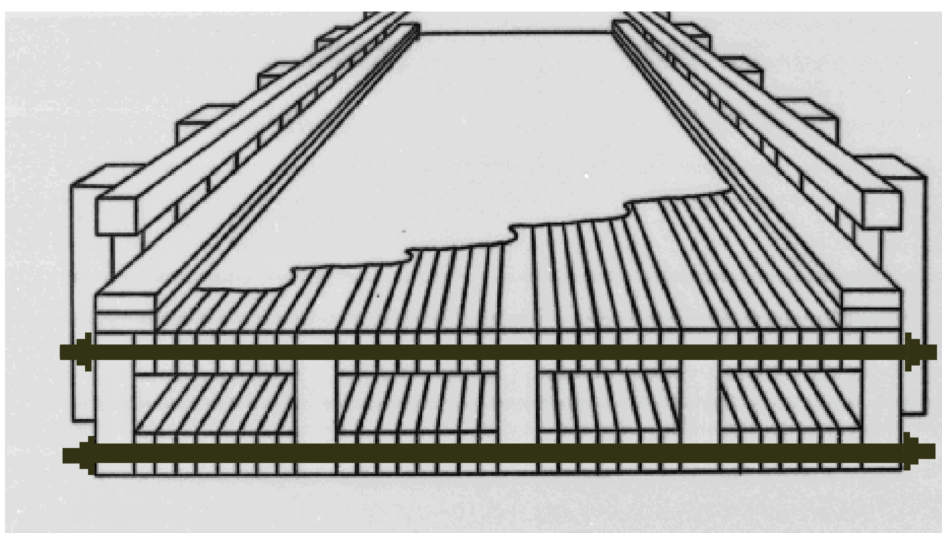

Figure 6.3.7 Typical Section of a Stress-Laminated Timber Box Beam (Source: Barry Dickson, West Virginia University)

Figure 6.3.8 Stress-Laminated Timber Box Beam Bridge Being Erected

Stress-Laminated Timber K-frame Bridges

Stressed K-frame bridges represent further development of the stressed deck bridge by the Ontario Ministry of Transportation and Communications. These bridges consist of three spans in which the stressed deck is supported at two intermediate points by stressed laminated timber struts (see Figure 6.3.9). This bridge type has been used for a bridge with a total length of 13 m (43 feet), and it has a potential for span lengths over 15 m (50 feet).

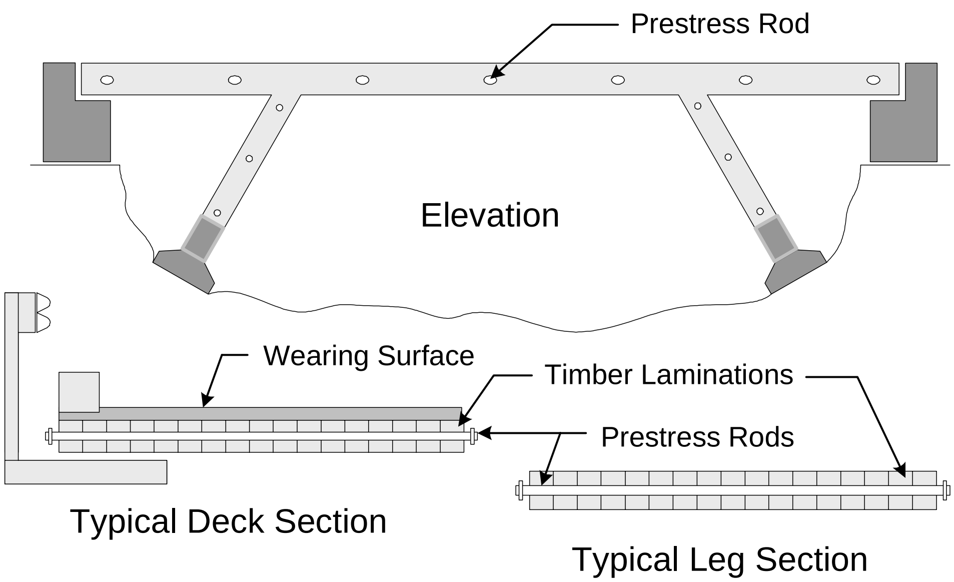

Figure 6.3.9 Stress-Laminated Timber K-frame Bridge

Primary and Secondary Members

The primary members are the decks, slabs, tee beams, box beams, and frame legs. The secondary members are the diaphragms and cross bracing between beams.

6.3.3 Overview of Common Defects

Common defects that occur on stressed timber bridges include:

- Checks, splits, shakes
- Decay by fungi
- Damage by insects and borers
- Damage from impact/collisions
- Damage from wear, abrasion, and mechanical wear
- Damage from weathering/warping
- Damage from overstress
- Damage from fire
- Loose connections
- Failure of protective system

A less common defect that may be encountered by the inspector includes damage from chemical attack. Refer to Topic 2.1 for a more detailed presentation of the properties of timber, types and causes of timber deterioration, and the examination of timber.

6.3.4 Inspection Procedures and Locations

Inspection procedures to determine other causes of timber deterioration are discussed in detail in Topic 2.1.7. The inspection of stress-laminated timber bridges is similar to those for glulam bridges.

Procedures

Visual

The inspection of timber splits, cracks, shakes, fungus decay, deflections, crushing, delaminations, and loose connections is primarily a visual activity.

Physical

The physical examination of a timber member can be conducted with a hammer or pick. The hammer is used to sound the members to detect hollow areas or internal decay. Picks are used to determine the condition of the surface.

Advanced Inspection Techniques

Several advanced techniques are available for timber inspection. Nondestructive methods, described in Topic 13.1.2, include:

- Pol-Tek
- Spectral analysis
- Ultrasonic testing
- Vibration

Other methods, described in Topic 13.1.3, include:

- Boring or drilling

- Moisture content
- Probing
- Shigometer

Locations

Stressing Rods

Examine the condition of the steel stressing rods, and inspect for crush and splits in the fascia members. Check for loss of prestress in the rods, which would be indicated by shifted planks in the stress-laminated timber element and excessive deflection or loose rods. This may be observed when the bridge is subject to a moving live load.

Figure 6.3.10 Broken Stressing Rods

Bearing Areas

Inspect the bearing areas for crushing of the beams. Investigate for decay and insect damage by visual inspection, sounding, and/or probing at the ends of the beams. Also check the condition and operation of the bearing devices if they are present (see Topic 9.1, Bearings).

Shear Zones

Examine for horizontal shear cracks and delaminations near the ends of the beam. Delaminations (i.e., separations in the laminations) can occur due to either failure of the glue or failure at the bond between the glue and the lamination (see Figure 6.3.11). Delaminations that extend completely through the cross section of the member are the most serious since this makes the member act as two smaller members.

Figure 6.3.11 Close-up View of End of a Stress-Laminated Timber Bridge Showing Laminations

Tension Zones

Examine the zone of maximum tension for signs of structural distress. The maximum tension generally occurs at the bottom half of the middle third of the beam span. Investigate for section loss due to decay or fire, especially near mid-span. Inspect for excessive deflection or sagging in the beams.

Areas Exposed to Drainage

Investigate for signs of decay along the full length of the member but especially where the beam is subjected to continual wetness or prolonged exposure to moisture. Decay and chemical attack may be evidenced by discolored wood, brown and white rot, the formation of fruiting bodies (the result of fungal attacks, which produce disc-shaped bodies that distribute reproductive spores), "sunken" faces in the wood, or the soft “punky” texture of the wood. Examine the curb line areas. Standing water soaks into the beam and corrodes the stressing rods.

Areas of Insect Infestation

Insect infestation can be detected in various ways. Carpenter ants generally leave piles of sawdust; powder-post beetles leave small holes in the surface of the wood; and termites can often be readily seen. Another indication of insect infestation is hollow sounding wood. Further probing or drilling should be performed in suspect areas.

Areas Exposed to Traffic

Check stress-laminated timber members for collision damage from vehicles passing below.

Areas Previously Repaired

Thoroughly examine any repairs that have been previously made. Determine if repaired areas are sound and functioning properly.

Secondary Members

Examine solid sawn or glulam diaphragms for decay, fire damage, and insect damage. Check steel cross bracing for corrosion, bowing, or buckling. Examine connections for tightness, cracks and splits, and corroded, loose, or missing fasteners. Deteriorated secondary members may indicate problems in the primary members.

Fasteners and Connectors

Inspect all fasteners for corrosion, tightness, and missing parts. Stressing rod hardware is the most important fastener system on a stress-laminated timber bridge.

6.3.5 Evaluation

State and federal rating guideline systems have been developed to aid in the inspection of timber bridges. The two major rating guideline systems currently in use are the FHWA's *Recording and Coding Guide for the Structural Inventory and Appraisal of the Nation's Bridges* used for the National Bridge Inventory (NBI) component rating method and the AASHTO element level condition state assessment method.

NBI Rating Guidelines

Using NBI rating guidelines, a 1-digit code on the Federal Structure Inventory and Appraisal (SI&A) sheet indicates the condition of the superstructure. Rating codes range from 9 to 0, where 9 is the best rating possible. See Topic 4.2 (Item 59) for additional details about NBI rating guidelines.

The previous inspection data should be used along with current inspection findings to determine the correct rating.

Element Level Condition State Assessment

In an element level condition state assessment of timber bridges, the AASHTO CoRe elements are:

Element No.	Description
11	Timber Deck - Bare
12	Timber Deck with A/C Overlay
54	Timber Slab - Bare
55	Timber Slab with A/C Overlay
111	Open Girder/Beam

The unit quantity for the timber superstructures is in meters or feet, and the total length must be distributed among the four available condition states depending on the extent and severity of deterioration. The sum of all condition states must equal the total quantity of the CoRe element. The unit quantity for decks and slabs is "each", and the entire element must be placed in one of the five available condition states based on the condition of the deck. Some states have elected to use the total area (m^2 or ft^2). When a total area is used, the total area must be distributed among the five available condition states depending on the extent and severity of deterioration. The sum of all condition states must equal the total quantity of the CoRe element. Condition state 1 is the best possible rating. See the *AASHTO Guide for Commonly Recognized (CoRe) Structural Elements* for condition state descriptions.

A Smart Flag is used when a specific condition exists, which is not described in the CoRe element condition state. The severity of the damage is captured by coding the appropriate Smart Flag condition state. The Smart Flag quantities are measured as each, with only one each of any given Smart Flag per bridge.

For damage due to traffic impact, the "Traffic Impact" Smart Flag, Element No. 362, can be used. There are three condition states for the "Traffic Impact" Smart Flag, with condition state 1 being the best.