Standard Plans for Southern Pine Bridges

Paula D. Hilbrich Lee
Michael A. Ritter
Michael Triche
Abstract

The development of standardized timber bridge plans and specifications is a key element in improving design and construction practices. The bridge plans presented were developed as a cooperative effort between the USDA Forest Service, Forest Products Laboratory (FPL), the University of Alabama; and the Southern Pine Council and are the first step in developing standardized designs for the southern United States where Southern Pine is the primary structural wood species group. This publication contains standardized designs and details for three timber bridge superstructure types, including stress-laminated sawn timber bridges, stress-laminated glued laminated timber (glulam) bridges, and longitudinal sawn timber stringer bridges with transverse plank deck.

Each set of plans encompasses numerous span length and width combinations, design loadings for AASHTO HS 20-44 and HS 25-44 vehicles, and two options for live-load deflection criteria.

Keywords: Bridge, stress laminated, Southern Pine, stringer, glulam

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Standard Plans for Southern Pine Bridges

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Introduction
Interest in timber bridges has increased significantly in recent years, primarily as a result of programs implemented through the Timber Bridge Initiative program by the 1988 Congress. During this period, the development of standard timber bridge plans and specifications has continued to be extended by bridge designers and builders as a key element for contributing to improved design and construction practices. Additionally, standard plans have been viewed as a beneficial tool for helping engineers address the critical transportation infrastructure needs of state, county, and rural regions. To meet this need, several projects to develop standardized timber bridge plans have been initiated at the Federal and local levels based on modern technology for design, fabrication, and construction.

The bridge plans presented in this publication are the first step in developing standardized designs for the Southern United States where Southern Pine is the primary structural wood species group. The plans were developed as a cooperative effort between the USDA Forest Service, Forest Products Laboratory (FPL), the University of Alabama, and the Southern Pine Council. The plans include standardized designs and details for 3 timber bridge superstructure types: stress-laminated sawn lumber bridges, stress-laminated glued laminated timber (glulam) bridges, and longitudinal sawn lumber stringer bridges with transverse planks decks. The stress-laminated bridges were developed at FPL, and the sawn lumbar stringer designs were developed at the University of Alabama. The plans are intended to serve as a useful guide to state, county, and local highway departments in the development of practical and economical bridge designs using Southern Pine lumber and glulam. They should be particularly valuable to smaller highway departments with limited engineering staffs.

In the development of these plans, every effort has been made to provide complete information for bridge superstructure design and fabrication for a range of design options. Each set of plans encompasses numerous span length and width combinations, design loadings for AASHTO HS 20-44 and HS 25-44 vehicles, and two options for live load deflection criteria. However, specific site conditions may necessitate modification because plans were developed for right-angle crossings only.

In all cases, these designs must be verified by a registered professional engineer prior to construction.

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Acknowledgments
We express appreciation to Mr. Marc Lohwedanski, formerly from the Southern Forest Products Association, and Mr. Mac Lupold, Federal Paperboard Inc., for their assistance in the development and review of these plans. We are grateful to the many individuals who provided review comments and suggestions during plan development.

References


Specifications


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Table: Stress-Laminated Glued Laminated Timber Decks

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Table: Longitudinal Stringer with Transverse Plank Decks

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Table: Rail Options

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Table: Notes and Design

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</table>
Stress-Laminated Sawn Lumber Bridge Decks
Rail Option Configuration and Scupper Spacing

12' Length

16' Length

20' Length

24' Length

Rail Detail
End View

Rail Detail
Side View

Curb Splice Detail

The bridge rail was successfully crash tested to the requirements for Performance Level 1 as outlined in the 1998 AASHO Guide Specifications for Bridge Railings.

Refer to "Pieces for Crash Tested Bridge Railings for Longitudinal Wood Design" (other and criteria, as needed) for additional crash tested bridge railings and approach railing transitions.

The bridge superstructures depicted on these drawings were developed under a cooperative research agreement between the USDA Forest Service, Forest Products Laboratory, the University of Alabama and the Southern Forest Products Association.

Standard Plans for Southern Pine Bridges

Stress-Laminated Sawn Lumber Decks

Rail Option Details

August 1996

Sheet 4 of 9
### Construction Recommendations and Procedures

The performance and longevity of any bridge depends on the materials and construction practices. Abraded recommendations for proper selection of the stress-lemmed bridge deck materials are included below. It is advisable to study and understand these recommendations prior to beginning construction. For additional information, refer to the drawings and Timber Bridges: Design, Construction, Repair, and Maintenance (AASHTO 1989).

**MATERIALS**

The following recommendations should be followed for materials:

1. **Lumber must be stress graded and properly treated with wood preservatives.**
2. **Laminations should be free from knots and nicks.** Laminations with warp, sweep, or cupping will make bar installation difficult.
3. **The width of flange of the lumber laminations must be cut to a uniform laminar thickness.** Variations in laminar thickness may cause lamination to break in the deck width and stay prevent full contact and load distribution between adjacent laminations.
4. **The moisture content of the laminations should not exceed the value specified.** Lumber that is dry will result in better deck performance because drying and associated bar force loss will be minimized. If lumber is placed at a high moisture content, it will eventually dry and shrink, which will result in bar loss.
5. **The location and size of holes in the laminations for stressing bars should be verified before the bridge is erected.** Misalignment of laminations will: make bar installation difficult and may require field cutting. Control holes may influence the bridge load capacity.
6. **Nuts for gusseting stressing bars must be oversized to compensate for the gusseting nuts that are not oversized or will not fit on the stressing bars.**
7. **Proper material certification and/or quality assurance certificates should be received and verified for all materials.**
8. **Field cutting and drilling of treated wood members must be minimized.** In cases where field fabrication is required, proper field treatment is essential.

**BRIDGE ASSEMBLY**

The stress-laminated bridge decks described in these plans are typically assembled and stressed on the abutments. Assembly begins by removing the bridge adjacent to the deck side and lifting the stressed bridge into place with a crane. Guidelines for bridge assembly using both transportable forms are included.

**Assembly on the Abutments**

1. **Laminations are placed individually.** Using this method, the first 4 to 8 laminations are placed at the deck edge location and nailed together so that they stand unsupported. The remaining laminations are then placed using wood dowels to align holes. When holes are aligned, bars may be used to hold the laminations in place or the stressing bars may be inserted and pushed through the holes as laminations are spaced. Bars are spaced such that they are supported on the pins and not allowed to bend excessively. Bar bending may damage the bar in the gusseting stresses.
2. **Laminations are processed into panels.** In this case, panels 2 to 4 ft wide are assembled by nailing laminations together. In this method, panels are spaced at each other's edge location and nailed together with metal bands. In both cases, the bolts must be aligned so that stressing bars can be easily inserted. If bending occurs, consider cutting off the damaged bars before the stressing bars are inserted. For stressing bars, use full support across the bottom of the panels so that individual laminations do not move relative to one another.

---

**Table 3: Table of Material Quantities**

<table>
<thead>
<tr>
<th>Item</th>
<th>Mark/Size</th>
<th>Bridge Length (ft)</th>
<th>10</th>
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<th>14</th>
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<th>18</th>
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<tr>
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<td>See Note 1</td>
<td>MI: 4</td>
<td>MI: 4</td>
<td>MI: 4</td>
<td>MI: 3</td>
<td>MI: 2</td>
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<td>MI: 4</td>
<td>MI: 4</td>
<td>MI: 4</td>
<td>MI: 4</td>
<td>MI: 4</td>
<td>MI: 4</td>
<td></td>
</tr>
<tr>
<td>Endure deck laminations</td>
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<td>MI: 2</td>
<td>MI: 2</td>
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<tr>
<td>Stressing bars</td>
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<td>6</td>
<td>7</td>
<td>7</td>
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<tr>
<td>Stressing bars nuts</td>
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<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>18</td>
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<tr>
<td>For bearing pins</td>
<td>MI: 8 through MI: 11</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>18</td>
<td>20</td>
<td></td>
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<tr>
<td>For anchor bolts</td>
<td>MI: 12</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
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<tr>
<td>Wearing Surface</td>
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<td>Rec豪华 strip</td>
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<td>Cap molding</td>
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**Figure 1: Tensioning Equipment and Configuration**

The bridge superstructures depicted on these drawings were developed under a cooperative research agreement between the USDA Forest Service, Forest Products Laboratory, the University of Alabama and the Southern Pine Forest Products Association.

**Standard Plans for Southern Pine Bridges**

<table>
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</table>
1. The capacity of the jack must be sufficient to provide the design tension force.
2. The pump may be hand operated or electric. Hand operated pumps are less expensive but slower than electric pumps. Electric pumps also require an on-site power source.
3. The size of the hydraulic gauge attached to the pump may be calibrated in Bé or psi. It is generally easier to work in psi. If the gauge is calibrated in Bé, a table which converts Bé to psi values to the jack force must be provided.
4. The steering of the hydraulic jack is normally hydraulically controlled. An example is a tapered welded steel steering joint for the bridge in the stress plate shown in Figure 2. It is important that the base of the joint be large enough to fit over the bar anchor plate, but remain on the bearing plate. The joint must not rest directly on the bearing plate. The height of the joint should be 0.13-inches times the length of the bar plus twice the thickness of the bearing plate.
5. The backplate is generally the same size as the bar anchor plate.

---

**Figure 3 - Typical Coupler and Extension Bar Assembly**

6. Several backplates should be kept on hand during bar stressing. After expected tonnaging, the backplates may be used to bind and should be replaced.
7. To tension the bars properly, there must be sufficient bar length beyond the nut on which to place the tonnaging equipment. It is generally beneficial to select a bridge stop and plate grip on criterion on that edge. On the opposite edge, the bar should extend approximately 1-in. beyond the nut. If there is insufficient bar length for the tonnaging equipment, make temporary coupler and bar extension may be used (Figure 3). If this is done, it is critical that each bar be threaded fully into both the coupler length. Failure to do so may result in unstable tonnaging. It is also important to verify that the holes in the hydraulic jack and stressing bar are large enough for the coupler to pass through.

8. Tighten the bar nut against the bridge anchor plate. As with normal procedures, the hydraulic pump will drop slightly. On occasion, the nut may bind slightly, causing the jack to be loose. It is important to tighten the nut sufficiently to ensure that a bar is tightly against the anchor plate.
9. Release the pump hydraulic pressure slowly and remove the tonnaging equipment. If the backplate binds, it is gently along the bar axis to loosen the strain.

---

**Tensioning Sequence**

10. For a stress-laminated bridge to function properly, all bars must be tensioned uniformly to the design force. As the bars are tensioned, the laminations compress and the bridge deck widens. When using a single hydraulic jack, tensioning one bar compresses the laminations and causes the force in adjacent bars to decrease. This effect is more pronounced when the bridge is initially tensioned and decreases as the force in all bars becomes more uniform. To compensate for this effect, bars must be sequentially tensioned several times to ensure that the bar force is generally accomplished by tensioning the first bar on one end of the bridge and sequentially tensioning each successive bar on the other end of the bridge and sequentially tensioning each successive bar until the total tension is reached.

11. As described in Note 32, Sheet 2, the tensioning must be completed three times during the construction process:

   1. At the time of bridge erection
   2. Approximately 1 week after the first tonnaging
   3. 5-6 weeks after the second tonnaging

When initially tensioning bars with a single jack, it is important that the tension be applied gradually to prevent distortion along the bridge width. If bars are already tensioned to the full design level, the bridge edges may become distorted. For best results, the following procedure is recommended for the first tonnaging:

1. Start at one end of the bridge, sequentially tension each bar to approximately 26% of the design level. During this process, a stringing may be used to ensure that the edges of the bridge remain straight.
2. Follow the same procedure. Intensive tension each bar to approximately 50% of the design level. Again, the bar force may be varied slightly to ensure that bridge edges remain straight.
3. Start at the other edge and sequentially tension each bar to the full design level. Again, the bar force may be varied slightly to ensure that bridge edges remain straight.
4. Return to the first bar, and repeat step 3.
5. Check the force in each bar using the procedure described below. Each time the force is decreased, the bars are readjusted to the new force level.

---

**Checking Bar Force**

The force in tensioning bars can be checked quickly with the use of equipment. The pump operates in parallel with the bar force, and the gauge method is applicable only to hand-operated hydraulic jacks.

**Bar Tonnage Method**

To determine the bar force using the pump tonnaging method, a vernier is placed on the pump bar adjacent to the jack frame and is slowly applied to the hydraulic jack. During the application of the tonnaging force, the wrench is shifted in the direction to loosen the nut. The gauge reading at the point where the nut first begins to turn can be compared to the approximate target force. In some cases, the nut may bind slightly on the bar and may not turn when the bar force is applied. In these cases, the pump pressure on the bar is pulled away from the bar force. It is essential to turn the nut slightly in both directions to loosen the binding. After turning the nut, be sure to return it to the original position prior to releasing the jack force. Without this accomplishment, the procedure to check the bar force can be completed using the following procedure:

**Gauge Method**

When the hydraulic jack applies tension to the bar, the gauge needle moves instantly quickly as the load is initially applied. As the force increases, and the full bar becomes tensioned, the needle movement is slower. When the bar force is overcome and the jack begins to apply force to the entire bar, there is a slight pause in the gauge needle rise. This occurs approximately at the point where the force in the jack equals the force on the bar. To check bar force using this method, slowly pump the hydraulic jack until the movement of the gauge needle. When the jack is fully pumped, and the needle drops reasonably, note the gauge reading. This reading represents the approximate bar force. At this time, the needle will also become slightly more difficult to pump the jack. Using this method requires a "feel" for the release point and should be practiced prior to determining the bar force.

---

**Tensioning Considerations**

As the bars are tensioned, the laminations compress, and the bridge width will narrow slightly. It is important that the bars are initially tensioned with some restraint. It is therefore advisable to check the structure and adjust the bars as needed to ensure that the bridge edges remain straight.
Design Guidelines for Stress-Laminated Bridge Decks Constructed with Visually Graded No. 2 Southern Pine Dimension lumber

**Background**
The concept of stress-laminated wood bridges is relatively new in the United States. Although bridges of this type have been built in Canada since 1980, they were not introduced in the U.S. until the late 1980s. In April 1991, the American Association of State Highway and Transportation Officials (AASHTO) published Guide Specifications for the Design of Stress Laminated Wood Bridges (AASHTO 1991). As a guide specification, the publication represents the recommendations of AASHTO and is not a commentary and revision prior to adoption in the AASHTO Standard Specifications for Highway Bridges. It is anticipated that design provisions for stress-laminated wood bridges will be included in the AASHTO within the next several years.

The design criteria for stress-laminated Southern Pine bridge superstructures presented in the preceding sections are based on design recommendations presented in the following references:


In general, the criteria follow the recommendations of the AASHTO Guide Specifications for the Design of Stress-Laminated Wood. However, minor modifications have been made to improve the design process or simplify the design process.

**Design Procedures**
The following procedures are used for stress-laminated decks constructed of No. 2 visually graded Southern Pine lumber. The lumber is dressed (US4) with a nominal thickness of 2 in. (5.1 cm) and actual widths of 8, 10, and 12 in. (20.3, 25.4, and 30.5 cm, respectively). Design references are included to AASHTO specifications with the notation "AASHTO" signifying the Standard Specifications for Highway Bridges and "AASHTO GS" signifying the Guide Specifications for the Design of Stress Laminated Wood Decks. Calculations and summary tables are included to illustrate the design methodology and values used for the plans. Numbers noted in the calculations and summary tables are rounded for the final solution, but generally were not rounded for intermediate steps. For additional design information, refer to the above references.

1. **Define deck geometry and design load.**
   - **Deck Geometry.**
     - **Definitions and options for deck geometry are as follows:**
       - **Width:** Bridge width is the total deck width measured cut-to-cut. The plans include options for single-lane bridge widths of 12 to 18 ft and double-lane bridge widths of 22 to 38 ft.
       - **Length:** Bridge length is the total deck length, measured end-to-end. The plans include bridge length options of 10 to 20 Mft in 2 Mft increments. These increments correspond to standard lumber lengths.

2. **Select a species and grade of lumber and compute allowable design values.**
   - All designs are based on nominal 2 in. thick Southern Pine dimension lumber, visually graded No. 2. The following tabulated design values are obtained from AASHTO Table 13.5.1.4.

3. **Choose a deck thickness and compute the distribution width and effective deck section properties.**
   - The design of stress-laminated decks is based on beam theory and assumes that one wheel line of the design vehicle is supported by a strip of deck width, measured normal to the bridge span, defined as the wheel load distribution width (AASHTO GS 3.25.5.2). The distribution width is a function of the deck thickness and the design vehicle maximum wheel load. Thus, a deck thickness is required for initial distribution width calculations. This estimated thickness may be revised later in the design process if it is found to be insufficient or too conservative.

4. **Compute the deck dead load, dead load moment, and live load moment.**
   - **Compute the dead load of the deck, including wearing surface, in pounds per square foot (psf) using unit weights of 50 lbs/ft³ for wood, 160 lbs/ft³ for asphalt concrete, and 450 lbs/ft³ for steel (AASHTO GS 3.3.6). The dead load of the bridge rail and stressing hardware is normally assumed to be equally distributed across the deck width.**

5. **Select a species and grade of lumber and compute allowable design values.**
   - Where: E = allowable modulus of elasticity (lbs/in²);
     - E = tabulated modulus of elasticity (lbs/in²);
     - Cw = wet service factor = 0.90 (AASHTO 13.5.4.1);
     - For 8, 10, and 12 in. nominal lumber:
       - E = 11,600,000 lbs/in²; Cw = 0.80 (AASHTO 13.5.4.4).

The distribution width is computed by the following equations:

\[ b_{d} = 0.025S \]

where:
- b = wheel load tire width (in.); S = maximum load width (in.); D = wheel load distribution width (in.);

- D = wheel load distribution width (in.); S = maximum load width (in.).

A summary of deck section properties is given in Table 3.

---

### Table 1 - Tabulated Values for No. 2 Southern Pine Dimension Lumber

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<th>Nominal Lumber Width (in.)</th>
<th>Tabulated Design Values (lbs/in²)</th>
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<td>Bending, Fb</td>
</tr>
<tr>
<td>8</td>
<td>2,000</td>
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<tr>
<td>10</td>
<td>1,050</td>
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<td>12</td>
<td>575</td>
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Allowable design values are based on wet service conditions and are computed in accordance with the following equations for bending, modulus of elasticity, and compression perpendicular to grain:

\[ R_b = F_{b} / C_{b} \]  
\[ E = C_{W} E \]  

---

### Table 2 - Estimated Deck Thickness

<table>
<thead>
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<th>Bridge Length (ft)</th>
<th>Bridge Span (in.)</th>
<th>Designated Deck Thickness (in.)</th>
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<tr>
<td>12</td>
<td>8</td>
<td>10.17</td>
</tr>
<tr>
<td>10</td>
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<td>10.17</td>
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<td>8</td>
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<td>10.17</td>
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<tr>
<td>10</td>
<td>24</td>
<td>10.17</td>
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Calculations for distribution width and section properties, as well as subsequent calculations for stresses and deflection, are based on the actual lumber size rather than the nominal size. For nominal 8, 10, and 12 in. lumber, the actual dimensions are 7.25, 9.25, and 11.25 in., respectively (AASHTO Table 13.2.1.4).

### Table 3 - Deck Section Properties

<table>
<thead>
<tr>
<th>Nominal Lumber Width (in.)</th>
<th>Actual Width (in.)</th>
<th>D1 (in.)</th>
<th>S (in.)</th>
<th>D2 (in.)</th>
<th>T (in.)</th>
<th>I (in.)</th>
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<td>7.26</td>
<td>3.65</td>
<td>1.61</td>
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<td>1.61</td>
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<tr>
<td>10</td>
<td>9.26</td>
<td>3.65</td>
<td>1.61</td>
<td>5.26</td>
<td>2.28</td>
<td>1.61</td>
</tr>
<tr>
<td>12</td>
<td>11.25</td>
<td>4.25</td>
<td>1.65</td>
<td>5.90</td>
<td>2.36</td>
<td>1.65</td>
</tr>
</tbody>
</table>

---

### Standard Plans for Southern Pine Bridges

**Design Procedure**

August 1995
Sheet 8 of 9

The bridge superstructures depicted on these drawings were developed under a cooperative research agreement between the USDA Forest Service, Forest Products Laboratory, the University of Alabama and the Southern Forest Products Association.
The maximum dead load moment for a simple span deck with a uniformly distributed load is computed by the following equation:

\[ M_{dmax} = \frac{DL \cdot L^3}{12} \]  

where:
- \( M_{dmax} \) = maximum dead load moment (ft-lb)
- \( L \) = bridge span measured center to center of bearings (ft)

A summary of dead load values is given in Table 4.

### Table 4 - Dead Load Summary

<table>
<thead>
<tr>
<th>Length</th>
<th>L (ft)</th>
<th>Acutal (in.)</th>
<th>DL (lb/ft)</th>
<th>HS 20-44</th>
<th>HS 25-44</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>9.7</td>
<td>7.28</td>
<td>98</td>
<td>290.9</td>
<td>2,956.5</td>
</tr>
<tr>
<td>10</td>
<td>9.7</td>
<td>9.25</td>
<td>106.4</td>
<td>357.5</td>
<td>3,752.5</td>
</tr>
<tr>
<td>11</td>
<td>11.7</td>
<td>9.25</td>
<td>106.4</td>
<td>357.5</td>
<td>3,752.5</td>
</tr>
<tr>
<td>13</td>
<td>13.7</td>
<td>9.25</td>
<td>106.4</td>
<td>357.5</td>
<td>3,752.5</td>
</tr>
<tr>
<td>15</td>
<td>15.7</td>
<td>9.25</td>
<td>106.4</td>
<td>357.5</td>
<td>3,752.5</td>
</tr>
<tr>
<td>20</td>
<td>19.7</td>
<td>11.25</td>
<td>116.4</td>
<td>457.5</td>
<td>4,952.5</td>
</tr>
</tbody>
</table>

Based on 30 kips/ft for rail and serving structures.

The maximum live load moment, \( M_{lmax} \), for one rail of the design vehicle on a simple span deck is computed using the formula or by obtaining the maximum value from dead load tables. Values used for preparation of the plans are shown in Table 5.

### Table 5 - Maximum Live Load Moment

<table>
<thead>
<tr>
<th>Length</th>
<th>L (ft)</th>
<th>Live load moment per rail (lb-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>9.7</td>
<td>36.7</td>
</tr>
<tr>
<td>10</td>
<td>9.7</td>
<td>85.7</td>
</tr>
<tr>
<td>10</td>
<td>9.7</td>
<td>114.7</td>
</tr>
<tr>
<td>14</td>
<td>13.7</td>
<td>72.7</td>
</tr>
<tr>
<td>15</td>
<td>15.7</td>
<td>66.7</td>
</tr>
<tr>
<td>20</td>
<td>19.7</td>
<td>76.7</td>
</tr>
</tbody>
</table>

6. Compute maximum dead load bending stress.

The maximum applied bending stress is computed by the following equation:

\[ \sigma_d = \frac{M_{dmax} \cdot I_{dmax}}{L \cdot (L^2 - L_{d,min})} \]  

The applied bending stress must not exceed the allowable bending stress. If \( \sigma_d \), the deck is sufficient in bending. If \( \sigma_d \) is substantially less than \( \sigma_d \), a thinner deck may be economically more advantageous. There are no changes in deck thickness that should be made until after load model deflection is checked. If \( \sigma_d \) is too high, the deck is insufficient in bending and the deck thickness must be increased.

A summary of bending stresses is given in Table 6.

### Table 6 - Bending Stresses

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>L (ft)</th>
<th>Actual (in.)</th>
<th>DC (lb/ft)</th>
<th>HS 20-44</th>
<th>HS 25-44</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>9.7</td>
<td>7.28</td>
<td>98</td>
<td>290.9</td>
<td>2,956.5</td>
</tr>
<tr>
<td>10</td>
<td>9.7</td>
<td>9.25</td>
<td>106.4</td>
<td>357.5</td>
<td>3,752.5</td>
</tr>
<tr>
<td>11</td>
<td>11.7</td>
<td>9.25</td>
<td>106.4</td>
<td>357.5</td>
<td>3,752.5</td>
</tr>
<tr>
<td>13</td>
<td>13.7</td>
<td>9.25</td>
<td>106.4</td>
<td>357.5</td>
<td>3,752.5</td>
</tr>
<tr>
<td>15</td>
<td>15.7</td>
<td>9.25</td>
<td>106.4</td>
<td>357.5</td>
<td>3,752.5</td>
</tr>
</tbody>
</table>

7. Determine the required prestress level.

The level of compressive prestress between the limitations must be sufficient to offset flexural stresses caused by transverse bending and vertical slip caused by transverse shear. Different methods for determining the prestress limit are given in several publications (AASHTO 1981; Ritter 1966). For this design, an initial prestress of 100 kips/ft was selected because it has been widely used and has provided good performance for Southern Pine decks.

8. Determine the size and spacing of the prestressing bars and the required prestressing force.

The size and spacing of prestressing bars must satisfy the equations of (AASHTO GS 13.11.2.3):

\[ A_p \leq \frac{2 \cdot f_{p,u} \cdot f_{p,c}}{f_{p,b} \cdot f_{p,c}} \]  

where:
- \( A_p \) = cross-sectional area of the prestressing bar in sq in.
- \( f_{p,b} \) = prestressing bar strength (ksi)
- \( f_{p,c} \) = allowable tensile stress for the prestressing bar in ksi
- \( f_{p,u} \) = prestressing force in kips

The required prestressing force, \( f_{p,b} \), is computed by the following formula:

\[ f_{p,b} = \frac{P}{A_p} \]  

for all spans and deck thicknesses. 5/8 in. to 2 in. diameter ASTM A722 bars are selected with a 24 in. center-to-center spacing. A summary of prestressing bar information is given in Table 7.

### Table 7 - Prestressing Bar Summary

<table>
<thead>
<tr>
<th>Normal t (in.)</th>
<th>Actual t (in.)</th>
<th>A_p (sq in.)</th>
<th>f_{p,c} (ksi)</th>
<th>A_p (sq in.)</th>
<th>f_{p,c} (ksi)</th>
<th>f_{p,b} (kips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>9.7</td>
<td>9.7</td>
<td>0.28</td>
<td>36.7</td>
<td>45.850</td>
<td>61.0</td>
</tr>
<tr>
<td>10</td>
<td>9.7</td>
<td>10.7</td>
<td>0.28</td>
<td>36.7</td>
<td>45.850</td>
<td>61.0</td>
</tr>
<tr>
<td>12</td>
<td>11.7</td>
<td>11.7</td>
<td>0.28</td>
<td>36.7</td>
<td>45.850</td>
<td>61.0</td>
</tr>
<tr>
<td>14</td>
<td>13.7</td>
<td>13.7</td>
<td>0.28</td>
<td>36.7</td>
<td>45.850</td>
<td>61.0</td>
</tr>
</tbody>
</table>

The minimum area of the steel bearing plate in square inches, A_p, is given by Equation 12 (AASHTO GS 13.11.2.4). Minimum bearing plate thickness is computed by Equation 13 (AASHTO GS 13.11.2.4):

\[ A_p = \frac{P}{f_{p,b}} \]  

where:
- \( A_p \) = bearing plate thickness in in.

The value of \( A_p \) computed by Equation 15 must be less than \( f_{p,b} \), which is 0.379 in. Bearing information is presented in Table 10.

### Table 10 - Bearing Summary

<table>
<thead>
<tr>
<th>Bearing</th>
<th>Normal t (in.)</th>
<th>Actual t (in.)</th>
<th>A_p (sq in.)</th>
<th>f_{p,c} (ksi)</th>
<th>A_p (sq in.)</th>
<th>f_{p,c} (ksi)</th>
<th>f_{p,b} (kips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>9.7</td>
<td>9.7</td>
<td>0.28</td>
<td>36.7</td>
<td>45.850</td>
<td>61.0</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>9.7</td>
<td>10.7</td>
<td>0.28</td>
<td>36.7</td>
<td>45.850</td>
<td>61.0</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>11.7</td>
<td>11.7</td>
<td>0.28</td>
<td>36.7</td>
<td>45.850</td>
<td>61.0</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>13.7</td>
<td>13.7</td>
<td>0.28</td>
<td>36.7</td>
<td>45.850</td>
<td>61.0</td>
<td></td>
</tr>
</tbody>
</table>

The bridge superstructures depicted on these drawings were developed under a cooperative research agreement between the USDA Forest Service, Forest Products Laboratory, the University of Alabama, and the Southern Forest Products Association.
Stress-Laminated Glued Laminated Timber Bridge Decks
A Curb Option Configuration and Scupper Spacing

B Suggested Deck/Substructure Attachment

C Wearing Surface

D Anchorage Configuration

E Drip Strip

F Standard Plans for Southern Pine Bridges

The bridge superstructures depicted on these drawings were developed under a cooperative research agreement between the USDA Forest Service, Forest Products Laboratory, the University of Alabama and the Southern Forest Products Association.

August 1995

Sheet 3 of 11
Rail Option Configuration and Scupper Spacing

26' Length

22' Length

24' Length

30' Length

36' Length

Scupper topsheet for bridge ends for bridge lengths of 26, 24, 28 and 32 ft are Mark 14. See fabrication details, Sheet 6.

Gusset rolls are full length. Refer to fabrication details, Sheet 5.

Handrails eliminated for clarity.

Sidewalk curbs may be continuous when larger number of sufficient length is available or when gusset historic curbs are used.

Refer to rail fabrication details, Sheet 5 and 6.

Roll Detail

See view

3/4 in. # x 16 in. olive splice at 1 1/2 in. lag screw at 1/2

Deck S

Ftred field boring

6 x 12 in. gussets

6 x 8 in. post

Spacer blocks, Mark 28

6 x 12 in. cross timber cut

Plate washer, Mark 26

2 x 6 in. lag bolt

4" split rings or back to back shear plates

3/4 in. # x 16 in. olive splice to 3/4 in. # x 16 in. lag screw at 1/2

3/4 in. # x 24 in. lag screw

Curb Splice Detail

Side View

2 1/2 x 6 in. lag screw

2 1/2 x 6 in. lag screw

5/8 in. # bolts

3/4 in. # bolts

1-1/4 in. bolt

This bridge rail was successfully crash tested to the requirements for Performance Level 1 as outlined in the 1996 AASHTO Guide Specifications for Bridge Railings. Refer to "Pins for Crash Tested Bridge Railings for Longitudinal Wood Decks" (Viver and others, in-press) for additional crash tested bridge railings and approaches to railing transitions.
The performance and longevity of any bridge depends on the materials and construction techniques used in its building. It is critical to understand the recommendations for the proper construction of stress-laminated bridges given in these drawings. Below you will find instructions on how to build the bridge properly. For additional information, please refer to the drawing notes and Timber Bridge Design, Construction, Preservation and Maintenance (Wilkens 1993).

**Materials**

- Glulam timbers must be treated with a preservative that meets the requirements of ANSI A19.3 and be properly treated with wood preservatives.
- The glue used must be an adhesive of a moisture content of 10% to 16%.
- The moisture content of the adhesives must be kept at or below 15% to maintain the low moisture content prior to construction.
- The location and size of holes in the laminations for stressing bars should not be more than 10% of the total area.
- Manufacturers or larger pores will reduce the stress in the wood and the stress in the wood.
- The proper mechanical treatment and quality assurance of the components should be maintained.
- Field curing and field moisture content must be minimized. In cases where field fabrication is required, proper field treatment is essential.

**BRIDGE ASSEMBLY**

The stress-laminated bridge decks shown in these plans are typically assembled and installed on the structure. Another option is to assemble the bridge components on the bridge site and place the steel bridge into place with a crane. Guidelines for bridge assembly using both approaches follow. In all cases, the laminations must be placed with the coater up.

**Assembly on the Lumberyard**

When the bridge is assembled on the lumberyard, there are two common approaches for placing the laminations:

1. **Laminates are placed individually.** Using this method, laminates are placed on the structure starting at the deck edge location. All laminates are usually labeled to align correctly. When labels are aligned, stressing bars are inserted and pushed through the holes. Continue to push the bars through the holes as subsequent laminations are added. It is important that the bars be supported on the free end so that they are not allowed to bend excessively. Bending may damage the bar or the girder's normal loading.
2. **Laminates are preassembled into panels.** In this case, panels 2 to 4 wide are assembled by bolting laminations together with metal plate or plate and bolted plates. After bolting the laminations, the panels must be moved to place them at their correct position. The panels are then placed on the structure and the bars are inserted and tensioned. When placing laminas, use full support across the bottom of the panels so that individual laminas do not move relative to one another.

In both cases, the bars are placed in the holes, and the panels are secured together. The bars are tensioned, and the laminas are secured by bolting them together. The panels are then placed on the structure, and the bars are inserted and tensioned. When placing laminas, use full support across the bottom of the panels so that individual laminas do not move relative to one another.

1. **Laboratory.** The bridge structures depicted in these drawings were developed under a cooperative research grant between the USDA Forest Service, Forest Products Laboratory, the University of Alabama and the Southern Forest Products Association.

### Standard Plans for Southern Pine Bridges

**August 1995**

**Stress-Laminated Glulam Timber Decks**

**Materials and Construction Recommendations**

- **Bridge Deck**
  - See Note 3
  - MK-5
  - MK-6
  - MK-7
  - MK-4
  - MK-3
  - MK-2
  - MK-1

- **Stressing bars**
  - See Note 6
  - 10
  - 6
  - 7
  - 8
  - 8

- **Stressing bar spacing**
  - 10
  - 12
  - 14
  - 16
  - 16

- **Steel bars**
  - 8
  - 12
  - 16
  - 14
  - 14

- **Stress Wearing Surface**
  - See Note 8
  - 3 1/2 in.
  - 3 1/2 in.
  - 3 1/2 in.

- **Cable Options**
  - See Note 9
  - 2 in.
  - 2 in.
  - 2 in.

- **Rolling specifications**
  - See Note 10
  - 12
  - 15
  - 16
  - 16
  - 16

- **Miscellaneous**
  - See Note 11
  - 1
  - 2
  - 3
  - 4
  - 5

- **Assembly Adjacent to the Site**

Stress-laminated bridges may be completely assembled adjacent to the site and lifted into place with a crane. To accomplish this, a series of steps is necessary. The stresses on the steel bridge should be distributed as evenly as possible. This is done by designing the stress-laminated bridge so that the stresses are distributed as evenly as possible.

**Equipment and Procedures**

Stress-laminated bridges are assembled with a hydraulic jack that applies tension to the stressing bars by pulling the bars away from the steel bridge. After the tension is applied, the stress is adjusted to the desired pressure and the stressing bars are released. The hydraulic equipment for lifting the steel bridge is described in Figure 11. The following should be considered regarding equipment:

- **Steel bridge** is suspended from a single hydraulic jack, which is the most economical and commonly used, as given below.
- **Laminating deck** is suspended from a single hydraulic jack, which is the most economical and commonly used, as given below.
Figure 2 - Typical Welded Steel Chair
All components A36 steel

Figure 3 - Typical Coupler and Extension Bar Assembly

Not To Scale

The bridge superstructures depicted on these drawings were developed under a cooperative research agreement between the USDA Forest Service, Forest Products Laboratory, the University of Alabama and the Southern Forest Products Association.

Standard Plans for Southern Pine Bridges

Stress-Laminated Glulam Timber Decks
Constructions Recommendations

August 1996
Sheet 8 of 11
Design Guidelines for Stress-Laminated Bridge Decks Constructed with Combination 24F-V3 Southern Pine Glued Laminated Timber

Background
The concept of stress-laminated wood bridges is relatively new in the United States. Although bridges of this type have been built in Canada since 1976, they were not introduced in the U.S. until the late 1980's. In April 1991, the American Association of State Highway and Transportation Officials (AASHTO) published A Guide Specifications for the Design of Stress-Laminated Wood Bridges (AASHTO 1993). As a guide specification, the publication contains the recommendations of AASHTO and is open to comment and revision prior to adoption in the AASHTO Standard Specifications for Highway Bridges. It is anticipated that design provisions for stress-laminated wood bridges will be included in the AASHTO within the next several years.

The design criteria for stress-laminated Southern pine bridge superstructures presented on the preceding sheets are based on design recommendations presented in the following references:


In general, the criteria follow the recommendations of the AASHTO Guide Specifications for the Design of Stress-Laminated Wood Decks. However, minor modifications have been made as needed in order to improve performance and simplify the design process.

Design Procedures
The following procedures are for stress-laminated decks constructed of Combination 24F-V3 southern pine glued laminated timber. The specifications have an actual thickness of 6.34 in. and actual widths of 11, 12.5, 13, 13.34, 15.18, and 18.12 in. Design references in AASHTO specifications are included. The notation "AASHTO" signifies the Guide Specifications for the Design of Stress-Laminated Wood Decks. Calculations and summary tables are included to illustrate the design methodology and values used for the plans. Numbers noted in the calculations and summaries were rounded for the final calculations, but generally were not rounded for intermediate steps. For additional design information, refer to ASCE 7A or references above.

1. Define deck geometry and design live load.

2. Deck Geometry

Definitions and options for deck geometry are as follows:
- Width: Bridge width is the total deck width measured center-to-center.
- Length: Bridge length is the total deck length measured end-to-end.
- Span: Bridge span is the distance measured center-to-center of bearing surfaces. The bridge is based on a uniform bearing length at each bridge end of 10 in. Thus, the bridge span is 10 in. less than the bridge length. A longer bearing length meets a slightly conservative design.

Design Live Load

Plan includes an option for either AASHTO HS 20-44 or HS 25-44 vehicle load.

3. Estimate dead load.

The dead load is comprised of the following:
- Live load (AASHTO 3.7.3)
- Dead load, including the weight of the deck and bearings, is normally assigned to be uniformly distributed across the entire deck width.

4. Compute the live load dead load.

The maximum dead load moment for a single span deck with a uniformly distributed load is computed by the following equation:

\[ M_{d} = \frac{W_{d}}{8} \]

where:
- \( W_{d} \) = total dead load acting along the distribution width (kN); \( L \) = bridge span measured center-to-center of bearings (m).

A summary of dead load values is given in Table 4.

Design Load

The following table defines the dead load acting across the distribution width of live load acting on the bridge:

<table>
<thead>
<tr>
<th>Bridge Length</th>
<th>Dead Load (kN)</th>
<th>HS 20-44</th>
<th>HS 25-44</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>172.2</td>
<td>333.7</td>
<td>485.2</td>
</tr>
<tr>
<td>23.17</td>
<td>217.1</td>
<td>399.6</td>
<td>556.7</td>
</tr>
<tr>
<td>26</td>
<td>262.8</td>
<td>464.3</td>
<td>643.3</td>
</tr>
<tr>
<td>29.17</td>
<td>312.2</td>
<td>556.7</td>
<td>764.0</td>
</tr>
</tbody>
</table>

Table 3: Deck Section Properties

<table>
<thead>
<tr>
<th>Section</th>
<th>Spacing (m)</th>
<th>A (mm²)</th>
<th>D (mm)</th>
<th>E (GPa)</th>
<th>F₀ (kN/m²)</th>
<th>F₁ (kN/m²)</th>
<th>F₂ (kN/m²)</th>
<th>F₃ (kN/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>25</td>
<td>32.6</td>
<td>158.7</td>
<td>43.3</td>
<td>115.3</td>
<td>265.3</td>
<td>450.0</td>
<td>750.0</td>
</tr>
<tr>
<td>20</td>
<td>50</td>
<td>32.6</td>
<td>158.7</td>
<td>43.3</td>
<td>115.3</td>
<td>265.3</td>
<td>450.0</td>
<td>750.0</td>
</tr>
</tbody>
</table>

5. Choose a deck thickness and compute the distribution width and effective deck section properties.

The design of stress-laminated timber is based on beam theory and assumes the entire width of the design vehicle is supported by a strip of deck width, measured normal to the bridge span. For the specified load distribution (AASHTO Q 25.6.2), the distribution width is a function of the deck thickness and the design vehicle's maximum wheel load. Thus, a deck thickness must be estimated for initial distribution width calculations. The estimated thickness may be revised later in the design process if it is found to be insufficient or too conservative.

Values shown in Table 2 are used to estimate deck thickness for 24F-V3 Southern Pine Glulam. Options are given for loading and deflection limits of L5800 and L6500. Note that in most cases, the same deck thickness is required for both the L5800 and L6500 deflection limits.

6. Estimate Deck Thickness

The distribution width is computed by the following equation:

\[ D = \frac{b_{2}}{b_{1}} \]

where:
- \( b_{1} \) = wheel load live load width (in) (AASHTO 3.3.3); \( P \) = maximum wheel load (lb) (AASHTO 3.7.3); \( 0.050 \times 0.04 \) = for HS 20-44 vehicle; 0.056 = for HS 25-44 vehicle
- \( b_{2} \) = actual deck thickness (in) (AASHTO G 3.25.5.3)
- \( t \) = actual deck thickness (in)

Subsection modulus and moment of inertia are computed for a beam with a depth and width such that:

\[ \frac{I}{t} = \frac{D^{2}}{C_{2}} \]

where:
- \( I \) = section modulus (in⁴); \( C_{2} \) = moment of inertia (in⁴)

A summary of deck section properties is given in Table 3.
Table 5 - Maximum Live Load Moment

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>L (ft)</th>
<th>Load Distribution per Wheel (in. lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>1.87</td>
<td>56,790</td>
</tr>
<tr>
<td>20</td>
<td>1.87</td>
<td>58,470</td>
</tr>
<tr>
<td>24</td>
<td>1.87</td>
<td>61,580</td>
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<td>26</td>
<td>1.87</td>
<td>64,810</td>
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<tr>
<td>28</td>
<td>1.87</td>
<td>68,370</td>
</tr>
<tr>
<td>30</td>
<td>1.87</td>
<td>72,270</td>
</tr>
<tr>
<td>32</td>
<td>1.87</td>
<td>76,520</td>
</tr>
</tbody>
</table>

6. Check live load deflection.

The maximum live load deflection is computed for one wheel line of the design vehicle. For deflection only, the wheel load distribution width may be increased by a factor of 1.15 (AASHO 53.5.3). Thus, the moment of inertia, I, is determined based on the deflection width and actual deck thickness is multiplied by 1.15. Deflection is computed by either of the following equations:

\[ \Delta_{y} = \frac{6P_0L}{EI} \]  

where:

- \( I \) = moment of inertia in inches
- \( L \) = length of the beam in feet
- \( E \) = modulus of elasticity
- \( P_0 \) = live load in pounds

7. Compute dead load deflection and camber.

For longitudinally stressed laminated girder decks, it is recommended that the bridge be centered to allow sagging caused by creep. The amount of camber depends upon the initial dead load deflection resulting from the uniform dead load acting over the distribution width \( D_0 \). For a simple span deck, the dead load deflection is computed by the following equation (AASHO 03.11.3.1): 

\[ \Delta_{d} = \frac{6P_0L}{EI} \]  

where:

- \( P_0 \) = dead load intensity in pounds per foot
- \( L \) = length of the bridge in feet
- \( E \) = modulus of elasticity
- \( I \) = moment of inertia in inches

A summary of the dead load deflection and minimum camber requirements is given in Table 8.
Table 10 - Pressuring for Anchorage Summary

<table>
<thead>
<tr>
<th>Parameter</th>
<th>11</th>
<th>12-3/8</th>
<th>13-3/4</th>
<th>15-1/2</th>
<th>16-1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing plate size #1</td>
<td>14 x 11</td>
<td>14 1/2 x 12</td>
<td>15 x 13</td>
<td>14 1/2 x 15</td>
<td>14 1/2 x 16</td>
</tr>
<tr>
<td>Anchor plate size #2</td>
<td>6 x 4</td>
<td>6 x 4</td>
<td>6 x 4</td>
<td>6 x 7</td>
<td>6 x 7</td>
</tr>
<tr>
<td>A&lt;sub&gt;b&lt;/sub&gt; min. (in.²)</td>
<td>153.3</td>
<td>172.4</td>
<td>191.6</td>
<td>210.7</td>
<td>229.9</td>
</tr>
<tr>
<td>A&lt;sub&gt;b&lt;/sub&gt; actual (in.²)</td>
<td>184.0</td>
<td>194.0</td>
<td>195.0</td>
<td>217.5</td>
<td>232.0</td>
</tr>
<tr>
<td>L&lt;sub&gt;b&lt;/sub&gt; (in.)</td>
<td>342.8</td>
<td>341.4</td>
<td>339.5</td>
<td>333.8</td>
<td>341.4</td>
</tr>
<tr>
<td>k</td>
<td>4.00</td>
<td>4.25</td>
<td>4.50</td>
<td>4.25</td>
<td>4.50</td>
</tr>
<tr>
<td>t&lt;sub&gt;b&lt;/sub&gt; minimum (in.)</td>
<td>0.91</td>
<td>0.96</td>
<td>1.01</td>
<td>0.95</td>
<td>1.02</td>
</tr>
</tbody>
</table>

*Note: design is based on interior bar spacing and corresponding force.*

11. Determine the support configuration and check bearing stress.

Supports for stress-laminated decks must be designed to resist the vertical and lateral forces transmitted from the superstructure to the substructure. As with other longitudinal wood superstructures, the required bearing length is normally controlled by considerations for bearing configuration, rather than compressive strength, perpendicular to grain. From a practical standpoint, a minimum bearing length of 10 in. is recommended for stress-laminated decks. Bearing attachments are normally made through the deck to the supporting cap or sill, or from the deck underside. Such attachments are illustrated on Sheet 4.

Bearing stress in compression perpendicular to grain is checked for the maximum reaction at the support due to the bridge dead load and one wheel line of the design vehicle. This load is distributed over an area defined by the distribution width, E<sub>d</sub>, and the bearing length, L<sub>b</sub>.

Bearing in compression perpendicular to grain is computed using the following equation:

\[ L_b = \frac{R_d + R_s}{D_G} \]

where:
- \( R_d \) = dead load reaction (lb)  
- \( R_s \) = maximum live load reaction for one wheel line of design vehicle (lb)  
- \( D_G \) = dead bearing length at the support (in.) = 10 in.

The value of \( L_b \), computed by Equation 18 must be less than \( t_{b,max} \). A summary of bearing information is presented in Table 11.

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>L</th>
<th>t (in.)</th>
<th>20-ft live loading</th>
<th>25-ft live loading</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>16-1/2</td>
<td>22.210</td>
<td>25.390</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>15-1/2</td>
<td>22.210</td>
<td>25.390</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>14 1/2</td>
<td>22.210</td>
<td>25.390</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>13-3/4</td>
<td>22.210</td>
<td>25.390</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>12-3/8</td>
<td>22.210</td>
<td>25.390</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>11</td>
<td>22.210</td>
<td>25.390</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>10</td>
<td>22.210</td>
<td>25.390</td>
</tr>
</tbody>
</table>

*Table 11 - Bearing Summary*
Longitudinal Stringer with Transverse Plank Decks
9. The maximum thickness of a plank shall be no greater than 1/2 in. longer than its nominal thickness. The maximum width along the length of a plank shall not exceed 3/8 in.

10. Stingers shall be visually graded No. 1 Dense, No. 2, or better Southern Pine lumber as specified in Table 1, Sheet 2.

11. Stingers are rough sawn (dressed) with a minimum size of 3/8 in. less than nominal dimensions.

12. Variation in depth between stingers shall not exceed 3/8 in. so as to provide a flat surface across the width of the bridge to ensure planks have firm contact with all stingers.

13. Curbs, Snapper Blocks, and Rail Posts

14. Rail posts shall be visually graded No. 2, or better nominal 6 x 6 in. surfaced all sides (454) with a minimum dressed size of 5-1/2 x 5-1/2 in.

15. All raxon lumber shall be treated in accordance with the requirements of AWPA Standard C14 with one of the following preservatives:

a. Creosote conforming to AWPA Standard P1
b. Pentachlorophenol conforming to AWPA Standard P8 in hydrocarbon solvent, Type A, conforming to AWPA Standard P9

16. Treated material shall be free of excess preservative on the wood surface. The treating process for these preservatives shall include an expansion bath, steaming and/or dipping to ensure that preservative will not bleed.

17. Treated wood shall be inspected and certified in accordance with AWPA Standard M2.

Steel Fasteners and Hardware

18. Steel plates and shapes shall comply with the requirements of ASTM A36.


Design Values

1. Allowable design values used to determine the plank sizes given in Table 2, Sheet 2 are those tabulated in the National Design Specification (NDS) Supplement with applicable adjustment factors applied.

2. Allowable design values for 3 x 4-in. thick planks are obtained from the NDS supplement Table 48 with wind service factors applied. The freezing factor is also applied to the NDS tabulated bending values. When the planks are continuous over the full bridge width, a shear stress modification factor of 2 is used to adjust the tabulated shear stress.

3. Allowable design values for 5 x 2-in. thick planks are obtained from the NDS supplement Table 40 without adjustment except, the shear stress is doubled for continuous plank decks.

Calculation of Internal Forces

4. All section properties are determined using the minimum rough green sizes. The span used is as specified in AWASHTO 3:25-1.2.

5. Bending

Maximum moment is calculated as 80% of the maximum simple span moment.

6. Shear

The maximum shear force is calculated assuming a simple span between stingers, neglecting all loads closer than the plank depth from the face of the stringer. The calculation for shear follows the NDS 3.4.3.

7. Deflection

Maximum deflection is calculated as 80% of the maximum simple span deflection. Shear distortions are neglected. The calculated deflection is limited to an absolute deflection limit of 0.01 in. to prevent reflective cracking in the wearing surface. However, plank decks designed by this criteria may experience reflective cracking problems.

Stringer Design

8. Loading

Live load consists of a 12,000 lb wheel load with the load distributed according to AASHTO 3:25.1. Dead load consists of a 2-in. asphalt wearing surface and the minimum rough green plank size. Unit weight of asphalt and timber is taken as 150 lb/ft and 50 lb/ft, respectively.

9. The bridge superstructures depicted on these drawings were developed under a cooperative research agreement between the USDA Forest Service, Forest Products Laboratory, the University of Alabama and the Southern Forest Products Association.