

## Inspection of Timber Bridges in the Pacific West (ID-150)

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### Summary

Thirty timber bridges were inspected in the Pacific West region. Twenty four were sawn timber bridges and six were glulam. For the sawn timber bridges, all of the timber components were pressure treated DF with the exception of one bridge which was not treated and one bridge that was treated with copper naphthenate. For the sawn timber bridges, 21 had multiple girders and the remaining 3 had longitudinal slab decks. The sawn timber bridges ranged in age from 31 years to 78 years and were determined to be meeting performance expectations. The glulam bridge components were all DF and were pressure treated with penta in oil. Four of the glulam bridges were multiple girder bridges with either a timber or concrete deck and the other 2 were longitudinal glulam deck bridges. The glulam bridges have been in service from 21 years to 46 years and were determined to be performing at a good or very good level.

**Key Words:** field inspection, timber bridges, sawn timber, glulam, NBI ratings

### Introduction

The Pacific West region was identified as an integral part of the *Field Performance of Timber Bridges: a National Study* project. The Pacific West region consists of the states of California, Oregon and Washington. According to the NBI, each of these states has an existing inventory of over 550 timber bridges. A study of the NBI was undertaken by the team to determine which counties (two per state) should be included in the study. Variables evaluated included the number of bridges in a county, the type of construction, the age of construction and environmental considerations.

As a result of this evaluation, the following counties were identified for inclusion in the study:

California: Del Norte and Siskiyou counties  
Oregon: Klamath and Washington counties  
Washington: Grays Harbor and Yakima counties

Each of these counties is located in either zone 3 (intermediate) or zone 4 (high) according to the AWP Wood Decay Hazard Map. The team identified possible bridges for inclusion in the

study for each county and then met with county officials to review these choices. Following this and based on input from the counties, the team selected the bridges to be included and provided this information to the management team for approval. The end result is that 30 bridges in total were included for the Pacific West region.

The primary tools used for inspection were a visual assessment of the bridge, hammer sounding of the timber members and the measurement of moisture content. When areas of high moisture content and/or possible decay were identified, a resistance drill was used. All of the timbers were DF. Preservative treatments varied and included creosote, penta in oil and copper naphthenate.

### Grays Harbor, WA

Four bridges were inspected in Grays Harbor County, WA. Grays Harbor is in Western WA and borders the Pacific Ocean with an approximate latitude of 47.0 N and longitude of 123.4 W. It is in the Olympic Mountain range and has a relatively high annual rainfall. The 4 bridges were all multiple girder sawn timber bridges and 3 had nail laminated timber decks while the fourth had a cast in place concrete deck. Details regarding the bridges are summarized in Table 1.

Table 1 Grays Harbor County, WA Bridges

| Bridge ID                      | Superstructure Type                   | Year Built | # spans | Span Lengths, m | ADT  | Width (m)/ # lanes | Wearing surface | NBI Rating |      | Repair comments              |
|--------------------------------|---------------------------------------|------------|---------|-----------------|------|--------------------|-----------------|------------|------|------------------------------|
|                                |                                       |            |         |                 |      |                    |                 | Girders    | Deck |                              |
| Garrard Creek                  | Sawn timber girders and timber deck   | 1970       | 3       | 5.6             | 225  | 7.7/2              | Asphalt         | 7          | 6    | No repairs to superstructure |
| Middle Branch Wildcat Creek #2 | Sawn timber girders and timber deck   | 1951       | 3       | 5.2             | 600  | 7.4/2              | Asphalt         | 6          | 6    | No repairs to superstructure |
| Middle Branch Wildcat Creek #3 | Sawn timber girders and timber deck   | 1951       | 2       | 5.3             | 650  | 6.5/2              | Asphalt         | 7          | 6    | No repairs to superstructure |
| Sylvia Creek                   | Sawn timber girders and concrete deck | 1935       | 3       | 6.8             | 4250 | 16.3/2             | Asphalt         | 7          | 6    | No repairs to superstructure |

The girders were all creosote treated DF. The range in age of these bridges is from 43 years to 78 years and all had an NBI rating of 6 or higher for the girders with 3 having a rating of 7. The three nail laminated decks all had an NBI rating of 6. According to county records, no major repairs had been made to any of the superstructure elements.

The Sylvia Creek Bridge is the oldest bridge inspected in the Pacific West region and is noteworthy in that it was originally constructed to carry 4 lanes of traffic. However, subsequent road construction in the county resulted in it only carrying 2 lanes with an ADT of over 4000 which was the highest for any bridge inspected in the region. This is shown in Figure 1. The bridge is posted for legal loads due to a badly deteriorated concrete guardrail system shown in Figure 2 which is well off of the travel paths and not planned for repair.



Figure 1 Sylvia Creek Approach



Figure 2 Sylvia Creek Guardrail

With 3 spans, the bridge has 60 individual girders and there was no significant decay observed in any of these despite being in service for 78 years. The concrete deck is 6-1/2” in thickness and is generally in good condition. There were some full width lateral cracks that reflect through the asphalt and alligator cracking was typical on the underside of the deck. There were some repaired sections of deck and areas of water staining on girders from deck leakage.

Overall, these 4 bridges had a total of 169 sawn timber girders with no signs of significant decay in any of them. The major types of distress noted in the girders were some areas of high moisture content and minor checking. The major types of distress noted in the nail lam decks were areas of high moisture content, several decayed lams and an instance of fungal body growth. Some decay was also observed in the curbs. There was rutting of the asphalt in the upstream lane of Wildcat Creek #2 with water staining and high moisture content in the deck lams and girder below.

### Yakima County, WA

Seven bridges were inspected in Yakima County, WA. Yakima County is in Southern WA and is on the Eastern edge of the Cascade Mountain Range. It has an average elevation of 1100 ft, and has a relatively low annual rainfall but with a relatively high annual snowfall. It has an approximate latitude of 46.0 N and longitude of 120.5 W. The 7 bridges were all multiple girder sawn timber bridges with transverse sawn timber decks. Details regarding the bridges are summarized in Table 2.

Table 2 Yakima County, WA Bridges

| Bridge ID | Superstructure Type                 | Year Built | # spans | Span Lengths, M | ADT | Width (m) # lanes | Wearing surface           | NBI Rating       |      | Repair comments              |
|-----------|-------------------------------------|------------|---------|-----------------|-----|-------------------|---------------------------|------------------|------|------------------------------|
|           |                                     |            |         |                 |     |                   |                           | Girders          | Deck |                              |
| 508       | Sawn timber girders and timber deck | 1965       | 2       | 5.9             | 10  | 7.4/2             | Chip and seal with gravel | Ext. 5<br>Int. 6 | 5    | No repairs to superstructure |
| 509       | Sawn timber girders and timber deck | 1965       | 1       | 7.1             | 60  | 7.1/2             | Chip and seal with gravel | 7                | 6    | No repairs to superstructure |

|      |                                     |      |    |     |      |       |                           |   |   |  |
|------|-------------------------------------|------|----|-----|------|-------|---------------------------|---|---|--|
| 521  | Sawn timber girders and timber deck | 1959 | 3  | 5.6 | 30   | 7.1/2 | Chip and seal with gravel | 7 | 6 | No repairs to superstructure           |
| 724  | Sawn timber girders and timber deck | 1959 | 1  | 6.8 | 105  | 7.1/2 | Chip and seal with gravel | 5 | 4 | No repairs to superstructure           |
| 738  | Sawn timber girders and timber deck | 1938 | 2  | 4.4 | 1605 | 7.7/2 | Asphalt                   | 7 | 6 | No repairs to superstructure           |
| 739* | Sawn timber girders and timber deck | 1939 | 4* | 5.6 | 1605 | 7.7/2 | Asphalt                   | 6 | 6 | One girder repaired with a helper beam |
| 740  | Sawn timber girders and timber deck | 1939 | 2  | 5.9 | 3375 | 7.7/2 | Asphalt                   | 6 | 6 | No repairs to superstructure           |

\* It is noted that the inspection team was not able to hammer sound the girders in the center spans of this bridge but they all appeared to be visually sound with no signs of decay.

The girders on 6 of the bridges were creosote treated DF. Bridge 724 is an anomaly since it is the only bridge inspected in the Pacific West region that used untreated DF girders and deck. Four of the bridges were on low volume roads with gravel surfaces over a very thin (less than 25 mm) asphalt layer which was the remnant of previous chip and seal applications. The other 3 had asphalt wearing surfaces and were on relatively high volume farm to market roads with ADTs of over 1600. The range in age of these bridges is from 48 years to 74 years. The NBI ratings for the girders ranged from 5 to 7 and the ratings for the decks ranged from 4 to 6. According to county records, no major repairs had been made except for the addition of a helper beam for bridge 739.

Since bridge 724 used untreated DF and has been in service for 54 years, it had relatively low NBI ratings as would be expected. The deck had numerous wide gaps (severe delamination) allowing moisture to readily penetrate to the girders below as shown in Figure 3. The result was high moisture content and moderate decay in several of the girders. Figure 4 shows significant checking in an untreated exterior girder.



Figure 3 Deck cracks in bridge 724



Figure 4 Untreated girder in bridge 724

For the remaining 3 bridges with the old chip and seal surface, the NBI ratings for the decks was primarily influenced by separation of the deck lams and relatively high moisture contents as would be expected for this type of surface. The deck on bridges 508 and 509 also had decay in

the laminations near the bridge ends. The girders for these bridges were in relatively good condition with the exception of some areas of decay in the upper 6” of the exterior girders in bridge 508.

For the three bridges with the asphalt wearing surface, there were no signs of decay in the girders but shear cracks appeared to be developing in several girders in bridges 739 and 740 leading to a lower NBI rating. The asphalt wearing surface on all 3 bridges is badly cracked.

### Washington County, OR

Seven bridges were inspected in Washington County, OR. Washington County is in Northwestern OR and is in the Willamette Valley. It is about 60 miles east of the Pacific Ocean and has a relatively high annual rainfall with over 160 days of precipitation annually. It has an approximate latitude of 45.3 N and longitude of 122.5 W. Five of the 7 bridges were multiple girder sawn timber bridges with transverse sawn timber decks. The remaining two bridges were longitudinal glulam deck systems. Details regarding the bridges are summarized in Table 3.

Table 3 Washington County, OR Bridges

| Bridge ID | Superstructure Type                 | Year Built | # spans | Span Lengths, M | ADT  | Width (m) # lanes | Wearing surface | NBI Rating       |      | Repair comments  |
|-----------|-------------------------------------|------------|---------|-----------------|------|-------------------|-----------------|------------------|------|--|
|           |                                     |            |         |                 |      |                   |                 | Girders          | Deck |  |
| 1228      | Sawn timber girders and timber deck | 1975       | 3       | 5.3             | 1010 | 5.9/2             | Asphalt         | 6                | 7    | No repairs to superstructure                               |
| 1232      | Sawn timber girders and timber deck | 1959       | 4       | 4.7             | 280  | 5.9/2             | Asphalt         | 6                | 6    | One outside girder replaced / several deck boards replaced |
| 1293      | Sawn timber girders and timber deck | 1960       | 2       | 4.7             | 55   | 6.5/2             | Asphalt         | 6                | 6    | One outside girder replaced                                |
| 1298      | Sawn timber girders and timber deck | 1960       | 3       | 4.7             | 1130 | 5.9/2             | Asphalt         | 7                | 7    | One outside girder replaced                                |
| 1302      | Sawn timber girders and timber deck | 1960       | 5       | 4.7             | 1130 | 5.9/2             | Asphalt         | Ext. 4<br>Int. 6 | 6    | No repairs to superstructure                               |
| 1358      | Longitudinal glulam deck            | 1992       | 3       | 7.4             | 1520 | 7.7/2             | Asphalt         |                  | 8    | No repairs to superstructure                               |
| 1360      | Longitudinal glulam deck            | 1992       | 1       | 7.4             | 390  | 8.3/2             | Asphalt         |                  | 8    | No repairs to superstructure                               |

The timbers on the 5 multiple girder bridges were all creosote treated. These 5 bridges ranged in age from 38 years to 54 years. The decks were all plank deck systems in relatively good condition with NBI ratings of 6 and 7. The girders had NBI ratings from 4 to 7. The low rating of 4 for the exterior girders on bridge 1302 was due to the fact that 2 outside girders are badly decayed and need replacement as shown in Figure 5. Washington County has an excellent maintenance program and has replaced several girders and deck boards during the last decade as noted. With the exception of bridge 1293, which was recently resurfaced, the asphalt surfaces on the other 4 girder bridges have significant cracking and are scheduled for maintenance.

The two longitudinal glulam bridges were treated with penta in oil. While they have only been in service for 21 years, they are in excellent condition with moisture contents at 16% or below as shown in Figure 6. There is some asphalt cracking at the bridge ends and over intermediate piers on bridge 1358. The county is very pleased with the performance of these bridges.



Figure 5 Decay in G14 of bridge 1302



Figure 6 Glulam deck on bridge 1360

### Klamath County, OR

Five bridges were inspected in Klamath County, OR. Klamath County is located in South Central OR and is on the border with California. It is on the Eastern edge of the Cascade Mountain Range and has an average elevation of 4100 ft. It has a relatively low annual rainfall but a relatively high annual snowfall. It has an approximate latitude of 42.0 N and longitude of 121.0 W. Two of the 5 bridges were multiple girder sawn timber bridges with transverse sawn timber decks. The remaining three bridges have longitudinal sawn timber slab decks. Details regarding the bridges are summarized in Table 4.

Table 4 Klamath County, OR Bridges

| Bridge ID    | Superstructure Type                 | Year Built | # spans | Span Lengths, m | ADT | Width (m) # lanes | Wearing surface | NBI Rating |      | Repair comments              |
|--------------|-------------------------------------|------------|---------|-----------------|-----|-------------------|-----------------|------------|------|------------------------------|
|              |                                     |            |         |                 |     |                   |                 | Girders    | Deck |                              |
| Anderson Rd. | Sawn timber girders and timber deck | 1970       | 2       | 5.5             | 70  | 8.3/2             | Asphalt         | 7          | 7    | No repairs to superstructure |
| Hill Rd.     | Longitudinal sawn timber slab deck  | 1965       | 1       | 6.8             | 270 | 8.3/2             | Asphalt         |            | 7    | No repairs to superstructure |
| Homedale Rd. | Longitudinal sawn timber slab deck  | 1963       | 2       | 4.7             | 315 | 8.3/2             | Asphalt         |            | 7    | No repairs to superstructure |

|                 |                                     |      |   |     |     |       |         |   |   |                              |
|-----------------|-------------------------------------|------|---|-----|-----|-------|---------|---|---|------------------------------|
| Old Midland Rd. | Longitudinal sawn timber slab deck  | 1971 | 1 | 7.4 | 375 | 9.5/2 | Asphalt |   | 7 | No repairs to superstructure |
| Summers Lane    | Sawn timber girders and timber deck | 1982 | 1 | 7.4 | 100 | 9.5/2 | Asphalt | 7 | 7 | No repairs to superstructure |

All of these bridges were in good condition with NBI ratings of 7 for the girders and decks. Figure 7 shows the typical condition of the slab deck bridges. The timbers were all creosote treated with the exception of the girders and deck on the Summers Lane Bridge which appeared to be treated with copper naphthenate as indicated by Figure 8. The bridges ranged in age from 31 years to 50 years. The asphalt wearing surfaces were all in relatively good condition with transverse cracks near the bridge ends being typical.



Figure 7 Longitudinal slab deck on Old Midland Rd. bridge



Figure 8 Sawn timber stringers on Summers Lane Bridge

### Del Norte County, CA

Four bridges were inspected in Del Norte County, CA. Del Norte County is located in the extreme NW corner of the state and borders on Oregon and the Pacific Ocean. It is in the Cascade Mountain Range and has a high annual rainfall and a relatively high annual snowfall. It has an approximate latitude of 42.0 N and longitude of 123.7 W. All of the bridges were multiple girder glulam bridges and are located on a Forest Service road with low traffic volumes. One of the bridges has a transverse sawn timber deck with steel running plates and the other 3 have concrete decks. Details regarding the bridges are summarized in Table 5.

Table 5 Del Norte, CA Bridges

| Bridge ID | Superstructure Type            | Year Built | # spans | Span Lengths, m | ADT | Width (m) # lanes | Wearing surface      | NBI Rating |      | Repair comments              |
|-----------|--------------------------------|------------|---------|-----------------|-----|-------------------|----------------------|------------|------|------------------------------|
|           |                                |            |         |                 |     |                   |                      | Girders    | Deck |                              |
| Knopki    | Glulam girders and timber deck | 1967       | 1       | 13.9            | 50  | 4.7/1             | Steel running plates | 7          | 8    | No repairs to superstructure |

|                       |                                  |      |   |              |    |       |          |   |   |                              |
|-----------------------|----------------------------------|------|---|--------------|----|-------|----------|---|---|------------------------------|
| Middle Fork Bridge #2 | Glulam girders and concrete deck | 1973 | 3 | 7.4/23.7/7.4 | 50 | 4.1/1 | Concrete | 7 | 7 | No repairs to superstructure |
| Middle Fork Bridge #1 | Glulam girders and concrete deck | 1972 | 2 | 20.1         | 50 | 4.4/1 | Concrete | 7 | 7 | No repairs to superstructure |
| Griffin Creek         | Glulam girders and concrete deck | 1978 | 2 | 13.0/21.3    | 50 | 5.7/1 | Concrete | 4 | 8 | No repairs to superstructure |

All of these bridges were in good condition with NBI ratings of 7 for the girders and 7 and 8 for the decks with the exception of the Griffin Creek Bridge. The girders for the Griffin Creek Bridge received an NBI rating of 4 due to the downstream 72 ft. span girder having a horizontal shear crack extending approximately 1/3<sup>rd</sup> of the span from the EOB abutment. Figure 9 shows the crack which is visible through the width of the girder and which resulted in a horizontal offset of more than 1 inch at the end. The remaining girders in the bridge were in good condition and would have an NBI rating of 7 similar to the other 3 bridges.

The glulam girders were all treated with penta in oil and the bridges ranged in age from 35 years to 46 years. The concrete decks were in good condition but two of them had some water ponding on them. The Knopki Creek Bridge was the only bridge inspected that had steel running plates as shown in Figure 10. Both the running plates and the transverse timber deck were in good condition after 46 years of in-service use.



Figure 9 Horizontal shear crack in Griffin Creek bridge



Figure 10 Steel running plates and transverse timber deck on Knopki Creek Bridge

### Siskiyou County, CA

Three bridges were inspected in Siskiyou County, CA. Siskiyou is located in the NW part of the state and borders on Oregon and Del Norte County. It is in the Cascade Mountain Range and has a medium annual rainfall and a relatively high annual snowfall. It has an approximate latitude of 41.5 N and longitude of 122.0 W. All of the bridges were multiple girder sawn timber bridges with different deck framing systems. Details regarding the bridges are summarized in Table 6.



Table 6 Siskiyou County, CA bridges

| Bridge ID           | Superstructure Type                 | Year Built | # spans | Span Lengths, m | ADT | Width (m) # lanes | Wearing surface       | NBI Rating       |      | Repair comments              |
|---------------------|-------------------------------------|------------|---------|-----------------|-----|-------------------|-----------------------|------------------|------|------------------------------|
|                     |                                     |            |         |                 |     |                   |                       | Girders          | Deck |                              |
| Red Bridge          | Sawn timber girders and timber deck | 1959       | 2       | 5.3             | 45  | 5.3/1             | Timber running planks | 6                | 6    | No repairs to superstructure |
| Shovel Creek Bridge | Sawn timber girders and timber deck | 1977       | 1       | 8.3             | 40  | 7.4/2             | Timber deck           | Ext. 5<br>Int. 7 | 5    | No repairs to superstructure |
| Fishhook Bridge     | Sawn timber girders and timber deck | 1960       | 1       | 7.4             | 225 | 8.6/2             | Asphalt               | 7                | 7    | No repairs to superstructure |

The bridges in this county ranged in age from 36 years to 54 years. One of the bridges has a transverse sawn timber deck, one has sawn timber stringers with sawn timber running planks and one has transverse sawn timber deck planks. Two of the bridges are on low volume roads and the third, the Fishhook Bridge, carries a relatively high volume of RV traffic as it is on an access road to a popular resort area. This bridge was determined to be in good condition with an NBI rating of 7 for the girders and deck

The Shovel Creek Bridge has sawn timber deck planks as the wearing surface and due to the traffic pattern, significant grooves exist in the two wheel paths as shown by Figure 11. This was the newest bridge inspected in the county and had the lowest NBI rating suggesting that using transverse deck panels functioning as the structural deck and the wearing surface is not conducive to longevity. The Red Bridge which has been in service for 54 years was unique in that it was the only bridge inspected that uses timber running planks as shown in Figure 12. It was considered to be in good condition considering the age of the bridge although one girder had previously been repaired using steel straps.



Figure 11 Wheel path depressions in timber deck on Shovel Creek Bridge

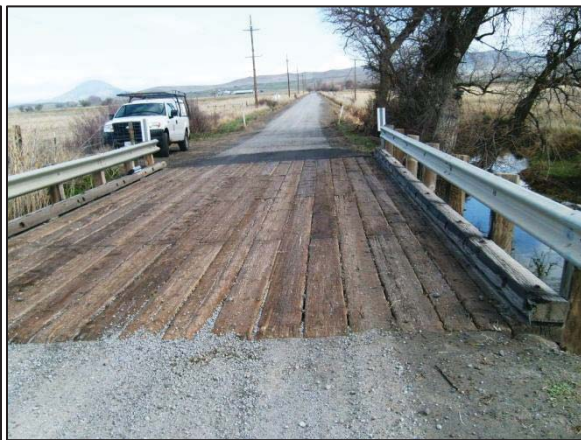


Figure 12 Timber running planks on Red Bridge

## Conclusions

Of the 30 bridges inspected in the Pacific West region, 24 were sawn timber bridges and 6 were glulam. For the sawn timber bridges all of the timber components were pressure treated DF with the exception of one bridge in Yakima County which was not treated and one bridge in Klamath County which had been treated with copper naphthenate. The glulam bridge components were all DF and were pressure treated with penta in oil.

For the sawn timber bridges, 21 had multiple girders and the remaining 3 had longitudinal slab decks. All of the slab deck bridges have been in service for over 40 years and all had an NBI rating of 7 and were considered to be performing well with no noticeable signs of distress or decay. For the multiple girder bridges, 18 had NBI ratings of 6 or 7 for the girders and deck. The remaining 3 had lower ratings due to observed decay in some deck laminations and decay in one or more girders in each bridge. This included the untreated bridge. A total of 742 individual girders were inspected for the 21 multiple girder sawn timber bridges. Of these, only 11 girders or 1.5% had significant decay and needed replacement.

Four of the glulam bridges were multiple girder bridges with either a timber or concrete deck and the other 2 were longitudinal glulam deck bridges. While they have only been in service for 21 years, the longitudinal glulam deck bridges received the highest NBI ratings for the bridges inspected in this region with a rating of 8. The multiple girder glulam bridges have all been in service for over 40 years and received an NBI rating of 7 with the exception of one bridge which received a lower rating due to a horizontal shear failure in one girder. The inspection team could not detect any discernible reason for the shear failure and determined that, in general, the glulam bridges are performing well.

Overall, the inspection team felt the in-service performance of the bridges in the Pacific West met or exceeded expectations.