Inspection of Louisiana Timber Bridges

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Summary

This paper reports the result of a study undertaken to assess the condition of timber bridges in four distinctly different geographic regions in the state of Louisiana. This study was carried out as part of an overall national study spearheaded by the U.S. forest Products Laboratory to investigate the field performance of timber bridges. Louisiana, with the second highest number of timber bridges in the nation spread across the entire state, was an excellent location to assess the performance of these bridges under different environmental conditions. The bridges inspected were representative of the various types of timber bridges in the state and covered different exposure conditions. The inspections were conducted with the assistance of the Louisiana DOTD (Department of Transportation and Development) bridge inspection team. The inspection teams utilized advanced assessment tools such as the resistance micro-drill and acoustic devises to evaluate the condition of the suspect regions of the timber sub- and super-structure elements. The availability of the advanced inspection tools eliminated the bridge inspection teams from having to rely on the traditional tools such as the "pick and hammer" to guess the internal condition of the timber member and significantly improve the ability of the bridge inspectors to assign the proper load rating to existing timber bridges. Detailed results of the inspection conducted on a select group of bridges are presented and the benefits of utilizing the advanced assessment tools are highlighted. Lessons learned from the inspections are presented.

Keywords: Timber bridges, inspection, condition assessment, field performance

1. Introduction

Louisiana has the second largest number of timber bridges in the nation. The 2,068 timber bridges in the state account for 8.5% of all the timber bridges in the country. With nearly half of its timber bridges rated as structurally deficient and another 15% rated as functionally obsolete, the state has the second largest number of deficient timber bridges in the nation. Investigation of the field performance of the timber bridges is of particular interest to the state since the study has the potential to provide insight into construction methods/techniques that can improve the service life and functionality of the timber bridges. The inspection of a selected group of timber bridges in different regions of the state was conducted by the authors with the assistance of a bridge inspection team from the Louisiana Department of Transportation and Development, LaDOTD.

2. Selection of Timber Bridges for Inspection

LaDOTD provided a list of candidate timber bridges located in distinctly different geographic regions of the state. The bridges also represented different timber superstructures used in the state. US Forest Products Laboratory, which was spearheading the national study, made the final selection of the bridges to be investigated from the list of candidate bridges. Eleven bridges located in Districts 02, 08, 61 and 62 shown in Figure 1 were selected for the study. These four districts very effectively represent the different soil and environmental conditions that timber bridges are exposed to in the state.

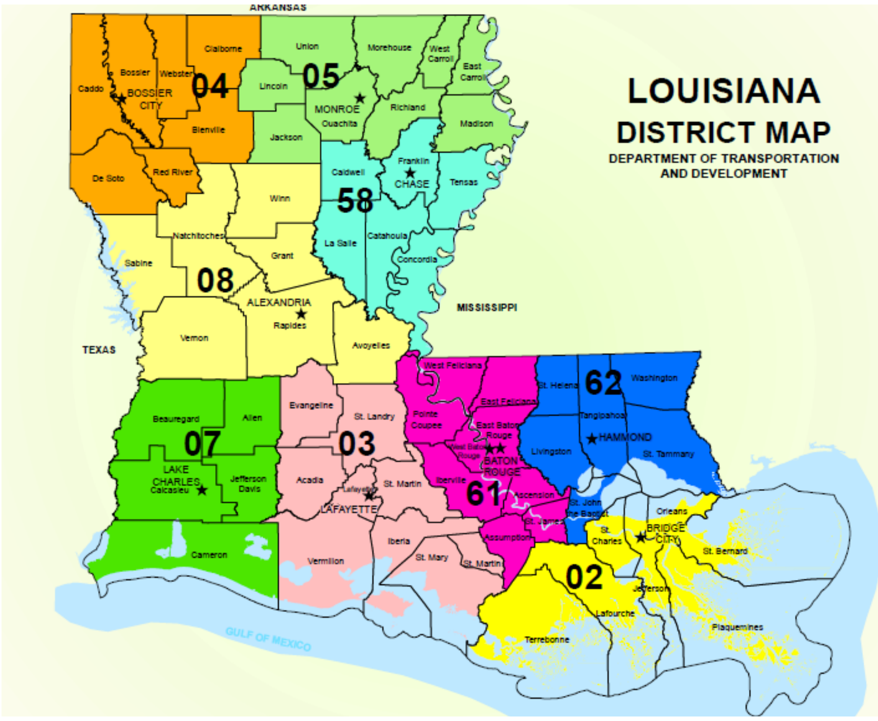

Fig. 1 Louisiana DOTD Districts

Specifically, the bridges inspected were located in LaFourche and Jefferson parishes in District 02, Winn and Natchitoches parishes in District 08, East Baton Rouge parish in District 61, and Tangipahoa parish in District 62. District 02 represents the coastal and marsh region of the state, District 08 represents the mid-section of the state that is outside the Mississippi flood plain, District 61 and 62 represent the low lying areas in the lower Mississippi delta plain. From the Wood Decay Hazard Map shown in Fig. 2 it is evident that all timber bridges in Louisiana fall in the Severe Deterioration Zone.

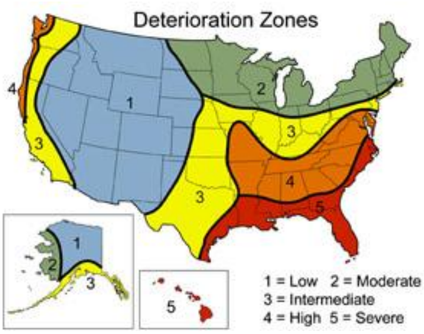

Fig. 2 Wood Decay Hazard Map (American Wood Protection Institute)

3. Bridges Inspected in Various LADOTD Districts

The bridges inspected in the four LaDOTD districts are listed in separate tables in the sequence in which they were inspected within a district. With the exception of the overlay and dimensions, the bridges within a district had similar construction features. The details of the bridges are presented in the tables to facilitate discussion of the bridges.

Table 1 Details of Bridges inspected in District 08

Bridge No.	Decking	Runners / Overlay	Stringers	Piling	Length	Max Span	Num. Spans	Built
08-1	Timber Plank	7" Asphalt	Sawn Lumber	Timber	39	10	4	1967
08-2	Timber Plank	2" Gravel	Sawn Lumber	Timber	170	19	10	1977
08-3	Timber Plank	4" Asphalt	Sawn Lumber	Timber	58	19	3	1941
08-4	Timber Plank	4" Asphalt	Sawn Lumber	Timber	77	19	4	1941

Table 2 - Details of Bridges inspected in District 62

Bridge No.	Decking	Runners / Overlay	Stringers	Piling	Length	Max Span	Num. Spans	Built
62-1	Timber Plank	2" Gravel	Sawn Lumber	Timber	31	15	2	1980
62-2	Timber Plank	5" Gravel	Sawn Lumber	Timber	154	19	8	1960
62-3	Timber Plank	5" Asphalt	Sawn Lumber	Timber	58	19	3	1968

Table 3 - Details of Bridges inspected in District 02

Bridge No.	Decking	Runners / Overlay	Stringers	Piling	Length	Max Span	Num. Spans	Built
02-1	Timber Plank	Runners	Sawn Lumber	Timber	57	15	4	1960
02-2	Timber Plank	Runners	Sawn Lumber	Timber	53	15	4	1980

Table 4 - Details of Bridges inspected in District 61

Bridge No.	Decking	Runners / Overlay	Stringers	Piling	Length	Max Span	Num. Spans	Built
61-2	Concrete	AC Ovrly	Sawn Lumber	Timber	56	19	3	1974
61-1	Concrete	AC Ovrly	Sawn Lumber	Timber	96	20	5	1960

4. Inspection Methods

All the bridges were inspected following a protocol recommended by the US Forest Products Laboratory and a 5-step inspection procedure. The 5-step procedure involved the following:

1. Labeling abutments, piers, girders, etc.
2. Conducting initial visual assessment with hammer sounding
3. Obtaining moisture content measurement in suspect & decay-prone areas
4. Establishing baseline NDE data by collecting stress-wave & resistance micro-drilling data from areas of suspected sound wood;
5. Investigating marked areas to measure the extent of internal deterioration by utilizing stress wave timer and resistance micro-drilling tool as needed.

Hi-resolution digital photographs of the bridge were taken to record the end views, side views, wearing surface, deck underside, and decayed or damaged areas of the bridge. Particular attention was paid to construction details and flaws. The impact of these details and flaws on the bridge durability/service life was noted. Photographs were obtained to record all aspects of these observations. Prior to visiting the bridge site, information about the bridge was collected from the bridge inspection division to facilitate compilation of information about the bridge. If the information did not contain the construction plans/drawings, then sketches were made on site to capture the necessary details of the bridge. The field sketches were converted to scale drawings in the office.

Figures 3 - 6 show a member of the bridge inspection team conducting various inspection tasks utilizing the traditional tools and the NDE equipment to assess the condition of the components of the sub- and super-structure. Figure 7 shows the labeling used to identify areas investigated in the bridge.

Fig. 3 Inspector using hammer to assess condition of pile from sound

Fig. 4 Determing moisture content of wood deck with moisture meter

Fig. 5 Resistance Microdrilling to assess condition of stringer

Fig. 6 Resistance Microdrilling to assess condition of pile suspected of being hollow

Fig. 7 Labeling of girder locations for reference

6. Bridge Examples

In this section the observations made in assessing the conditon of two of the bridges investigated in Louisiana are presented. The two bridges are located in central Louisiana in Winn Parish and LaDOTD District 08.

6.1 Bridge 08-4

This bridge is located on LA 126 and has four spans of 19 ft. each. The superstructure comprising of timber girders and timber deck is supported on a timber pile substructure. The timber deck is topped with asphalt paving. An average driver will not realize that he is crossing a timber bridge because of the asphalt paving. The bridge was built in 1941 and is heavily utilizied by logging trucks plying on the Highway 126. The following figures present various views of the bridge from above and underside.

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Fig. 8 View of Approach to Bridge 08-4

Fig. 9 Side View of Bridge

Fig. 10 Bridge Abutment

Fig. 11 Stringers supporting timber deck

Fig. 12 View of deteriorated wood deck

Fig. 13 View of logging trucks traversing bridge

This timber bridge has been in service for over 70 years and appears to be in very good condition. Though the bridge is load posted for 40T for trucks, it was evident during the inspection that it was carrying significantly higher loads imposed by the logging trucks. The heavy creosote treatment used for the timber members contributed to a longer than expected service life for the structural elements.

6.2 Bridge 08-2

This bridge is located in Kisatchie National Forest on Carter Crossing Road. The bridge spans the Dudgemona River and has ten spans and aan overall length of 177 ft. The superstructure comprising of timber girders and timber deck is supported on a timber pile substructure. The timber deck is topped off with gravel that is periodically leveled by a grader. The bridge doesn't experience heavy traffic but offers the only crossing of the river in the forest. The bridge was built in 1977 and is traversed by light trucks.

The following figures present various views of the bridge from above and the underside and clearly show the significant damage caused to the decking primarily by the 41 and is heavily utilizied by logging trucks plying on the Highway 126. The following figures present various views of the bridge from above and underside and show the damage caused to the deck by the grader utilized to level the gravel topping on the deck. While the substructure and the stringers are in good condition, the deck is serious state of disrepair.

Fig. 14 View of Approach to Bridge 08-2

Fig. 15 Side View of Bridge

Fig. 16 Stringers supporting timber deck

Fig. 17 Deteriorated deck exposing stringers

Fig. 18 Loss of deck section spanning stringers

This major concern with this timber bridge is the loss of deck due to the grader. The inspection clearly indicated the need to replace the gravel topping with timber runners that can provider protection to the deck. The absence of adequate railing was of concern since the railing currently in place only serves the purpose of identifying the edge of the bridge and does provide any impact resistance. Extreme caution is necessary to cross the bridge in its current condition.

7. Challenges in Bridge Inspection

The inspection team encoutered a few challenges in conducting the study.

- Some of the timber bridges that were originally selected for inspection could not evaluated because of the high water level, currents and inadequate headroom to conduct an inspection from a boat. Substitutions were made to ensure the desired number of bridges were inspected.
- In long-span bridges it was extremely difficult, if not next to impossible, to use the resistance microdrill to assess the condition of the stringers and deck due to height of the pile bent. Climbing the braces provide access only to the pile cap and the strengers at the supports. Also, operating the microdrill at the top of the bent with one hand is nearly

impossible. Significant amount of equipment has to be mobilized to gain access to the underside of long-span bridges with tall bents.

- Bridges with low clearance under the stringers offered a challenge also since it was difficult to operate the NDE equipment in such small clearances.
- It was critical to have a three member team to conduct the investigation because of the extensive documentation of the bridge inspection and assessment.

8. Summary and Conclusions

The investigation of the selected timber bridges in Louisiana was conducted successfully with the support of the LaDOTD inspection team. Most of the bridges inspected have been in service for over 50 years and appear to have delivered the expected service. The following observations were made from the inspections and these can be used to improve on the construction methods used for timber bridges.

1. The use of asphalt paving over the timber deck has contributed to the decay and deterioration of the deck in a majority of the cases because of the trapping of moisture between the paving and the deck. Once the asphalt cracks -- which it does due to the flexibility of the timber deck -- moisture travels to the wood deck and gets trapped over the deck since there is no provision for moisture to escape.
2. It is critical that a flexible and reliable vapour barrier be placed between the timber deck and the asphalt paving to improve the service life of the deck.
3. The use of a water shedding groove in the timber deck board is important to avoid trapping of moisture.
4. The use of timber abutments, while an easy alternative in some cases, should be avoided if possible to improve the service life of the overall bridge. The abutments can become a weak link the bridge system.
5. Timber pile deterioration in the zone of wetting and drying was observed in several bridges. Inexpensive treatment of piles sections in this zone with inorganic resins will significantly reduce pile deterioration which is the single most important cause for DOTs staying away from timber bridge systems.
6. The lack of emphasis on keeping the timber deck dry and restricting access to moisture has been a major contributor to the deterioration of the deck in timber bridges.

9. References

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