# EVALUATION AND TESTING OF TIMBER RAILROAD BRIDGES

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Timber has been used to build railroad bridges since railroads were first constructed in the United States. Up to the mid-19th century, limber was the primary railroad bridge material; thousands of miles of timber bridges were constructed as railroads developed and spread across the country. In the latter 19th and early 20th centuries, the use of limber began to slowly decline as other materials such as steel and concrete became increasingly popular for bridge construction. Though not as popular today as they once were, more than 500 miles of timber bridges are still in service on the nation's railroads. Most of these bridges are trestles with ballasted deck or open-deck configurations. Ballasted decks typically consist of a timber deck that supports a layer of ballast where the ties and rail are placed. Open decks consist of two longitudinal limber chords made up of four or more stringers that directly support the ties and rail. Experience shows that both the ballasted deck and open-deck timber railroad bridges typically provide more than 50 years of acceptable service when properly designed, constructed, and maintained.

Although timber bridges have been used for many years, little information is available on their performance characteristics. A literature review of timber railroad bridges (laboratory and field tests) and/or bridge components conducted by the authors showed tests had been conducted on timber railroad bridges as early as the late 19th century. Most of the tests, though small in number, have been performed since the 1940's with field tests in Canada and Australia as recently as 1988 and 1991, respectively.

With the increasing loads carried by modem freight cars, **a** fundamental understanding of bridge structural behavior and load distribution characteristics is necessary in order to provide cost-effective, efficient new designs and accurate assessments of existing structures. This information is particularly critical now since many timber bridges are nearing the end of their service life. Two alternatives appear to be available for improving the current load carrying capacity of these bridges; replacement using new materials and/or designs or repair using the addition of material to the existing structure. The very limited information in the literature primarily addresses aspects of component behavior and provides little specific technical information on toad distribution.

Additional information on load distribution and structural behavior is needed to improve the design and evaluation of timber railroad bridges. This need was recognized by the Association of American Railroads (AAR) and the Southern Pacific Lines (SP) in the initiation of two studies to assess the static and dynamic load distribution characteristics of two existing open-deck timber railroad bridges and to evaluate the short term effectiveness of rehabilitation of these same two existing open-deck bridges using similar static and dynamic load testing. The SP's southern main line was chosen for testing because it included many open-deck timber bridges and carried heavy axle load (HAL) traffic. In addition, the SP has an aggressive inspection and monitoring program that enabled the follow-up testing on the two bridges rehabilitated in 1996. The information presented in this abstract is part of an overall test program to increase the capacity and remaining service life of existing timber bridges.

Several spans of two 60-year old open-deck timber railroad bridges were field tested to determine the vertical load distribution characteristics of the superstructure. initial testing was done in 1995 with the bridges in their in situ condition and tests were repeated in 1996 after the two bridges were rehabilitated. The test spans of the in situ bridges measured 14 to 15 feet center to center of supports and contained two chords, each consisting of four sawn timber stringers. Two of the four stringers in a chord are alternated with the other two so that two stringers always are spanning continuously across two spans. The stringers were about 7 5/8 inches wide and 16 inches deep. A thorough condition assessment and documentation were performed before testing. Both bridges were determined to be in poor condition and it was noted that one bridge was previously repaired about 15 years ago, using replacement stringers. The rehabilitation associated with this project involved only the superstructures; the sub structures were left intact. One of the bridges remained an open-deck structure, but was rehabilitated using glued laminated stringers that were about 6 3/4 inches wide and 18 inches deep on the same spans as noted above. The other bridge also used similar glued laminated stringers, but in addition this bridge was converted to a ballast deck by placing a 3/4 inch steel plate on top of the chords to hold the ballast material. Again the spans were similar In length to the in situ bridge.

Both static and dynamic test data were obtained for the in situ and rehabilitated bridges using a special test train and typical revenue freight trains. Deflections were measured primarily on individual stringers within a chord at the mid span of two adjacent spans, and at the end of each span. Accelerations were obtained at the mid span of each chord. Both rails were instrumented at mid span of the instrumented chords to determine axle loads of the test and revenue trains.

Several specific comparative results (in situ versus rehabilitated) of each bridge show that for the open-deck structure, the overall chord deflections were decreased slightly after rehabilitation. Relative deflections between individual stringers within a chord were similar for both cases at both the mid span and at the bents. The magnitudes of the chord accelerations were also similar. For the bridge that was convened to a ballast deck structure, the overall chord deflections were reduced significantly afler rehabilitation. In addition, the relative deflections between stringers In a chord at mid span and at the bents were reduced significantly. The chord accelerations were also reduced significantly after the bridge was converted to a ballast deck structure. Additional general observations from the testing include the followlng:

- there was no significant continuity of deflection between the stringers in two adjacent spans, in contrast to the assumption typically made in design,
- the measured stringer deflections at the bents are the result of poor stringer bearing conditions and can lead to unexpected stress in the stringers due to the connection details,
- excessive chord deflections, and more importantly, excessive relative deflection differences between individual stringers within a chord, still exist at the bents,
- the rehabilitation methods on all of the bridges had a beneficial effect on the short term performance of the bridges, however, there are some indications that the long term performance maybe similar to that of the other solid sawn bridges unless design modifications are undertaken.

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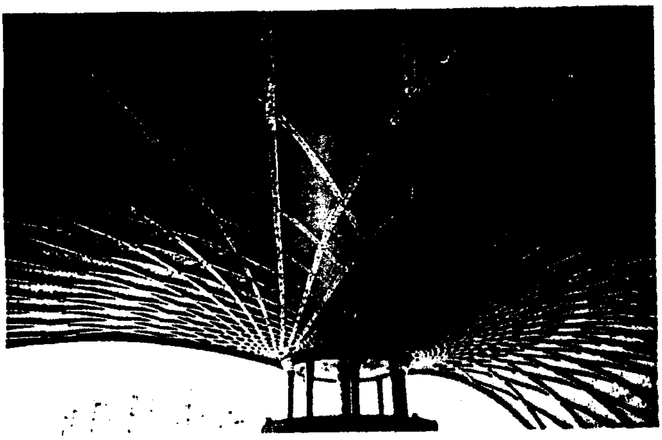

# PROCEEDINGS

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