



Field Testing of Railroad Flatcar Bridges

tech transfer summary

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RESEARCH PROJECT TITLE

Field Testing of Railroad Flatcar Bridges

SPONSORS

Iowa Highway Research Board (TR-498)
Iowa Department of Transportation

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The Bridge Engineering Center (BEC) is part of the Center for Transportation Research and Education (CTRE) at Iowa State University. The mission of the BEC is to conduct research on bridge technologies to help bridge designers/owners design, build, and maintain long-lasting bridges.

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Railroad flatcar bridges can serve as a low-cost alternative to replace deficient bridges in Iowa.

Objectives

- Investigate variables in railroad flatcar (RRFC) bridge construction to improve performance, constructability, and cost.
- Design, construct, and test several single span and multiple span RRFC bridges implementing variables under investigation.
- Refine the design methodology presented in the previous demonstration project (TR-444).
- Develop a load rating process for RRFC bridges.

Problem Statement

According to a 2004 National Bridge Inventory report, Iowa has 5,260 structurally deficient bridges and 1,699 functionally obsolete bridges. Since Iowa ranks 30th in the United States in terms of population, the state has a lower tax base, which limits the funds available for Iowa counties to repair or replace deficient and obsolete bridges. Because of this, the Bridge Engineering Center (BEC) at Iowa State University has researched low-cost bridge alternatives for use on low-volume roads. One such alternative is the use of decommissioned railroad flatcars (RRFCs) for bridge superstructures.

Research Description

For this project, different design parameters, such as span lengths, span configurations (single vs. multiple), longitudinal connection types, and abutment attachments were investigated through the field testing and subsequent analysis of eight RRFC bridges located in four different counties in the state of Iowa. Five single span and three multiple span bridges were investigated.



56-foot railroad flatcar prior to trimming

In order to determine the structural live load capacity and behavior of the single span and multiple span RRFC bridges, strain transducers and deflection transducers were mounted on the RRFCs. In the field load tests, a truck was driven slowly across the bridges in different lanes while a data acquisition system recorded the strains and deflections measured by the strain and deflection transducers. Strains and deflections were compared with maximum allowable levels as set forth by the American Association of State Highway Transportation Officials (AASHTO).

To further increase the ease with which a RRFC bridge can be implemented, a simplified design procedure was developed to aid in the design of future RRFC bridges. The simplified design procedure relates a single flexural moment value for the entire bridge to a target girder live load moment value using a lateral distribution factor. This factor, which is dependent on the RRFC type, longitudinal connection, and span configuration, was developed for all the different bridge configurations that were tested as part of this investigation.

Using the AASHTO allowable stress rating methodology, a rating procedure was developed with the use of appropriate live load distribution factors, which were selected using the factors developed for the simplified design procedure.

Key Findings

- Single span RRFC bridges composed of two or three RRFCs are an economical solution to bridge replacement if the longitudinal connections and bridge span length are correctly engineered.
- The longitudinal reinforced concrete beams connecting adjacent single span RRFCs, along with transverse timber planks on the bridge deck, effectively transfer the live load forces transversely across the bridge.
- Single span RRFC bridges with little or no overhang at the abutments should be restricted to clear span lengths of less than 66 ft. Increasing the clear span lengths would increase the total maximum stresses beyond the allowable steel stress.
- Multiple span bridges constructed using the 89-foot RRFCs are effective replacement bridges for use on low-volume roads where longer span lengths are required.
- Strains and deflections of the multiple span bridges tested in conjunction with this project were below the allowable limits as set forth by the AASHTO.
- Preliminary investigation into the use of sheet pile abutments for multiple span RRFC bridges indicates that the use of such abutments is a viable alternative for low-volume roads for a compatible superstructure.



Single span RRFC bridge constructed using 56-foot railroad flatcars



Multiple span RRFC bridge constructed using 89-foot railroad flatcars



Deflection instrumentation installed below RRFC bridge



Test truck driving across single span RRFC bridge