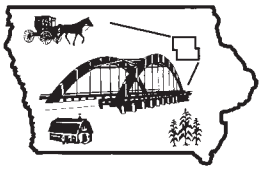
BUCHANAN CO.



BRIDGE ENGINEERING CENTER

Railroad Flatcars for Low-Volume Bridges

Iowa Counties Adopt Low-Cost Structures

B. P. KEIERLEBER, J. WITT, T. J. WIPF, AND F. W. KLAIBER

Two Iowa countries have adopted a technique that incorporates railroad flatcars in low-volume bridge superstructures.

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A safe and efficient transportation system is essential to the nation's economy. Low-volume roads and bridges carry a substantial portion of the system's traffic and enable the local transportation of goods and services.

Problem

Iowa has the sixth largest number of bridges in the nation. Approximately 81 percent of the 25,000 bridges in Iowa are on secondary roads and are the responsibility of the counties. The state ranks 30th in population, however, which limits the tax base. As a result, Iowa county engineers have insufficient funds to address all of the problems that arise with low-volume bridges.

Solution

To provide Iowa county engineers with low-cost bridges, the Bridge Engineering Center at Iowa State University investigated the feasibility of using railroad flatcars as the superstructure for bridges on low-volume roads. Several characteristics make flatcars desirable for bridge superstructures: flatcars are easy to install, can be used on current or new abutments, are available in various lengths, and are relatively inexpensive.

A feasibility study indicated that properly designed flatcar bridges are capable of supporting Iowa legal loads. To test the constructability, adequacy, and relative economy, two flatcar demonstration bridges were designed and constructed—one in Buchanan County and the other in Winnebago County.

The Buchanan County bridge was constructed as a single span of three adjacent 56-foot-long flatcars supported at each end by reinforced concrete abutments. Reinforced concrete in the substructure allowed for an integral abutment at one end of the bridge and an expansion joint at the other end.

Reinforced concrete beams served as longitudinal connections between the adjacent flatcars and distributed the live loads. A model of this connection beam was tested in the laboratory for flexure and torsion before installation in the field. Guardrails and an asphalt milling driving surface completed the bridge.

The Winnebago County bridge incorporated three 89-foot-long flatcars side by side. Preliminary calculations, however, indicated that the flatcars were not adequate as 89-foot simple spans. Therefore, new steel-capped piers were placed to support the flatcars at the bolsters—that is, where the wheels had been

Testing of Winnebago County Bridge before connecting adjacent flatcars.

located—and abutments supported the flatcars at the ends. The resulting structure consisted of a 66-foot main span with two 10-foot end spans.

The longitudinal connections between the adjacent flatcars, however, were not adequate to support significant loads. As a result, transverse, recycled timber planks were used to distribute live loads effectively across all three flatcars. A gravel driving surface was placed on top of the timber planks, and a guardrail system was installed to complete the bridge.

Strain and deflection data from field tests validated the bridge behavior predicted by the analytical models of each bridge. The engineered flatcar bridges have low live-load stresses and deflections that are below the limits set in the bridge design specifications of the American Association of State Highway and Transportation Officials.

In the Buchanan County and Winnebago County flatcar bridges, the maximum live load plus dead load stresses in the girders were 12,700 and 16,700 pounds per square inch, respectively. The field tests demonstrated that flatcar bridges can support Iowa legal loads.

Application

In the past 3 years, Buchanan County has replaced five bridges with railroad flatcar structures. When possible, the county applies federal bridge replacement funds and uses salvaged materials in the replacement of bridges.

Benefits

Like many other states, Iowa has bridge problems. Research on the use of railroad flatcars has helped Iowa counties address some of the problems. Counties can purchase railcars for a fraction of the cost of steel beams and decking materials.

Winnebago County constructed the 89-foot by 27-foot railroad flatcar bridge at a cost of less than $30 per square foot—a substantial savings from the nearly $70 per square foot for a standard concrete slab bridge in Iowa. The savings for the six flatcar bridges constructed to date exceed the cost of the research.

The Winnebago County bridge is esthetically pleasing and has tested and performed satisfactorily. The project exemplifies the dividends of research for states, cities, and counties.

Criteria now have been established for the selection of structurally adequate flatcars for bridge projects. In addition, design recommendations were developed to simplify the calculation of live-load distribution in the bridges.

The results of this research show that proper flatcar selection, construction, and engineering make flatcar bridges a viable, economical replacement bridge system. A flatcar bridge requires less construction time—approximately one-half to two-thirds the time required to construct a similar-sized slab bridge—and at approximately one-half the cost of a slab bridge.

Completed Winnebago County Bridge.

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Suggestions for "Research Pays Off" topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001 (telephone 202-334-2952, e-mail gjayaprakash@nas.edu).