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New Jersey Department of Transportation
Bureau of Research

Technical Brief

Elimination of Weight Restriction on Amtrak, NJ Transit and Conrail Lines

This report looked at the impact of increasing the weight of freight rail car on various passenger lines in New Jersey. Several typical railway bridges were load rated based on the current American Railway Engineering and Maintenance-of-Way Association (AREMA) Specifications. Furthermore, these bridges were instrumented and field-tested under live load. Results were compared with those from detailed finite element (FE) models. Based on the results of load rating and evaluation of these bridges, guidelines for maintaining and load-rating existing railroad bridges, as well as recommendations based on cost-benefit analysis for this increase in freight weight limits were provided.

Background

The Association of American Railroads (AAR) declared an increase in freight railcar weight limits from 263,000 lb (1,170 kN) to 286,000 lb (1,272 kN). However, most of the railway bridges in New Jersey were built prior to World War II and are not designed for this increased railcar weight. Thus, there is a need for accurate and efficient methods to evaluate and load rate existing bridges that will reveal their actual capacities. Various methods are currently used for evaluating existing railway bridges, including traditional load rating method based on AREMA specifications, finite element modeling method, and field testing method. To evaluate the impact of the 286-kips (1,272 kN) rail cars on bridges on passenger lines, this research study adopted various methods and combined them with the experience of the Rutgers Infrastructure Monitoring and Evaluation (RIME) research team obtained from previous research projects. Figure 1 shows the instrumentation of the Main Line MP 15.95 Bridge with various types of sensors. Sensors such as strain transducers, Laser Doppler Vibrometer (LDV) to measure deflections, and accelerometers were used. Figure 1 also shows the detailed finite element model for this bridge used in the analysis. A total of five critical bridges were selected for this study.

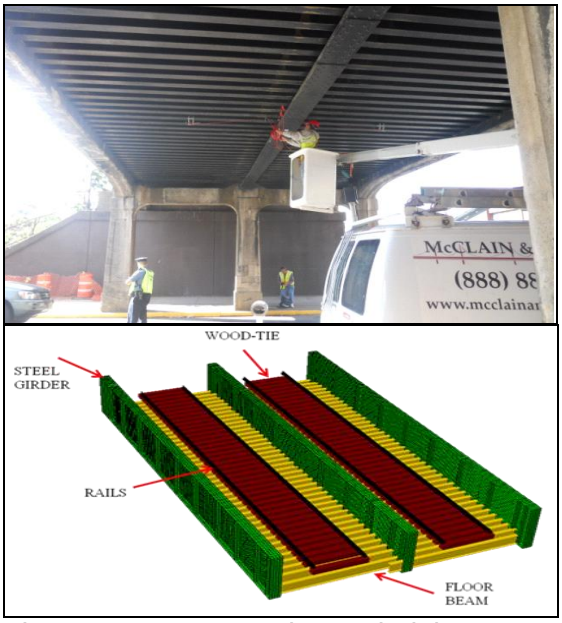

Figure 1. Instrumentation and Finite Element (FE) model for the Mainline MP 15.95 Bridge.

Research Objectives and Approach

The primary objective of this study was to evaluate current conditions of selected railroad bridges and to load-rate them according to the AREMA provisions under 286-kips (1,272 kN) rail cars. To achieve this objective, the following tasks were performed:

1. Evaluated and load-rated current conditions of selected railroad bridges according to AREMA provisions.
2. Developed detailed FE models for selected railroad bridges and perform the evaluation using FE models.
3. Conducted field tests to evaluate the capacity of selected railroad bridges and collected various structural responses to validate the accuracy of FE models.
4. Performed cost-benefit analysis to evaluate the financial impact of increasing railcar weight limit.
5. Provided general guidelines for bridge repair and strengthening to accommodate 286-kips (1,272 kN) rail car loads.

Figure 2 shows typical strain transducers with wireless units as well as typical strain record collected from field tests performed on the HX Draw Bridge. Moreover, Figure 3 shows excellent correlation between measured and predicted (using FE model) girder strains.

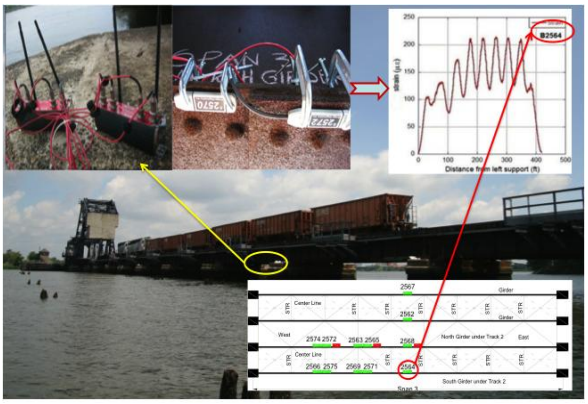

Figure 2. Typical strain transducers with wireless units and strain records collected in the field for the HX Draw Bridge.

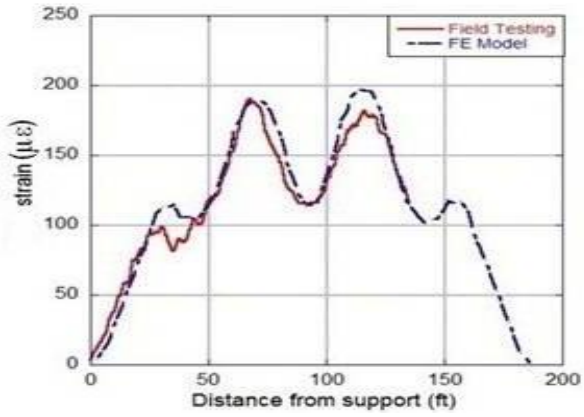

Figure 3. Typical results for measured and predicted (FE model) girder strains.

Findings

The following conclusions and recommendation are made from this study:

- Overall, the Main Line MP 15.95 Bridge is in good condition. The load rating based on the FE modeling indicated that the bridge is capable of carrying 286-kips (1,272 kN) railcar. However, based on the load rating results using AREMA's simple beam analysis, there is a need to upgrade the through-girders in span 2 in order to satisfy a level of demand over capacity (D/C) ratio of 80%. Lower rating results than those obtained by the FE model were observed when using AREMA's specifications because the assumed boundary conditions are pinned supports.
- For the Main Line MP 15.14, although the rating of the critical member is low, this critical member (FB20) is under the abandoned track and will not affect the performance of the bridge directly. The load rating based on the FE analysis indicated that the bridge is capable of carrying a 286-kips railcar. However, the load

rating results using simple beam analysis indicated that the load rating of Girder 37 is larger than the D/C ratio of 113%. Thus, in order to satisfy the limit of the D/C of 100% (as well as for D/C of 80%), certain repairs may be needed for Girder 37.

- For the Bergen County Line MP 5.48 (HX Draw), the rating of the bridge was improved from the results in the latest inspection report due to the recent repairs conducted after 2007 by NJ Transit. However, in order to safely carry 286-kips (1,272 kN) rail cars, various repair alternatives were proposed, including adding cover plates to the bottom flange and limiting the train's maximum speed.
- For the Raritan Valley Line MP 31.15, the rating results show that the bridge is capable of carrying 286-kips (1,272 kN) rail cars. However, the ratings of some of the sections are fairly close to the limit (e.g. the D/C is 98% for the midspan section). Therefore, repairs are needed to maintain an adequate safety of D/C <80%.
- For the North Jersey Coast Line MP 0.39 (River Draw) Bridge, it is in an overall fair condition and the rating results show that the bridge is capable of carrying 286-kips rail cars. However, the ratings of some of the sections are fairly close to the limit (e.g. the D/C is 97% for the section that is 24.5 ft (7.47 m) away from the support). Therefore, few repairs are needed to improve the performance of the bridge and maintain an adequate safety of a D/C <80%.
- The study performed in this project is focused on five typical NJ Transit bridges only. These bridges may not be representative of the remaining bridges on Amtrak, NJ Transit, and Conrail Lines. Therefore, further review and evaluation of other types of bridges is needed before extending the conclusions to other bridges or other rail lines.
- Currently, NJDOT is also considering operation of 286-kips (1,272 kN) freight cars on other lines in the state. These structures should be inspected, modeled, and load-rated to allow for 286-kips (1,272 kN) freight cars.
- This study included preliminary results for the fatigue load rating and the evaluation of the fatigue remaining life due to the frequent use of the heavier 286-kips (1,272 kN) rail car. A more detailed fatigue research study is needed, including field long-term monitoring during the operation of 286-kips (1,272 kN) rail cars using the in-place sensors. Field inspections and evaluation will be needed to focus on various critical members including those identified in this study.

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A final report is available online at: http://www.state.nj.us/transportation/refdata/research/. If you would like a copy of the full report, send an e-mail to: Research.Bureau@dot.state.nj.us.

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