ALTERNATIVES FOR RECONSTRUCTION OF BRIDGE 204.66 OVER THE MISSISSIPPI RIVER
BURLINGTON, IOWA
BURLINGTON NORTHERN AND SANTA FE RAILWAY

By:

Chris J. Brown
HNTB Corporation
715 Kirk Drive
Kansas City, Missouri 64105
Phone – 816-472-1201
Fax – 816-472-5013
&
John W. Hronek
HNTB Corporation
715 Kirk Drive
Kansas City, Missouri 64105
Phone – 816-472-1201
Fax – 816-472-5013

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ABSTRACT

Alternatives for Reconstruction of BNSF Bridge 204.66 over the Mississippi River, Burlington, Iowa.

This paper will detail the studies and coordination with the BNSF Railway and the United States Coast Guard for the replacement of a major river bridge crossing deemed a hazard to navigation under the Truman-Hobbs Act. The paper will include information on the structural, mechanical/electrical geotechnical and cost apportionment studies that were completed in meeting the goals of providing a 300' horizontal navigation channel with minimum planned disruptions to river and railroad traffic.

The planned project is in Burlington, Iowa, a medium sized Mississippi river town. The existing double track swing bridge has a span of 362' and the original bridge crossing was opened to rail traffic in 1869. Rating of the existing swing span and determination of the remaining service life of the bridge components were part of the effort in the preliminary studies made to arrive at the current proposed bridge which utilized the existing rest piers of the swing span for the new lift span bearings and tower supports.

Key words: Movable bridge, Truman-Hobbs, rehabilitation

INTRODUCTION

The purpose of this paper is to present the investigations involved in a Truman-Hobbs bridge replacement project beginning when the order to alter was issued through the completion of the final design phase.

BRIDGE DESCRIPTION

The existing bridge is located at Burlington, Iowa and crosses the Mississippi River at River Mile 403.1. The bridge is comprised of the following spans from west to east: two 70 foot deck plate girder spans, the 362’ swing span, and six 250’ through truss spans. The bridge is double track with an open timber deck. The west approach is on 8 degree curve and the east approach is on a 3 degree 15 minute curve. The navigation channel is on the west side of the river at this location. The original bridge was constructed at 1869 at this location. The two rest piers for the swing span and the pivot pier are composed of stone masonry constructed on timber mats. The timber mats are supported by timber piles and the piers are adequate for the current loading conditions. The railroad has strengthened the piers on several occasions by encasement.

The current superstructure was erected in 1891 and there were significant improvements to the structure in 1930, 1976 and 1992. The effective navigation channel is approximately 150’ upstream and downstream in the current span configuration. Due to the many barge with collisions with the Pier 9 protection cells over the years, an order to alter was issued by the USCG in August 1991. The requirements of the order called for a span arrangement that would be reconstructed on the same general alignment and would provide a 300' horizontal navigation channel and 60' minimum vertical clearance from the normal pool elevation.

STRUCTURAL

The preliminary studies began in 1992. Phase A consisted of developing outline plans and a design criteria. The outline plans would then form the basis for the preliminary design during Phase B. Three alternatives were developed for preliminary design consideration. Alternative 1 (Figure 1) considered an unsymmetrical span arrangement, with the center of the new lift span shifted to the east of the swing span pivot pier. Alternative 2 (Figure 2) considered the replacement of the entire bridge on an alignment downstream of the existing bridge and Alternative 3 (Figure 3) considered the replacement of the existing swing span with a new vertical lift span and strengthening of the existing rest piers to support the increased loadings.

ALTERNATIVE 1

Alternative 1 (Figure 1) considered replacing the swing span with a new vertical lift span and shifting the centerline of the navigation channel eastward to accommodate construction.

In order to meet the horizontal channel width requirements, a new tower pier would have to be constructed in the existing westerly (downstream) navigation channel and another new tower pier built under the easterly adjacent fixed truss span. The westerly tower would be a braced tower with the front tower columns supported on the new pier and the rear tower columns supported on the existing swing span rest pier. The old swing span west rest pier (Pier 9) could support the rear tower legs without strengthening, because in this alternate, the loads on the rest pier would be reduced.

The easterly tower would be a braced tower with the front tower columns supported on the new tower pier (Pier 7) and the rear tower columns supported by the new approach truss span extending to the adjacent existing fixed pier (Pier 6). Since the final design loads would be reduced to Pier 6, Pier 6 would be adequate without strengthening. Some modification of the top of pier would be required to accommodate the new truss bearing locations.

The primary advantages to this alternative were:

- Substructure construction would be away from the navigation channel
- Pier construction could be completed without detouring rail traffic
- Most of the pier construction could be completed outside the limits of the existing structure, minimizing impacts to rail operations.
- The easterly navigation channel could be retained in operation during construction (except during span change out periods).

Some disadvantages to this alternate were:

- This alternate would require bobtailing of the swing span, and modifications to balance the span while operating as an unsymmetrical swing span.
- Marine traffic would be limited to the east side of the swing span for both upstream and downstream movements.
- The existing easterly approach truss span adjacent to the swing span would have to be removed and replaced.
- Removal and replacement of the approach truss span would require an additional interruption to rail traffic.

- The upstream protection cells would need to be removed and replaced to be in line with the new tower piers.

ALTERNATIVE 2

Alternative 2 considered the total replacement of the existing bridge on a new alignment downstream of the existing bridge. (Figure 2). The offset in alignment would be enough to permit uninterrupted operation of the swing span during construction.

For purposes of the alternate evaluation the bridge length was assumed to be the same as the existing bridge. Two new tower piers would have to be constructed to comply with the horizontal clearance requirements of the order to alter the bridge. In order to maintain uninterrupted upstream and downstream river navigation through the existing swing span, a new lift span would have to be over 400 feet in length, however it was decided to limit the new lift span length to 330', providing for the required 300' horizontal channel clearance. Cost implications ruled out consideration of the 400' lift span.

Advantages of Alternate 2

- Shift in the navigation channel to east, facilitating river navigation.
- No disruption to rail traffic during construction.
- Only one shut-down to marine navigation during installation of the new lift span.
- Reduction in existing curvature on west approach tracks.
- Provide for new bridge shore to shore.

The disadvantages to Alternative 2 were:

- Most expensive construction alternate.

- Would require additional environmental studies since new construction would be outside of existing railroad right of way.
- Marine traffic would be limited to the east of the existing pivot pier once the west tower pier began construction.

ALTERNATIVE 3

This alternate (Figure 3) considered replacing the existing swing span with a new vertical lift span, maintaining the centerline of the navigation channel in its present location.

In order to satisfy the requirements of the order to alter using this alternative, the existing rest Piers 7 and 9 would have to be reinforced and strengthened to support the new loads applied to the piers. Unbraced towers would be considered in this alternate so that the existing approach spans could be reused and no additional piers would need to be constructed.

Advantages of this alternate were:

- Only one marine and rail traffic interruption when the new lift span is placed and the existing swing span is removed.
- The existing navigation channel remains in the same alignment.
- Additional substructure units are not required.

Disadvantages of the alternate include:

- Pile driving for pier strengthening will have to be closely coordinated with rail operations due to the proximity of the piles to the existing pier.
- Existing pier monitoring will be required to evaluate pier movement during construction. Excessive movement could limit swing span operations, leading to marine traffic interruptions.

- Pier strengthening will reduce channel widths during construction, affecting marine traffic operations.

During evaluation of the alternatives cost and in negotiations with the BNSF and the USCG, Alternative 3 was chosen to go forward into final design.

MECHANICAL/ELECTRICAL

Lift span operation will be of the span drive type. A span drive was selected because of its positive alignment features and because BNSF Railway has utilized this drive on other lift span bridges. The main drive operating machinery and electrical drive and control system will be located at midspan on the lift span. Power for the lift span is available at the west approach from an existing transformer station. The control house would be also be located on the lift span, because a shore or pier location for the control house was determined to be impracticable.

GEOTECHNICAL

A geotechnical investigation was concluded in 1994. Soil borings were taken around the existing piers to establish the bedrock profile at existing piers 7 and 9. Rock layers varied and were sloping across the pier width. The rock profile was used in establishing that steel H piles would provide the most economical support for the pier strengthening. In order to minimize the effects of the pier strengthening on the existing foundation, the sheet piles for the cofferdam are to be left in place and cut off at the top of the footing.

COST APPORTIONMENT

In a Truman-Hobbs project, costs are apportioned between the owner, interested third parties and the federal government under the administration of the United States Coast

Guard. To determine the appropriate cost sharing based on the Truman-Hobbs guidelines, an investigation into the steel strength was necessary. Steel coupons were tested to determine the tensile strength for rating purposes. The strength used in the current apportionments was 33,000 psi, however after construction is complete, it was agreed to take more representative member samples and determine final yield strength for the final construction cost apportionment.

CONCLUSION

In conclusion, the studies associated with a Truman-Hobbs replacement are very detailed and result in the development of approximately 30% plans, suitable for cost estimates and construction sequence that will be an economical solution to the Order to Alter.