Preferred Concept Design

For the Preferred Concept, the two reasonable alternatives were combined for to make a Preferred Concept. The Preferred Concept was then refined using the design criteria and modeling software to come up with a more developed concept.

J4I2337 – I-435 South Corridor Concept Study

Appendix B - Existing Bridge Assessments and Recommendations

Completed June 10, 2014

This report documents HNTB's finding from the review of the existing bridge plans and inspection reports provided to HNTB by the Missouri Department of Transportation (MoDOT) and a brief joint site visit by HNTB and MoDOT. The site was visited on May 14, 2014 by personnel from HNTB and MoDOT to develop an initial assessment of the condition of the bridges included in this study. The photographs included in the report were taken during the May 14th site visit.

The level of review which forms the basis for this report was determined by the agreement for the services. The opinions, statements, and recommendations made in this report are based solely on conditions revealed by the document reviews and the limited visual site review. No representation or warranty is made that all defects have been discovered or that defects will not later appear. Nothing contained herein shall be deemed to give any third party a claim or right of action against the Engineer or to create a duty on behalf of the Engineer to such third party.

Grandview Roadway over I-435

Bridge A-5249

Description and Historical Sketch

Grandview Road over I-435 was constructed in 1994. The superstructure is composed of continuous composite steel welded plate girders with two main spans of 152'-8 3/4" and 152'-8 3/4" for a total length of 352'-5 1/2". The roadway is 38'-10" wide and carries two lanes of traffic.

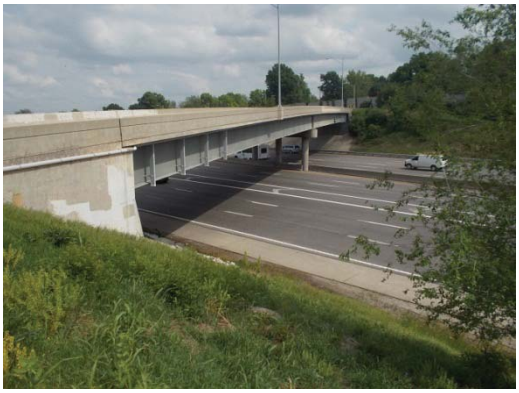

Figure 1. Elevation view looking south

Site Visit and Document Review

The deck and substructure are in good condition (condition rating 7) and the superstructure is in very good condition (condition rating 8) per the most recent MoDOT report.

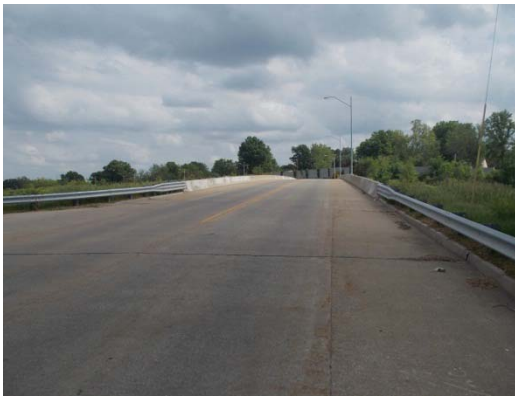

Figure 2. Approach view looking south

Recommendations

- No repairs recommended.

I-435 over Blue River and Blue River Road

Bridge A-0610

Description and Historical Sketch

I-435 bridges over the Blue River and Blue River Road were constructed in 1966. The superstructure consists of continuous composite haunched steel plate girders of spans 113'-5", 144'-10 $^{5}/_{8}$", 144'-10 $^{5}/_{8}$" and 113'-11 $^{5}/_{8}$" for a total length of 517'-1 $^{7}/_{8}$".

The original roadways were 44'-0" wide. In 1994, the westbound roadway was widened to 75'-11" and the eastbound roadway was widened to 63'-11". The existing bridges were widened on the outside and in the median. The original deck was removed and replaced.

Figure 3. General view of framing and piers

Site Visit and Document Review

The superstructure is in fair condition (condition rating of 5) per the most recent MoDOT report. The superstructure contains several fatigue sensitive details near stiffeners, lateral bracing connections and longitudinal stiffener connections. The diaphragm connection stiffeners were not welded to the girder flanges and fatigue cracks have developed at the top of the stiffener. These cracks occur at three locations: in the girder web at the toe of the web to flange weld, in the stiffener to web weld, and in the web at the toe of the stiffener weld. Most of the cracks are in compression areas of the girder. Clip angles have been added between the connection stiffeners and the girder bottom flange to prevent cracks in those locations.

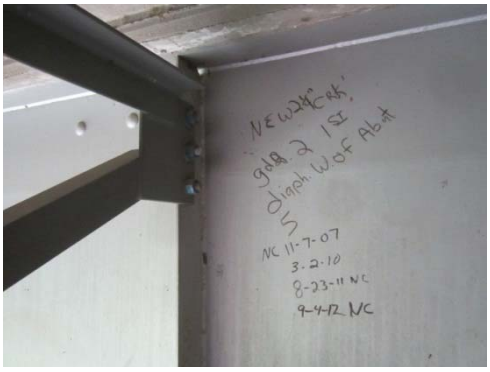

Figure 4. Typical crack in girder web

The longitudinal stiffeners are welded to the girder webs and either there is no weld gap to the stiffener welds or the weld gap is small allowing the potential for a concentration of stresses to form. The longitudinal stiffeners are located near the compression flange but areas near the girder splices may be in reversal zones. Therefore, the potential for fatigue cracks exists at those locations.

Figure 5. Small or missing gap at longitudinal stiffener

The lateral bracing gusset plates are also welded to the girder web in the interior spans near midspan where the web is in tension. Similar to the longitudinal stiffeners, the weld gaps are small allowing the potential for a concentration of stresses to form which could lead to cracking.

The bridge was painted in 1984 (System B) and there are isolated areas of rust on the girders generally at the flange edges and the east abutment bearings.

The deck is in good condition (condition rating of 7) per the

Figure 6. General view of lateral bracing connection

most recent MoDOT report. Isolated transverse cracks with light efflorescence were noted on the bottom of the deck. The east abutment expansion joint elastomer is worn and torn in several locations. Longitudinal cracks were noted at the top and bottom of the median barriers.

The north end of the west abutment is slightly undermined with the piling exposed. Voids were also noted under the paved slope protection at this location.

Figure 7. Deterioration in east abutment joint

Conclusions

The structural steel has several fatigue sensitive details that may shorten its life. The cracks at the top of the connection stiffeners do not exhibit significant growth since discovery. Providing a positive connection to the girder top flange will help prevent further growth. No cracks have been noted in the welds of the lower lateral bracing and the longitudinal stiffeners. Future fatigue studies would be necessary to determine the likelihood of cracks developing in these areas. Repairs are recommended to preclude crack development in these areas.

Figure 8. Cracks in median barrier

The deck is twenty years old and may have another twenty to thirty years of life. The paint is thirty years old and at the end of anticipated paint life. The existing paint does not have significant areas of deterioration and spot painting is an option to extend the paint life for several more years.

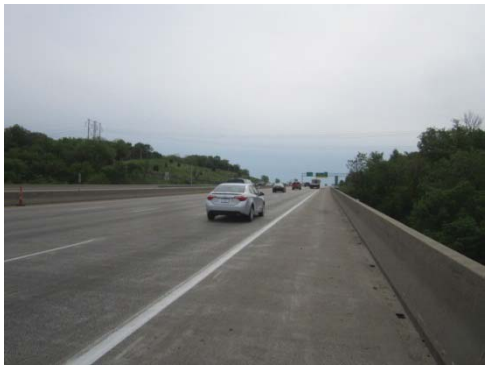

Figure 9. Approach view looking east

Recommendations

- Replace the east abutment strip seal joint system.
- Spot clean and paint areas with light rust or, alternatively, clean and paint all structural steel.
- Retrofit the lateral bracing gusset plate connections to the girder web.
- Retrofit the connections of the stiffeners to the girder top flange.
- Retrofit the longitudinal stiffener connections to the girder web in the tension areas.
- Replace the median barriers.
- Repair erosion damage at the north end of the west abutment for the eastbound Bridge.

I-435 over Union Pacific Railroad and 104th Street

Bridge A-1427

Description and Historical Sketch

I-435 bridges over the Union Pacific Railroad and 104th Street were constructed in 1966. The eastbound structure is composed of continuous composite rolled steel beams of spans 45'-0", 72'-0", 72'-0", 58'-0" and 46'-0" for a total length of 293'-0". The westbound structure is composed of continuous composite rolled steel beams of spans 45'-0", 72'-0", 72'-0", 72'-0" and 54'-0" for a total length of 315'-0". The roadway widths were 44'-0".

In 1986, cathodic protection was installed and a $1^3/_4$" latex modified concrete wearing surface was placed. In 1995, the westbound roadway was widened to 63'-11" and the eastbound roadway was widened to 71'-11". The existing bridges were widened on the exterior as well as in the median. Cathodic protection was installed and a 1 3/4" latex modified concrete wearing surface was placed in the widened areas.

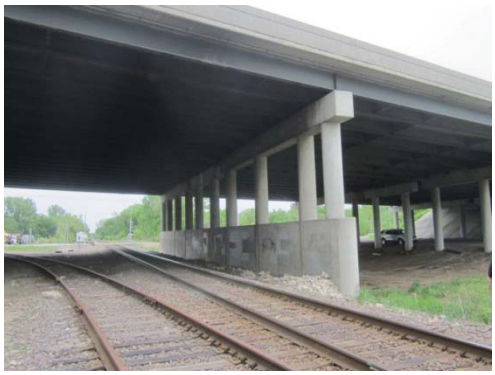

Figure 10. Elevation view looking north

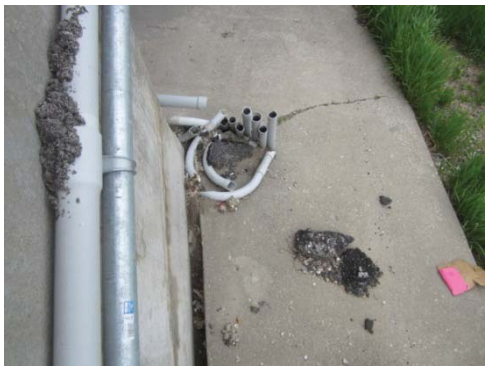

Figure 11. Missing cathodic protection wiring

Site Visit and Document Review

The deck is in satisfactory condition (condition rating of 6) and beams are in good condition (condition rating of 7) per the most recent MoDOT report. The wiring in the exposed conduits for the cathodic protection has been vandalized and the wiring is missing. Isolated areas on the underside of the deck have minor water staining. Several areas of patching were noted on the top of the deck generally near the expansion joints. The median barrier was damaged in one location and longitudinal cracks were noted at the top and near the bottom of the barrier. The bridge was painted in 1995 (System F) and isolated areas of rust were noted on the girders generally at the flange edges.

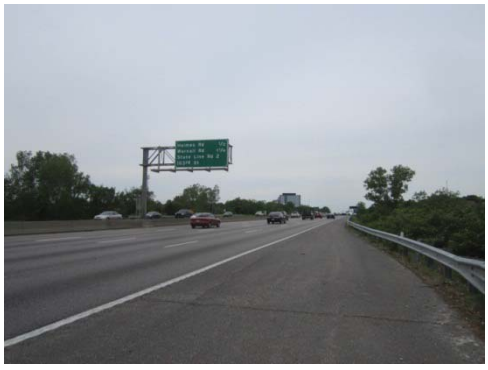

Figure 12. Roadway view looking east

Conclusions

The deck over the existing girders is original concrete with uncoated reinforcing steel. The reinforcing steel was cathodically protected for a portion of the life of the structure but has not been protected since the wiring was disabled. Deterioration accelerates quickly in uncoated reinforcing steel and may pose problems in the near future.

The paint is twenty years old and is near the end of anticipated paint life. The existing paint does not have significant areas of deterioration and spot painting is an option to extend the paint life for several more years.

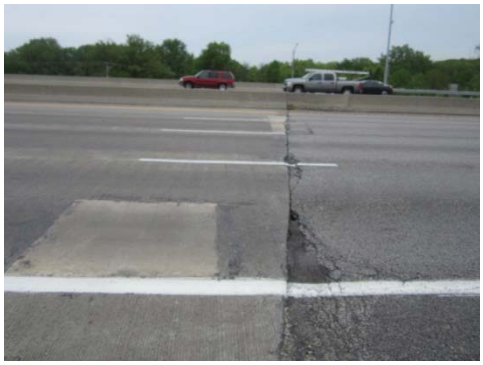

Figure 13. Deck patching at abutment

Recommendations

- Spot paint areas with light rust or, alternatively, clean and paint all structural steel.
- Remove and replace deck and strip seal joint systems.

I-435 over Holmes Road

Bridge A-1662

Description and Historical Sketch

I-435 over Holmes Road bridges were constructed in 1966. The superstructure is composed of continuous concrete voided slabs spans of 44'-3", 55'-0", 52'-0" and 39'-3" for a total length of 190'-6". The original roadway widths were 49'-6".

In 1984, the bridges were widened to the outside to provide 58'-0$^{1}/_{2}$" roadways. Additional substructure elements and concrete voided slabs were added. A longitudinal expansion joint was placed between the existing and widened structures.

In 1994, additional substructure elements and concrete voided slabs were added between the existing bridges to provide 74'-0$^{1}/_{2}$" roadways. The new voided slab was constructed composite with the existing structure.

Figure 14. Elevation view looking northeast

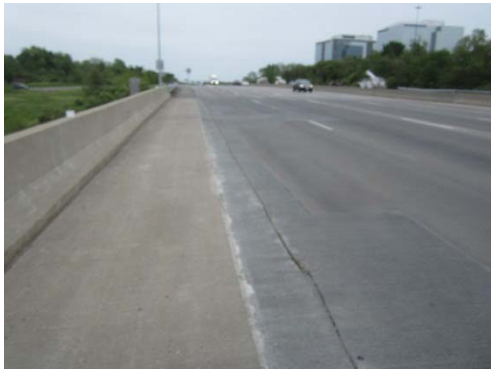

Figure 15. Approach view looking east

Site Visit and Document Review

The superstructure and deck are in satisfactory condition (condition rating of 6) per the most recent MoDOT report. The longitudinal joints between the widening and the existing deck are deteriorated and had significant spalling. Water and rust stains were noted on the underside of the deck at the voided slab weep holes. Longitudinal cracks with rust stains were also noted near the east abutment. Areas of map cracking and deck patches were noted in the top of the deck. Significant erosion damage of the concrete slope protection at the west abutment was noted.

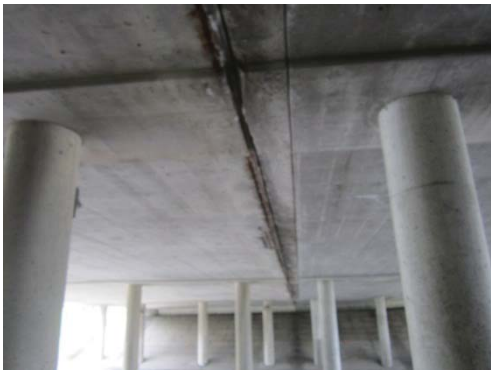

Figure 16. Spalls along longitudinal joint

Conclusions

The numerous patches in the deck and water stains in the bottom of the slab indicate that water and chlorides have saturated the concrete. Generally, maintenance and repair costs accelerate rapidly when the chlorides have permeated the structure. An overlay would slow the deterioration of the slab, but uncertainty exists as to how much damage exists currently inside of the voids and significant deck repairs would be required prior to placing the overlay. Maintenance activities will escalate with time even with the deck repairs and new concrete may not participate fully in resisting the loads on the structure.

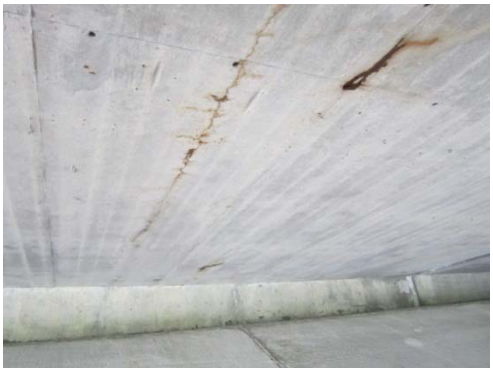

Figure 17. Cracks and rust stains on bottom of deck

Recommendations

- Remove and replace both bridges.

I-435 over Wornall Road

Bridge A-1240

Description and Historical Sketch

I-435 bridges over Wornall Road were constructed in 1966. The superstructure is composed of continuous concrete box girders of spans 62', 80' and 62' in length for a total length of 204'. The box girders originally supported twin roadways each 49'-6" wide.

In 1986, cathodic protection was installed and a $1^3/_4$" latex modified concrete wearing surface was placed.

In 1993, the bridges were widened. New substructure elements and additional concrete box girders were placed between the existing bridges to create two 64'-0" wide roadways. An open center joint was placed between twin median barriers at the centerline of I-435. The new structure was connected to the existing deck cantilever with a cold joint. Cathodic protection was placed in the widened area and a $1^3/_4$" latex modified concrete overlay placed.

Later, retaining walls were constructed to retain fill in front of the abutments in order to provide additional traffic lanes and pedestrian access on Wornall Road.

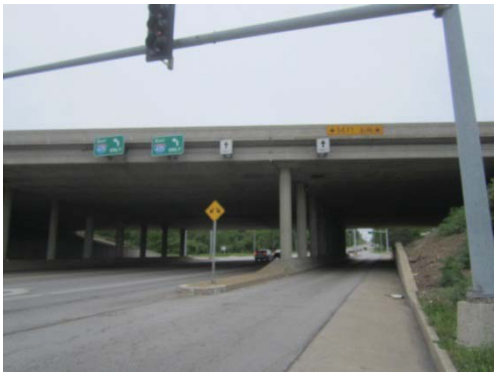

Figure 18. Elevation looking north

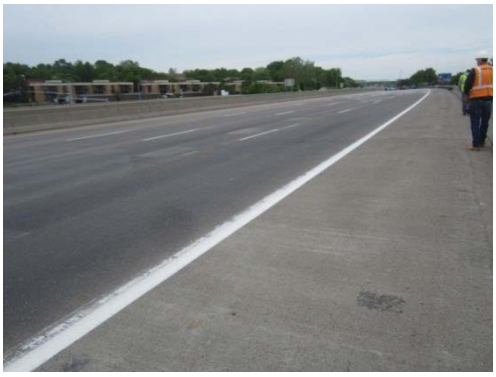

Figure 19. Approach view looking west

Site Visit and Document Review

The superstructure and deck are in fair condition (condition ratings of 5) per the most recent MoDOT report. Shear cracks were noted in the box girder webs at the east abutment of the eastbound bridge and west abutment of the westbound bridge. Water stains were noted in the bottom of the box at both abutments as well as several isolated locations throughout the bridges. Patched and cracked areas were noted in the top of the deck along the longitudinal cold joints between the widening and the original deck for over 50% of the length. There are numerous additional patches in the top surface of the roadway. The substructure was in satisfactory condition (condition rating of 6) per the most recent MoDOT report. The concrete bents are in overall good condition although spalls were noted at the end of the abutments. The vertical clearance at the southeast corner is posted at 14'-6".

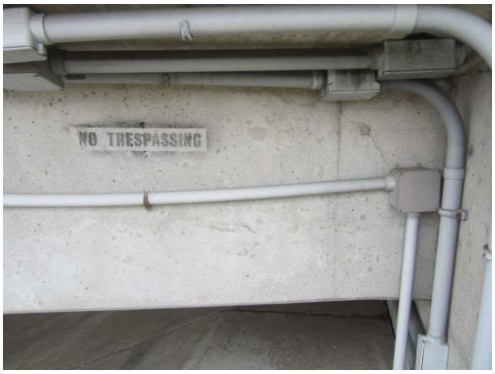

Figure 20. Shear cracks in box girder webs

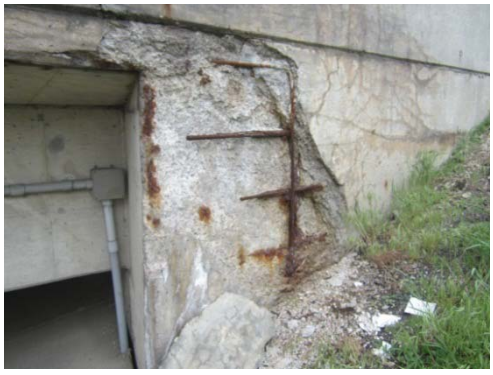

Figure 21. Spall with exposed reinforcing steel

Conclusions

The numerous patches in the deck and water stains in the bottom of the box girders indicate water and chlorides have saturated the concrete. Generally, maintenance and repair costs accelerate rapidly when the chlorides have permeated the structure. A deck replacement would slow the

deterioration of the concrete box, but replacing the concrete deck would be costly and the new concrete may not participate fully in resisting the loads. Concrete box girder deck replacement will require falsework underneath the structure, or the deck would have to be removed and replaced in narrow strips, either of which would be very costly.

Recommendations

- Remove and replace both bridges.