

## Executive Summary and Research Readiness Level Assessment

# Standard Design for Nebraska County Bridges

### Research Objectives

First, evaluated the various sections currently available for spans up to 60 ft. This included solid planks, void planks, box beams, and stemmed members (single and double tees).

Second, integrated the results of this evaluation with an experimental program to verify the analytical studies through actual testing of the transverse connections and the longitudinal capacity of the most popular system(s).

The goal was to provide standard design, recommendations and construction provisions that will be directly integrated into the NDOR BOPP manual as well as the NDOR Standard Specifications for Highway Construction.

### Research Benefits

- If prestressing was used, only straight strands were employed. The section would have enough standardized and uniform reinforcement that it could be stored and readily used as needed; saw cutting after production would have no negative effects on in-service capacity.
- That ASTM A1035 – high strength reinforcement with a specified yield stress of 100 ksi can be employed alternative to the strands in this design.
- The joint between units were designed such that it is easy to construct (self-contained) and durable. This is an improvement over the current plank joints.
- The new concrete mixture(s) has approximately 3,000 psi compressive strength at an 18-hours prestress release time. The new beams will not require more than 3,000 psi at prestress release, which was met with careful rearrangement of the strands in the section.

### Background

The objective of this research project was to develop and evaluate a cross section that can be easily configured for optimal structural efficiency across a range of spans from 40 to 60 feet, while reducing the number of shear keys, and retaining the ease of construction presented by the plank design. To achieve this objective, four phases of research were conducted. The first phase included evaluating various sections for spans up to 60 ft. This phase was completed through an extensive literature review and a new type of cross section was proposed in this study. The second phase of the research evaluated a new type of transverse connection to connect adjacent units of the proposed cross section for the proposed state county bridge system through small-scale testing on ten slab specimens. The third phase of the research includes testing five sets of full-scale bridge specimens to evaluate the system behavior, including the performance of the proposed transverse connection that included the new type of mechanical connection, staggered rebar splice joints with a commercial high-performance concrete used for the shear key, and full-scale specimen with the staggered splice joint filled with three different types of high performance. Finally, the last phase of the research conducted a design review of various proposed sections and generated span charts that could be implemented for Nebraska County bridge design.

### Conclusion

Test results indicated that the new type of mechanical joint system (transverse connection of adjacent precast beam bridges) can resist an experimental joint moment of 38 ft-kip on average, provided that the maximum spacing between mechanical joints along the bridge span does not exceed 4 ft. It was also noted that the high-performance concrete can carry a joint moment of 17.5 kip-ft per foot length which is 2.5 times larger than the equivalent moment carried by the mechanical joint system with self-consolidating concrete grout. Other possible designs that were not tested through the small scale or full-scale experimental program were proposed by a local engineering firm in Omaha and reviewed in this research. The final standard design and design span charts are proposed for Nebraska County Bridges based on literature review, small scale testing, full-scale testing, and engineering calculations.

### Principal Investigators

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### Lead TAC Member

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Final report is available at:  
[NDOT Research Website](#)

### NDOT Recommendations Based Off of Research Project

The objective of this research project was to develop and evaluate a cross section that can be easily configured for optimal structural efficiency across a range of spans from 40 to 60 feet, while reducing the number of shear keys, and retaining the ease of construction presented by the plank design. This project started in order to provide the Nebraska County Bridge engineer a tool for design.

The County consultant engineers were part of the TAC members for the life of the research project – NDOT recommended to the locals, the use of the new type of mechanical joint system (transverse connection of adjacent precast beam bridges) with UHPC.

NDOT provided the design charts to the local consultant engineers recommending the use of high strength steel to extend bridge span length.

The County is in the process of implementing the design chart using high strength steel.

- *As provided by Fouad Jaber, Lead TAC Member*

### Research Readiness Level (RRL) Assessment

#### Level 4: (Implementation with Follow up)

-Research/Technology refined and adopted by the Department. Benefits of the implementation will be evaluated for a time frame of 5 years.

**RRL 4**

This brief summarizes Project SPR-1 (17) M064  
“Standard Design for Nebraska County Bridges”  
Nebraska Department of Transportation Research Program