# Standards Updates for Single Span Prefabricated Bridges Technology Transfer Technical Brief

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**Research Project Title:** Standards for Single Span Prefabricated Bridges

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## Introduction

Standards for Single Span Prefabricated Bridges were developed by HDR for the Iowa Department of Transportation in 2016 for the use on the county road system. These standards incorporated single span precast or precast/pretensioned concrete box beams with span lengths ranging from 30-feet to 70-feet, clear roadway widths of 24-feet and 30-feet, and skews of 0°, 15° or 30°. Additionally, the standards provided both cast-in-place and precast abutment design options founded on steel H-piles. The abutment designs allowed for either steel sheet pile or concrete wing walls for the 0° skew bridges, with concrete wingwalls only for abutments at a 15° or 30° skew. The standards were developed utilizing the MicroStation V8i CADD software.

After the development of the standards, the Iowa Department of Transportation developed a procurement package under a federal grant for up to 14 bridge sites throughout the state using the single span prefabricated bridge standards. All the bridges in the procurement package used 50-foot spans at 0° skew. The purpose of the procurement package was to encourage the use of the standards amongst contractors and precast fabricators operating in Iowa. This initial procurement of bridges generated a request from the precast fabricator supplying the concrete box beams to eliminate fully tensioned prestressing strands from the tops of the box beams because the precast fabricator's tensioning beds and formwork could not accommodate the forces from the top strands. To address the precast fabricator's request and based on updated calculations for the 50-foot span, the precast fabricator was allowed to add mild reinforcing steel in the top flange and reduce the pretensioning in the top strands to a nominal 5000-pounds each (one located in each top corner). Subsequently, additional modifications were made to partially debond pretensioned strands in the bottom flange and to taper the ends of Styrofoam voids in the ends of the boxes to control tension cracks that developed in the tops of the boxes at the ends.

As a result of the modifications during the initial procurement project, the Iowa Highway Research Board requested an update to the standards to provide an option to eliminate fully tensioned prestressing strands in the top flange for all span lengths and substitute these strands with mild reinforcing steel. An additional purpose for updating the standards was to update the CADD files from the MicroStation V8i platform to MicroStation CONNECT platform.

## Conversion from MicroStation V8i to MicroStation CONNECT

The first step in updating the Short Span Bridge Standards was to perform a conversion of the CADD files from the MicroStation V8i platform to MicroStation CONNECT platform to create updated base sheets prior to other design revisions to the standards. The significant challenge of this conversion was capturing the formatting changes to the appearance of the line work and text styles from the new Iowa DOT CONNECT standards in an efficient manner. These changes also include:

a. In V8i, foot and inch dimensions did not use the " symbol for inch dimensions, whereas CONNECT shows the " symbol, requiring manual updates to all applicable dimensions.
b. In V8i, all notes and text utilized capital letters and CONNECT uses upper- and lower-case sentence structure, requiring retyping of all text and annotations.
c. The size of plan sheets changed from V8i to CONNECT. As a result, in many cases details had to be manually rearranged on the plan sheets to fit the new sheet size.

In addition to the effort by CADD technicians to make the manual revisions, the changes required extensive review by engineering staff to confirm all changes had been made correctly and information was not inadvertently deleted. Originally, it was assumed the CADD conversion would require the creation of several new sheets as it was estimated that the information previously on MicroStation V8i platform drawings may require extra sheets using MicroStation CONNECT platform. However, through discussion and meetings with the Iowa DOT staff working on the MicroStation CONNECT platform addressing challenges relating to text size, the original sheet count was able to be maintained through the conversion process.

## Design Updates to Eliminate Fully Stressed Top Strands

Once new base sheets were generated through the CADD conversion, the next step was to make updates to the design standards to provide an option eliminating fully tensioned prestressing strands in the top flanges of box beams. Knowing some precast fabricators would not have the limitations of the precast beam supplier from the initial procurement contract, the original design was preserved in the standards and the Iowa Department of Transportation requested additional drawings be generated to provide an option of eliminating fully stressed top flange strands. As a result, new calculations were performed for all span ranges to substitute mild reinforcing steel in the top flange and provide a top prestressing strand loaded to a nominal 5000-pounds in each top corner. The revisions to the standards also used partially debonded bottom flange prestressing strands and tapered box beam void forms to control top fiber tension and top flange cracking near the ends of the beams.

The optional designs eliminating fully tensioned top strands are detailed on the supplemental "A" series drawings in the standards update. Accommodating this design option required the addition of 18 new drawings and the modification of one drawing for the standards for both the 24-foot and 30-foot roadways.

## Possible Future Updates to the Standards

The current concrete box beam design used in the Short Span Standards for Single Span Prefabricated Bridges utilizes a 7 ½" tall x 3" deep keyway near the tops of the boxes reinforced with straight reinforcing steel dowel bar inserts and utilizes Ultra High-Performance Concrete (UHPC) cast in the keyways between adjoining box beams. Iowa State University has researched and tested an alternative keyway configuration in which the height of the keyway extends to within 2 ¾" of the bottom of the box section, is 3 ¼" deep, incorporates hooked dowel bar inserts and utilizes conventional Class C concrete cast in the keyway between adjoining boxes.

Initially, the Iowa Highway Research Board expressed an interest to incorporate the new keyway geometry into these current standards update. However, incorporation of this new keyway geometry would have substantially changed the geometry of the concrete boxes and thus would have required a complete reanalysis and redesign of the box beams along with extensive new detailing. As a result, incorporation of this keyway geometry change was deferred to a possible future update of the standards.

## Conclusions

The current update to the Short Span Standards for Single Span Prefabricated Bridges successfully implements the conversion of the standards to the MicroStation CONNECT platform and addresses obstacles to some precast fabricators regarding the use of fully tensioned top strands. In addition, the update addresses performance issues identified in the early procurement contract regarding top flange cracking near the ends of the concrete box beams resulting from elimination of the fully stressed top strands.