

MPC-439

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Project Title:

Precast Bridge Girder Details for Improved Performance

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Research Needs:

Many bridges on the local highway system need replacement. Local governments rely on the South Dakota Department of Transportation (SDDOT) to help replace the deficient bridges. With limited resources, SDDOT can only help replace about 30 bridges statewide each year, causing a backlog of local bridges in need of replacement.

The current standard bridge used in these replacements is the double tee precast girder bridge for its relatively low construction cost, outsourced design, and short construction duration. The expected design life of these bridges was 50 to 70 years, but some built less than 40 years ago already need replacement. The most common problem is that longitudinal joints become damaged over time, most likely due to inadequate shear transfer between the girders, allowing water and debris to enter the joints. It is only a matter of time before the joint begins to spall, creating a path for moisture to reach the prestressing steel, initiate corrosion, and degrade the structural capacity of the bridge. It should also be noted that the double tee should be designed for girder continuity, often achieved by a reinforced concrete overlay or transverse post tensioning. Many local bridges are not designed for girder continuity, however, resulting in longitudinal joint deterioration and a non-redundant structure.

Precast bridge elements are routinely used in bridge construction, general concerns for performance of these bridges is focused on the joints. Longitudinal joint performance has been noted by engineers to be one of the most commonly encountered problems especially in precast girder bridges without cast-in-place decks. This problem can be alleviated through improved joint connection details or transverse post tension. Hanna et al. (2009) presents a review of the various practices in the transverse design and detailing of adjacent-box-girder bridges and discussed the basis for calculating the transverse post-tensioning force according to PCI's Precast Prestressed Concrete Bridge Design Manual. In a previous SDDOT study (SD2010-02), a bridge near Sioux Falls, SD was inspected and this longitudinal joint problem was found to be severe for simply supported double tee girders with asphalt overlay on deck also. Li et al. (2010 a, b, c) conducted a series of studies on applying improved longitudinal joint details in decked bulb tee girders. The proposed detail relies mainly on grout and steel connectors to provide the joints with strength to resist transverse bending. In Li's study, the proposed details were tested using small specimens, which did not completely simulate the true load and deformation demands at these

joints under realistic boundary conditions. Numerical studies were also used to evaluate similar problems, such as a joint spring model developed by Smitha et al. (2011).

Routine maintenance of these bridges does increase the life span, but is not a feasible long-term solution. The amount of routine maintenance required to keep the joints sealed is too costly for local governments. Other methods, such as asphalt overlays, are also expensive and can cause increased damage over time by trapping moisture that eventually reaches the prestressing steel.

Research Objectives:

- 1) Identify alternatives to the double tee precast girder for improved shear transfer between longitudinal joints and reduced joint degradation.
- 2) Perform load testing on alternative girder(s) and double tee girder, and compare results.

Research Methods:

Through review of existing literature and practices at state and national level, this research will first establish potential improved details that will help longitudinal load transfer. Then the researchers will survey and consult with local precast companies to identify the details that will be submit to the technical panel for discussion.

Once the proposed details are approved for testing by the technical pane, full-scale bridge girders will be constructed with the detail and tested under ultimate and fatigue loads at SDSU's structures lab. Traditional double tee girder currently used will also be tested as the controlled case. The performance comparison will be made and recommendations will be made on the implementation of the proposed girder details.

Expected Outcomes:

This research could potentially produce a new girder design for use by local governments for the construction of bridges. The new girder design should diminish longitudinal joint distress, extend the service life of bridges owned by local governments, and reduce maintenance costs.

Relevance to Strategic Goals:

The expected outcomes of this project are directly related to the following goals: State of Good Repair and Economic Competiveness.

Educational Benefits:

This project will provide a valuable learning experience to both graduate and undergraduate students. A master's level graduate student will be hired to work on this project which will provide the material for a master's thesis. Undergraduate students will also be hired to work on this project. Results from the study can be incorporated into courses on prestressed concrete and bridge design.

Work Plan:

- 1) Perform literature review of precast girder technologies with alternative shear transfer at the longitudinal joint.
- 2) Create and administer survey to other Departments of Transportation to identify other viable precast bridge girder designs.
- 3) Contact precast companies, describe problems with current design, and inquire about solutions to longitudinal joint details or entire sections.

- 4) Design and construct full-scale bridge girders conforming to the traditional double tee and the proposed alternative girder design.
- 5) Perform monotonic and fatigue load testing of traditional double tee girders and the proposed alternative girders.
- 6) Develop a recommendation to the SDDOT based on cost and performance of the alternative girders compared to the double tee.
- 7) Prepare a final report and executive summary.

Project Cost:

Total Project Costs: \$160,000

MPC Funds Requested: \$72,000

Matching Funds: \$88,000

Source of Matching Funds: SDDOT

Project Duration: 24 months

TRB Keywords:

Bridge girders; Prestressed concrete; Double tee

References:

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