

MPC-500

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Project Title

Rehabilitation of Longitudinal Joints in Double-Tee Bridge Girders

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Research Needs

In a recent SDDOT research project (SD2013-01), which was co-funded by SDDOT and the Mountain Plains Consortium (MPC) University Transportation Center, SDSU researchers investigated the development of a new longitudinal joint detailing for improved performance of double-tee girder bridge systems. The researchers tested at the Lohr Structures Lab two full-scale 23" deep double-tee girder bridge system specimens under fatigue loading. The fatigue load was determined in accordance with AASHTO specifications (AASHTO, 2012). The objective of the tests was to determine the long term performance of longitudinal joints built according to the current standard detailing and to an alternative proposed detailing. The fatigue test results revealed severe inadequacy of the standard joint and exceptional performance of the proposed joint. The standard joint started to leak at the equivalent of 4 years in service and the first weld failure in a joint connection occurred at the equivalent of 12 years of service. Most of the welded connections failed at the equivalent of 16 years in service. On the other hand, the specimen with the proposed joint detailing was subjected to fatigue loading equivalent to more than 100 years of service without showing any significant joint or stiffness degradation (Konrad, 2014).

Currently, there are hundreds of double tee bridges on South Dakota highways that were built using the standard joint detailing. Based on observed field performance and test results, those bridges may be deteriorating at a fast rate and their useful lifespan may be much shorter than the expected 50 – 75 years. While new bridges can be built using the proposed joint detailing developed under project SD2013-01, replacing the currently existing deficient bridges would be cost-prohibitive. Therefore, a cost-effective retrofit to upgrade the joints of existing bridges would be an attractive alternative to replacing deficient bridges and extending the life span of existing bridges.

Research Objectives

- 1) Review and evaluate rehabilitation methods for longitudinal joints on double-tee bridge girder systems.
- 2) Test longitudinal joint rehabilitation designs for the existing double-tee girder system used in South Dakota for fatigue and ultimate load.
- 3) Recommend a longitudinal joint rehabilitation method for double-tee girders in South Dakota based on performance and cost-effectiveness.

Research Methods

Through review of existing literature and practices at state and national level and using the research findings in project SD2013-01, this research will first establish potential methods for retrofit of longitudinal joints of the double tee girder bridges in South Dakota. Then the researchers will survey and consult with local producers and contractors to identify the feasibility of the identified retrofit techniques. The identified techniques will be submit to the technical panel for discussion.

Once the proposed details are approved for testing by the technical panel, full-scale bridge girders will be constructed, retrofitted, and tested under ultimate and fatigue loads at SDSU's structures lab. The test results obtained from the previous research study (SD2013-01) of double tee bridges that are currently in service will be used as the control case. The performance comparison will be made and recommendations will be made on the implementation of the proposed retrofit details.

Expected Outcomes

This research will develop and validate a rehabilitated joint design that will inherently reduce longitudinal joint distress and extend service life. The work will produce a marketing brochure that describes the purpose, applicability, and method of performing a longitudinal joint rehabilitation on existing double-tee bridges.

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

The proposed research work is divided into 13 Tasks. Following is a listing of the project tasks.

Task 1: Meet with the technical panel to review project scope and work plan.

Task 2: Interview SDDOT and construction company personnel in South Dakota for feasible rehabilitation concepts.

- Task 3: Review bridge inspection data, including condition, pavement type, location, and chloride use, for in-service double-tee bridges in South Dakota.
- Task 4: Perform literature review for possible concepts for rehabilitating the longitudinal joint, including joint designs, construction methods, and estimated cost for each method.
- Task 5: Prepare and submit a technical memorandum that describes existing double-tee bridges by age, condition, and sufficiency rating notes, proposes feasible rehabilitation methods, estimates implementation costs, and recommends rehabilitation on double-tee bridges where applicable.
- Task 6: Meet with the project technical panel to discuss the results of the literature review and technical memorandum and have the panel decide which concept(s) to advance to the testing phase.
- Task 7: Prepare a technical memorandum detailing joint designs, construction methods, and a complete instrumentation and testing plan for technical panel review.
- Task 8: Upon approval of the plan by the technical panel, proceed with construction and instrumentation of test girders, providing the technical panel at least two weeks' notice to allow technical panel members to observe the construction and instrumentation.
- Task 9: Perform ultimate and fatigue loading of rehabilitated girders, providing the technical panel at least two weeks' notice to allow technical panel members to observe the testing.
- Task 10: Compare test results to results of the original and improved joint designs of SD2013-01 to draw conclusions on constructability, structural performance, and cost.
- Task 11: Prepare a marketing brochure for local government highway officials including rationale for rehabilitation, guidance for determining when rehabilitation is appropriate, and a description of how rehabilitation is achieved.
- Task 12: In accordance with Guidelines for Performing Research for the South Dakota Department of Transportation, prepare a final report and executive summary of the research methodology, findings, conclusions, and recommendations.
- Task 13: Make an executive presentation to the SDDOT Research Review Board at the conclusion of the project.

Project Cost

Total Project Costs: \$160,000

MPC Funds Requested: \$74,278

Matching Funds: \$85,722

Source of Matching Funds: SDDOT

TRB Keywords:

Bridge girders; Prestressed concrete; Double tee; Joint retrofit

References:

American Association of State and Highway Officials (AASHTO) (2012) "*AASHTO-LRFD Bridge Design Specifications.*" Sixth Edition. Washington, D.C.

Konrad, M. (2014) "*Precast Bridge Details for Improve Performance.*" A thesis in partial fulfillment of the requirements for Master of Science in Civil Engineering. South Dakota State University, Brookings, South Dakota.