Executive Summary, Research Readiness Level Assessment, and Technology Transfer

Synthesis of Repair Practices of Damaged Precast/Prestressed Concrete Girders

Research Objectives

The main project objective was to develop a comprehensive repair manual for NDOT precast/prestressed concrete girders subjected to various types of damage. The manual was organized in a similar fashion to the PCI manual for the valuation and repair of precast, prestressed concrete bridge products. The manual addressed the damage type to present the following:

- Damage description.
- Possible causes and prevention methods
- Engineering effects
- Repair Methods and Procedures

Research Benefits

1. Provide repair alternatives and a methodology for selecting concrete girder repair that enables NDOT and contractor to make timely and cost-effective repair decisions.
2. Repair damaged bridge girders minimize the need for full replacement, which are time consuming, traffic disruptive, and cost friendly.

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Background

Precast/prestressed concrete girders are widely used in bridge construction in Nebraska. Occasionally, girders are subjected to damage due to different reasons, such as accidental collision of over-height vehicle/equipment, incidental damage during abutment/deck replacement, malfunctioning of supports/joints, and/or corrosion of reinforcing steel/strands.

The current Nebraska Department of Transportation (NDOT) Bridge Office Policies and Procedures (BOPP) document provides limited information regarding the assessment and repair procedures for damaged precast/prestressed concrete girders. Specifically, general standard notes provide for concrete rehabilitation and repair in Section 2.3.4. On the other hand, several other transportation agencies in USA and Canada have developed repair manuals/special provisions for the repair of damaged concrete components with a particular focus of girders.

In addition, several studies sponsored by NCHRP and State DOTs evaluated the effectiveness of different repair and retrofit techniques, such as carbon-fiber reinforced polymers (CFRP), ultra- high-performance concrete (UHPC), external post-tensioning, and strand splicing. These techniques continuously evolve, and new ones are developed.

Conclusion

Bridge girders are constantly subjected to various types of damage during their service life. There is currently limited knowledge or guidelines provided by the NDOT Bridge Office Policies and Procedures (BOPP) regarding the assessment and repair procedures of damaged precast/prestressed concrete girders. This report aimed to develop a comprehensive repair manual for precast/prestressed concrete girders subjected to damage caused by over-height vehicular collision and damage located at the girder ends. Over-height vehicular collision damage typically occurs at the middle portion of the exterior girders and the primary concerns are focused on flexural deficiencies. Girder end damage can occur due to corrosion of prestressing strands or reinforcement, malfunctioning joints, or during deck/abutment replacement; where the primary concerns are focused on shear deficiencies. When damage occurs, the decision-making process regarding whether to repair, rehabilitate, or replace the girder is typically challenging. A literature review on the classification of damage and a proposed damage classification are presented for each damage type. Repair methods and procedures for each damage class are then presented for each damage type. Previous repair cases done by NDOT are documented and their performance is evaluated by visual inspection records. Ultimate limit state structural calculations are presented in the form of design examples to calculate the flexure or shear strength of the undamaged and damaged girder according to AASHTO LRFD. The ultimate flexure or shear strength of a strengthened girder using FRP wrapping is also presented according to ACI 440.2R-17 as a design example. Suggested material properties are presented for each repair method according to previous research work and previous NDOT repair cases.

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Interested in finding out more?
Final report is available:
HERE

NDOT Recommendations Based Off Research Project – 2020 – RRL4

Bridge Division Repair Section is implementing the guidelines stated in the research report. The long-term planning is to develop a collision prestress girder repair policy and manual. The repair section in the Bridge division is implementing the repair alternatives along with sketches of repair detailing and sample design calculations included in the report.

Bridge Division will coordinate with Material and Research to review the repair materials suggested in this research for prestress collision girder repair to be placed in the NDOT Approved Product List (APL).

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

NDOT Recommendations Based Off Research Project – 2025 – RRL5

Bridge has adopted this research in the NDOT Bridge Design Manual in Chapter 7 Repair and Preservation. Section 7.4.4.2 – Prestressed Concrete Girder Repairs refers to this report when introducing repair practices. This research has been a standard policy since November 2024.

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

Research Readiness Level (RRL) Assessment

RRL 5

Level 5: Standard Practice / Full Understood

Research adopted; no evaluation is required. Moved up from RRL Level 4, assessed in 2020.

This brief summarizes Project SPR-P1(19) M090
"Synthesis of Repair Practices of Damaged Precast/Prestressed Concrete Girders"
Nebraska Department of Transportation Research Program