Research Brief

Wisconsin Highway Research Program
Project 0092-17-02
May 2019

Strength and Serviceability of Damaged Prestressed Girders

Research Objectives

- Develop recommendations and guidelines for the inspection, evaluation, repair, or other necessary safety and operational responses related to damaged prestressed concrete girders

Research Benefits

- Developed Prestressed Bridge Assessment, Repair, and Strengthening (PreBARS) software for assessing serviceability and strength of girders
- Produced detailed guidelines for inspecting, assessing and repairing top and bottom flanges under various states of damage

Principal Investigator

Habib Tabitabai
University of Wisconsin - Milwaukee
ht@uwm.edu

Project Manager

Aaron Bonk
WisDOT
aaron.bonk@dot.wi.gov

Background

Prestressed concrete bridge girders suffer unpredictable damage from accidental over-height-vehicle impacts and unintended construction-related damage during deck removals. These damage situations complicate strength assessments due to section loss and the asymmetrical condition of the girder after damage. The objective of this research was to develop recommendations and guidelines for the inspection, evaluation, repair and other necessary safety and operational responses related to damaged prestressed concrete girders.

Initial-impact (top left) and rebound-impact (bottom right) damage

Methodology

The research team inspected five Wisconsin bridges exhibiting various levels of flange damage, including ones that had been repaired. These inspections, in addition to other damaged girder reviews, were used to develop the Prestressed Bridge Assessment, Repair, and Strengthening (PreBARS) software, a comprehensive program for assessing serviceability and strength characteristics of girders under undamaged, damaged and repaired conditions. Procedures were developed to assess changes in service stresses due to damage. These procedures were implemented in the PreBARS program. PreBARS was then used to conduct multiple case studies on two prestressed I-girder bridges, one with a long span (146 feet) and the other with a short span (50 feet). Different levels of strand damage in the bottom flange (up to 25 percent loss) were simulated on girders from both structures, and various repairs were applied in each case. Carbon Fiber Reinforced Polymer (CFRP) repairs applied on the bottom flange and the webs were

"This research provides WisDOT a better understanding of the effect of different types and severities of girder damage, which will lead to consistent project review and repair strategies statewide."
– Aaron Bonk, WisDOT Bureau of Structures

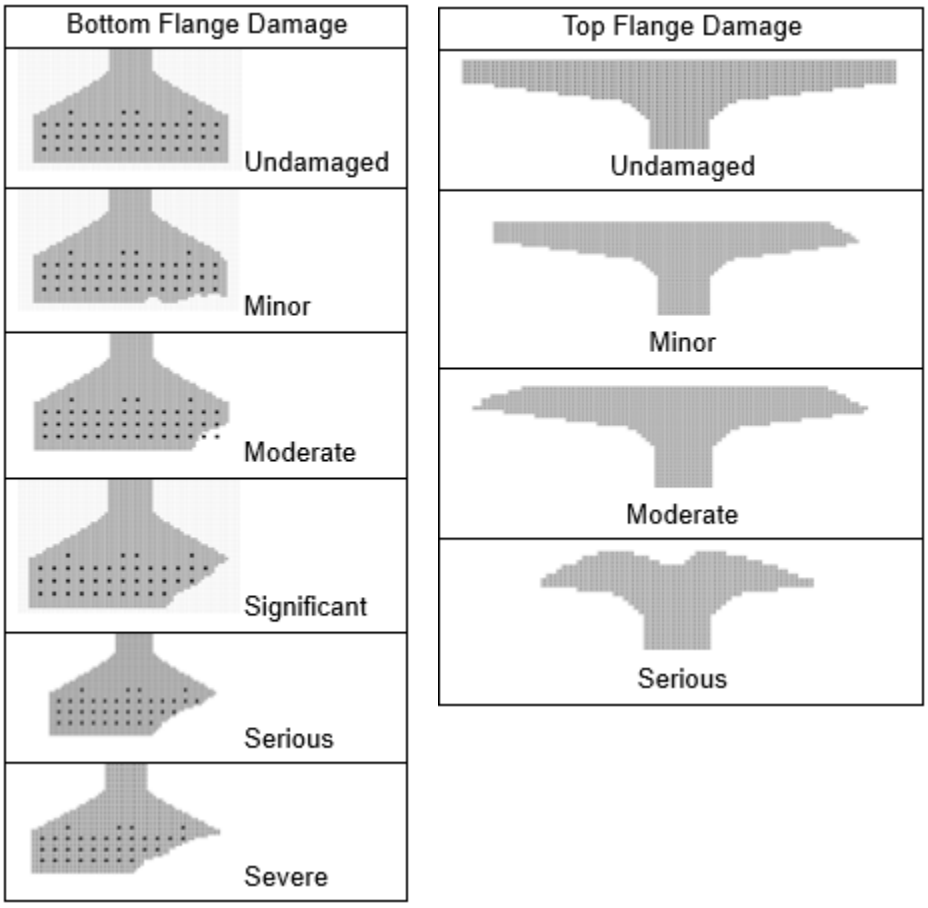
Interested in finding out more?

Final report is available at:
WisDOT Research website

examined in conjunction with the partial splicing of the severed strands for bottom-damage cases. Similarly, different levels of top flange damage were introduced in girders from both structures (up to 50 percent loss of top flange).

Results

The research team developed categorical definitions and descriptions of flange damage through the PreBARS program. Damage categories for bottom flanges reflect the severity of cracking, spalling, strand exposure and strand severance. Damage categories for top flanges reflect the severity of cracking, loss of section, girder sweep and weakening of interface shear reinforcement.



Recommendations for implementation

The research team developed the PreBARS software and detailed recommendations for inspecting, assessing and repairing damage to top and bottom flanges. These tools will aid WisDOT in making prompt decisions on the appropriate course of action when a girder is damaged. Repairs may include patches, strand splices, and external CFRP reinforcement; or a combination of these strategies.

This brief summarizes Project 0092-17-02,
"Strength and Serviceability of Damaged Prestressed Girders"
Wisconsin Highway Research Program