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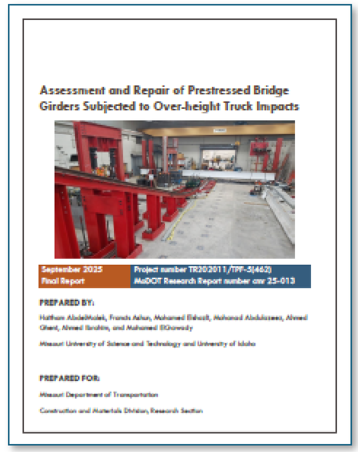
Research Summary


Assessment and Repair of Prestressed Bridge Girders Subjected to Over-height Truck Impacts

September 2025
Final Report
Project number TR202011/TPF-5(462)
MoDOT Research Report number cmr 25-013

PREPARED BY:

Missouri University of Science and Technology and University of Idaho

PREPARED FOR:

Missouri Department of Transportation

Construction and Materials Division, Research Section

Assessment and Repair of Prestressed Bridge Girders Subjected to Over-height Truck Impacts

This comprehensive research project addresses the increasingly frequent and costly problem of over-height vehicle collisions with prestressed concrete (PC) bridge girders. The research combined full-scale experimental testing, nonlinear three-dimensional finite element modeling (FEM), and analytical methods to quantify the extent of damage, assess residual structural capacity, and evaluate repair strategies for prestressed girders subjected to lateral impact. Fourteen MoDOT Type II prestressed concrete girders (46 feet long) were subjected to 23 full-scale tests, including lateral impacts and static flexural loading. Damage scenarios ranged from minor to severe, simulating strand losses from 17% to 50%.

Key technical findings from this research provide crucial insights into the behavior and rehabilitation of prestressed concrete girders subjected to over-height truck impacts. Among the most significant discoveries was the identification of shear failure as the dominant mode of damage resulting from lateral impacts.

An important design implication emerged from the observation that accidental lateral eccentricity—often introduced during impact—substantially reduces a girder's flexural resistance. Based on experimental and numerical results, the study recommends the adoption of a 15% reduction factor in flexural capacity within AASHTO LRFD Bridge Design Specifications to conservatively account for this effect in design and evaluation procedures.

In addressing post-impact evaluation, the study developed and validated a non-destructive method for estimating residual prestress forces in the field. This method demonstrated strong agreement with destructive testing, with a conservative deviation margin of only 9.6%, offering a practical and safe approach for field assessment without compromising girder integrity.

"This work equips engineers with validated, cost-effective strategies to restore damaged prestressed girders, ensuring public safety and economic continuity."

The efficacy of various repair strategies was thoroughly evaluated. Mechanical strand splicing proved highly effective in restoring up to 95% of original flexural strength in girders with up to 33% strand loss. However, its performance declined when strand loss exceeded 25% in the absence of adequate confinement. Externally bonded CFRP repairs restored or exceeded the original capacity for girders with up to 33% strand loss, delivering an additional strength reserve of 15%–23%, depending on the extent of damage and configuration.

Finally, a hybrid repair system, integrating mechanical strand splicing with CFRP U-wraps for transverse confinement, was examined and found to perform favorably in scenarios with extensive damage (e.g., 50% strand loss).

This research fills a critical gap in national infrastructure policy by providing validated, full-scale data and practical guidance for bridge engineers. The findings offer DOTs a clear path to cost-effective, performance-based repair solutions, ultimately enhancing the resilience and safety of the nation's transportation infrastructure.

Figure 1: Impact testing and reapir using CFRP

Project Information

PROJECT NAME: TR202011/TPF-5(462)—Assessment and Repair of Prestressed Bridge Girders Subjected to Over-height Truck Impacts

PROJECT START/END DATE: January 2021-April 2025

PROJECT COST: $805,000

LEAD CONTRACTOR: Missouri University of Science and Technology

PRINCIPAL INVESTIGATOR: Mohamed ElGawady, PhD

REPORT NAME: Assessment and Repair of Prestressed Bridge Girders Subjected to Over-Height Truck Impacts

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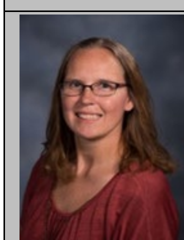
Project Manager



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