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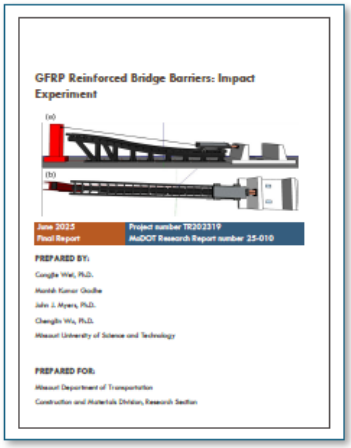
Research Summary

GFRP Reinforced Bridge Barriers: Impact Experiment



The primary objective of this research is to design and conduct a series of impact tests on concrete barriers reinforced with glass fiber-reinforced polymer (GFRP) and a control test specimen with mild steel reinforcing materials. The GFRP reinforcement consists of a hook-shaped piece and a spiral piece, which form the required confinement to develop the strains of the transverse bars and provide shear resistance. The spiral piece was embedded into the slab to achieve the bending effects needed for the barrier impact. The theoretical feasibility of this design has been demonstrated in our previous project and is detailed in the report titled "GFRP Reinforced Bridge Barriers: Numerical Modeling".

Concrete road barriers are crucial for safeguarding lives on roadways. As a final safety measure, these barriers must effectively prevent vehicles that have lost control from crossing into opposite lanes of traffic or crashing into adjacent fields, scenarios that could result in more severe accidents than collisions with the barriers themselves. Understanding how these barriers behave and potentially fail under various impact conditions, determined from vehicle types, impact angles, and other influential factors, is essential for ensuring their effectiveness [1-5].

Currently, steel bars are the most commonly used reinforcement material for concrete structures. However, corrosion is a main issue, especially for structures impacted by freezing and thawing environments in the Midwest regions. Each year in the US, hundreds of millions of dollars are spent on corrosion-related repair or maintenance projects. If not repaired or maintained effectively, structures impacted by corrosion, such as bridges, could experience a catastrophic failure, which could lead to loss of human life.

> *"Concrete road barriers are crucial for safeguarding lives on roadways."*

Replacing steel reinforcement with corrosion-resistant or corrosion-free materials has been actively pursued in the past decades. For instance, corrosion-free, glass fiber reinforced polymer (GFRP), emerges as a promising alternative to steel reinforcement. GFRP does not undergo the corrosive processes that can significantly degrade steel reinforcement, thereby preserving both the structural integrity and the longevity of concrete infrastructure.

In this work, four concrete bridge barriers were constructed on two concrete slabs. For comparison consideration, three barrier specimens were reinforced with GFRP materials, while one was reinforced with steel bars. The impact tests were conducted by utilizing an impact cart mounted on a straight, long sled system. Strain gauges, string-pots, load cells, and

accelerometers were installed and used to measure force and deformation during and after the impact loading was applied.

The results showed that for all cases, the fluctuations of strain, force, and acceleration quickly returned to zero after a significantly small amount of time. The sustained impact load exceeds the design load. After impact tests, the specimens exhibited no damage or cracks. No significant lateral displacements were observed for the barrier. The strain measured along the GFRP bars shows lower values than the yield strain of the steel, indicating an elastic response of the specimens. These results demonstrate the capability of GFRP-reinforced concrete barriers to withstand the same level of impact force as traditional steel-reinforced concrete barriers.

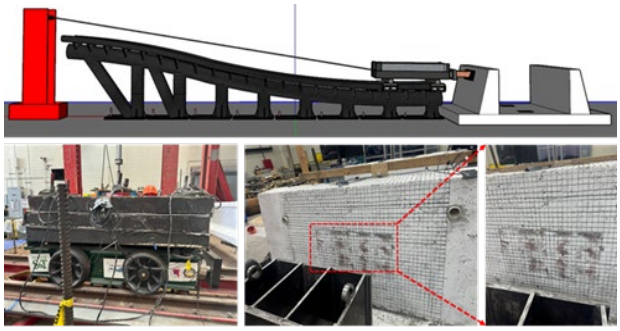


Figure 1: Impact test of GFRP reinforced concrete bridge barriers.

Project Information

PROJECT NAME: TR202319—Impact Test of GFRP Reinforced Bridge Barriers

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