

# Executive Summary, Research Readiness Level Assessment, and Technology Transfer

## Truck Platooning Effects on Girder Bridges - Phase I

### Research Objectives

The primary objectives:

1. Evaluated whether truck platooning on highway girder bridges in Nebraska violated safe load limits according to typical assumptions and methods used by NDOT, and under what conditions.
2. Provided guidelines for how to manage truck platooning operations, accounting for more exact knowledge of truck loading magnitudes and distribution and reduced uncertainty with platooning.

### Research Benefits

Most research and development efforts for truck platooning have focused on traffic operations and vehicle control. The structural safety of bridges carrying increased load from truck platoons has not yet been thoroughly studied, but DOT needed to ensure that their structural assets will not be compromised before allowing platooning operations in their jurisdictions. This project enabled the Nebraska DOT to keep pace with advancements in autonomous vehicles while also maintaining structural safety for girder bridges in their transportation network. Revisiting the reliability implications with reduced truck loading uncertainty justified allowing heavier vehicles than routinely allowed when justified by data sharing from trucking companies combined with effective automated enforcement strategies.

### Principal Investigators

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### Lead TAC Member

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### Background

Connected and Automated Driving System (C/ADS)-equipped vehicles are expected to become increasingly common in the United States and similarly affluent countries globally. To address the challenges posed by these new systems on infrastructure, the Transportation Research Board funded NCH RP Project 20-102: Impacts of Connected Vehicles and Automated Vehicles on State and Local Transportation Agencies. These studies focus primarily on transportation fuel efficiency, with little consideration of impacts on structures.

As automated vehicle control systems continue to develop, the findings from this research were integrated with software packages to automatically configure optimal configurations at each structure for a specified platoon. The trucks in the platoon will then dynamically adjust configuration when transitioning between roadways on grade and particular bridge structures. This research provided the baseline work for the highly automated systems that will be forthcoming in the next decade and informed associated policy decisions. The research team produced actionable guidelines for safe truck platoon configurations corresponding to the data provided by the trucking company and the structures on the targeted route.

### Conclusion

This research provided a framework for determining how much a platoon permit load might be increased given strict control over the load characteristics and operational tactics. The research evaluated the Strength I limit state for steel and prestressed concrete I-girder bridges designed with LRFD and LFD. Herein, platoons are assumed to be advanced not only with respect to traffic operations but also in their ability to weigh and report axle weight and spacing, mobile-WIM (mWIM). Consequently, the live load statistics (bias and CoV) differed from code assumptions, and are perhaps controllable, which posed significant opportunity with respect to operational strategies and associated economies.

A parametric study considered different girder spacings, span lengths, numbers of spans, types of structures, truck configurations, numbers of trucks, and adjacent lane loading scenarios. Reliability indices  $\beta$  were calculated for each load case based on the Monte Carlo Simulation Method. The results indicated that loads significantly higher than legal loads are acceptable for truck platoons with lower uncertainties while maintaining a traditional operating target  $\beta = 2.5$ , consistent with permit loading in the Manual for Bridge Evaluation. Live load factors were developed and presented for a potential new permit load, i.e., a platoon permit. This approach helps to inform owners of effective operational strategies to safely benefit economies on a state or multistate corridor basis.

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Final report is available at:  
[NDOT Research Website](#)

### NDOT Recommendations Based Off of Research Project

This research provided the baseline work for the highly automated vehicle systems that will be forthcoming in the future and informed associated policy decisions to manage and assess this technology. The research provided guidelines for how to manage truck platooning operations, accounting for truck loading for strength and shear magnitudes and distribution factor associated with platooning. The research evaluated the Strength I limit state for steel and prestressed concrete I-girder bridges designed with LRFD and LFD. The research team provided guidelines for safe truck platoon configurations corresponding to the data on I-80 between Nebraska and Wyoming. NDOT will be able to guide and manage the information provided by the trucking company and the structures on the targeted route. Platoons of heavy trucks will be economically advantageous for freight operators in the near future, this research provided information currently is insufficient for bridge Division to establish platoon operation limitations and guidelines ensuring safe and serviceable loading demands in girder bridge structures in terms of vehicle weights, live load uncertainties, and headways. The Department proposed a [Phase II- Truck Platooning Effects on Girder Bridges](#) in which the research focus will be to calibrate appropriate live load factors for use with platoons to address the Service III limit state for concrete girder bridges and calibrate appropriate live load factors to address the Service II limit state for steel girder bridges.

- As provided by Fouad Jaber, Lead TAC Member

### Research Readiness Level (RRL) Assessment

**Level: Level 3: Development**

Research/Technology developed in an operational environment (real-world situation).

**RRL 3**

### Technology Transfer

#### Upcoming Webinars/Presentations

- Presenting a submitted paper titled "Safe Platooning Headways on Girder Bridges" at the 2021 [International Bridge Conference](#), sponsored by the Engineers' Society of Western Pennsylvania. Scheduled to be held June 7-10, 2021.

**This brief summarizes Project SPR-P1(20) M030  
 "Truck Platooning Effects on Girder Bridges"  
 Nebraska Department of Transportation Research Program**