The condition of the road leading up to a bridge influences the amount of strain the bridge experiences under the weight of a vehicle.

RESEARCH SOLUTIONS

Estimating the effects of oversize and heavy vehicles on Iowa's bridges

When a vehicle travels over a bump or dip on a bridge, the vehicle may bounce, which can amplify the vehicle's weight by as much as 30 percent and substantially increase the impact to the bridge. When issuing permits for extremely large or heavy vehicles, Iowa DOT considers this potential strain to determine which bridges can support the load. A method for calculating bridge strain developed in this study will ensure Iowa DOT's permitting and estimation processes are reasonable.

THE NEED

Iowa DOT requires motor carriers and agricultural transporters to obtain permits to travel on state-owned roads. The permit application process requires operators of vehicles carrying especially large or heavy loads to provide the exact route they plan to take through the state. The agency's regulators then review the proposed route before issuing a permit to ensure that only bridges that can safely accommodate the oversize or overweight vehicles will be used.

While bridges on the state's primary highway system are designed to support high traffic volumes and heavy loads, many of the bridges along lower-volume roads are not. As a condition of its overweight permit, Iowa DOT can require a motor carrier to travel a different route than proposed or to slow down significantly before crossing a bridge — sometimes to speeds as slow as 5 mph — to minimize the vehicle's effects on the bridge. These restrictions are intended to prevent premature bridge damage, but they can have negative consequences such as traffic delays, which impact all road users, and less-efficient routes, which can increase motor carriers' fuel consumption and operational costs.

(continued)

"The lessons we learned from this research could one day lead to better permitting and assessment processes in Iowa."

— **SCOTT NEUBAUER,**
Iowa DOT Bridge Maintenance and Inspection Engineer

To ensure that its permitting and estimation processes produce accurate results, Iowa DOT sought to develop and evaluate a different process for estimating potential bridge strain.

RESEARCH APPROACH

A 2016 Iowa DOT research project found that the condition of the road at the entrance to a bridge directly influences the amount of strain that a vehicle exerts on the bridge as it crosses. When the entrance to a bridge is in better condition, a vehicle has less impact as it traverses the bridge. The current project sought to further investigate this correlation and determine whether surface condition data, which is routinely collected in Iowa, could be used to predict bridge strain.

Researchers selected 20 bridges of varying lengths, girder materials, and deck conditions to serve as a representative sample of the bridges across the state. These bridges were then outfitted with strain gauges and monitored as traffic passed over the bridge. Videos taken simultaneously at each site helped to match the strain data with the corresponding vehicle.

Road condition data from four locations at each bridge were applied to the strain data to determine the relationship between the road surface and impact factors.

WHAT IOWA LEARNED

The data showed that a bridge experiences less strain when the road condition is better near the bridge entrance. Additionally, a bridge with a higher skew angle will experience less strain than a bridge with a lower skew angle. As this information is already collected for each bridge in the state, the researchers developed an equation that incorporates both factors to predict bridge strain for any bridge in the state.

The equation was validated on 13 state bridges; however, the researchers noted that a bridge's actual strain could be up to 10 percent higher or lower. A second phase of this study was conducted to further validate the equation. In an analysis of nine additional bridges, the equation showed a deviation of up to 5 percent higher or lower from the actual bridge dynamic response, which is considered accurate.

PUTTING IT TO WORK

Using readily available data, Iowa DOT has developed a new tool to estimate the strain that a heavy vehicle will exert on a bridge. Though this method is not currently used in Iowa, the equation could be used in the future to allow the agency to issue overweight vehicle permits with fewer restrictions while still protecting the state's valuable infrastructure.

ABOUT THIS PROJECT

PROJECT NAME: Evaluation of the Use of IRI Data to Estimate Bridge Impact Factor
Final Report | Technical Brief Verification of Proposed DIF Estimation Equation

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