Understanding how bridges perform over time allows Iowa DOT to update and improve its design specifications.

RESEARCH SOLUTIONS

Increasing service life at bridge ends

The use of integral or semi-integral abutments in bridges has the potential to reduce maintenance and increase service life by preventing surface water and deicing chemicals from seeping in and causing deterioration, especially at bridge ends. However, design specifications for these abutments vary, and researchers sought to understand which design details would achieve the expected structural integrity and performance under service loads. Inspection and instrumentation of bridges in the field, paired with numerical assessments, provided firsthand information that will help engineers evaluate the long-term impact of abutment choices, taking into consideration a range of design factors.

THE NEED

Jointless bridge designs are used in Iowa and other Midwestern states because of their potential to offer improved long-term performance. Expansion joints are eliminated from the ends of these bridges, offering an economical design choice with minimal maintenance needs. Yet some bridges in Iowa were showing signs of distress, such as widening gaps at curb joints and transverse cracking. Specifications for these designs lack consistency. This research project studied existing integral and semi-integral abutment bridge designs to gain some consensus on design elements that would eliminate problems in new bridge designs and remedy issues with existing bridges in the field.

RESEARCH APPROACH

A literature search of the designs and detailing requirements for integral and semi-integral abutments provided considerable information about practices that various states and localities are using for bridge end specifications. The literature search identified many areas

(continued)

"We gathered so many useful details for improving our bridges. The next step is sifting through all we learned and integrating those details into our designs."

— **MICHAEL NOP,**
Iowa DOT Bridge Project Development Engineer

of interest in terms of optimizing specifications moving forward.

Visual inspections of nine Iowa bridges built with integral and semi-integral abutment designs evaluated the performance of these structures over time. Inspections yielded evidence of recurring problems but did not reveal how the problems emerged. To address this standing question, four additional bridges were instrumented with sensors to further advance understanding of the potential issues impacting the long-term behavior of integral and semi-integral abutment bridges in service.

Strain gauges, earth pressure cells, crackmeters, and displacement meters were used to monitor bridge performance and obtain various structural response measures over time. The sensors within the abutments and approach slabs provided a much more insightful set of data on how loading demands develop over a period of years. The monitoring helped demonstrate the performance of the relevant design choices not only individually but also in comparison with each other.

Finite element modeling and simulations of the four instrumented bridges provided additional insights about a suite of contributing factors, such as approach slab friction, soil stiffness, tie bar type, and bridge skew.

WHAT IOWA LEARNED

The information obtained from this study will allow engineers to create more uniformity in bridge end designs and also address problem areas. For example, looking at the skew effects at bridge ends, the research showed a notable variation in the distribution of tie bar stresses across tied approach joints. Other bridge details, including those for abutments, approach slabs, and their connections, were also found to need attention.

In this study, design choices could mitigate the issues occurring at the bridge ends in most cases. For example, barrier rails could be placed on top of the approach slab when these slabs are tied to the abutments. Strip seals were also recommended for new construction of integral and semi-integral abutments. Addressing soil settlement, joint opening, transverse cracking, and other issues that could be introduced by using these abutment types was also noted to lead to improved service life of integral and semi-integral abutment bridges.

PUTTING IT TO WORK

Through this research, Iowa DOT obtained a much greater understanding of bridge performance and of design characteristics that can be modified to improve safety and structural performance, especially at bridge ends. The agency has begun identifying resources to undertake the significant work needed to integrate the knowledge acquired in this project into standard bridge designs.

ABOUT THIS PROJECT

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Final Report | Technical Brief

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