Executive Summary and Research Readiness Level Assessment

Development of an NDT Tool for In Situ Assessment of Prestress Loss

Research Objectives

The research objective developed a non-destructive testing (NDT) method to evaluate the prestress loss in prestressed concrete bridge girders using ultrasonic waves. The work principle was based on acoustoelastic effect - ultrasonic wave velocity varies with stress level in prestressed concrete. A self-reference test setup was proposed to measure wave velocity in two orthogonal directions (prestress and unstressed directions) in the girder. This setup was able to reduce effects of material variation and temperature change.

Research Benefits

The proposed research provided a solution with simple test setup. A significant advantage of the proposed technique is that no baseline is needed, so it is suitable for in-situ measurement on existing structural members. The proposed research increased the accuracy of assessment of prestressed members and improved the safety and durability of bridges.

Principal Investigators

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Background

The concept was first validated on small concrete specimens (cylinders and beams) in laboratory. A signal analysis algorithm was developed to reliably measure P wave velocity change with stress, i.e. the acoustoelastic coefficient. Then the proposed technique was applied to a full-scale prestressed concrete bridge girder (131 ft long) to monitor the stress release process. The stress change monitored by the ultrasonic test showed good agreement with the result from the strain measurement. In both the small beam test and the large girder test, the measured acoustoelastic coefficients were in the range of 0.7%/ksi.

Conclusion

The temperature effects on acoustoelastic coefficient were investigated on two prestressed concrete members. Experimental results showed a slight difference between temperature induced velocity changes in the prestress and unstressed directions. Although temperature variation can cause large change of velocity, the self-reference setup will be able to correct about 80% of temperature effect. The relationship between relative wave velocity changes and stress changes in two orthogonal directions after temperature correction can be used to predict the stress level in concrete and reduce environmental influences.

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Final report is available:
HERE

NDOT Recommendations Based Off of Research Project

"Phase I research proved the feasibility of using ultrasonic waves for stress evaluation and monitoring. In phase II research, we will extend the study to prediction of prestress loss and camber growth of prestressed girders during the period from release to deck construction. In order to apply this NDT technique to practice, we propose the following research objectives in phase II research:

(1) Build the relationship between ultrasonic wave velocity and strain in concrete based on measurements on Nebraska prestressed girders;
(2) Understand and correct temperature effects on ultrasonic and camber measurements;
(3) Develop a calculation procedure to predict stress loss and camber from production to deck placement based on ultrasonic measurement;
(4) Improve the current camber calculation procedure by measuring actual modulus of elasticity E using ultrasonic waves before prestress release."

- *As proposed by Jinying Zhu (P.I.). The Department agrees that Phase II is needed for additional information and validation of the research.*

Research Readiness Level (RRL) Assessment

RRL 2

Level 2: Applied Research/Proof Concept – Lab Level

-Research/Technology developed in a laboratory environment. Integration of components

This brief summarizes Project SPR-1(17) M074
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Nebraska Department of Transportation Research Program