Continuous Real-Time Highway Bridge Joint Monitoring System

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Abstract

Due to the extensive use of simply supported spans in road construction following the 1956 Federal-Aid Highway Act, most of the bridges that are towards the end of their service life in USA has expansion joints as key components for their stress release mechanisms. Monitoring the response of these expansion joints can not only track their performance but also indicate the overall health of the bridge, as any displacement in the superstructure or substructure can be recorded through them. However, despite its significance, highway agencies have long relied on visual inspections, lacking a cost-effective monitoring system. To address this gap, a wireless expansion joint monitoring system has been developed in this study, capable of measuring and transmitting joint performance data in real-time over the long term at a low cost. Utilizing ultrasonic distance sensors, 6TiSCH and hardware, and cloud-based servers, the system enables sensing, communication, data management, and visualization. Its sensing capabilities have been compared with conventional LVDT sensors, showing comparability. The system was deployed on an in-service bridge in Connecticut for over 2 months to monitor small movement asphaltic plug joint. During this monitoring period, deformation at the expansion joint, bridge superstructure temperature, and humidity were measured. Furthermore, a full 3D finite element model of the bridge in ANSYS was developed to validate the monitoring results, with simulation and field monitoring data showing good agreement. Additionally, an assessment framework for the overall bridge health condition based on the measured data fused with FE results is underway. Preliminary result has shown that a correlation with bearing and superstructure conditions, demonstrating the feasibility of assessing bridge health through expansion joints.

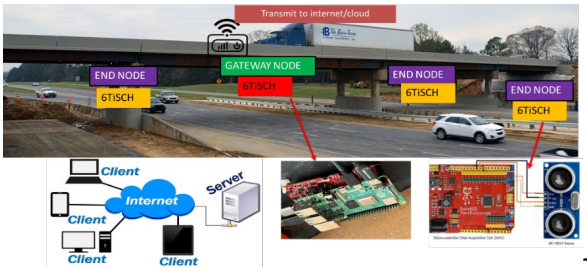

Figure 1: Final design of wireless expansion joint monitoring system

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References:

Commented [RM2]: Add about 3 references

[1] Ni, Y. Q., Hua, X. G., Wong, K. Y., & Ko, J. M. (2007), "Assessment of bridge expansion joints using long-term displacement and temperature measurement". Journal of Performance of Constructed Facilities, 21(2), 143-151.DOI: 10.1061/ASCE0887-3828200721:2143

[2] Ren, D., & Fils, P., & Jang, S. (2022). "Technical Survey and Literature Review on Bridge Joint Monitoring Practices". ASEE-NE 2022, Wentworth Institute of Technology, Massachusetts. https://peer.asee.org/42208

[3] Yarnold, M.T.; Moon, F.L.; Emin Aktan, A(2015). "Temperature-Based Structural Identification of Long-Span Bridges". Journal of Structural Engineering, 141, doi:10.1061/(asce)st.1943-541x.0001270.