VDOT Virginia Department of Transportation
Virginia Center for Transportation INNOVATION & RESEARCH

Research Brief
VCTIR 12-R10RB August 2013

Thermal Response of a Highly Skewed Integral Bridge

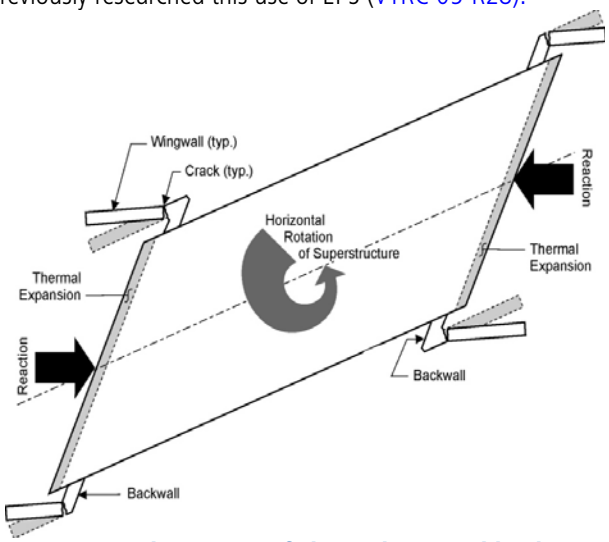
Perspective Current Virginia Department of Transportation (VDOT) design policy promotes the relatively new technology of jointless, or integral, bridges, primarily because their lifetime maintenance costs are manifestly lower than those of conventional (jointed) bridges.

However, VDOT and many other state departments of transportation have placed restrictions on the design of integral bridges until researchers field evaluate bridge physical behaviors, such as the long-term effects of repetitive, thermally induced cyclic movements, and recommend design modifications in response to what they observe. With successive cycles of field research and design policy re-evaluation, VDOT is able to introduce incremental changes to their design methodology that allow broader use of integral bridges.

Background This Virginia Center for Transportation Innovation and Research (VCTIR) research project was initiated at the request of VDOT's Staunton District Structure and Bridge Office. An existing skewed bridge on Route 18 over Blue Spring Run in Alleghany County was functionally obsolete. VDOT designers wanted to replace it with an integral bridge, but existing design restrictions did not allow the 45° skew angle needed for the new bridge to connect to the existing roadway. Bridge designers needed more data to account for the substantial rotational forces to which a highly skewed integral bridge is subjected.

Ultimately, VDOT granted a design exception to allow the 45° skew, with the understanding that the new bridge would be monitored by VCTIR researchers. As a result, this research project provided a unique opportunity for VCTIR to help VDOT lead the way in the design of integral bridges.

Research and Recommendations VCTIR researchers monitored the performance of the new semi-integral bridge with a 45° skew for 5 years. During this period, electronic data loggers automatically recorded ambient air temperatures, induced displacements, loads, and pressures at hourly intervals. In addition, conventional surveys were conducted to evaluate the settlement at bridge approach embankments. The bridge incorporated a layer of elasticized expanded polystyrene (EPS) at the abutment. It was designed to absorb thermally induced movement of the superstructure, thus minimizing its impact on the approach fill. VCTIR previously researched this use of EPS (VTRC 05-R28).



Horizontal rotation of skewed integral bridge

The researchers analyzed field data and formulated several design recommendations. They found that when the bridge was subjected to large thermal expansion, the stress from horizontal rotation acting on the bridge abutment wingwalls was greater than expected. The study recommendations address various design details and calculations. Most significant, the study recommends that VDOT consider amending their bridge design guidelines to raise the allowable skew angle limit for semi-integral bridges from 30° to 45°.

For the full report, see VCTIR 12-R10. For more information about the research, contact Edward J. Hoppe, Ph.D., P.E., VCTIR senior research scientist, at Edward.Hoppe@vdot.virginia.gov.

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