CURVED INTEGRAL ABUTMENT BRIDGE DESIGN

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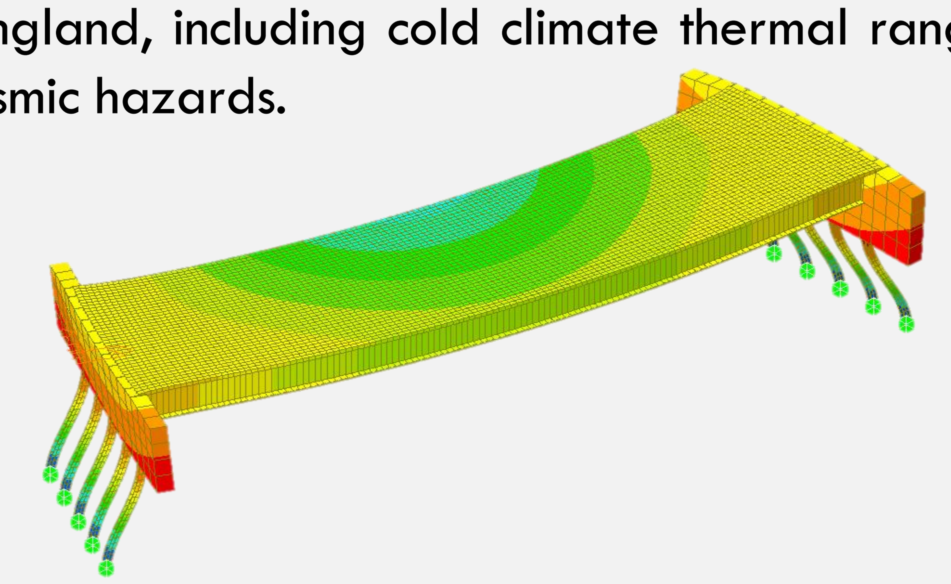
ABSTRACT

Straight integral abutment bridges have been used throughout the New England states to reduce bridge maintenance costs and extend the service life of structures. Extending integral abutment bridges to curved alignment applications offers bridge owners additional areas to reduce construction costs associated with the lengths of approaches and right-of-way acquisitions as compared to tangent alignments. The purpose of this research is to investigate the effects of various bridge parameters pertaining to the behavior of curved integral abutment bridges (CIAB's). The results are to be used to make recommendations for a simplified design method for CIAB's. The simplified design method is to be implemented in a design guideline to enhance the bridge design practice throughout the New England region. A finite element analysis parametric study was performed to investigate the behavior of CIAB's. The results of this study have been used to develop the *Curved Integral Abutment Bridge Design Guidelines* to supplement the bridge design guides for the region's state transportation agencies, and are intended to aid in the design of CIAB's that would be encountered under typical conditions in New England, including cold climate thermal ranges and low seismic hazards.



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DATA

The results from 585 finite element model iterations with on assumed typical composite steel I-girder cross section were compiled to evaluate any trends based on changing the parameters summarized in Table 1. The following results were investigated to evaluate the impact of the changing parameters:

- Global thermal movement
- Pile head displacements & rotations
- Pile forces and reactions
- Beam end forces
- End of deck stresses

Table 1: Study Parameters

Parameter	Variations
Curve Radius	340 ft. up to Straight Bridge
Bridge Length / Span	50 ft. to 300 ft. / 1 & 2 spans
Skew Angle	0, 10, & 20 degrees
Wingwall Orientation	In-line and U-Wingwalls
Pile Orientation	Weak and strong axis
Pile Cantilever length	10 ft. to 30 ft.

RESULTS

Pile head displacements are the most sensitive to the changing study parameters and resulted in the following conclusions:

- U-wingwalls with weak-axis pile orientation (U_W) produce consistently low transverse pile head displacements compared to in-line wingwalls (In_W & In_S) (Figure 1). These displacements are predictable in relation to curve radius, skew, and expected longitudinal thermal displacement (Figure 3).
- In-line wingwalls are highly sensitive to soil conditions surrounding the piles, modeled using varying pile cantilever lengths (Figure 2). U-wingwalls do not show the same sensitivity

Table 2 indicates the impact level of each parameter studied. The noted impact level shaped the project in the following ways:

- High: this was a defining parameter when creating the design guide and resulted in significant performance effects
- Medium: this parameter had a significant impact on results, but variation can be accommodated in design
- Low: this parameter was not significant in the design guidance

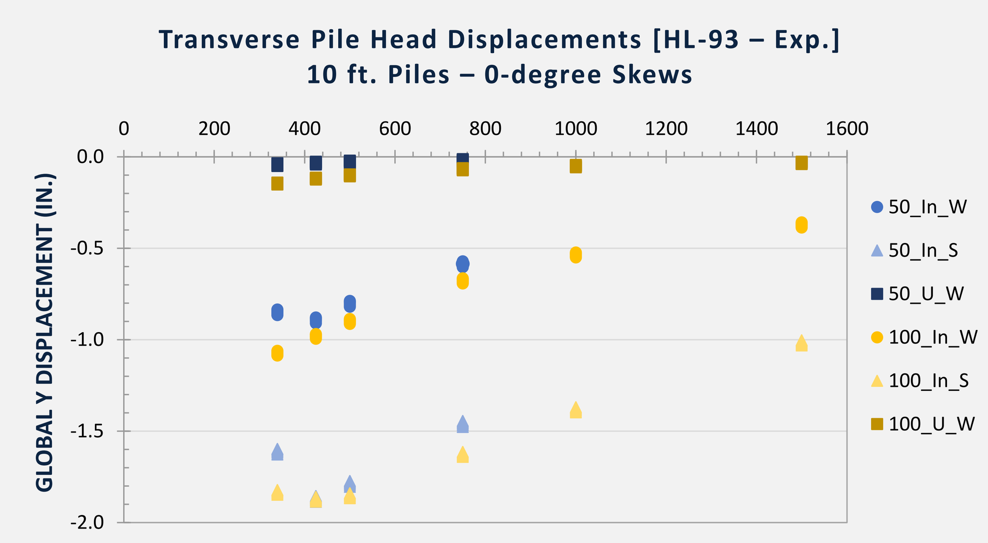

Figure 1

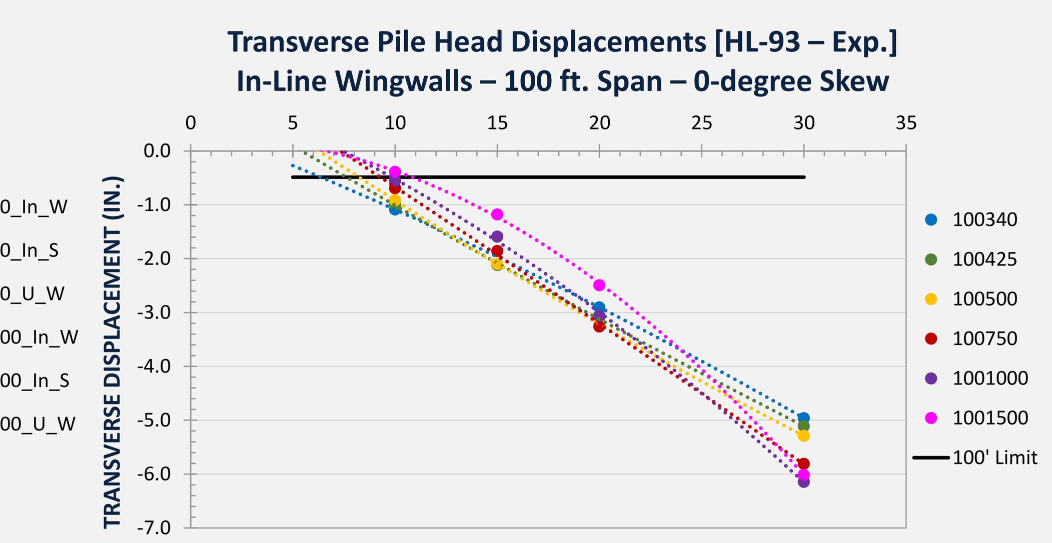

Figure 2

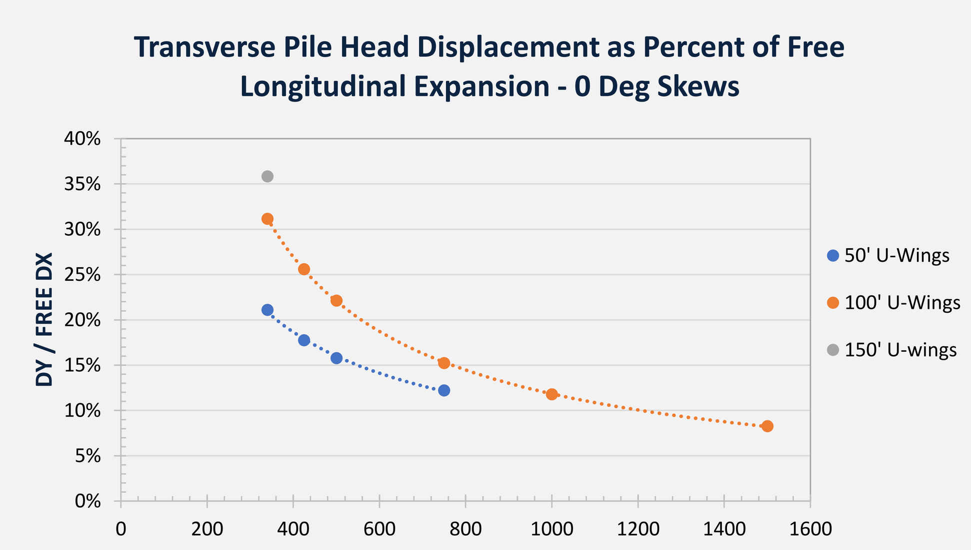

Figure 3

Table 2: Study Parameter Impacts

Parameter	Impact Level
Wingwall Orientation	High
Pile Orientation	High
Curve Radius	Medium
Skew Angle	Medium
Pile Cantilever Length	Medium
Span Configuration	Medium
Bridge Length	Low

CONCLUSIONS

A simplified design method for curved integral abutment bridges has been developed to supplement existing bridge design guidance. The intent is to extend the use of integral abutments to a wider range of structure geometry by simplifying the design process.

- Applicable to curved integral bridges with U-Wingwalls across a large range of parameters
- Eliminates the need for a refined model to design the piles

Recommendations for refined analysis of structures falling outside the criteria for the simplified design method are provided in the guide.