The impact of the abutment wall height, the bridge span length range, and the roadway profile grade on the moment profile and lateral displacement profile of HP or W piles under thermal expansion in integral abutment bridges (IABs)

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Introduction

Integral abutment bridges (IABs) are indeterminate framed structures. As in any indeterminate frame, the distribution of the forces between the frame members depends on the relative stiffness of its members.

Therefore, parameters such as span length, abutment wall height, stiffness of soil behind the abutment wall and around the piles, roadway profile grade and so on will control the distribution of forces between superstructure and substructure of IABs, especially under thermal loading.

The objective of this study is to determine the impact of the abutment wall height, span length range, soil profile grade on forces, moments and lateral displacement profile of HP or W piles caused by thermal expansion in IABs.

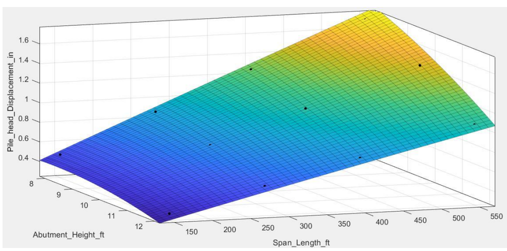


Fig. 1 Variation of pile head displacement vs. span length and abutment wall height

Parametric study of sample IABs under thermal loading

Three-dimensional finite element models with nonlinear soil-structure interaction for four three-span IABs with total lengths of 150 ft, 275 ft, 400 ft, and 550 ft were created and they were used to study the impact of parameters such the abutment wall height and the soil grade profile behind the walls on the moment and the lateral displacement profile of the HP or W piles under thermal expansion.

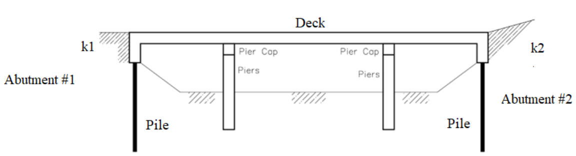


Fig. 2 Elevation view of sample IAB

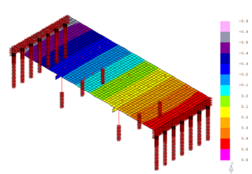
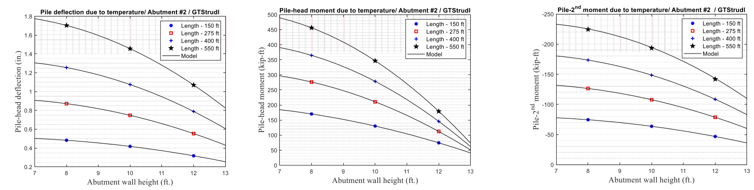


Fig.3 Displacement contour of sample IAB

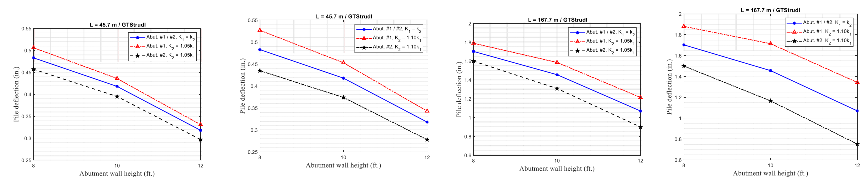
Results

Figures 4(a)-(c) show the pile head lateral displacement and pile's maximum moments under thermal expansion for a range of span lengths and abutment wall heights. Figures 5(a) –(d) compare the impact of (i) different soil grade profiles behind the abutment walls and (ii) abutment wall height, on pile head displacement under thermal expansion.



(a) (b) (c)

Figs 4 (a) Pile-head displacement, (b) pile-head moment, (c) pile-2nd moment



(a) L=150 ft (b) L=150 ft (c) L=550 ft (d) L=550 ft

Figs. 5(a) - (d) Pile head displacement vs. abutment wall height

Conclusion

Under thermal expansion, increasing the abutment wall height will decrease the pile head displacement, the pile's maximum moment, and the effective length of the fixity point.

Under thermal expansion, varying the stiffness of the soil behind one abutment wall with respect to the other one, will decrease the piles' maximum moment and the lateral displacement at the abutment with stiffer soil and will increase them on the other abutment. The decrease or increase in the pile's maximum moment or displacement will be larger for IABs with longer spans and longer wall heights. Therefore, we should design accordingly.

Acknowledgments

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