VERMONT
AGENCY OF TRANSPORTATION

FACT SHEET

The Impact of the Use of Geofoam Adjacent to the Back Walls on the Design of Foundation Piles in Integral Abutment Bridges (IABs)

PROJECT TITLE

The impact of the abutment walls heights, bridge span range, and the roadway profile grade on the forces/moments and lateral displacement profile of W or HP piles caused by thermal expansion in integral abutment bridges (IABs)

STUDY TIMELINE

June 2018 – June 2023

INVESTIGATORS

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KEYWORDS

Integral abutment bridges (IABs)
Design optimization
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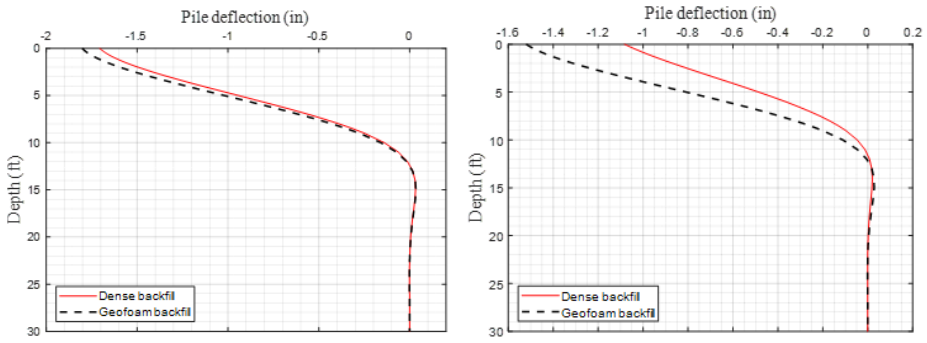
Indeterminate framed structures.
Thermal expansion
HP or W shape piles
Fixity point
Abutment wall height
Variation of Soil property

Introduction

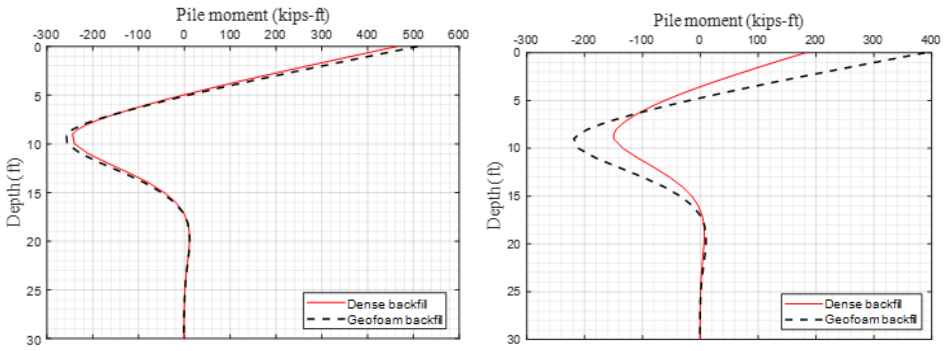
Integral abutment bridges (IABs) are indeterminate framed structures interacting with the soil behind the back walls and the soil surrounding the piles. The thermal loading is a major contributor to the stress in the superstructure and substructure of IABs. The biggest uncertainty in the analysis and design of IABs is the reaction of soil behind the abutment walls and next to the foundation piles.

In many long span IABs the soil adjacent to the back wall is replaced by Geofoam to allow the back wall to move more freely to reduce stresses in the girders and the back wall. This, however, adversely affects the foundation piles. There has not been any significant study on the impact of Geofoam on foundation piles and there is a need for such studies.



(a) H=8 ft (b) H=12 ft

Fig.1 Displacement Profiles of Abutment Pile. L=550 ft, $\Delta T = 100^{0F}$



(a) H=8 ft (b) H=12 ft

Fig.2 Moment Profiles of Abutment Pile. L=550 ft, $\Delta T = 100^{0F}$

Methodology

The objective of this work has been to compare the effect of the use of Geofoam adjacent to the backwall, instead of dense soil, on the thermally

FUNDING

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induced displacements, forces, and moments in steel piles in IABs. To accomplish this objective, a parametric study was conducted using a commercially available finite element software to create a full three-dimensional finite element model of a three-span IAB with a total span length of 550 ft, a width of 54 ft., and with seven rows of plate girders and seven rows of W piles supporting each back wall and then comparing the displacements and moment profiles of the piles in the case of dense soil with that of Geofoam.

Conclusions

This study shows that, under thermal expansion, increasing the abutment wall height will decrease the piles maximum displacement and maximum moment.

Using Geofoam to replace the dense soil adjacent to the abutment wall will have adverse effects. It will increase the pile's maximum displacement and maximum moment. The increase is less critical for shorter back walls, but it is critical for longer walls.

Potential Impacts

The knowledge gained will help bridge engineers to design the foundation piles of IABs more accurately, leading to a reduction in construction cost and an increase in their safety.