VERMONT
AGENCY OF TRANSPORTATION

FACT SHEET

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)

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

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KEYWORDS

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

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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 the frame members.
In the past few decades many researchers have studied the behavior of IABs and have examined the impact of parameters such as bridge length, stiffness of soil behind the abutment wall and around the piles, pile length, skew angle, and so on, by means of field testing and data collecting, finite element modeling, and parametric studies. Many design and modeling recommendations have been made and more IABs are being designed and constructed.

However, the need remains for a unified set of design guidelines to be provided. IABs are generally limited to prescriptive span lengths and skew angles set by local agencies, without substantial research to support these limitations.

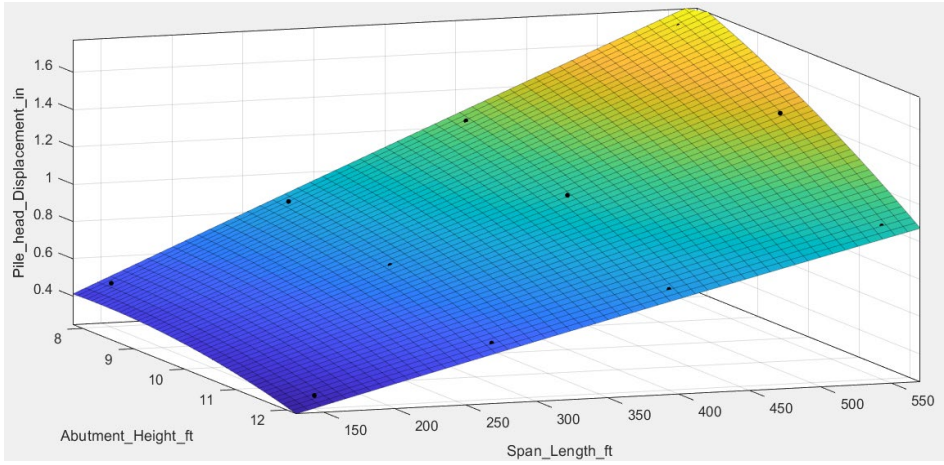

Fig.1 Variation of pile head moment vs. span length and abutment wall height

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More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Methodology

The objective of this work is that of determining the impact of the abutment wall height, span length, and soil profile grade on the forces/moments and lateral displacement profile caused by thermal expansion in the HP or W shape piles forces in IABs.

A parametric study was conducted by creating three dimension finite element models with nonlinear soil structure interaction for sample three-span IABs for a range of abutment wall heights, different span lengths, and different soil condition from one abutment to the another under thermal expansion.

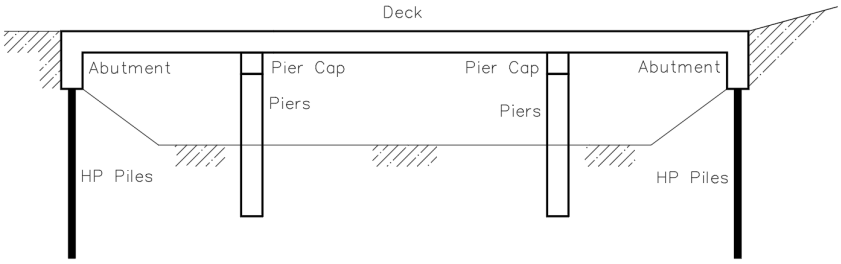

Fig. 2 Elevation view of a three-span IAB

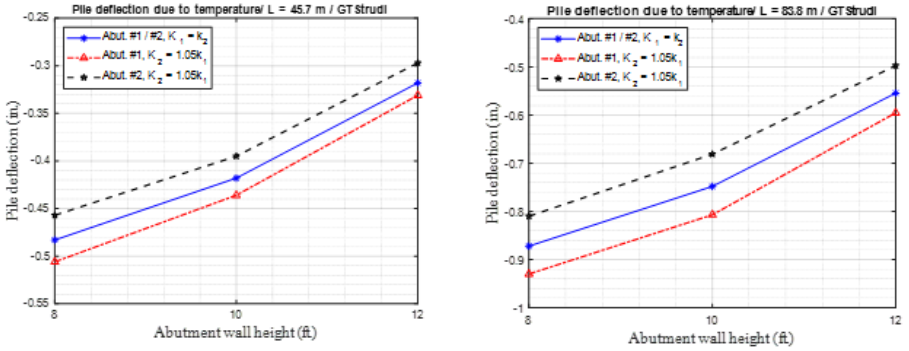

Fig. 3 Pile head displacement vs. abutment height

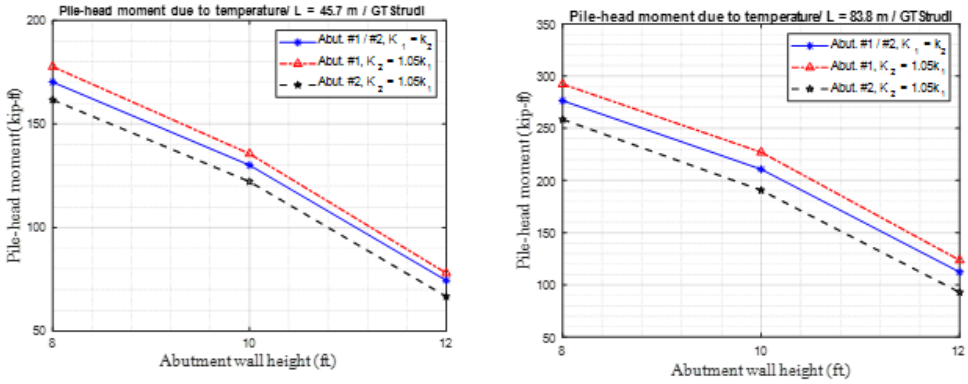

Fig. 4 Pile head moment vs. abutment height

Conclusions

This study shows that, with an increase in the abutment wall height from 8 to 12 ft, there will be decreases in the effective length of the fixity point, the pile head displacement, and the maximum of the pile regardless of the soil conditions around the piles.

In addition, by varying the soil profile behind the wall from one abutment respect to the other, the forces/moments and the displacement of the piles on the abutments will not be identical. There will be a decrease on one side and an increase on the other side, in comparison with the identical soil profiles.

The goal of this ongoing research is to identify all the parameters impacting the distribution of forces between the superstructure and substructure of IABs, so their design can be optimized.

Potential Impacts

The finding of this research will help bridge engineers predict the forces/moments in HP or W shape piles, caused by thermal loading in IABs, more accurately and optimize their design.