The Impact of The Abutment Wall Lateral Displacement Due to Bridge Span Length and The Soil Profile on The Design of Steel Piles in Integral Abutment Bridges (IABs)

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Introduction

Integral Abutment Bridges (IABs) are single or multiple span continuous deck bridges. Instead of movable expansion joints between the spans and bearings at the abutments, IABs have continuous decks integral with abutment walls. In order to minimize the effect of the longitudinal forces in the abutments, the abutment foundation is made flexible by supporting abutment walls on flexible piles. Many researchers have studied the behavior of IABs by means of field testing, finite element modeling, and parametric studies. It is important to identify the impact of abutment stiffness on the steel pile forces to design efficiently.

Objective

The objective of this study is to identify the impact of the bridge span length and soil conditions around the abutments on the pile forces and displacement, under thermal expansion. That is, how the range of span length and the soil behind the wall will impact the fixity

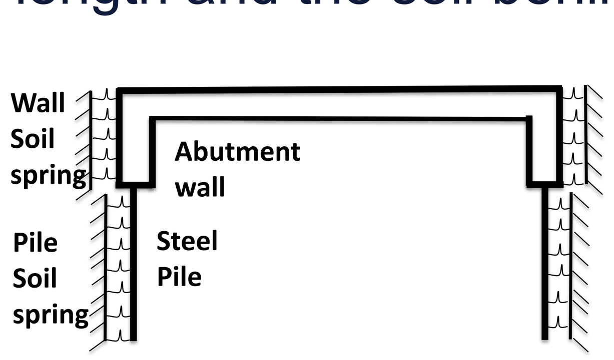

Fig.1 IAB with pile

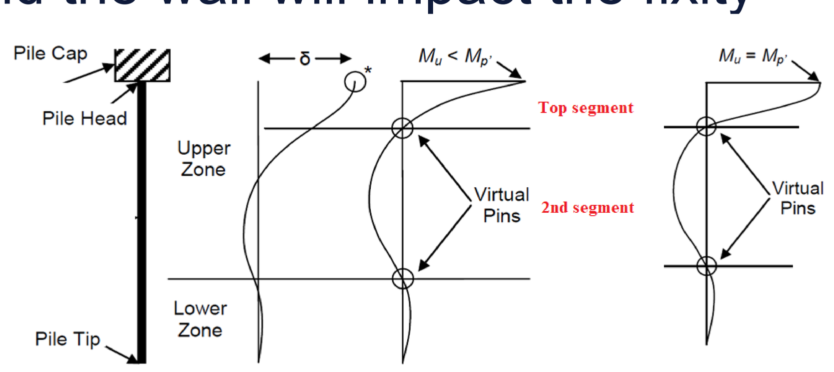

Fig.2 Pile Design Model

point, pile head displacement, and bending moment in the piles oriented in a weak direction. The study was done by using 3D finite element modeling, varying the bridge span length from 150 to 275 ft., and soil behind the abutment wall from dense to loose, but, keeping the thermal loading, soil around pile and cross-sectional properties of the pile constant.

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Pile Modeling Result

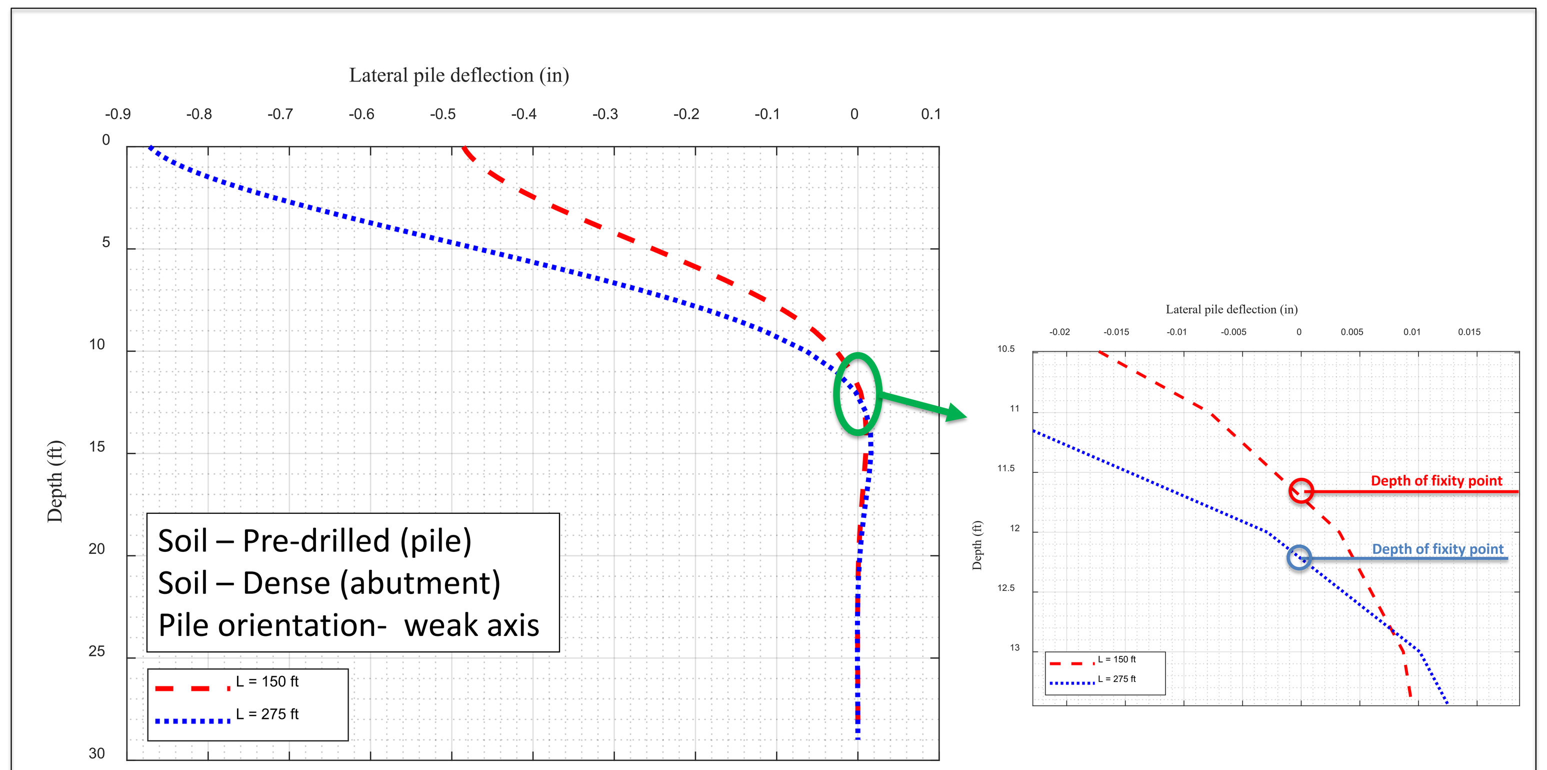

Fig.3 Pile lateral deflection at different span length - dense soil

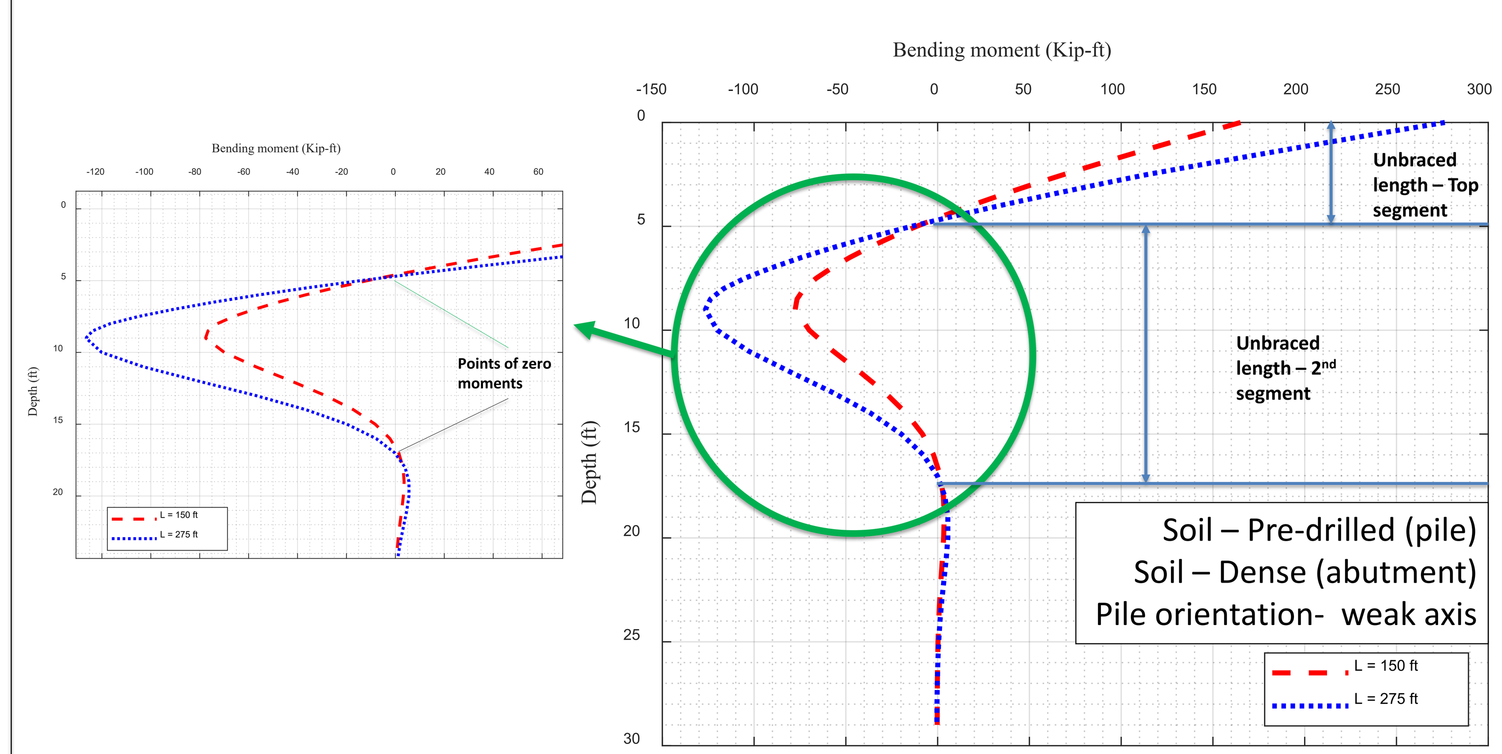

Fig.4 Pile bending moment at different span length - dense soil

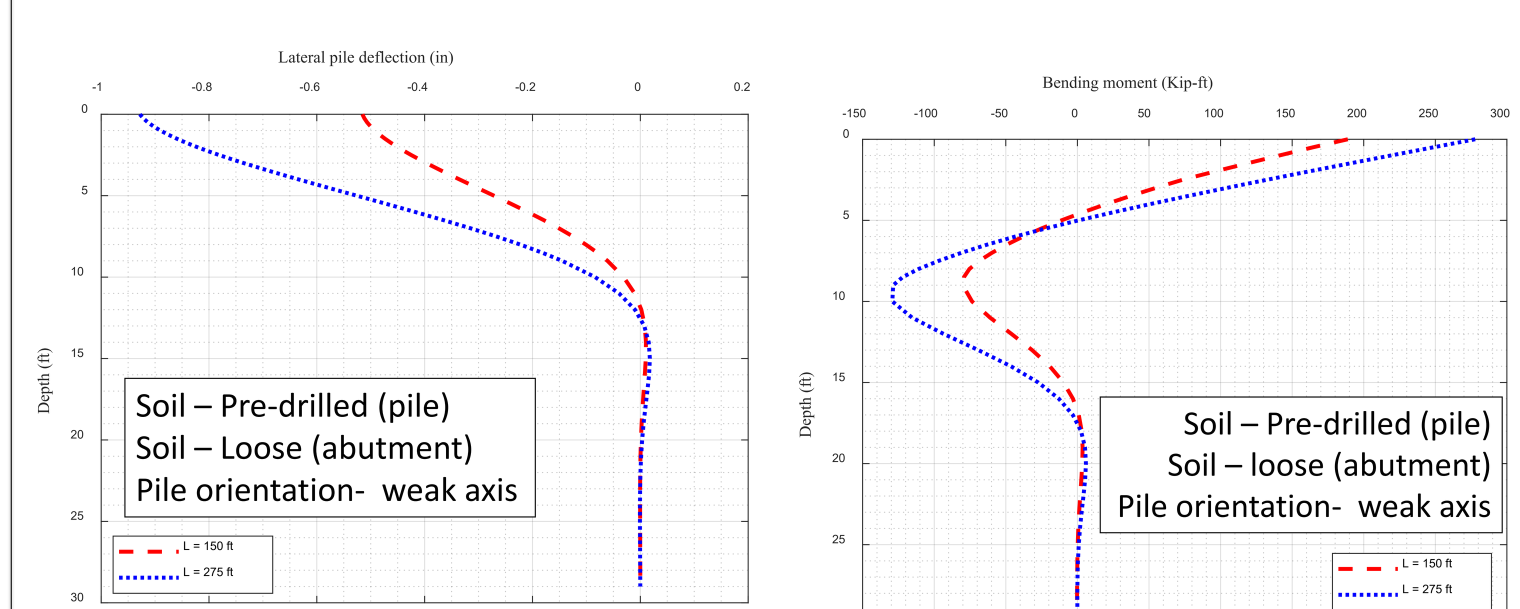

Fig.5 Pile lateral deflection and bending moment at different span length – loose soil

Span Length (ft)	Soil condition	Pile head displace ment (in)	Max. Moment (kips-ft)	Fixity point (ft)
150	Dense	-0.48	165 / -77	11.70
	Loose	-0.87	266 / -127	12.25
275	Dense	-0.51	189 / -80	11.95
	Loose	-0.92	278 / -128	12.50

Table 1 Pile head displacement, moments and fixity point of various span length and soil condition behind abutment wall

Summary

- Various pile head displacements were generated are representation of constant ΔT and different range of span length and soil behind the abutment wall.
- The increment of bridge span length will increase effective length of the fixity point, the pile head displacement, and the maximum moment at the top and 2nd segment by 0.25 ft, 6.0%, 10% and 2% respectively.
- On the other hand, dense soil behind the wall will decrease effective length of the fixity point by 0.55 ft, the pile displacement by 45%, and the maximum moment at the top and 2nd segment by 35% and 38% in the pile due to more stiffness of abutment with compared to loose soil behind the wall.

November 2022 – www.tidc-utc.org

Funding for this research is provided by the Transportation Infrastructure Durability Center at the University of Maine under grant 69A3551847101 from the U.S. Department of Transportation's University Transportation Centers Program.