Quarterly Progress Report:

Project Number and Title: 3.7 Development of general guidelines related to the effects of factors such as the bridge span range, range of pile length, roadway profile grade, and skew angle range on integral abutment bridges (IABs)

Research Area: Trust 3: New systems for longevity and constructability

PI: Susan Faraji, University of Massachusetts Lowell

Reporting Period: 4/1/2021 - 6/30/2021

Submission Date: 6/30/2021

Overview:

The overall objective of this research is to improve the guidelines for the modeling, design, and construction of integral abutment bridges (IABs). Based on input from the DOTs the following topics were considered for the study: (1) a study of the effect of skew angle and other factors on the distribution of forces between superstructure and substructure; (2) a study of the effect of the roadway profile grade on the substructure; and (3) a study of the constructability of HP piles supported on a site with shallow bedrock.

Years 1-2

The focus of the first two years of the research project was the analytical study of the above three selected topics for a single span IAB. The analytic study generated a closed form analytical solution for (a) the skew rigid plate shown in Fig. 1 that takes into consideration all three topics and (b) the rigid frame shown in Fig. 2 taking into consideration topics (2) and (3).

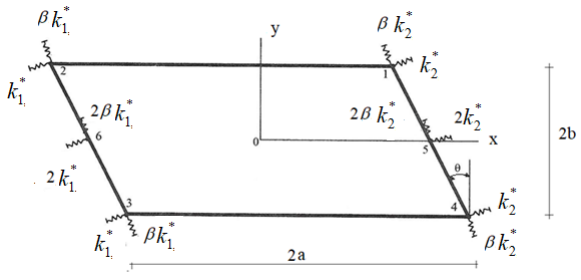


Fig. 1 Skew rigid plate

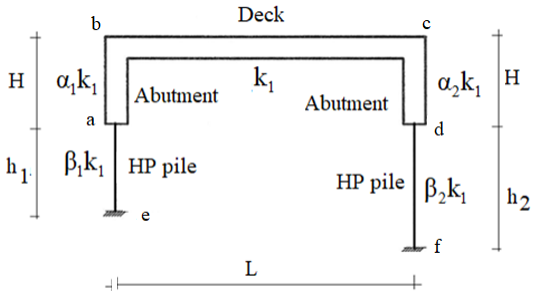


Fig.2 Rigid frame

Year 3

The focus of the third year of this study is as follows:

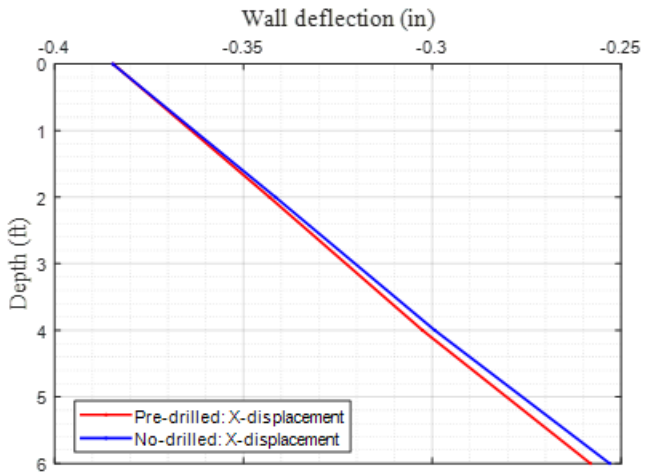
(a) verifying the findings of the analytical study in Years 1 and 2 of skew IABs. This is being done by means of a parametric study using a full three dimensional finite element model of a sample single span skew IAB, varying parameters such as the skew angle, the ratio of the length to the width of the bridge, and the relative stiffness parameters of substructure;

(b) based on input from the DOTs and from industry, enhanced guidelines will be provided for the finite-element modeling and the assessment of the impact of modeling techniques on the accuracy of the analysis results for skew and non-skew IABs

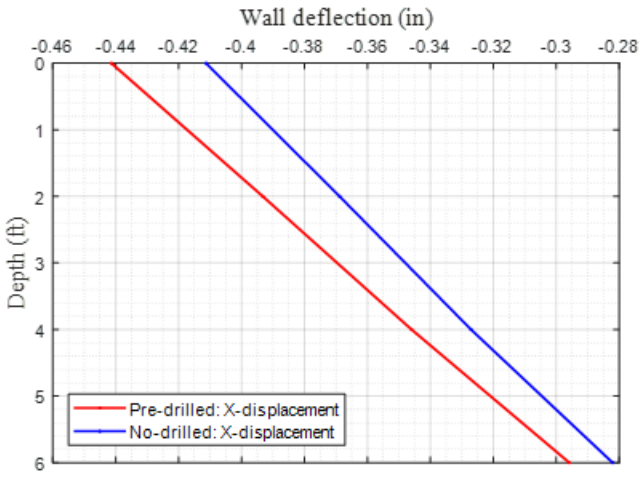
Summary of the activities performed during the reporting period:

- Completed the first two years of the project. The documentation of the findings of the 1st two years of research project has been completed and will be made aviable .
- Continued discussions of findings of the ongoing research project with VTrans and industry through Zoom meetings, phone discussions, and email exchanges.
- Continuation of the development of a new graduate IAB bridge design course for Fall 2021 at UMass Lowell. 32 graduate students are already registered.
- Continuation of the parametric study of the sample bridges.

Some of the results of the parametric study of the sample single span and three span IABs are shown below:



(a) Center node



(b) Edge node

Fig.3 Horizontal displacement profile of the abutment wall for a 3-span (150 ft) sample bridge under thermal loading.

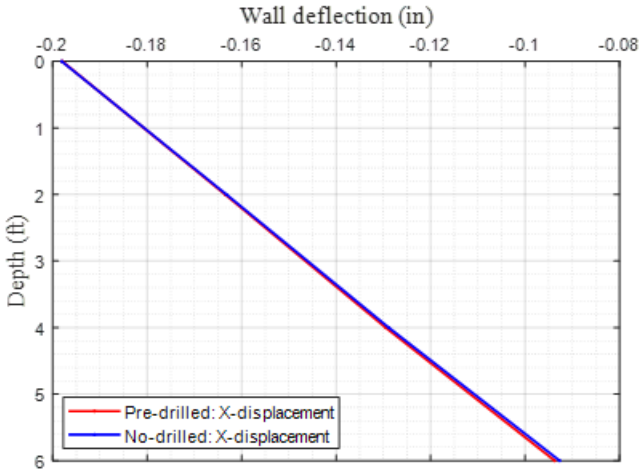
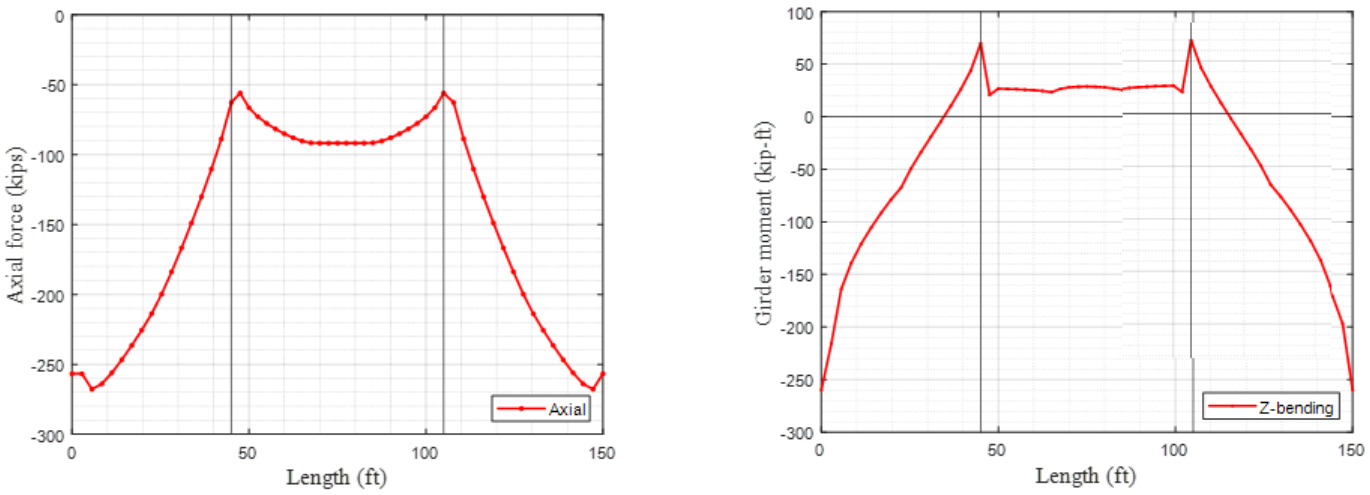
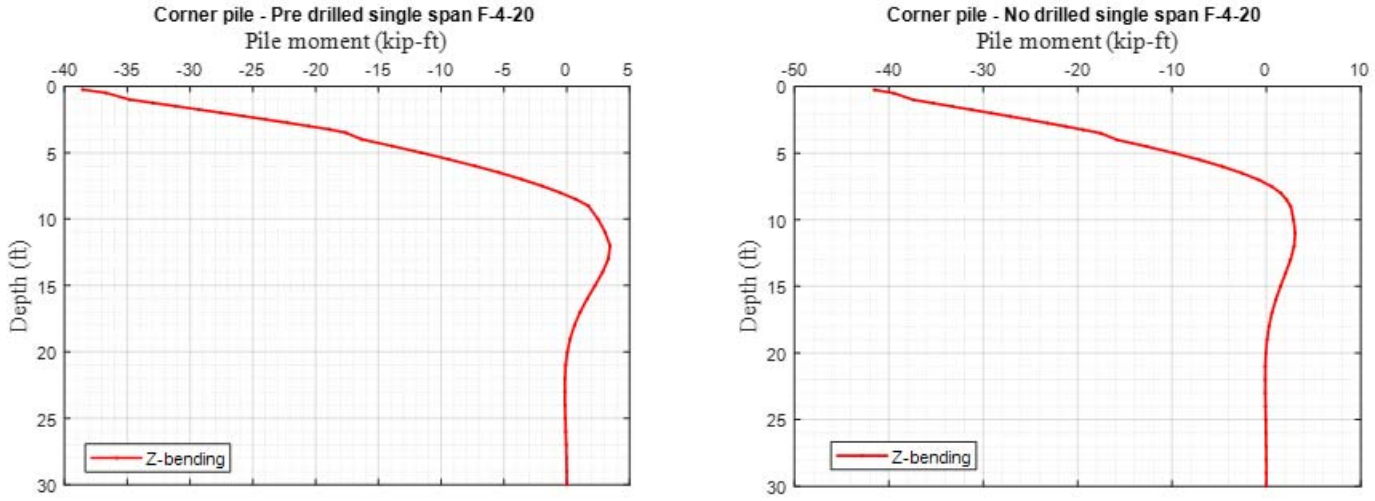


Fig. 4 Horizontal displacement profile of the abutment wall for a single span (75 ft) sample bridge under thermal loading.



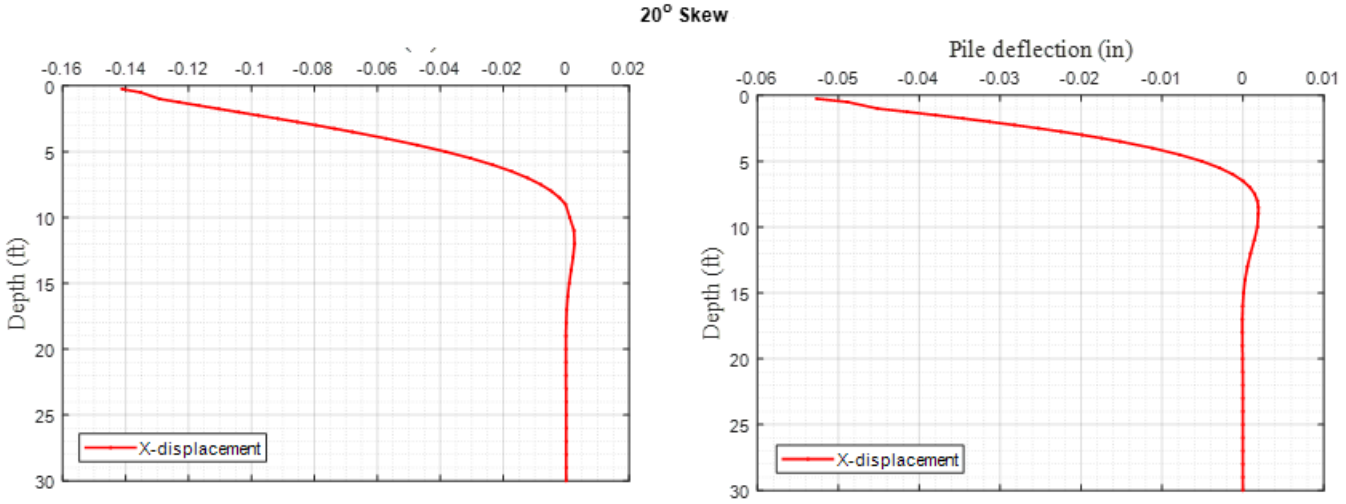
(a) Axial force (b) Bending Moment

Fig.5 Axial force and bending moment profiles in the center-girder for a 3-span (150 ft) sample bridge under thermal loading.



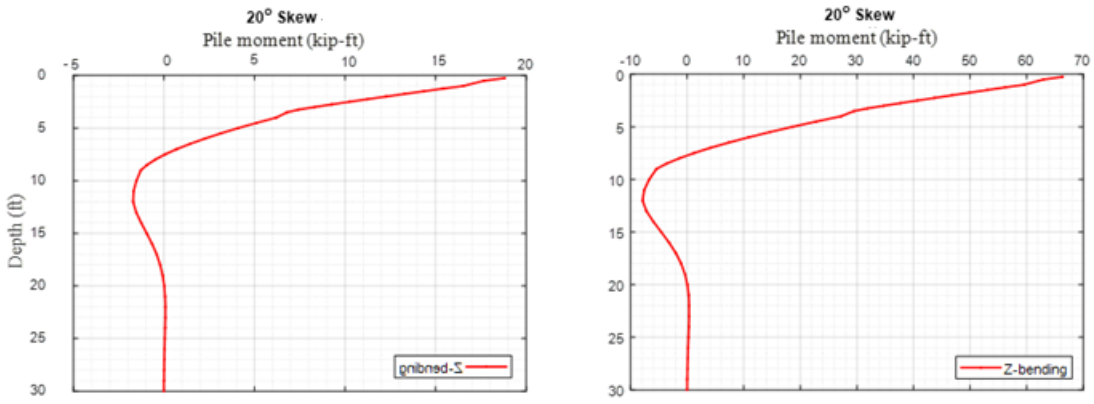
(a) (b)

Fig. 6 Moment profile for HP piles for a single span (75 ft) sample bridge under thermal loading



(a) Obtuse corner (b) Acute corner

Fig.7 Horizontal displacement for the HP piles for a single span (75 ft) sample bridge with 20 degree skew under thermal loading.



(a) Acute corner (b) Obtuse corner

Fig.8 Moment profiles for HP piles for a single span (75 ft) sample bridge with 20 degree skew under thermal loading

All the research done to date falls within the parameters of the tasks listed.

Table 1(a): Task Progress Years 1-2*			
Task Number	**Start Date**	**End Date**	**% Complete**
Task 1:	7/1/2018	6/30/2021	100%
Task 2:	11/1/2019	6/30/2021	100%
Task 3:	11/1/2019	6/30/2021	100%
Overall Project:	1/1/2019	6/30/2021	100%

*The project's years 1 and 2 have been completed.

Table 1(b): Task Progress Year 3			
Task Number	**Start Date**	**End Date**	**% Complete**
Overall Project:	1/1/2021	12/31/2021	30%

Table 2: Budget Progress Year 3		
Project Budget	**Spend – Project to Date**	**% Project to Date***
$125,625 (62,500 + 63,125)	**0**	0 %

Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members			
Individual Name	**Email Address**	**Department**	**Role in Research**
Dr. Susan Faraji, Professor	Susan_Faraji@uml.edu	Civil and Environmental Engineering	Project Principal Investigator

Table 6: Student Participants during the reporting period				
Student Name	**Email Address**	**Class**	**Major**	**Role in research**
Harsh Gandhi*		Ph.D.	Civil and Environmental Engineering	Use of LPILE software for soil modeling and literature search on instrumentation

* Harsh Gandhi has been ½ RA since September of 2020.
Harsh Gandhi, RA, 8 hours per week since June 1st, 2021

Table 8: Research Project Collaborators during the reporting period						
Organization	**Location**	**Contribution to the Project**				
		Financial Support	**In-Kind Support**	**Facilities**	**Collaborative Research**	**Personnel Exchanges**
Vermont Agency of Transportation	Vermont		x (Bridge design)		X	x (Technical Champion)
DOT	Maine					x
Hexagon PPM/Intergraph Corporation	Alabama		x (Computer software)			x (Technical support)

Technical Champion for this project:

Mr. James Lacroix PE

State Bridge Design Engineer

Vermont Agency of Transportation

James.Lacroix@vermont.gov

Tel: 802-272-6862

Changes:
No change

Planned Activities:

- Continue with the parametric study and data analysis of the sample bridges.

- Continue with the documentations and presentations of the outcomes of the ongoing research.

- Continue with the preparation of the new graduate IAB bridge design course for its Fall 2021 offering at UMass Lowell.