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: 10/1/2020 - 12/31/2020

Submission Date: 12/29/2020

Overview:

The overall objective of this research is to improve the guidelines for the modeling, design, and construction of integral abutment bridges (IABs) by completing the following tasks:

Task 1: Literature review and gathering of information

Task 2: Improve the guidelines for the modeling, design, and construction of IABs

Based on the input from a number of state DOTs (Mass, Vermont, and Maine), the following tasks have been undertaken:

(a) A study of the effect of the roadway profile grade on substructure;

(b) A study of the constructability of pile-supported IABs at a site with shallow bedrock;

(c) A study of the effect of skew angle along with other factors such as bridge span to width ratio, relative stiffness of substructure with respect to superstructure on the distribution of forces between superstructure and substructure;

(d) Improve the finite–element modeling and analysis of IABs.

Task 3: Provide general guidelines in a final report regarding the topics studied.

Summary of the activities performed during the reporting period:

The focus of research in this quarter was on how the accuracy of finite–element modeling or lack of it will impact the substructure design of skewed IABs.

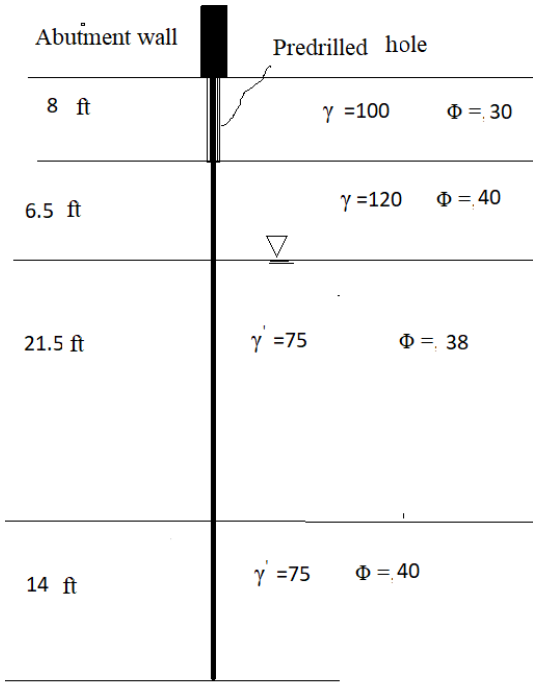
Task 1: Completed literature review.

Task 2(d):

- For a sample 70 feet long single non-skew integral abutment bridge (IAB) the displacement profiles and moment profiles for the HP piles were created to be compared (i) using the LPILE version 2019 software (ENSOFT, INC.) and (ii) using GTSTRUDL Version 2020 software (Intergraph Corporation) to create a three-dimensional finite element model of the sample bridge with nonlinear springs.

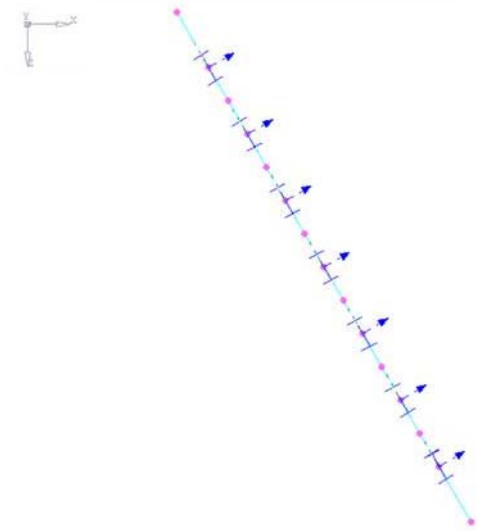
HP 12x74 pile Fy=50 ksi E=29000 Ksi L=75 ft $\Delta T=80^{0/F}$ $\alpha=6.5(10)^{-6}$ $P_{axial}=70$ kip

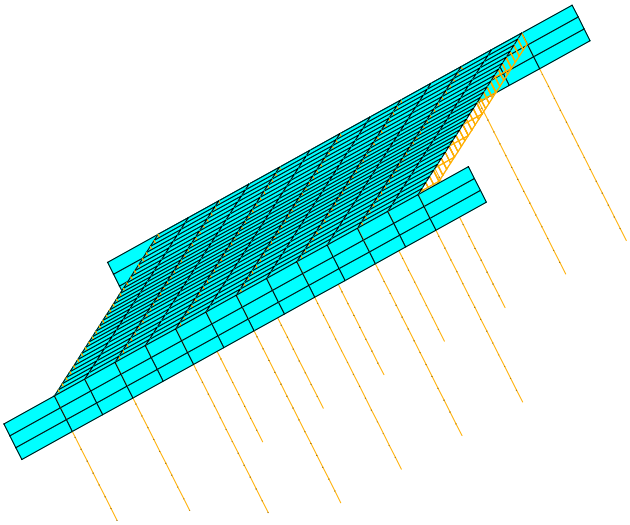
Layers	Depth, feet	Unit weight, lb/in^3	Φ =, degree	Modulus of surcharge lb/in^3	X at bottom of each layer
1	8	γ =100	30	250	96 in
2	6.5	γ =120	40	125	174 in
3	21.5	γ' =75	38	125	432 in
4	14	γ' =75	40	125	600 in

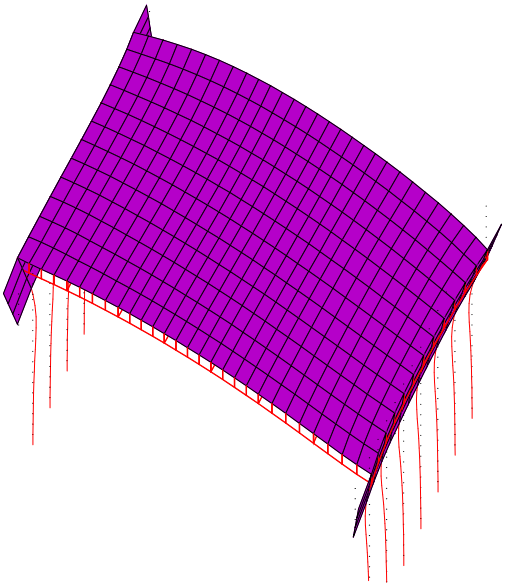


Task 2(d): The focus of the research in this quarter was on how the accuracy of finite–element modeling or lack of it will impact the substructure design of skewed IABs.

By using GTSTRUDL Version 2020 software (Intergraph Corporation) a three dimensional finite element model of a sample 70 feet long single IAB with a 30 degree skew was created to study the effect of modeling techniques on the design of the substructures of skewed IABs.







Task 3:
Documenting how the accuracy of finite–element modeling or lack of it for skewed IAB's will impact the substructure design for the final report.

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

Table 1: Task Progress			
Task Number	**Start Date**	**End Date**	**% Complete**
Task 1:	7/1/2018	12/31/2020	100%
Task 2:	11/1/2019	12/31/2020	90%
Task 3:	11/1/2019	12/31/2020	70%
Overall Project:	1/1/2019	12/31/2020	85%

Table 2: Budget Progress		
Project Budget	**Spend – Project to Date**	**% Project to Date***
$200,943	**$98,432**	85%

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	**Event**	**Type**	**Location**	**Date(s)**
*The Effect of orientation of HP piles, sloping ground, and soil profile on the pile fixity points in IABs.	Annual TIDC Student Recognition Night	Webinar	Virtual	October 21 , 2020
Discussion of connections and modeling of IAB's	Presentations to Project Champion at Vermont Agency of Transportation	Sessions	Virtual	December 9, 2020 December 15, 2020

*Doctoral student Harsh Gandhi participated in the TIDC poster competition contest and ranked "first place" by peer voting.

Table 4: Publications and Submitted Papers and Reports				
Type	**Title**	**Citation**	**Date**	**Status**
**				

** Two papers for submission to the Journal of Bridge Engineering and the Journal of Structural Engineering are under revision.

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		Doctoral Candidate	Civil and Environmental Engineering	Use of LPILE software for soil modeling and literature search

Student Name	**Role in Research**	**Degree**	**Graduation Date**
Harsh Gandhi *	Data collection, literature search and field instrumentation	Doctoral Candidate	2023

* Harsh Gandhi has been ½ RA since September of 2020.

		Contribution to the Project				
Organization	**Location**	**Financial Support**	**In-Kind Support**	**Facilities**	**Collaborative Research**	**Personnel Exchanges**
Vermont Agency of Transportation	Vermont		x (Bridge design)			x (Technical Champion)
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

802-272-6862

Changes:

I was granted a 6 month, no-cost, extension. Therefore, the project's end date has been extended to June 30, 2021.

Planned Activities:

- Submission of two papers to the Journal of Bridge Engineering and the Journal of Structural Engineering.
- Presentation to the Boston society of Civil Engineering.
- Presentation to Vermont Agency of Transportation.
- Will continue working on the final report of the project based on the findings of the 1st two years of research.