Quarterly Progress and Performance Indicators 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: 1/1/2022 - 3/31/2022

Submission Date: 3/31/2022

Overview:

Brief highlights of activities performed during the reporting period.

- Parametric studies were conducted on a 3-D finite element model of a sample 150 feet three span non-skew IAB
  (i) To study the impact of the abutments walls' height, ranging from 8ft to 12 ft under thermal expansion, on the axial force and bending moment in the girders and on the deflection and the bending moment profile of the steel piles at the abutments

  (ii) To study the impact of the pile head rotation on the pile's moment profile, the moment profiles of the piles being compared to the moment profile of an individual pile with fixed head using Lpile software.
  A few sample plots are shown below.

- Continued my discussions of the findings of the ongoing research project with the project champion through phone discussions and email exchanges.

- My research assistant, PhD student Harsh Gandhi, made a presentation "A parametric study of steel piles in integral abutment bridges (IABs)" to the Infrastructure Research Seminar at UMass Lowell on March 15, 2022

- My September 2021 abstract presentation at the VTrans Research and Innovation Symposium, "Parameters Controlling the Rotation of the Deck in Skewed Integral Abutment Bridges under Thermal Loading" was showcased in the February Research Newsletter Vtrans (Volume 15 | February 22, 2022).

- As an expert on bridges, I was interviewed by the Lowell Sun newspaper on concerns about the safety of the Rourke Bridge, I examined the inspection reports and made a recommendation that was published in the January 30, 2022, issue of the Lowell Sun.

Meeting the Overarching Goals of the Project:

How did the previous items help you achieve the project goals and objects? Please give one bullet point for each bullet point listed above.

(i) Transfer of technology to the general public, engineering audiences, and students by means of presentations and publications. See above.

(ii) Progress was made toward the overall goal of this research project.

(iii) Updated the project champion on the progress of the project.

(iv) Provided support for one doctoral student.

Accomplishments:

List any accomplishments achieved under the project goals in bullet point form…

- Technology transfer
- Progress toward refined design guideline for IABs.

Task, Milestone, and Budget Progress:

Complete the following tables to document the work toward each task and budget

Table 1: Task Progress			
Task Number	**Start Date**	**End Date**	**% Complete**
Task 1-1: Literature Review	1/1/2019	12/31/2020	100%
Task 1-2: Improved guidelines for modeling, design, and construction of IABs	11/1/2019	3/31/2021	100%
Task 1-3: General guideline creation	11/1/2019	6/30/2021	100%
Phase 1 Overall	**1/1/2019**	**6/30/2021**	**100%**
Task 2-1: Selection of Sample Bridges	1/1/2021	6/30/2022	100%
Task 2-2a: Modeling strategy and accuracy of analysis results	1/1/2021	6/30/2022	95%
Task 2-2b: Modeling and analysis guidelines	1/1/2021	6/30/2022	90%
Task 2-3: Design guidelines for skew IABs	1/1/2021	6/30/2022	60%
Phase 2 Overall	**1/1/2021**	6/30/2022	**90%**
Task 3-1: Templates for skewed single span and three span sample IABs	9/1/2021	9/30/2024	10%
Task 3-2: Templates for non-skew single span and three span IABs	9/1/2021	9/30/2024	70%
Task 3-3: Verification of the accuracy of finite element modeling analysis results	9/1/2021	9/30/2024	10%

Task 3-4: Design guideline creation	9/1/2021	9/30/2024	5%
Task 3-5: Presentations and final report	9/1/2021	9/30/2024	0%
Phase 3 Overall	9/1/2021	9/30/2024	**15%**
Full Project Overall	1/1/2019	9/30/2024	**40%**

Table 2: Budget Progress

Project Budget	Spend – Project to Date	% Project to Date*
Phase 1: Year 1: $138,832 (62,500 + 76,333) Year 2: $137,502 (61,169 + 76,333)	100%	100% - 6/30/2021
Phase 2: Year 3:125,625(62,500+63,125)*	60%	90% - 6/30/2022
Phase 3: Year 4: $125,625 (62,500 + 63,125) Year 5: $125,625 (62,500 + 63,125) Year 6: $62,500 (31,250 + 31,250)	0%	15% - 9/30/2024

Is your Research Project Applied or Advanced?

☒ **Applied** (*The systematic study to gain knowledge or understanding necessary for determining the means by which a recognized and specific need may be met.)*

☐ **Advanced** *(An intermediate research effort between basic research and applied research. This study bridges basic (study to understand fundamental aspects of phenomena without specific applications in mind) and applied research and includes transformative change rather than incremental advances. The investigation into the use of basic research results to an area of application without a specific problem to resolve.)*

Education and Workforce Development:

Answer the following questions (N/A if there is nothing to report):

1. Did you provide any workforce development or training opportunities to transportation professionals (already in the field)? If so, what was the training? When was it offered? How many people attended? N/A

2. Did you hold meetings with any transportation industry organizations or DOTs? If so, what was the meeting's purpose? When was it offered? How many people attended? N/A

3. Did you host/participant in any K-12 education outreach activities? If so, what was the activity? What was the target age/grade level of the participants? How many students/teachers attended? When was the activity held? N/A

Technology Transfer:

Use the table below to complete information about conference sessions, workshops, webinars, seminars, or other events you led/attended where you shared findings as a result of the work you conducted on this project:

Table 4: Presentations at Conferences, Workshops, Seminars, and Other Events

Type	Title	Citation	Event & Intended Audience	Location	Date(s)
Presentation by Harsh Gandhi, Research Assistant	A parametric study of steel piles in integral abutment bridges (IABs)		Infrastructure Research Seminar at UMass Lowell Engineers and Engineering students	Virtual	March 15, 2022

Use the table below to report any publications, technical reports, peer-reviewed articles, newspaper articles referencing your work, graduate papers, dissertations, etc. written as a result of the work you conducted on this project. Please list only completed items and exclude work in progress.

Table 5: Submitted/Accepted Publications, Technical Reports, Theses, Dissertations, Papers, and Reports

Type	Title	Citation/Site	Date	Status
Newsletter VTrans	Parameters Controlling the Rotation of the Deck in Skewed Integral Abutment Bridges under Thermal Loading	AOT Research and Innovation Newsletters. (Volume 15) VTrans	February 22, 2022	Published

Lowell Sun Newspaper	Pressure Builds to Address Rourke Bridge Concerns	https://www.lowellsun.com/2022/01/30/pressure-builds-to-address-rourke-bridge-concerns/	January 30, 2022	Published

Answer the following questions (N/A if there is nothing to report):

1. Did you deploy any technology during the reporting period through pilot or demonstration studies as a result of this work? If so, what was the technology? When was it deployed?

   N/A

2. Was any technology adopted by industry or transportation agencies as a result of this work? If so, what was the technology? When was is adopted? Who adopted the technology?

   N/A

3. Did findings from this research project result in changing industry or transportation agency practices, decision making, or policies? If so, what was the change? When was the change implemented? Who adopted the change?

   N/A

4. Were any licenses granted to industry as a result of findings from this work? If so, when? To whom was the license granted?

   N/A

5. Were any patent applications submitted as a result of findings from this research? If so, please provide a copy of the patent application with your report.

   N/A

6. Did industry organizations or DOTs provide cost-share (cash or in-kind) to your research during the reporting period? Who was the organization? Please provide an in-kind support invoice from the organization with your report (this is kept confidential and used for record keeping purposes only).

   N/A

Please add figures/images that can be included on the website and/or in marketing/social media materials to further clarify your research to the general public. This is very important to our Technology Transfer initiatives.

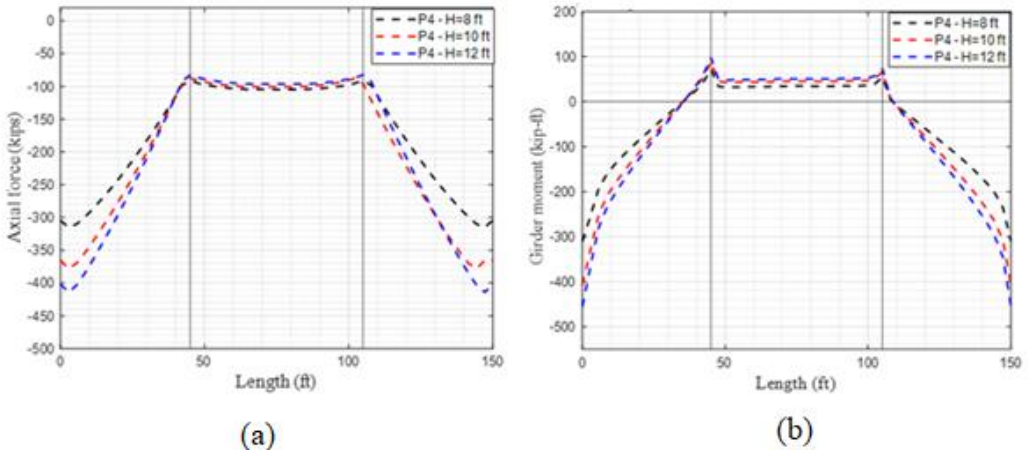

Fig. 1 Axial force and Bending Moment diagrams for a steel girder of a sample IAB for a range of abutment wall heights under thermal expansion using GTSTRUDL software

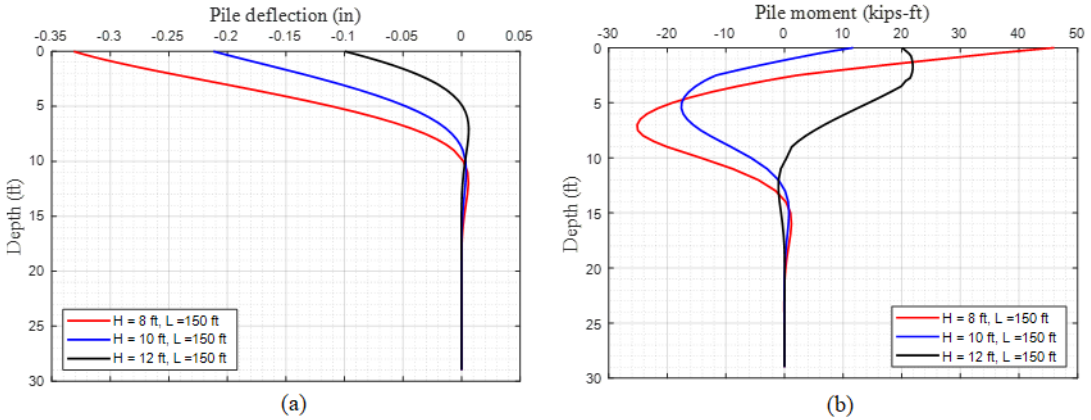

Fig. 2 Displacement and moment profiles for a HP pile of a sample IAB for a range of abutment wall heights under thermal expansion using GT Strudl software

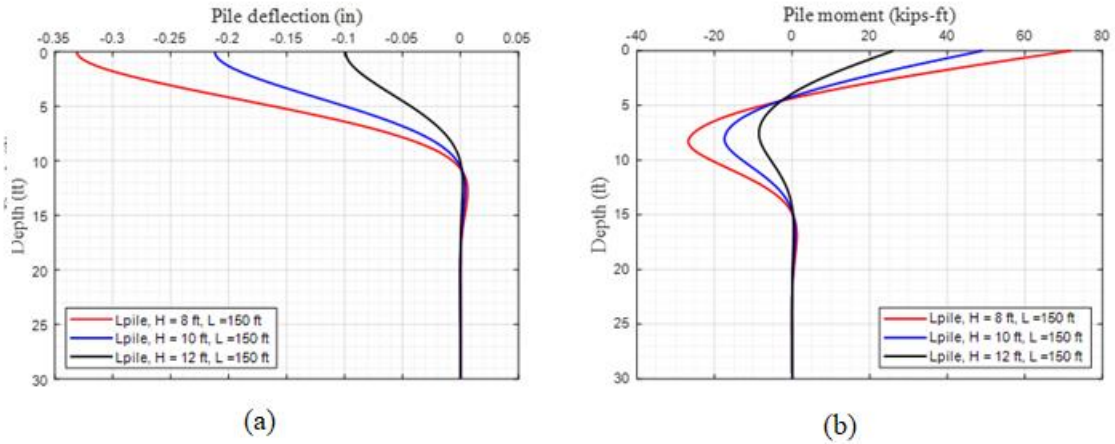

Fig. 3 Displacement and moment profiles for a HP pile of a sample IAB for a range of abutment wall heights under thermal expansion using LPILE software

Describe any additional activities involving the dissemination of research results not listed above under the following headings:

Outputs:

- Listed above

Outcomes:
Definition: The application of outputs; any changes made to the transportation system, or its regulatory, legislative, or policy framework resulting from research and development activities. List any outcomes accomplished during this reporting period:

- Listed above

Impacts:

- Listed above

Participants and Collaborators:

Use the table below to list individuals (compensated or not) who have worked on the project other than students.

Table 6: Active Principal Investigators, faculty, administrators, and Management Team Members				
Individual Name & Title	**Dates involved**	**Email Address**	**Department**	**Role in Research**
N/A	N/A	N/A	N/A	N/A

*Use the table below to list **all** students who have participated in the project during the reporting period. (This includes all paid, unpaid, intern, independent study, or any other student that participated in this project.) **ALL FIELDS ARE REQUIRED.***

Table 7: Student Participants during the reporting period								
Student Name	**Start Date**	**End Date**	**Advisor**	**Email Address**	**Level**	**Major**	**Funding Source**	**Role in research**
Harsh Gandhi	1/1/2022	3/31/2022	Dr. Susan Faraji		PhD	Civil Engineering	TIDC	Soil modeling and data analysis of finite element modeling

Use the table below to list any students who worked on this project and graduated or received a certificate during this reporting period. Include information about the student's accepted employment during the reporting period (i.e. the student is now working at MaineDOT) or if they are continuing their students through an advanced degree (list the degree and where they are attending).

Table 8: Students who Graduated During the Reporting Period			
Student Name	**Degree/Certificate Earned**	**Graduation/Certification Date**	**Did the student enter the transportation field or continue another degree at your university?**
N/A	N/A	N/A	N/A

Use the table below to list any students that participated in Industrial Internships during the reporting period:

Table 9: Industrial Internships			
Student Name	**Degree/Certificate Earned**	**Graduation/Certification Date**	**Did the student enter the transportation field or continue another degree at your university?**
N/A	N/A	N/A	N/A

*Use the table below to list **organizations** that have been involved as partners on this project and their contribution to the project during the reporting period.*

Table 10: 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	(Design of IABS)
Hexagon PPM/Intergraph Corporation	Alabama		** Educational Grant to University			x (Technical support)
ENSOFT Inc.	Texas		***			x (Technical support)

* Exchanged ideas and provided material related to the design of IABs.

** Provided technical support on the use of GTSTRUDL software for the research project.

*** Provided technical support on the use of the LIPE and GROUP software for the research project.

*Use the table below to list **individuals** that have been involved as partners on this project and their contribution to the project during the reporting period. (**List your technical champion(s) in this table.** This also includes collaborations within the lead or partner universities who are not already listed as PIs; especially interdepartmental or interdisciplinary collaborations.)*

Table 11: Other Collaborators

Collaborator Name and Title	Contact Information	Organization and Department	Date(s) Involved	Contribution to Research
Technical Champion of the project: Mr. James Lacroix, PE, State Bridge Design Engineer		Vermont Agency of Transportation	1/1/2022-3/31/2022	Discussion of progress of the research project and exchange of ideas on design of IABs

Use the following table to list any transportation related course that were taught or led by researchers associated with this research project during the reporting period:

Table 12: Course List

Course Code	Course Title	Level	University	Professor	Semester	# of Students
N/A	N/A	N/A	N/A	N/A	N/A	N/A

Changes:

No change

Planned Activities:

- Completion of the 3rd year of the project.

- Presentation of the findings of the 3rd year of research to DOTs.
- The final draft of the paper on skew IABs has been completed and will be submitted to the *Journal of Bridge Engineering* within the next few weeks.
- Continuation of the parametric study and data analysis of the sample IABs.
- Continued discussions of the findings of the ongoing research project with the champion of the project through Zoom meetings, phone discussions, and email exchanges.