Quarterly Progress Report:
Project Number and Title: 3.7 Development of general guidelines on the effects of bridge span range 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: 1/1/2020-3/31/2020
Submission Date: 3/31/2020

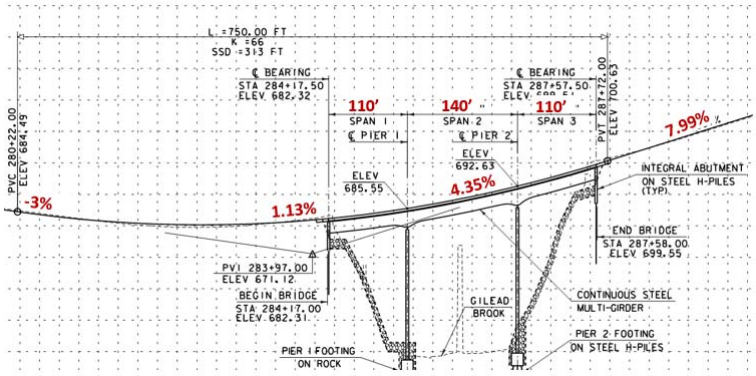
Overview:

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 guidelines for the modeling, design, and construction of IABs)

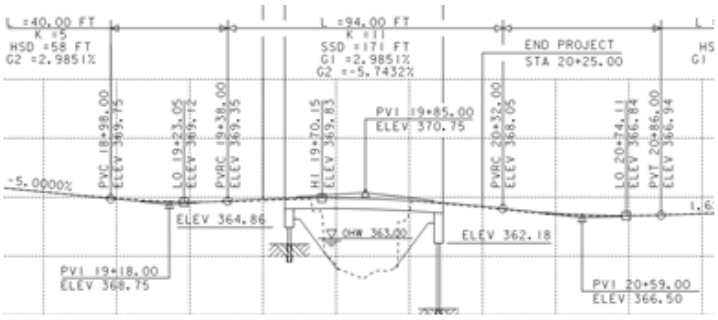
Based on the input from a number of state DOTs (Mass, Vermont, and Maine), the following tasks will be undertaken:

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



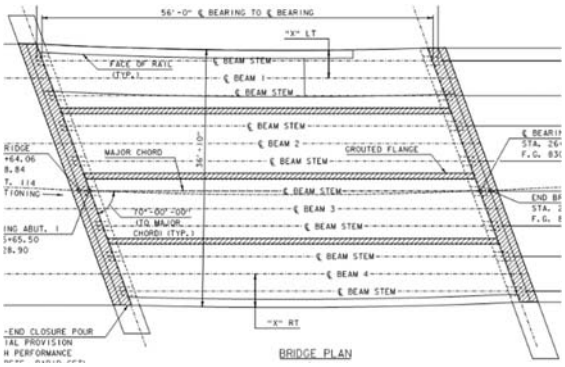
Bridge #38, Bethel, Vermont

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

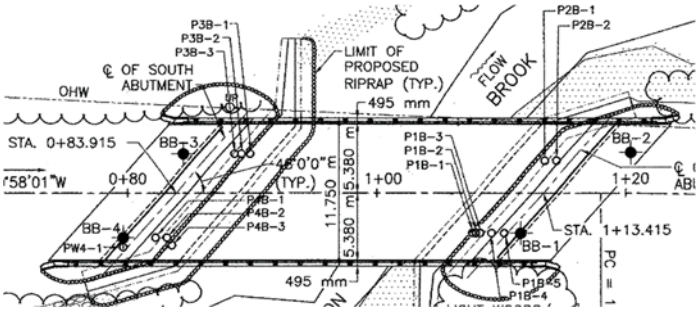


Bridge #41, Fairfield, Vermont

(c) A study of the effect of range span and of skew angle on axial and bending stresses in the superstructure and substructure;



Bridge #13, Burke, Vermont (skew angle=20)



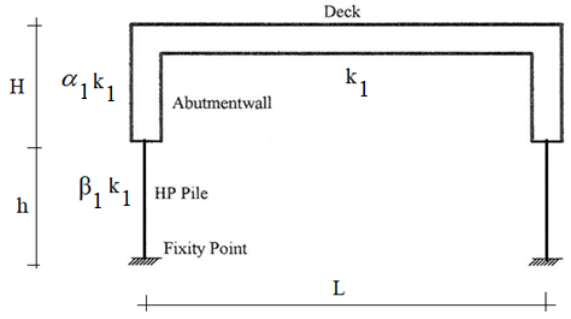
Bridge #B-28-006, Buckland, Mass (skew angle 42.5)

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

Task 3: (General Guideline) Provide a final report regarding the topics studied.

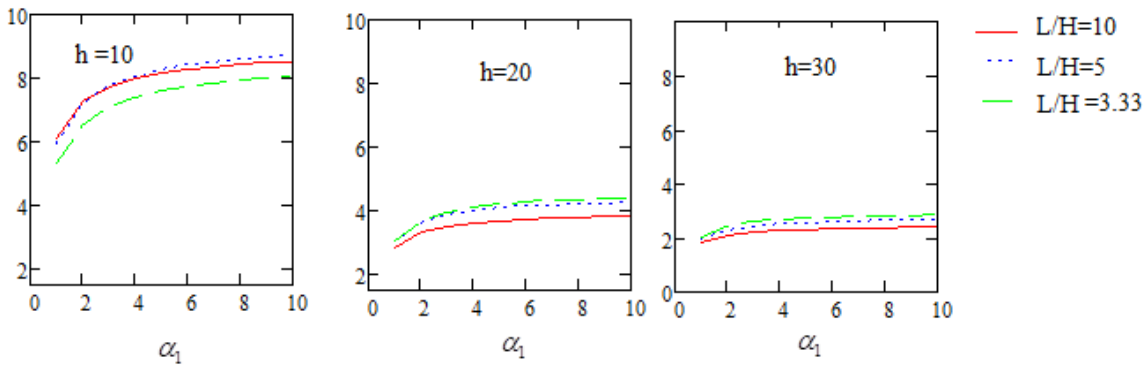
Summary of the activities performed during the reporting period:

- Using the direct stiffness method, an analysis was conducted for a single story rigid frame with one horizontal member and two legs, where the legs of the frame are made of two members with different degrees of stiffness to be representative of a single span non-skew IAB. Parametric equations were derived for the axial force and the moment at the junction of the horizontal and the vertical members and the shear and moment at the junction of the vertical members under thermal and gravitational loading.

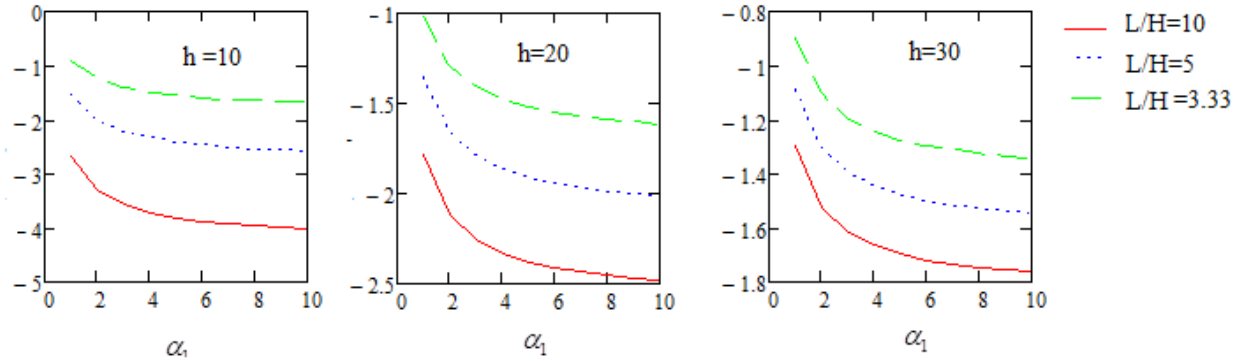


Single story rigid frame representing a single span non-skew IAB

Some of the analytical solutions results are shown in the following figures:

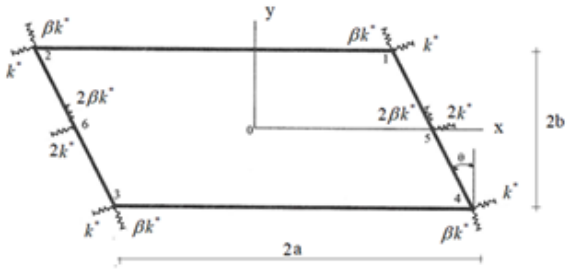


Moments at the junction of the horizontal and vertical members of the rigid frame under thermal loading for a range of relative stiffness α_1

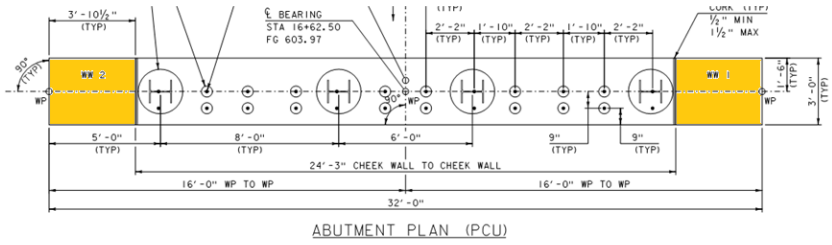


Moments at the junction of the two vertical members of the rigid frame under thermal loading for a range of relative stiffness α_1

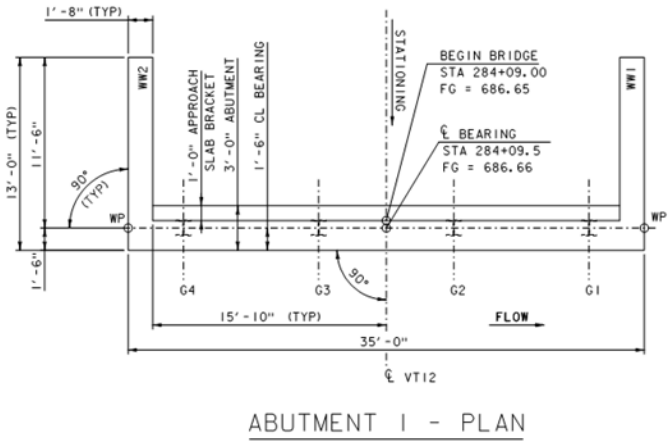
- The analytical and parametric studies of the skewed rigid plate under thermal expansion were continued, taking into consideration the effect of different type of wing walls (U, Flared, and in-line).



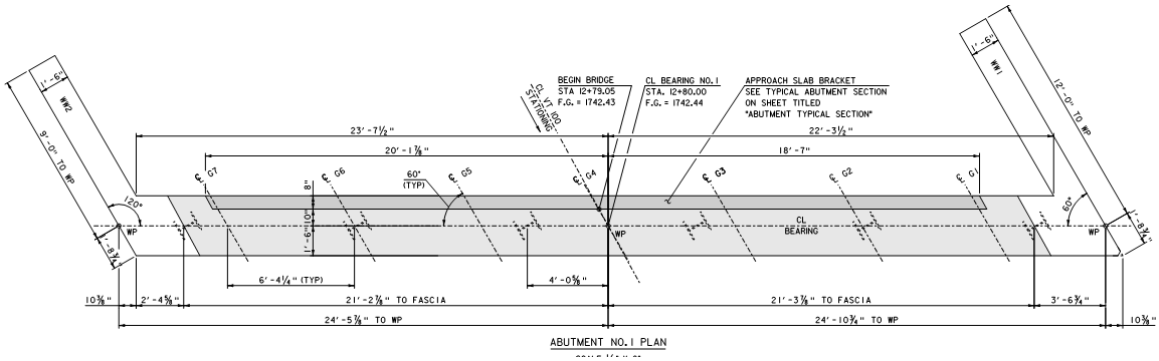
Geometry of a skew plate and location of springs



In-line wing wall (Bridge #25, Fairfield, Vermont)

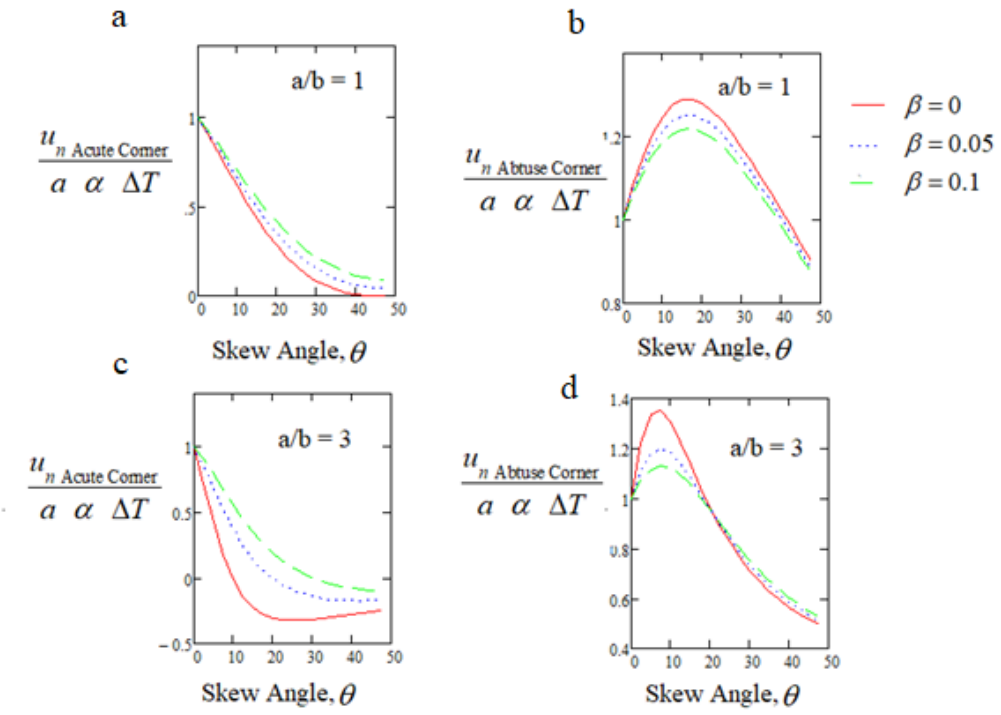


U wing wall (Bridge #38, Bethel, Vermont)

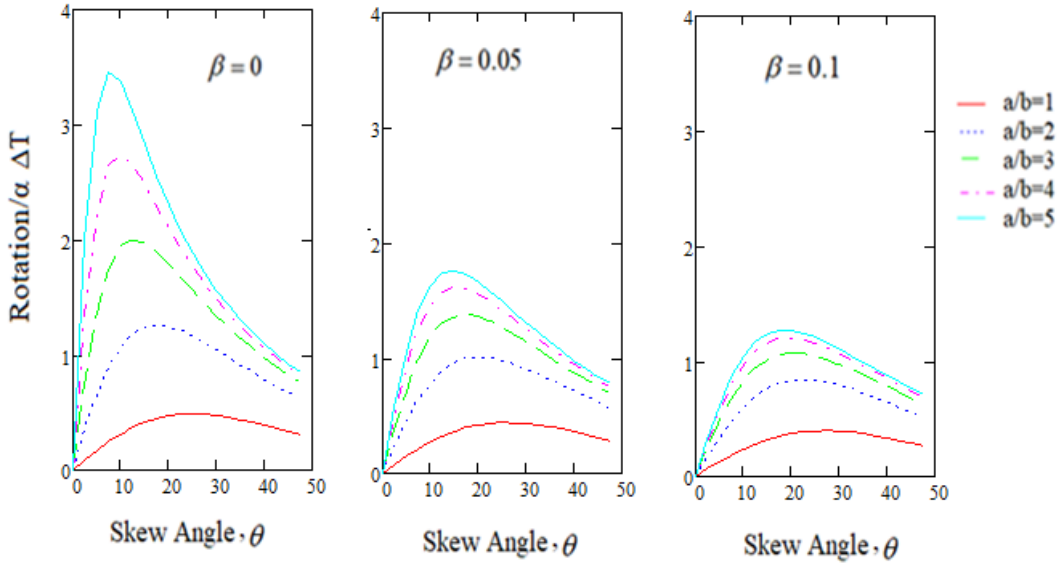


Flared wing wall (Bridge #59, Dover, Vermont)

Some of the analytical solutions results are shown in the following figures:



Horizontal variation of normal displacements of rigid plate for range of skew angle (α) and range of relative stiffnesses of wing wall (β=0, .05 , 01). (a) Acute corner, Length/width=1. (b) Obtuse corner, Length/width=1. (c) Acute corner, Length/width=3.(d) Obtuse corner, Length/width=3



Horizontal variation of in-plane rotation of rigid plate for a range of skew angles and a range of relative stiffness of wing wall (β=0, .05 , 01)

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	10/31/2019	80%
Task 2:	11/1/2019	9/30/2020	50%

Task 3:	11/1/2019	9/30/2020	10%
Overall Project:	1/1/2019	9/30/2020	50%

Table 2: Budget Progress		
Project Budget	**Spend – Project to Date**	**% Project to Date***
$200,943	**$98,432**	50%

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	**Event**	**Type**	**Location**	**Date(s)**
Scheduled Presentation Canceled	Boston Society of Civil Engineering	Seminar Boston Canceled	Boston	April 1, 2020

Table 4: Publications and Submitted Papers and Reports				
Type	**Title**	**Citation**	**Date**	**Status**
None*				

* The submission of a paper to a refereed journal has been delayed because of the need for more time to verify the analytical findings in comparison with the finite element analysis results for sample bridges.

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**
Hamed Abshari		Doctoral candidate	Civil Engineering	Computer modeling and literature search

Note 1: Hamed Abshari resigned from the RA/TA position and withdrew from the doctoral program on March 7, 2020.

Note 2: The search for his replacement has started.

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**
VTrans	Vermont		x			
Mass DOT	Massachusetts		x			

- Vermont Agency of Transportation.
  I have been in contact with Mr. James Lacroix (the project's champion), State Bridge Design Engineer, Vermont Agency of Transportation, via telephone discussions and email exchanges.

- Massachusetts Department of Transportation.

I have been in contact with Mr. Alexander Bardow, State Bridge Engineer for the Mass DOT, via telephone calls, email exchanges, and meetings.

Changes:

Because of the departure of the graduate student and other factors there will be the delay of a few months in the planned publications and presentations. The search for replacement of the graduate student has started.

Planned Activities:

Analytical and parametric studies will continue within the parameters of Task 2 of the project.