Bi-Monthly Progress Report:

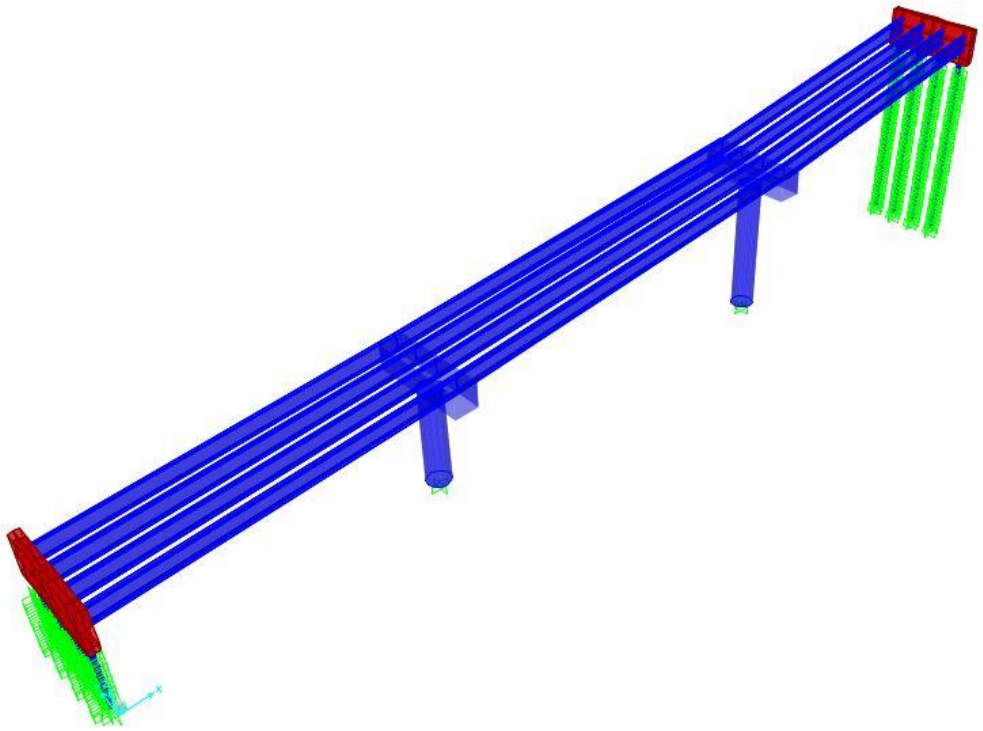
Project Number and Title: 3.7 Development of general guidelines on the effects of bridge span range and skew angle range on integral abutment bridges (IAB's)

Research Area: Trust 3: New systems for longevity and constructability
PI: Susan Faraji, University of Massachusetts Lowell

Reporting Period: 6/1/2019-7/31/2019
Date: 7/31/2019

Overview:
Summary of the activities performed during the reporting period:

1. Completed a full three dimensional finite element model of a sample three span steel girder IAB (Bridge #38 in the town of Bethel, Vermont) incorporating the nonlinear soil response behind the abutment walls, adjacent to the HP piles under the abutment walls, and adjacent to the piers at the bents.

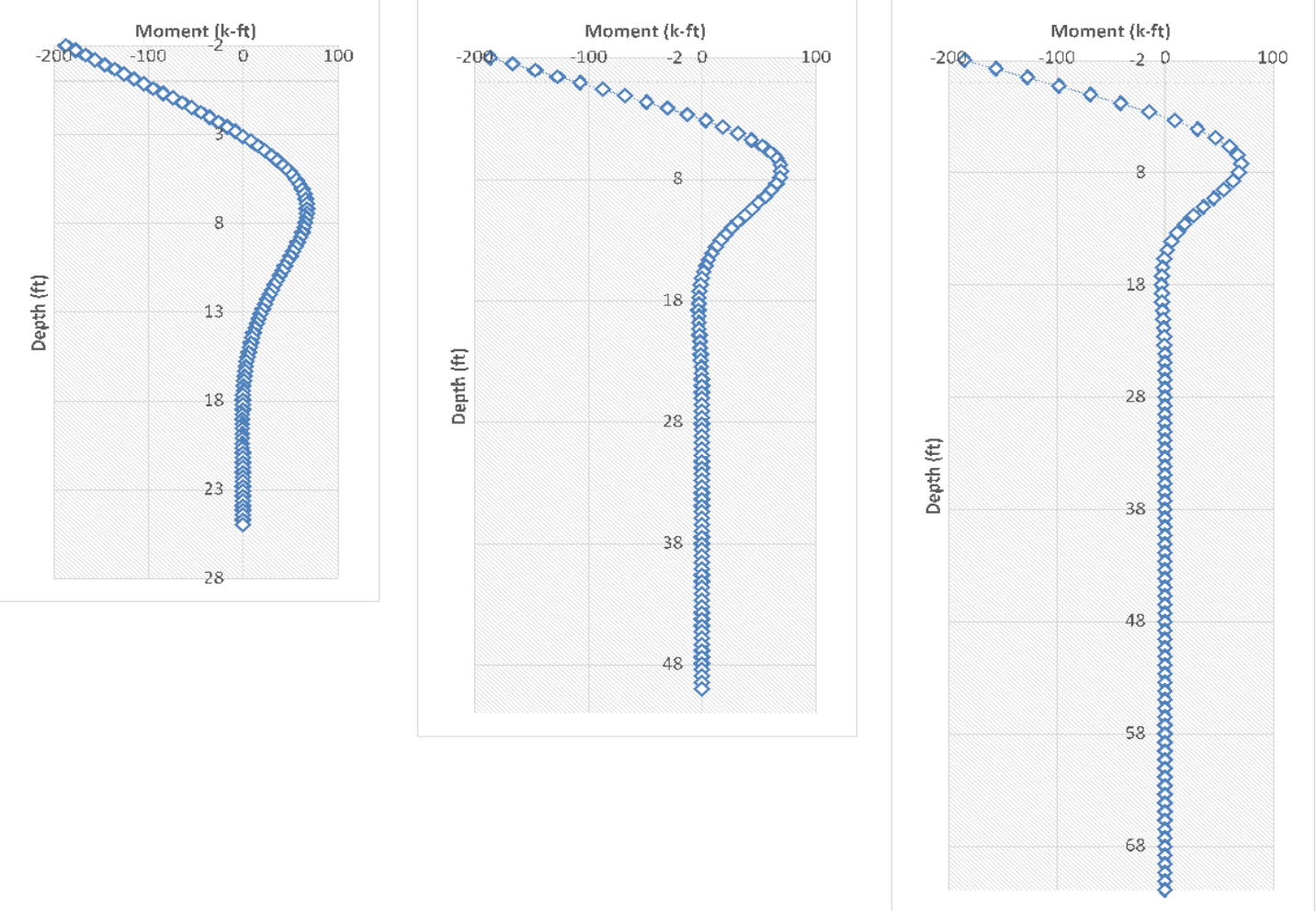


3-D model of bridge #38

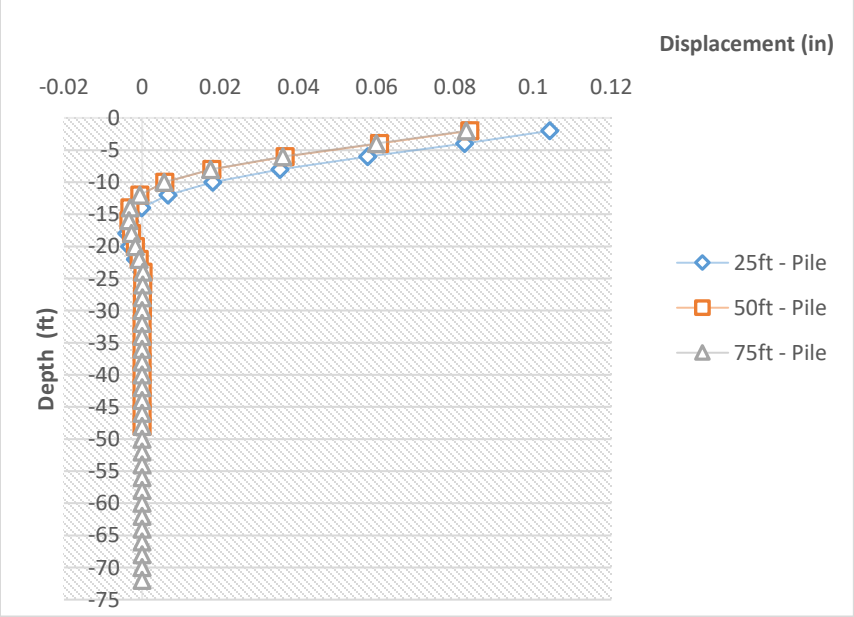
2. Analyses were conducted for a thermal loading increment of 110 degrees Fahrenheit, with the following sets of parameters varied:

   - The roadway profile grade (ranges 0-10%);
   - The soil compaction level next to the HP piles;
   - The orientation of the HP piles;
   - The length of the HP piles;
   - The skew angle.

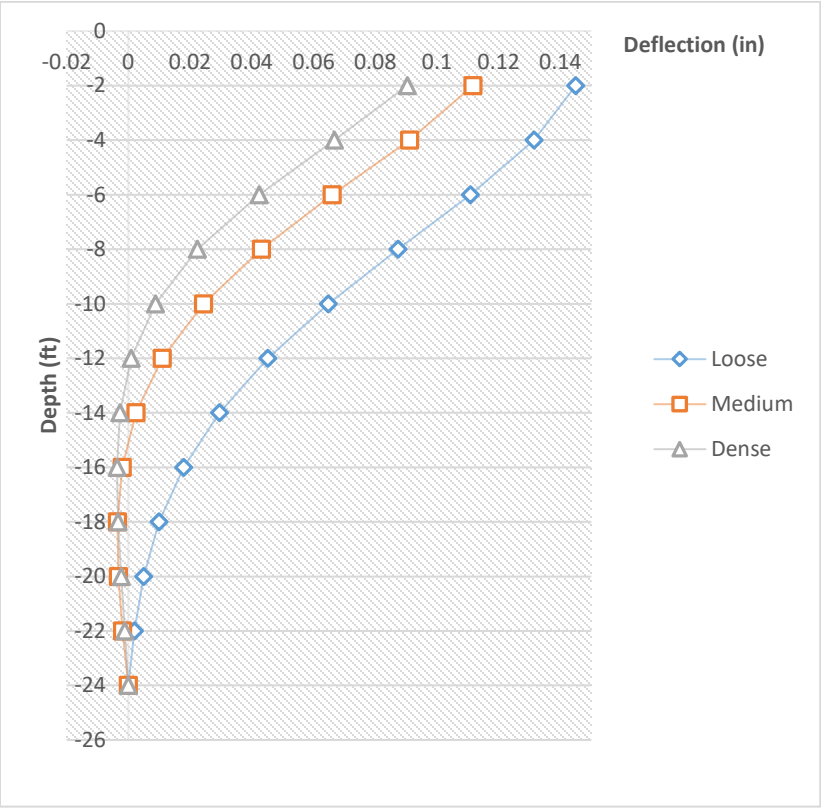
Some of the results are shown in the following figures:



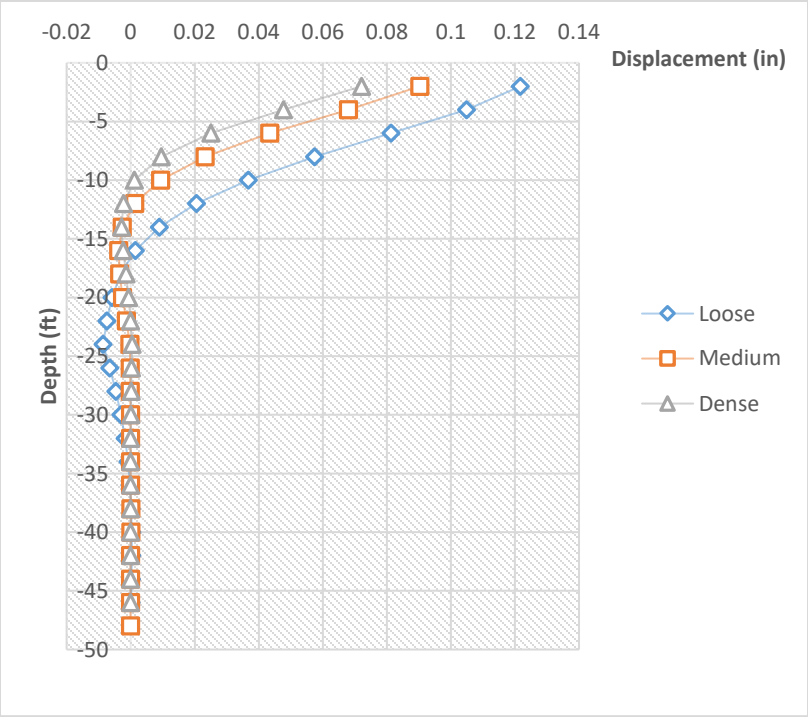
Moment diagrams for HP pile for range of pile length



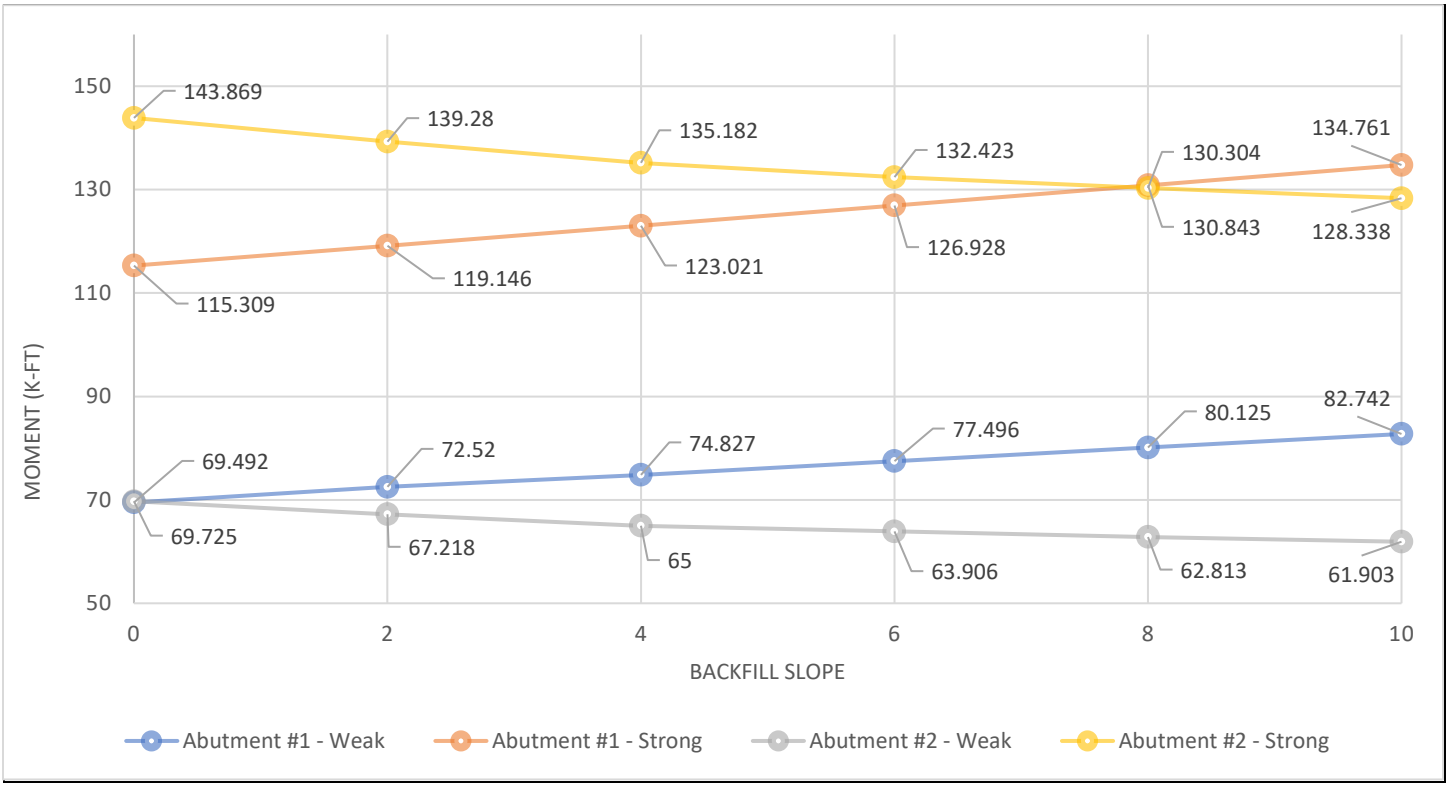
HP Pile deflection profile for range of pile lengths



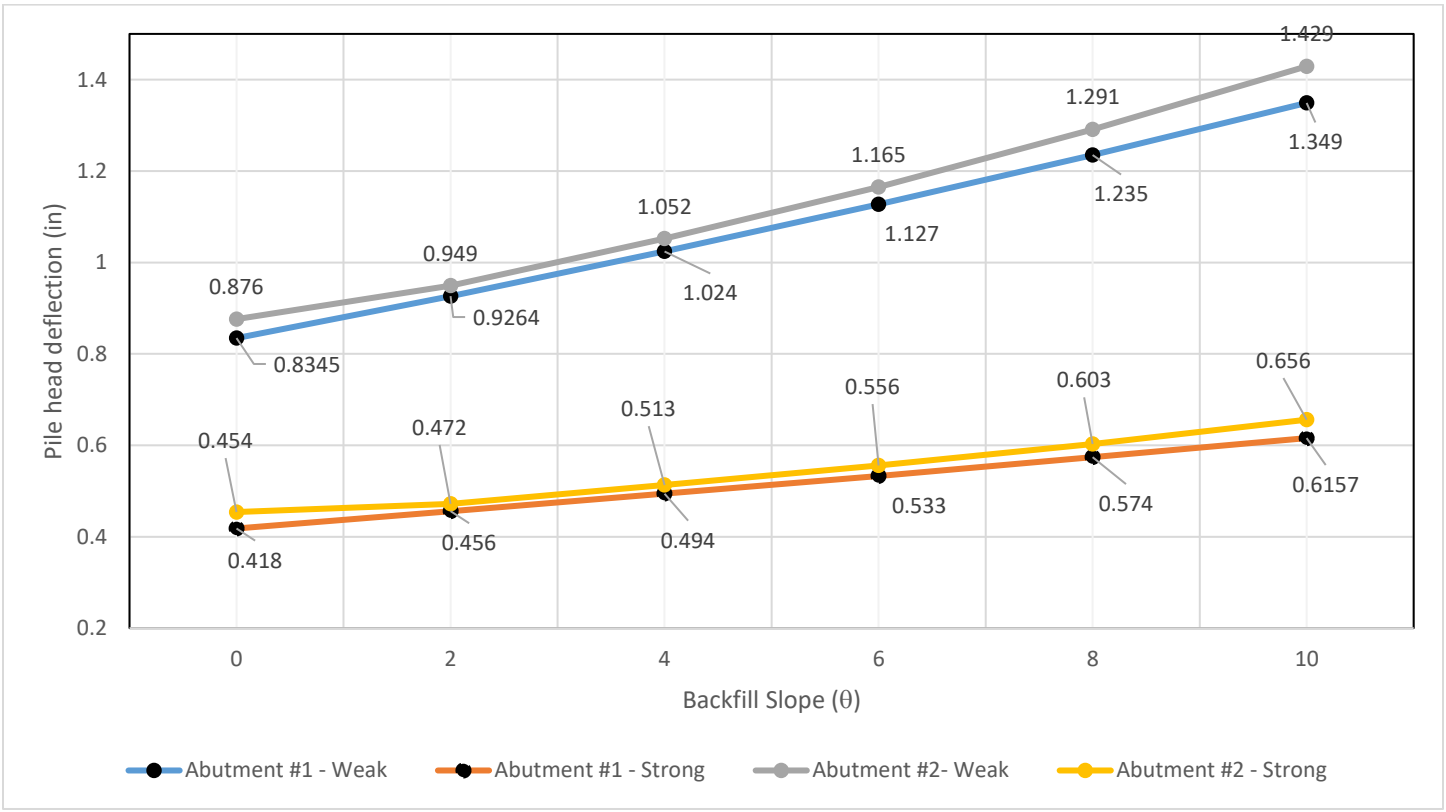
Deflection profiles for 25 ft. long HP piles for range of soil density



Deflection profiles for 50 ft. long HP pile for range of soil density



HP Piles head moment vs range of slope (0-10%) for Bridge #38



HP Piles head deflection vs range of slope (0-10%) for Bridge #38

The original research proposal was revised based on input from a number of state DOTs (Mass, Vermont, and Maine), recommendations of the advisory board members, and the TIDC program manager. As revised, the research proposal includes three tasks.

Task 1: (Literature review and gathering of information)

- Contact a number of state DOTs to collect information on the areas related to the modeling, design, or construction of IAB bridges that they believe need improvement. Generate a list of the areas understood to be needing improvement**.**
- Collect the integral abutment design guidelines of the different states to identify the similarities and differences in their approaches to the analysis, design, or construction of integral abutment bridges. Generate a list of the major differences.
- Gather the published research papers on the modeling, design, or construction of IAB bridges and identify areas needing more study.

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;
(b) A study of the constructability of pile supported IABs at a site with shallow bedrock;
(c) A study of the effect of range span and of skew angle on axial and bending stresses in the superstructure and substructure;
(d) Improve the finite–element modeling and analysis of IABs.

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

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

Participant and Collaborators:

During the reporting period, the following participants have worked on the project:

- Dr. Susan Faraji, Professor, Civil and Environmental Engineering, UML – Project principal investigator
- Mr. Hamed Abshari, graduate RA, Doctoral candidate, Civil and Environmental Engineering, UML-computer modeling and data analysis (started May 2019)
- Sina Razzaghi, undergraduate RA, Masters Candidate, Civil and Environmental Engineering, UML- Computer modeling (started May 2019)

Collaborators during the reporting period:

- Vermont Agency of Transportation.
- The other collaborators and contacts that have been involved in the project include Intergraph Corporation of Madison, Alabama, and ADAPT Corporation of Redwood City, California.

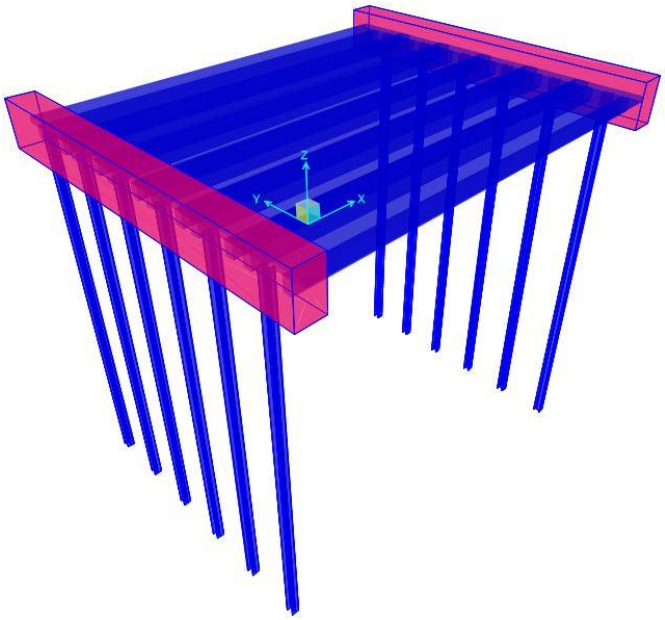
Changes:

Do not anticipate any problems or changes at this stage of the project.

Planned Activities:

In the next reporting period, the following tasks will be conducted:

1. A full three dimensional finite element model of the following four sample IAB's incorporating the nonlinear soil response behind the abutment walls and adjacent to the HP piles will be completed:
   - Bridge #46 (single span solid slab IAB with short piles, in the town of Fairfield, Vermont)
   - Bridge # 14 (single span solid slab IAB with long piles, in the town of Fairfield, Vermont)
   - Bridge #13 (single span skewed IAB with Next Beams, in the town of Burke, Vermont)
   - Bridge # 59 (single span skewed IAB with steel girders, in the town of Dover, Vermont)



3-D model of bridge #59

2. Analyses will be conducted for a thermal loading increment of 110 degrees Fahrenheit, with the following sets of parameters varied:
   - The roadway profile grade (ranges 0-10%);
   - The soil compaction level next to the HP piles;
   - The orientation of the HP piles;
   - The length of the HP piles;
   - The skew angle.
3. An up-to-date summary of the findings will be reported.
4. Planning to attend the 10th New York City Bridge Conference, August 26-27.