Semi-Annual Progress Report

Project Number and Title: 3.4 Testing, Monitoring and Analysis of FRP Girder Bridge with Concrete Deck
Research Area: Thrust Area 3
PI: W. Davids, UMaine
Co-PI(s): H. Dagher, UMaine
Reporting Period: 3/1/2019 – 3/31/2019
Date: 3/31/2019

Overview:

Provide overview and summary of activities performed during previous two months….
Over the past few months, finite element analyses have been performed on both single-girder and whole bridge models utilizing the hybrid FRP-concrete tub girder developed at UMaine. These analyses have directly supported the design of the Hampden Grist Mill demonstration bridge, which is currently being designed by Advanced Infrastructure Technologies (AIT) and will be constructed in Hampden, Maine in the 2019 construction season. These models were designed to investigate the distribution of shear stresses in girder webs and global girder stability during deck placement. The shear stress model, pictured in Figure 1, was used to validate the conservatism in the assumed web shear stress distribution under dead-loading, live-loading, and combined loading for a single girder and for the entire bridge. The stability model, pictured after Eigenvalue buckling analysis in Figure 2, investigated the girder's tendency for lateral-torsional buckling under the action of wet concrete.

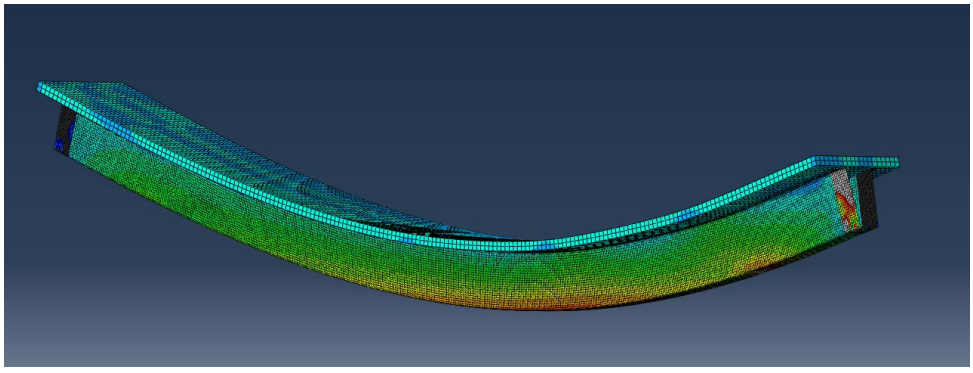

Figure 1: *Single Girder Shear Stress Model*

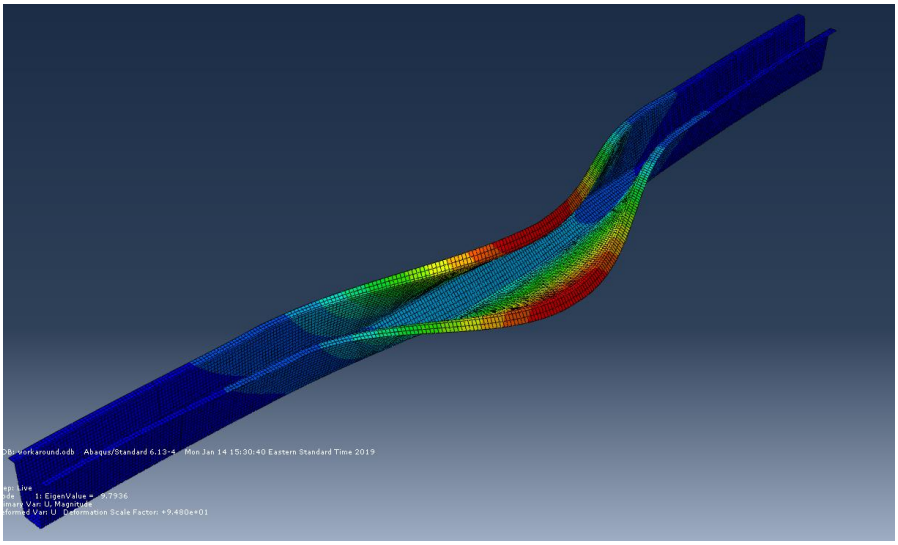

Figure 2: *Single Girder Lateral-Torsional Buckling Model*

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Provide context as to how these activities are helping achieve the overarching goal of the project…
The previously stated activities are in direct support of the overarching project goal of assessing the constructability and design methodology for FRP bridge girder bridges. Shear stress distribution analysis was performed to confirm that the assumptions made in the shear design of the girder were conservative. Lateral-torsional buckling analysis was performed to assess the stability of girders during construction so as to anticipate premature failure. With these confirmations, design and construction can proceed as intended.

Describe and accomplishment achieved under the project goals…
The completed tasks support the bridge design, which must be completed before the major project tasks of construction and monitoring.

Describe any opportunities for training/professional development that have been provided…
The project PI regularly provides input to the AIT engineers on design details and provides feedback on design assumptions and procedures employed by AIT.

Describe any activities involving the dissemination of research results (be sure to include outputs, outcomes, and the ways in which the outcomes/outputs have had an impact during the reporting period)…
In order for conclusions drawn from the described tasks to be disseminated to the designers, two executive reports were drafted and provided to AIT outlining the analysis procedures and conclusions drawn from the two FE analyses.

Participants and Collaborators:

What organizations have been involved as partners on this project?
The designers of the bridge (AIT) as well as the future bridge owner, MaineDOT have partnered with UMaine on the development and completion of this project. There are regular meetings between AIT and UMaine to disseminate relevant research results. In addition, additional development of the girder system is proceeding with separate federal funding from the US Army Corps of Engineers which will enhance the constructability and economy of future projects after the Hampden Grist Mill Bridge.

Have other collaborators or contacts been involved? If so, who and how?
No additional collaborators have been contacted.

What students have participated in the project? (Include class standing, major, role in the research)
Three graduate students have participated in this project. One, a M.S. student in Mechanical Engineering, developed the original prototype girder system and has been assisting in the design of the demonstration bridge as a part-time employee of AIT. A second M.S. student in Civil Engineering funded by the US Army has been developing a novel shear connection system to ensure composite action between the girder and deck. A third M.S. student in Civil Engineering has developed and performed FE analyses in support of the design of the demonstration bridge as described above.

Changes:

Discuss any actual or anticipated problems or delays and actions or plans to resolve them…
No significant problems have arisen to this point which require resolution.

Discuss and changes in approach and the reasons for the change…
No changes in approach have been required.

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Planned Activities:

Description of future activities over the coming months.

In future months the manufacture of the girders and construction of the bridge will begin. Monitoring will then commence that will include girder layup and infusion, placement of girders, and pouring of the deck and parapets. When construction has finished, load testing and analysis will commence.