Memo

To: RITA Project Team

From: D. Harris

CC:

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Number: 19

Re: Lab progress, structural modeling and remote sensing response correlation

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Since the previous quarter, activities in the lab and the structural modeling have shifted focus to the field demonstration planned for Quarter 7 (August 2011). A summary of the field deployment plan is presented in Technical Memo 20, which emphasizes field instrumentation installation and calibration as well as the field deployment. This memo describes the laboratory and structural modeling progress that was made with the following technologies in Quarter 6.

Digital Image Correlation

The application of digital image correlation in this project has historically used non-proprietary MATLab code, but in the past quarter the project team has shifted to a commercially available software package (Correlated Solutions Vic2D) which was much more user friendly and applicable to the global system measurements of interests. The team has had success in using our existing digital SLR cameras with this software package and is currently testing the limitations for field application of the technology. Efforts have focused on establishing the sensitivity of the technology as compared to traditional methods, testing of the influence of aspects such as angle of measurement and lighting, and final equipment requirements for field testing (e.g. lenses, lighting, and marking pattern). It is expected that digital image correlation will be deployed on one of the three proposed bridge sites with a focus on measuring global deflection for further correlation with finite element results and tradition deflection measurement tools.

LiDAR

The application of LiDAR was not originally included in the assessment plan, but collaboration with a current Michigan Tech faculty member, who purchased a LiDAR system, prompted

reconsideration. In the past quarter, the LiDAR system was evaluated on a trial basis collect sample data that could be included in the beta Decision Support System. In addition to the MTU owned system, the project team has also initiated discussions with Michigan Department of Transportation (MDOT) for acquisition of LiDAR data collected by MDOT's surveying group with MDOT owned equipment. The data sets from both of these collaborations have proven useful to the project and as a result, plans have been initiated to incorporate LiDAR data collections in the field deployment plan. The proposed activities include collection with both LiDAR systems for comparison to other technologies being deployed (e.g. deck surface features using 3D photogrammetry and deflection measurements using digital image correlation).

Additional progress has been made on other technologies including thermal IR, 3D optics, and streetview-style photography, synthetic aperture radar (SAR), and interferometric synthetic aperture radar (InSAR), but these efforts have primarily centered on challenges and logistics associated with field deployment and are not presented herein.

STRUCTURAL MODELING

The finite element modeling in this project has consistently been coupled with global response metrics and as a result aligns well with technologies that assess global response such as digital image correlation and the recently added LiDAR. In the past quarter, the finite element model development has been limited due to preparations for the field deployment; however it is expected that results from the field deployment, specifically digital image correlation and LiDAR results, will be compared against finite element model simulations of the bridge response. Future activities will include the development of models for the bridges that will be evaluated for global system response (see Technical Memo 20 which describes the field deployment plan). While the models will be capable of simulating the response of the bridge to a variety of loading scenarios, the results from the field deployment will be limited to specific locations and loading scenarios and as a result will not provide sufficient detail for model updating techniques.

REMOTE SENSING CORRELATION

When considering the overall objectives of this study, the primary emphasis has been placed on establishing an indicator of global health of bridges. In the initial stages of the project, a decision was made to focus on indicators of health that can likely be observed using classical and non-classical remote sensing technologies. With consideration of the guidance provided by the project partners (MDOT) and our TAC, the focus of the project shifted to challenges of deterioration and condition monitoring on a temporal basis rather than structural safety (e.g. engineering behavior and safety). As a result of this focus shift, the project team recognized that the concept of a bridge health signature is extremely useful to a decision-maker, but the components of this signature are unique to each user and beyond the scope of this limited study. In lieu of developing a unique signature, the project team will focus efforts to provide ground truth of the various remote sensing technologies with traditional methods of evaluation and developing a highly adaptable decision support system that provides the user with indicators of condition upon which to make decisions to implement into the development a unique bridge signature.