Virtual Lab – Structural Health Monitoring

Rutgers University 2017-2018 Workplan

# Task 1 – Continued Development of Interactive SHM Web Content

Interactive SHM content has already been created and implemented in the Virtual Lab website. This content will be error checked and refined. Additionally, this content will be expanded upon to provide further value. Another interactive module, showcasing static load testing, will be created and integrated into the website. Finally the interactive content will be accompanied by “Khan Academy” style videos that provide instruction in how to use the modules and guide the users through educational scenarios.

1. Examine existing “Impact Test” module for simulation inconsistencies and identify any corrections/improvements that will provide an experience most representative of field testing.
2. Provide additional complexities to “Impact Test” module by allowing for different bridge geometry (e.g. skewed, asymmetric).
3. Expand “Impact Test” module by adding an “ambient” case whereby the user chooses ambient input (rather than impact locations) and the sensor locations.
4. Implement “Static Load Test” module. This will include compiling data corresponding to the different load cases, and structural configurations, writing python functions for querying and plotting specific data sets, and working with Drexel University personnel to integrate into the Virtual Lab web site.
5. Create “tutorial” videos that illustrate how to interact with the SHM modules and guide the user through educational scenarios.
6. Provide descriptions and background for SHM technologies/methodologies and best practices to be hosted on the web page and referenced by the modules and case studies.

# Task 2 – I76 Penncoyd Viaduct Case Study

The behavior of the viaduct has been extensively documented as a result of several test efforts. However, the test results alone cannot identify the mechanisms and scenarios that create excessive vibrations and large dynamic amplifications. Rather, an FE model will serve as a digital twin that will be created with attributes matching the viaduct. With this digital twin we can gain a more complete understanding of the structure and vibration issue.

1. Create and update FE model/models to create a digital twin(s) that is/are representative of the viaduct and capable of recreating the responses measured in the field. This will be done through a three stage process: (1) updating the FE model of the bridge using ambient vibration testing results, (2) updating of the truck model using the vibration tests conducted on test truck, and (3) refined updating of the models using the data obtained from the combined truck/bridge interaction experiment.
2. Through a series of multi-dimensional parametric studies (using the vehicle/structure interaction capabilities of LUSAS), identify the structural and vehicular mechanisms that govern the distinctive behavior observed, thereby understanding if and how the situation may be remedied by altering the structure or restricting traffic.
3. Perform a suite of simulations (using the vehicle/structure interaction capabilities of LUSAS) to investigate and quantify the influence of special loading scenarios on the observed dynamic bridge/truck interaction (e.g. platooning of trucks).
4. Incorporate work into web content that effectually delivers not only the conclusions but also the methods that guided the investigative efforts (with a particular focus on the structural identification/digital twin concept). Special attention will be paid to provide links between the case study and the interactive modules.

# Task 3 – IBS Bridge Case Study

This bridge was the focus of numerous past studies that aimed to trace the presence of various performance problems to their root causes. Of particular interest in this study, will be the large and active crack located on a cantilevered portion of one of the pier caps. Although this crack was originally thought to be due to a poor detail, the detail alone cannot explain the presence of the crack and more importantly why the crack didn’t appear elsewhere in the structure (as the poor detail was repeated in several locations). Rather, it is hypothesized that the presence of the crack is due to dynamic amplification caused by moving traffic that increased the forces in the pier cap that cracked, but not in the other pier caps (due to the unique geometry of the bridge).

1. Develop and update an FE model based on the results of the (a) short-term static testing, (b) forced vibration testing, and (c) long-term static monitoring conducted on bridge. It is envisioned that with will build on the work conducted by Weidner (2012) and will enhance it through the inclusion of the monitoring study by Glisic et al.
2. Through performing a multi-dimensional parametric study (using the vehicle/structure interaction capabilities of LUSAS), identify the loading conditions and bridge geometry that result in problematic stress concentrations. Investigate the effectiveness of a series of interventions (including modifications to system stiffness and/or damping) aimed at reducing the dynamic responses to a point where damage to the pier would have been prevented.
3. Gather previous testing and analysis documentation and compile along with documentation from new efforts into web content. Special attention will be paid to provide links between the case study and the interactive modules.

# Schedule

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|  | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| **Task 1** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Task 1.a |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Task 1.b |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Task 1.c |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Task 1.d |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Task 1.e |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Task 1.f |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Task 2** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Task 2.a |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Task 2.b |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Task 2.c |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Task 2.d |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Task 3** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Task 3.a |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Task 3.b |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Task 3.c |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |