RUTGERS

Center for Advanced Infrastructure and Transportation

Project Overview Report

1. UTC Identifying Number

   DTRT13-G-UTC28

2. Center Identifying Number

   CAIT-UTC-NC23

3. Project Title

   Multi-Scale Condition and Structural Analysis of Steel Bridge Infrastructure

4. Principal Investigator & Contact Information

   Jennifer McConnell
   University of Delaware
   Newark, DE 19716

5. Rutgers/CAIT Project Manager

   Patrick Szary, Ph.D.

6. Customer Principal

   Richard Dunne
   Director of Structures
   Michael Baker International

7. Project Description

   The data that exists or can be obtained regarding the condition and behavior of our nation's infrastructure presently exceeds the profession's ability to make efficient use of said data. Existing data sets span an enormous range of relative breadth and depth. For example, the breadth of the National Bridge Inventory (NBI) is comprehensive, but relatively basic with respect to structural condition. At the opposite extreme, state of the art structural models (i.e., finite element analysis) of individual structures can be created that give accurate and detailed information on the stress and displacement profiles throughout the structure under diverse loading conditions, but are only performed on rare occasions where the level of effort involved in their creation is worthwhile. Between these two extremes is element level data recorded by owners that quantifies more precise information on the severity and extent of deteriorated conditions than the NBI. Each of these data types has been used for various applications, but there are no known studies that have attempted to systematically identify and evaluate the inter-relationships between these data types. The objective of this project is to integrate this gradient of breadth and depth that can be described by these existing methodologies using big data analysis techniques to reveal a greater understanding of the structural causes of atypical bridge deterioration. This project will focus on identifying structural characteristics leading to above- or below-average performance, after accounting for differences in climate, use, etc., by creating finite element analysis models of these outliers and big data analysis techniques to systematically evaluate potential differences in stress distributions between bridges with differing conditions despite similar environments. As a result, possible short term outcomes include guidance on more efficient inspection procedures and / or more efficient and durable structural designs.

   These objectives will be achieved by first using NBI records for each structure over multiple years to assess deterioration over time. This information will be assessed in the context of climate and environmental data, which can be approximated at each bridge site based on existing data quantified at known locations and geographic information systems (GIS) software. There are also expected differences in deterioration due to factors traffic and age of the structure, to name a few. Thus, state of

the art big data analysis techniques will be used to reveal structures that are true outliers with respect to their condition, having either significantly better or worse condition than their peers, when considering all parameters currently known to affect long term performance. With these outliers identified, causes for their above or below average performance will then be explored. These causes may include structural characteristics, construction quality, or the influence of other influential parameters that have yet to be considered. This project will focus on identifying structural characteristics by creating finite element analysis models of these outliers and a novel big data analysis technique to systematically evaluate potential differences in stress distributions between bridges with differing conditions that are otherwise similar.

8. Implementation of Research Outcomes (or why not implemented)

   Results of this research will be presented to local and national DOT personnel. Through this action and subsequent communications it is envisioned that the research results could find application in the real world through enhanced recommendations for visual inspection practices (as described elsewhere) and / or more durable future bridge designs. Similarly, the knowledge gained via this research could inform best practices for bridge retrofits on aging infrastructure.

9. Impacts/Benefits of Implementation (actual, not anticipated)

   TBD

10. Dates and Budget

    Start Date: 2/1/2016
    End Date: 8/31/2017
    UTC (CAIT) Dollars: $ 57,654
    Cost Sharing: $ 57,726
    Total Dollars: $ 115,380

11. Keywords

    aging; corrosion; ratings; performance characteristics; climates; finite element analysis; big data

12. Web Links (Reports and Project Website)

    https://cait.rutgers.edu/cait/research/multi-scale-condition-and-structural-analysis-steel-bridge-infrastructure