Project Title: Detecting Weakened Highway and Railroad Bridge Substructures at Deck Level

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Project Summary:
Aging bridges located on or crossing highway, railway, and transit routes constitute a major component of our transportation system vital to its functionality, sustainability, and its role in economic development. The safe performance of these critical components depends on the proper functioning of the primary engineering components, superstructure and substructure, as well as construction and foundation materials. Establishing the current state of deterioration of bridge components and materials is a key aspect of the proper maintenance to ensure their continuing performance and safety of the traveling public or transported commodity.

The proposed study will address a difficult task in routine bridge maintenance and attempt to provide a reliable method of supplementing or reducing visual inspection intervals for typical substructure subsystems. The study further examines the cross-benefits of modeling and experimental approaches currently underway in an ongoing NCITEC project (UM2012_24). The study will apply the developed techniques to typical substructure systems found in the multimodal transportation system in the north Mississippi region, accessible to the research team. The study area includes three interstate corridors I-55, in maintenance stage; I-69, in completion, planning, and construction stages; and I-22, in planning stage. Note that I-22 will make use of the existing US-78 route, which includes numerous state and county highways including MS 2, 6, 9, 15, and 30 as well as the transcontinental railroad traveled by BNSF and two short intercity lines. The BNSF line supports the nearby Toyota plant, which is a major economic engine for the region and state.

The engineering aspects of select bridges in the study area will be identified for detailed analysis to determine the deck effect on displacements and modal vibration resulting from significant damage. Specific damage modes to be examined include corrosion, impact, and scour to primary substructure elements at levels below the deck. The study area is exposed to a moderate earthquake hazard due to its proximity to both the New Madrid Fault Zone and smaller local zones, and it is vital to identify potential weaknesses and the vulnerability they pose to these regional transportation lifelines. Many of the bridges cross water or flood plains, including the sizable Mississippi River and the Delta, and incorporate substructures that comprise a multi-pile bent. Finite element models incorporating soil-pile interaction will be constructed for these subsystems to establish the effect of plausible pile weaknesses on the modal vibration characteristics of the select bridges. Laboratory scale models will be constructed for select cases to demonstrate proof of concept and provide verification of associated numerical results.