NSF-REU Site: Sustainability of Horizontal Civil Networks in Rural Areas
2021 Project Description

Faculty Mentor Name:
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Project Title:
Revisiting Reliability for Rural Bridges
Research Area Description & Significance (3 – 4 sentences):
Rural bridges are crucial not only to agricultural economic activities, but also to disaster response and recovery efforts following extreme natural hazards. Many bridges in rural areas are at or beyond their intended service life, were designed assuming noncomposite behavior, and were designed either to lower vehicle loading than required in modern codes, or to unknown vehicle loading demands. Field testing and detailed analyses typically reveal substantial margins of reserve capacity unaccounted for by routine approximate analysis techniques. However, one persistent source of uncertainty is the composite effectiveness for bridges with steel deck welded to steel girders. The most conservative approach is to neglect the benefits from composite action entirely. This approach may unnecessarily extend evacuation timelines and material resupply routes during recovery. On the other hand, presuming composite effectiveness may lead to compromised service performance, requiring demolition and reconstruction of a bridge, or even collapse during response and recovery efforts.
Research Questions/Objectives (1 – 2 sentences):
The primary research question will be: how do the reliability characteristics of composite effectiveness relate to service and strength limits for off-system bridges under emergency vehicle loading?
Student Participation & Tasks (3 – 4 sentences):
The REU student will review literature to develop familiarity with reliability analysis and limit states applicable to bridge engineering. After developing familiarity with relevant frameworks and pertinent methods, the student will examine the sensitivity of bridge strength and serviceability with respect to loading characteristics (emergency vehicles vs. legal loads, dynamic amplification) and bridge composite effectiveness. At a minimum, this will be performed for a case study bridge which has previously been field tested. Ideally, the bridge characteristics will be parametrically extended. Further extension to consider comparative economic outcomes with competing decision alternatives (incur damage vs. lengthening transit routes) may also be explored.
Necessary Prerequisite Knowledge:
The student should have familiarity with computational software, Microsoft Excel at a minimum (typically acquired in freshman year), and Matlab (or equivalent) preferred. Familiarity with structural engineering, transportation engineering, and economic concepts are preferred, but not essential.