2019 UDOT RESEARCH PROBLEM STATEMENT

*** **Problem statement deadline is Feb. 6, 2019. Submit statements to UTRAC@utah.gov.** ***

Title: Evaluation of ABC Grouted Coupler Connected Bridge Piers Subject to Vehicular Impact **No. (Office Use):** 19.04.05

Written By: Andrew D. Sorensen **Organization:** USU **Email:** andrew.sorensen@usu.edu **Phone:** 435.797.6377

Submitted By UDOT Employee: Rhett Arnell **Email:** rarnell@utah.gov **Phone:** 435.979.7083

UDOT Champion (if different): **Email:** **Phone:**

Select ONE Subject Area ☐ Materials/Pavements ☐ Maintenance ☐ Traffic Mgmt/Safety ☒ Structures/Geotech ☐ Planning ☐ Perf Mgmt/Data Analytics ☐ Public Transportation ☐ Other

1. Describe the problem to be addressed:

Accelerated Bridge Construction (ABC) refers to a bridge construction type that incorporates innovative techniques, methodologies, and materials to efficiently reduce the construction time, traffic disruption and dynamic performance. Evaluation for seismic performance of typical ABC column-footing connections has been undertaken in high earthquake prone states like Utah, California, Nevada, and Idaho. However, apart from the dynamic load exhibited by earthquake, the behavior of these connections to other dynamic loadings, like blast and impact, are also critical and warrant investigation. This is especially true when the frequency of occurrence of vehicular impact to bridge structures, which far surpasses that of earthquake, is considered. One of the issues with vehicular impact is that while the damage resulting from the impact may appear to only be cosmetic, the residual capacity of the pier can be drastically reduced. This makes it even more susceptible to failure under subsequent extreme dynamic loading such as seismic.

The behavior of traditionally constructed bridge piers subject to vehicular research has been researched previously, however the grouted connections used in ABC (such as those described in the *UDOT Structures Design & Detailing Manual*, Section 20.4.6.3) have yet to be considered. Application of the results from traditionally constructed piers to ABC coupler connected bridges is not feasible because of the different base connection which introduces new potential failure modes including base shear, grout fracture and de-bonding, and coupler failure. Of particular concern is the grout in the coupler. If the grout in the coupled connection is fractured under impact the bond between the coupler and the reinforcing steel is lost allowing the reinforcing steel to pull out from the coupler under further dynamic loading.

This project proposes to look at the behavior of UDOT's current ABC grouted coupler connections (as detailed in the *UDOT Structures Design & Detailing Manual*) under impact loading. The research will be carried out at the Utah State University SMASH Lab where a one story impact pendulum is currently under construction. At completion, the pendulum will be capable of replicating impact loads on structures on the same magnitude as a sedan traveling at 55 m.p.h. Typical connections will first undergo impact testing to determine the resulting damage indices. These indices will be compared to results of traditionally constructed piers. The impact coupler piers will also be evaluated to determine failure modes and inspected for de-bonding between the pier and support base. Some of the impacted piers will then be carefully cut open to inspect the grout within the coupler for evaluation. Finally, the remaining impacted piers will be subjected to simple pushover analysis.

2. Write the project objective (25 words or less):

Evaluate the current UDOT grouted coupler connection configurations under impact loading to determine corresponding failure modes, damage indices and residual capacity.

3. Explain why this research is important:
(In response, consider addressing specific UDOT goals, applicability in Utah or other states, etc.)

This research is in direct response to UDOT's goals of preserving infrastructure and optimize mobility. Although there are a limited number of ABC bridges currently in service in Utah, it is likely that as UDOT replaces existing bridges, ABC methods will be used to reduce construction time and impact on traffic mobility. UDOT has been at the forefront of ABC construction and has already invested research funds to insure that these types of connections are suitable for seismic loading. However, this research assumes a completely healthy connection. A vehicularly damaged grouted coupler would produce significantly less capacity. Insuring that existing and future ABC constructions can adequately withstand vehicular impact directly correlates to UDOT's ability to preserve infrastructure.

4. List the major tasks:

1. Carry out literature review of previous work on grouted coupler connections in bridge piers.
2. Carry out preliminary round of testing on coupler connected piers (as outlined in Section 1 of this proposal).
3. Preparation/submission of the mid-project report.
4. Carry out second round of testing on coupler connected piers based on feedback from UDOT TAC of the preliminary round.
5. Preparation/submission of the final project report.

5. List the expected deliverables (reports, manual, specification, design method, training, etc.):

1. State of the art paper on performance of bridge piers subjected to vehicular impact.
2. Mid-project report once the first round of testing is complete.
3. Final report including recommended changes if any to the *Structures Design & Detailing Manual.*

6. Describe how the research results will be implemented:
(In response, consider addressing UDOT leader support, process or standard improvement, etc.)

Based on the results of the study, changes to the *Structures Design & Detailing Manual* may be recommended.

7. Requested from UDOT: $55,500 **Other/Matching Funds:** $60,000 (Anticipated MPC) **Total Cost:** $115,500
(or UTA for Public Transportation)

8. Outline the proposed schedule, including start and major event dates:
Using the major tasks outlined in Section 4 of this proposal, the following Gant chart outlines the proposed schedule of the project (assuming a project start date of July 1 2019):

Task Item	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20
1												
2												
3												
4												
5												