2020 UDOT RESEARCH PROBLEM STATEMENT

Problem Statement deadline is March 16, 2020. Submit statements to UTRAC@utah.gov

All submitted problem statements become the property of UDOT and authors are not guaranteed a contract for related work.

Title: Blow-through analysis of concrete bridge decks **No. (Office Use): 20.04.10**

Written By: Fernando Fonseca **Organization:** BYU **Email:** fonseca@byu.edu **Phone:** 801-422-6329

Submitted By UDOT Employee: James Corney **Email:** JCorney@utah.gov **Phone:** 702-285-8809

UDOT Champion (if different): Cody Parker **Email:** CodyParker@utah.gov **Phone:** 385-226-4499

Select ONE Subject Group ☐ Materials/Pavements ☐ Maintenance ☐ Traffic Mgmt/Safety ☒ Structures/Geotech ☐ Planning ☐ Aeronautics ☐ Public Transportation ☐ Other

1. Write a brief research project objective:

Develop a simple model to predict the blow-through capacity of concrete bridge decks accounting for two-way behavior.

2. Explain the problem and why this research is important: (*Importance reflects 50% of the statement score*)

Repair of damaged concrete on bridge decks requires removal and replacement. Hydro-demolition is a technique that is becoming increasingly common for removal of the damaged concrete. Unlikely other techniques, hydro-demolition can be used to remove damaged concrete from even below the top reinforcement mat, which is both an advantage—concrete bridge decks that have damaged concrete below the top reinforcement may now be a candidate for repair—and a disadvantage—the high pressure water jet can cause a localize punching shear or blow-through failure of the deck.

Roper (Chloride Concentration and Blow-Through Analysis for Concrete Bridge Decks Rehabilitated Using Hydro-Demolition, MS Thesis, Brigham Young University, Provo, Utah, 2018) developed a model in EXCEL to predict the "blow-through" capacity of concrete bridge decks using Euler-Bernoulli simplified beam theory.

This research will develop the model by Roper further by including in it a comprehensive way to account for two-way capacity and behavior of concrete slabs. Although a model based on the finite element method could be developed, such a model would be most likely too sophisticated and would defeat the objective of having a simple and yet reliable and robust model. Also, a finite element model would require sophisticated software and expensive hardware. Thus, to stay in line with the objective, the classical plate theory and the finite difference method will be explored as the method to be implemented in the EXCEL model.

This research is important because the current model yields deliberately conservative results; the two-way capability of the model will tremendously enhance the model accuracy, reliability, and robustness.

3. Describe how the research results will be implemented and benefit Utah: (*Implementation reflects 50% of the statement score*)

The model will be another tool that can be used by UDOT engineers to better plan the repair of concrete bridge decks that have damaged concrete below the top reinforcement mat.

4. List the major research tasks:

Conduct a literature review on punching shear failure of concrete bridge deck; conduct a literature review on two-way analysis methods; examine the model developed by Roper; implement the chosen two-way analysis method in the model.

To validate the simplified model, the following approach is proposed:

Develop a finite element model of a concrete deck using ABAQUS (BYU has an ABAQUS license); use the FE model to predict the "blow-through" capacity of a suite of concrete decks; use the simplified model to predict the "blow-through" capacity of the same suite of concrete decks; compare the results obtained using both models; adjust, if necessary, the simplified model accordingly.

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

A written research report, a copy of the model with instructions, and an oral presentation that will include how the results can be implemented and benefit UDOT.

6. Requested from UDOT: $80,000 to S100,000 **Other/Matching Funds:** $ **Total Cost:** $

Briefly explain funding sources:

7. Outline the proposed schedule, including start and major event dates:

Literature review on punching shear – approximately 2 months
Literature on two-way analysis methods – approximately 2 months
Study the model developed by Roper – approximately 1 month
Implement the two-way analysis method in the model – approximately 5 months

To validate the simplified model:
Develop a finite element model – approximately 6 months
Predict "blow-through" capacity of a suite of concrete decks using both models – approximately 2 months
Analyze results and adjust, if necessary, the simplified model – approximately 3 months
Preparation of deliverables – approximately 3 months