

2019 UDOT RESEARCH PROBLEM STATEMENT

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

Title: Non-destructive Evaluation and Numerical Modelling of Unrated Installed Crash Barriers **No. (Office Use):** 19.03.23

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

Submitted By UDOT Employee: Robert Miles **Email:** robertmiles@udot.gov **Phone:** 801.965.4273

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:

The Utah Department of Transportation (UDOT) has approximately 3.6 billion dollars' worth of crash barriers currently in service. Crash barriers are currently rated for effectiveness using the AASHTO Manual for Assessing Safety Hardware (MASH). Prior to this, crash barriers were rated according to NCHRP – 350 criteria. The MASH manual specifies different testing criteria that crash barriers or guard rail must pass in order to be rated at certain levels. The basic level, or Test Level 3, for longitudinal barriers must support, for example, an 1100 to 2270 kg vehicle travelling at 100 km/h at a nominal impact angle of 25 degrees (as well as other impact scenarios). The previous NCHRP – 350 criteria was an 820 kg vehicle travelling at 100 km/h at a nominal impact angle of 20 degrees. Crash barrier are certified according to MASH standards prior to installation and new barrier designs are certified by the FHWA. However, a number of crash barriers currently in service around the state pre-date the new MASH rating system and as such, UDOT does not have a definitive knowledge of the impact resistance of these barriers. Additionally, the FHWA has recently announced plans to discontinue its practice of certifying crash barrier. These factors have necessitated a local ability to evaluate installed crash barriers non-destructively.

This project proposes to establish a procedure for the non-destructive evaluation and numerical modelling of unrated, currently installed crash barriers. A number of such crash barriers, identified by UDOT Traffic and Safety, will be non-destructively tested using experimental modal analysis (EMA). EMA is a non-destructive testing method that is effective in extracting physical characteristics of a structure such as mode shapes and the natural frequencies of the modes that are excited. These mode shapes and natural frequencies can then be used to validate a numerical model developed using Finite Element Analysis (hereafter referred to as the finite element model (FEM)). Using EMA, and soil samples collected at the installation site, the FEM can be developed and the installation specific boundary conditions validated. Once the FEM is validated, MASH loading conditions can be applied to the FEM to determine an approximate MASH rating. In addition to crash barriers with unknown MASH ratings, testing and modelling will also be carried out on a known barrier whose MASH rating is known. This will allow for further refinement and validation to the FEM.

This project provides a number of benefits to UDOT. First of all it will provide an estimated rating for crash barrier whose rating is currently unknown. This will provide decision makers within UDOT Traffic and Safety with information needed to properly manage these assets. Furthermore, this project also develops a procedure where new crash barriers can be evaluated prior to carrying out a fully constructed testing regime. This has the potential for significant cost savings to UDOT especially as the latest MASH standards require that a barrier pass all testing regimens without failure or the entire testing procedure must be started again at the beginning.

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

Develop a validated numerical modelling and testing procedure to approximate the MASH rating of UDOT crash barriers.

3. Explain why this research is important:

(In response, consider addressing specific UDOT goals, applicability in Utah or other states, etc.)

This project specifically addresses vision and mission of UDOT in that it contributes to public safety. Crash barriers and guard rails provide key support in achieving UDOT's goals to achieve zero fatalities as well as to preserve infrastructure. The obtainment of approximate MASH ratings for crash barriers will aid asset managers in their decision process. Additionally, developing numerical modelling techniques for future barriers can provide cost savings which is directly correlated to UDOT's core values of safety and fiscal responsibility.

4. List the major tasks:

1. Develop an overview of current practices in both physical testing and numerical modelling of crash barriers. This work will result in the development of a state of the art technical paper.
2. Identify three crash barriers for EMA testing (2 unknown and 1 known rated). Carry out EMA and soil testing on the three barriers.
3. Using the EMA and soil testing, develop three corresponding validated FEM's for the three barriers.
4. Use the validated FEM's to simulate MASH testing criteria in order to determine an approximate rating for the two unknown barriers.
5. Prepare a final report based on the results of the testing and MASH simulations.

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

1. A copy of the state of the art literature review technical paper on testing and numerical modelling of crash barriers.
2. A mid-project report submitted after the completion of the EMA testing with preliminary FEM's.
3. A final report detailing the results of the MASH simulations for the unknown guardrail.

6. Describe how the research results will be implemented:

(In response, consider addressing UDOT leader support, process or standard improvement, etc.)

The research results will be implemented with design process and standard improvement on future crash barrier construction.

**7. Requested from UDOT: \$60,000
(or UTA for Public Transportation)**

Other/Matching Funds: \$

Total Cost: \$60,000

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

Using the major tasks listed in Section 4 of this proposal, and assuming a start date of July 1, 2019 the following project timeline is proposed:

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												