2021 Initial Idea Development

2021-2022 NRRA Research and MnROAD Construction Development
(Updated Form – March 23, 2021)

Initial Proposal is for NRRA Executive Team to Approve for further development (keep to two pages)

Research Title:	Flooded Pavements Assessment App–Phase II
NRRA Team(s):	Geotechnical Team, Flexible Team
Type of Effort:	**Research**
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Research Funding Estimate:	$200,000
Research Years Expected:	2.5 years
Beneficial Partnerships:	The proposed idea will engage all NRRA member agencies and MnROAD/MnDOT.

Number of Test Sections:	Any existing or future test sections which sufficient moisture instrumentation
Instrumentation Effort:	**Minimal. Leveraging installed moisture sensors and piezometers/wells for water table**
MnROAD Monitoring:	**Routine monitoring and dynamic testing (as done before by MnROAD)**

Research Objectives:

What are the objectives of this research effort?

Research Need:

Pavements are dynamic structures and are affected by several parameters such as climate, loading conditions, or material properties. Current pavement analysis and design procedures often rely on empirical or mechanistic-empirical approaches, which renders their ability to incorporate moisture-dependency, especially during periods of excess moisture (such as, post flooding) and to conduct real-time and forecasted pavement capacity and load restriction analyses. While excess moisture in base and subgrade soils during and after inundation of roads has detrimental impacts on longevity and serviceability of pavements, immediate need for transportation agencies is often focused on road closure and opening decisions. The presence of excess water can be due to seasonal ground water level fluctuations, post-storm flooding, and thawing of soil frost and surface snow. An ideal agency decision App for roadway closures and/or load posting is the one that is mechanistic, and holistically evaluates different physical and environmental stressors. Such Application can enhance the resilience of pavement systems in response to extreme events and also results in more sustainable, efficient, and cost-effect roads.

State of previous work:

In an effort supported by the NRRA – Phase I, the research team at the University of New Hampshire (UNH) has studied the mechanistic response of flexible pavement systems during and after flooding events. This involved using system dynamics modeling approach to consider the interdependency of several influential factors on pavement response through sensitivity analysis and parameterization. Further, the team at UNH has developed an initial version of a user-friendly toolkit that would help agencies to decide on post-flooding roadway opening decisions by mechanistically assessing the pavement capacity on basis of pavement section characteristics, material properties, climatic conditions (past and forecasted), and traffic scenarios. The toolkit will assist public agencies to make reliable road opening decisions during and after flooding and for various traffic classes. The first version of the UNH's Flooded Pavement Assessment App was presented to NRRA members and also to at-large

transportation community during TRB 2021 annual meeting, which received significant attention and interest.

Proposed Research:

Efforts are proposed to enhance and amplify the recently developed post-flooding roadway assessment App. Although the current toolkit encompasses all fundamental aspects of pavement response, it incorporates several material models and constitutive relations from the literature. Some of these relations are approximate and some were developed for limited material options or boundary conditions. Thus, it is expected that the toolkit requires several versions of validation and modification. These modifications are needed to ensure the most accurate and reliable pavement response assessment. Further, this calibration and validation campaign should be done at different scales to provide a balanced approach between the practicality and technical soundness. A fivefold calibration and validation campaign was originally envisioned to be done in a phased approach: (1) using the currently available network-level data; (2) using the results of small-scale physical models; (3) using the results of large scale physical models; (4) using advance numerical models; and (4) using field data from instrumented road sections. The first round of validation has already been performed as the last task in NRRA-supported Phase I project. In addition, the ability to import agency specific inputs (such as each agencies traffic characterization system as well as load spectra and typical material inputs) is presently limited. For wide-spread implementation this functionality needs to be added. Lastly, the App needs to be enhanced both on computational efficiency and accessibility and also the graphical user interface.

Pavement Test Cells Needed:

What test sections (MnROAD or other roadways) do you propose to provide data? (None, if synthesis).

Data from existing and future MnROAD sections as well as those from various NRRA member agencies will be tremendously valuable for this research, especially post-flooding or heavy precipitation field data. Although, dedicated test sections are not required but if data become available will significantly benefit the research.

NRRA Sustainability/Resiliency and or Intelligent Construction:

How will this project fit the primary themes of NRRA Phase-II efforts?

Aligned with the NRRA Phase-II strategic goals of sustainability and resiliency, the proposed project will: (1) result in a more efficient and performance-based load restriction protocol that would reduce the maintenance operation programs (minimizing the impact of operations on the climate and environment); (2) enhance the pavement service life and help agencies to make more informed decisions post flooding (improve the resilience of our transportation systems); (3) provide a robust toolkit to maintain road safety and emergency transportation management (promote public health and healthy communities); (4) enhance resiliency of pavement infrastructure by use of real-time as well as forecasted climatic information to ensure that post extreme event emergency response can be planned and executed.

Cross-cutting Opportunities:

Can your idea fit with or utilize concepts proposed by other NRRA teams?

This project would fit within the goals of both Geotech and Flexible teams while also contribute to the mission of Maintenance (PM) team. Also, the project can benefit from data generated from some of the ongoing research on moisture monitoring and FWD testing on different road sections.

Implementation Plan:

How do you envision implementing the findings from this study?

The proposed research effort will focus on dissemination of research by providing training and implementation support to transportation agencies (local and state) to adopt the toolkit. This includes asking state members to test the toolkit and provide feedback during various phases of the project. The final product will provide immediate access to a decision toolkit that can be easily implemented by state DOTs for post-flooding roadway assessment.