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# FORMAT OF RESEARCH NEEDS STATEMENT FOR POSTING ON TRB WEBSITE

**I. RESEARCH NEEDS TITLE**

Efficient Collection of In-situ Mechanistic Response Measurements to Facilitate Pavement Design and Evaluation

**II. RESEARCH NEEDS STATEMENT**

The industry continues to advance towards mechanistic design, but efficient collection of in-situ measurements of critical pavement responses is still a challenge. Previous research efforts have focused on predicting pavement stresses, strains, and displacements, but the agreement between the measured and predicted pavement responses has been far from satisfactory. As technology continues to rapidly advance, we must again question if we are applying the most efficient and/or effective means for assessing in-situ measurements of pavement responses. These concerns need to be addressed in the development of the next generation of the mechanistic-based pavement analysis and design concepts.

The development of “smart” structures with embedded sensing capabilities has attracted significant attention in the context of autonomous structural health monitoring. Advancements in wireless sensor networks allow for long-term, continuous, real-time structural health monitoring of pavements and bridges at low cost. This approach has significant appeal within the context of sustainable infrastructure systems.

Technologies also continue to develop for efficiently and effectively monitoring critical responses without the use of embedded sensors. We are approaching the point where we can perform pavement structural characterization and condition monitoring using vehicle-mounted remote sensing. Remote sensors can collect *in-situ* data such as temperature, moisture, deflections, and deflection velocities. This type of data has the potential to efficiently and effectively aid engineers in determining when and where pavement deterioration is occurring (before the distress is noticeable to the traveling public), provide mechanistic inputs to support design, and aid in construction quality control.

**III. RESEARCH OBJECTIVE**

The objective of this research is to develop and/or validate advanced methods for recording mechanistic properties for use in pavement design and evaluation, using next-generation in-situ field measurements, rather than relying on sporadic sensor data or indirect measurements and relationships. Capabilities are needed to monitor and record critical structural responses, structural health, supporting efficient operation and maintenance of civil infrastructure through simultaneous measurement of multiple pavement properties.

While many designs and evaluations are still based on predictive models of assumed responses, technology is evolving to initiate collection of in-service mechanistic based data with sensor systems capable of real-time, monitoring of deflection, deflection velocity, strain/stress, temperature, and moisture content/relative humidity in highway structures. Such systems should be capable of integrating data acquisition, and multi-function sensor units capable of monitoring mechanistic responses.

**IV. ESTIMATE OF FUNDING AND RESEARCH PERIOD**

**Recommended Funding:**

$ 450,000-500,000.

**Research Period:**

36 months.

**V. URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION**

A significant portion of the existing roadway system in the US was built over 50 years ago, and it is beginning to need significant repairs, upgrades and/or replacement. It is increasingly being recognized that new construction and intelligent rehabilitation of deteriorating pavement systems include efficient and innovative use of high-performance materials, sensors, and mechanical and structural systems. There is need for real-time or quasi real-time in-situ testing of pavement properties for quality control (QC) to facilitate rapid pavement preservation, rehabilitation and construction processes.

Studies have shown that the technology is now available to provide field-measured pavement responses of various pavement layers that will facilitate the mechanistic design process. There are also several additional benefits of collecting field-measured pavement responses, including better prediction of the effects that traffic, material, design or construction have on pavement performance.

Continuous monitoring and cost-effective assessment of infrastructure systems can help engineers estimate risk at different stages of the pavement life and more efficiently plan maintenance and rehabilitation activities during the life-cycle of these structures.

Measurement of localized strain will be useful for early pavement damage detection and future condition evaluation. The strains measured by such systems could be used to estimate the remaining fatigue life of a pavement using Miner’s hypothesis in the context of mechanistic-empirical pavement design.

**VI. IMPLEMENTATION PLANNING**

These results should be applied by State Agencies and/or their consultants to improve the evaluation, design and construction of pavements.

**VII. PERSONS DEVELOPING THE PROBLEM**

Jerry Daleiden

**VII. PROBLEM MONITOR**

TRB Committee AFD20 on Pavement Monitoring and Evaluation and AFS20 on Geotechnical Instrumentation and Modeling

**III. DATE AND SUBMITTED BY**