SECTION C - DESCRIPTION/SPECIFICATIONS/WORK STATEMENT

Pavement Structural Evaluation at the Network Level

BACKGROUND

Current State Highway Agencies (SHAs) Pavement Management Systems are primarily based on surface condition data and surface cracking is mainly used as an indicator of the pavement structural condition. However, with effective pavement preservation activities that intervene early to preserve and extend the life of pavements and increasingly thicker long-life pavements, the surface cracks can no longer be relied on as a reliable indicator of structural condition or "health" of the pavement structure. This is because most preservation treatments correct surface cracks but do not correct bottom-up fatigue cracking, instead concealing them, while the bottom-initiated cracks continue to develop. In addition, the prevalence of top-down cracking in thicker pavements also makes it difficult to distinguish bottom-up fatigue cracking which is the common indicator of structural deterioration.

The true pavement structural condition and rate of deterioration are needed not only to plan optimal structural rehabilitation activities and future budget needs but also for assessing meaningful progress under a performance based Federal-Aid program. With an aging pavement network on our most trafficked highways, the fear is not when the next preservation treatment will be needed but when will this treatment no longer be effective, resulting in the need for major rehabilitation and/or reconstruction.

The SHAs state-of-the-practice pavement condition data collection is inadequate to meet this increasingly critical need and some SHAs have investigated the use of Falling Weight Deflectometer (FWD). While FWDs are the preferred device for project level structural evaluation, they are inefficient at the network level. FWD measurements are made at discrete points along the pavement sections and the equipment should remain stationary on the road during each testing point (typically 1-4 minutes, depending on the protocol). Since the equipment has to be stationary during measurements, this requires lane closures that disrupt traffic and traffic control. This limits the productivity and the number of discrete points where measurements can be obtained.

High speed continuous deflection devices were developed as a practical alternative to FWD for network level pavement structural evaluation. A number of recent studies have investigated the state-of-the-technology and use of high speed continuous deflection devices.[1, 2, 3] A more recent effort under the Strategic Highway Research Program, (SHRP) 2 Renewal Project 206(F) SHRP2-R06(F) project titled "Assessment of Continuous Pavement Deflection Measuring Technologies" reviewed all such devices under Phase 1 of a two phase effort and concluded that, for network level applications, there are two potential devices currently on the market – the Traffic Speed Deflectometer (TSD) and the Rolling Wheel Deflectometer (RWD).[1]

The TSD is manufactured in Denmark and to date is being used in Denmark, UK, Poland and Italy. In addition, several thousand miles of major roads in Australia were tested in 2010 and the manufactures are building a device for delivery to South Africa. The RWD was developed by Applied Research Associates, Inc. (ARA) in cooperation with FHWA. While RWD demonstration projects have been conducted in over 15 states, it has not been

embraced by SHAs for pavement management activities. The Phase 2 of the SHRP2-R06(F) effort was intended for limited field trials of selected pavement sections to evaluate the repeatability of the TSD and RWD and the reproducibility of both devices by comparison with the FWD. However, study authors noted that RWD was not available for testing during the Phase 2 evaluation period due equipment operational problems and data assembled as part of the Phase 1 assessment were used instead. While the Phase 2 of SHRP2-R06(F) was focused on repeatability of selected devices and reproducibility by comparison with the FWD, it also included limited analysis of the information from the devices for pavement structural evaluation to support pavement management application and decision making.

SCOPE OF WORK

The scope of this project is focused on traffic speed continuous deflection (or other pavement response that can be reliably related to pavement structural condition) devices for pavement structural evaluation at the network level for use in pavement management application and decision making.

CONTRACT OBJECTIVE

Using findings from the SHRP2-R06(F) and similar efforts included in the references section of this document as starting point, the objective of this project is to assess, evaluate and validate the capability of the RWD and the TSD (and any other traffic speed continuous deflection (or other pavement response that can be reliably related to pavement structural condition) devices that may have been developed since these efforts) for pavement structural evaluation at the network level for use in pavement management application and decision making. Develop analysis methodologies for enabling their use in pavement management. In this process, the following aspects shall be considered:

- The information desired is a reliable measure of the structural condition of the pavement layer as it deteriorates over time under traffic and environmental loading. In this case, the pavement layer is used to refer to all bound layers above the unbound base layer. While the base and subgrade may undergo seasonal changes, they don't generally deteriorate, at least not the way the bound layers do and their performance is accounted for in pavement design.
- The measure should be robust enough in capturing the structural condition or deterioration of the pavement layer notwithstanding the seasonal and spatial variation in base and subgrade layers.

If available devices do not have the capability meet the stated objective, the contractor shall develop recommendations to further develop promising device(s) and/or technologies.

Preliminary analysis efforts on the use of surface deflections for in-service flexible pavement structural evaluation at the network level have been conducted at the FHWA Turner-Fairbank Highway Research Center (TFHRC) and it is expected that close coordination and collaboration with the FHWA TFHRC staff through the COR will be required during Phase 2 of this project.[4]

WORK SCOPE

The project shall have two phases.

The goal Phase 1 is to identify available traffic speed continuous deflection (or other pavement response that can be reliably related to pavement structural condition) devices with potential to meet the stated objectives and develop a work plan for carefully designed field trials on instrumented pavement sections to evaluate and validate their capabilities. The devices' potential to meet the stated objectives shall be based on previous studies and theoretical and technical review of the measurement concept and the technology utilized.

The Contractor shall submit an interim report, including a detailed Phase 2 work plan to accomplish the project objectives. The contractor is also expected to describe research plans that can be realistically accomplished to meet the stated objectives. The plan shall present their current thinking in sufficient detail to demonstrate their understanding of the issues and the soundness of their approach.

Work shall not begin until approval of the final Phase 2 work plan has been received from the Contracting Officer's Representative (COR). The goal of Phase 2 is to implement the work plan as developed in Phase 1.

The Contractor shall thoroughly review and build upon the findings from efforts under FHWA Contract DTFH61-08-D-00025 entitled, "The State-of-the-Technology of Moving Pavement Deflection Testing" (Attachment J.9) and SHRP2-R06(F) project entitled "Assessment of Continuous Pavement Deflection Measuring Technologies."[1, 2]

PHASE 1: IDENTIFICATION AND ASSESSMENT OF CAPABLE DEVICES

DELINEATION OF TASKS:

Task 1. Kick-off Meeting / Detailed Project Management Plan

The contractor, including key personnel as identified in Section G.14, shall attend a face-to-face meeting in Washington DC with the COR and FHWA the project technical panel within 20 days of award. One week in advance of the kick-off meeting, the contractor shall prepare and submit a meeting agenda and draft project management plan to the COR for review and comment.

The purpose of the kick-off meeting is to rationalize the approach that will be utilized to meet the stated objectives of this project, discuss the project management approach and project management plan, introduce key resources, provide background information, clarify issues or concerns, define the roles and responsibilities, establish timelines, identify format of quarterly progress reports, and to respond to questions.

The contractor shall prepare a summary of this meeting along with a draft project management plan and submit them to the COR within 2 weeks after the kick-off meeting. Within 1 week of receiving the meeting summary and draft project management plan, the COR will review the documents to confirm that the correct perspectives were captured and

provide comments.

Within 1 week after receiving comments from the COR the contractor shall implement the comments into the summary and deliver a final detailed project management plan.

Task 2. Identification and Assessment of Capable Devices

The contractor shall review the findings from SHRP2-R06(F) and FHWA Contract DTFH61-08-D-00025, to critically assess the capabilities of available devices with specific focus on pavement structural evaluation at the network level for use in pavement management application and decision making. Using this information, the contractor shall identify promising devices for further evaluation. It is noted that past efforts have focused mainly on comparison with FWD. While that is a needed first step, the focus here is to provide reliable and robust measure of the structural condition of the pavement layer as stated in the objectives.

Within three (3) months of contract award, the contractor shall submit a technical memorandum outlining devices identified for further evaluation and the rationale for their selection.

Task 3. Access to and Documentation of Technical, Data Processing and Analysis Details of each Capable Device

The contractor shall receive commitment from device manufacturers to have the identified devices included in the field evaluation and validation in Phase 2. The contractor shall gather and document information from the manufacturers on the technical details of the devices, their stated capabilities and limitations, raw data collection, processing and analysis, and spatial averaging interval, if used, and its effect on identifying localized structural deficiencies. The contractor shall also identify or develop analysis methodologies to validate information from each device with independent measurements that reliably relates to pavement structure, including those from instrumented pavement sections.

Note:

Greenwood Engineering, manufacturers of the TSD, have reported of their plans to bring their latest TSD for demonstration testing in the US and the Contractor is expected to coordinate field trials accordingly so that transportation cost of TSD to the US are not incurred under this contract.

Task 4. Work Plan for Field Trials

The contractor shall develop a plan for conducting comprehensive field trials incorporating flexible and rigid pavements of varying conditions.

Note:

MnROAD pavememt test facility is recommended as a potential field trial location. However, the contractor can make the final determination based on its preference.

Task 5. Interim Report

The Contractor shall prepare an interim report documenting in detail the research approach and outcomes from the above tasks, as well as a detailed Phase 2 work plan and updated budget, if necessary and justified:

In its report, the contractor shall summarize previous efforts, devices reviewed or evaluated in those efforts, their relevancy to this project, and assessment of their capability to meet the stated objectives.

In the report, the contractor shall also cover the following aspects of Phase 1:

1) Selection of capable devices. Clearly describe the rationale for the selection and their ability to meet the stated objectives.

2) Documented commitment from manufacturers to include the selected devices in the field trials and each device's technical, calibration, data collection, and processing and data analysis details.

3) Location and details of instrumented pavement sections selected for field trials. The instrumented pavement sections shall include both asphalt and concrete surfaced pavement sections and the contractor shall propose the number of pavement sections required to enable statistically sound evaluation and validation of the candidate devices.

4) Describe associated work (e.g. pavement data to be collected prior testing, instrumentation and other data to be collected during testing and pre- and post- data processing and analysis methodologies for relating device measurements to pavement structural condition) necessary before the devices can be evaluated and validated.

Task 6. Presentation and Finalization of the Interim Report

Toward the end of Phase 1, the contractor shall schedule a meeting in Washington DC to meet with the FHWA technical panel and selected stakeholders to present and discuss the interim report. During the presentation, the contractor shall explain the findings from the Phase 1 investigations and present the proposed work to be performed under Phase 2. The COR will provide review comments on the interim report, including the proposed Phase 2 work plan in writing to the Contractor within 30 days after receipt of the interim report. Based on review comments, the Contractor shall prepare a summary of the meeting along with final interim report, including a final revised Phase 2 work plan within 30 days after receipt of the COR review comments.

PHASE 2: EXECUTION OF WORK PLAN – FIELD EVALUATION AND VALIDATION

Upon acceptance and approval of the Final Phase 2 Work Plan by the COR and exercise of the option via formal modification to the contract, the contractor shall proceed as follows:

DELINEATION OF TASKS:

Task 7. Field Data Collection

In coordination with device manufacturers and instrumented pavement facility owners, the contractor shall collect all necessary data to allow comprehensive evaluation and validation of the candidate devices' capability to meet the stated objectives.

Task 8. Evaluation and Validation of Devices

The Contractor shall assemble all raw data and conduct all analyses to enable independent evaluation and validation of the devices capability to meet the stated objectives. The evaluation and validation analyses shall utilize data collected from pavement instrumentation and other means of data collection to reliably evaluate measures obtained from devices to pavement structural condition.

Task 9. Analysis Methodologies and Processes for Incorporating Pavement Structural Information with SHAs Pavement Management Applications

If one or more devices are found to be capable to meet the objectives based on the evaluation and validation in the previous task, the Contractor shall develop analysis methodologies and processes for incorporating pavement structural condition information derived from the selected device(s) for use in SHAs pavement management applications. The analysis methodologies and processes developed shall consider and account for factors that are often outside the control of pavement management data collection, such as pavement temperature, speed, etc., as well as pavement data that can typically be expected to be available in a pavement management system.

Task 10. Final Report and Deliverables

The Contractor shall prepare a final report documenting the work performed, findings from investigations performed, results, and suggestions for future research. In addition to the final report, for any software developed as part of this project, the Contractor shall provide as a minimum, the executable version, as well as well-documented source code in electronic readable format, overall software architecture documentation, overall and individual module interface documentation, other support and library files, and a user's operations manual. The source code and support files included shall be in its entirety so that they can be compiled and linked using off the shelf software to recreate the executable version of software in its entirety. In addition, the Contractor shall prepare and submit an FHWA Tech Brief and a Microsoft PowerPoint presentation. The presentation shall explain the technical approach, findings, and products from the entire research project.

References:

1. Strategic Highway Research Program (2012) "Assessment of Continuous Pavement Deflection Measuring Technologies," Project SHRP2–R06(F), Washington, DC (http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2565).

2. Rada, G. R. and Nazarian, S. (2011) "The State-of-the-Technology of Moving Pavement Deflection Testing," Final Report, FHWA-DTFH61-08-D-00025, U.S. Department of Transportation, Washington, DC.

3. Jitin, A., Tandon V., and Nazarian S. (2006), "Continuous Deflection Testing of Highways at Traffic Speeds," Research Report No. FHWA/TX-06/0-4380-1, Center for Transportation Infrastructure Systems, The University of Texas at El Paso, El Paso, TX.

4. Thyagarajan, S., Sivaneswaran, N., Petros, K. and Muhunthan, B. (2011) "Development of a Simplified Method for Interpreting Surface Deflections for In-Service Flexible Pavement Evaluation", *8th International Conference on Managing Pavement Assets*, Santiago, Chile, November 15-19, 2011.