BACKGROUND

State is in need of assistance for the development of a multichannel, seismic geophysical data acquisition device and processing software for characterizing quality of newly paved Hot Mixed Asphalt (HMA) via surface wave velocity. Roughly 80% of State's paving projects are constructed or rehabilitated using asphalt paving materials at a cost of hundreds of millions of dollars annually. Current asphalt pavement designs rely primarily on performance based parameters (moduli) of pavement layers. However, current construction specifications for newly-constructed asphalt pavements rely primarily on index parameters (density, air void content, and layer thickness) which are commonly acquired as low frequency spot tests using destructive methods such as coring. Seismic methods have been used for several decades as a reliable, non-destructive means of characterizing mechanical behavior of pavement materials in both the field and lab. Advancements in processing capabilities and hardware make it probable to construct a device capable of accurately measuring high frequency surface wave energy in a rolling, air-coupled fashion such that seismic velocity and layer thickness can be reported for quality management purposes. The development of such a device has the potential to become an effective and efficient means of linking performance based design with construction quality management.

OBJECTIVE

The goal of this contract is to develop a seismic data acquisition system and associated software package capable of acquiring surface wave data in a non-destructive, non-contact, rolling and multichannel fashion for the purpose of swiftly and reliably determining and visualizing seismic velocity of newly-constructed asphalt pavement layers for quality management purposes. Processed surface and three-dimensional, lane-wide models of seismic velocity will be geo-referenced and mapped.

WORK PLAN

The Contractor will perform the following tasks:

Task Descriptions

Task 1: Project Management and Administration

1.1 Coordinate and conduct a kick-off meeting with the Technical Advisory Panel (TAP).
1.2 Provide quarterly progress reports to the TAP covering status of development and testing of hardware and software.
1.3 Present project goal, design concept, and progress to TAP and National Road Research Alliance (NRRA) at NRRA Meetings in spring 2020 and fall 2021.

Task 2: Hardware Development (Seismic Data Acquisition System) & Testing

2.1 Develop robust, portable, non-destructive, non-contact (air-coupled), rolling, multichannel, seismic geophysical data acquisition system for swiftly acquiring, processing, and characterizing newly-constructed asphalt pavement surface wave velocity measurements from geospatial 2D and 3D profiles. The data acquisition system will include minimum of the following components and capabilities:
  2.1.1 One multichannel digital recording device.
  2.1.2 Onboard control center for control of system.
  2.1.3 Optimum number of air-coupled receivers and source(s) for developing statistically valid 3D surveys within a minimum 6-foot measurement width.
  2.1.4 Wired or wireless means of transmission of digital data to onboard software.
  2.1.5 Export of data to removable device or cloud storage.
  2.1.6 Develop triggering system which synchronizes with a Geographic Positioning System (GPS)/Global Navigation Satellite System (GNSS) for geo-referencing of collected seismic data.
2.2 Test hardware (including, joint testing with software) to ensure that final data acquisition system and software collectively produce accurate and reliable surface wave velocity models. Report results per Task 1.2.

Task 3: Software Development & Testing

3.1 Develop software package capable of acquiring, processing, and analyzing seismic data measured from seismic data acquisition system. The software package will include a minimum of the following capabilities:
  3.1.1 Capable of outputting surface and 3D models of seismic velocity (minimum 6 feet wide) which are geo-

referenced.

3.1.2 Module for controlling recording parameters and data storage.

3.1.3 Automated Quality Assurance (QA)/Quality Control (QC) module for real-time signal-to-noise evaluation and faulty trigger detection.

3.1.4 Near-real-time and automated analysis module which performs filtering, constructs, and analyzes dispersion images, evaluates and displays layer thickness and shear wave velocity.

3.1.5 Analysis module for manually performing post-acquisition signal enhancements, Lamb wave dispersion and calibrations for Poisson's ratio and temperature, advanced inversion, and construction/display/management of 3D grid data sets of shear wave velocity, Young's and shear modulus.

3.1.6 User's manual which explains how to use the various components and modules of the software package.

3.1.7 Allows the operator to define the data lot, preferably using the standardized naming convention outlined in American Association of State Highway and Transportation Officials (AASHTO) PP-080 and PP-081.

3.1.8 Exported data preferably meets the requirements of AASHTO MP39 "File Format of Intelligent Construction Data" and is preferably in a format compatible with Veta.

3.2 Test software (including, joint testing with hardware) to ensure that final data acquisition system and software collectively produce accurate and reliable surface wave velocity models. Report results per Task 1.2.

Task 4: Delivery and Demonstration of Seismic Data Acquisition System and Software

4.1 Deliver and demonstrate final seismic data acquisition system and software. Demonstrate system setup, data acquisition, and analysis process as well as post-acquisition analyses. Present seismic velocity models produced from data acquired during the demonstration

4.2 Travel to Minnesota (MN) to conduct demonstration of final seismic data acquisition system and software for TAP on newly constructed asphalt pavement.

Task 5: Final Report

5.1 Prepare a final report which includes quarterly reports and summarizes and explains (but is not limited to) purpose and scope of project, surface wave geophysical theory/method, hardware and software development and quality control measures, conclusions, and recommendations.

Task Deliverables

Task:	Deliverable(s):
1:	One kick-off meeting and minutes. Seven quarterly progress reports. Oral presentation at two NRRA meetings.
2:	Submit to the State one seismic data acquisition system meeting a minimum of the above requirements. Minimum of three hardware tests and minimum of two joint hardware and software tests.
3:	Submit to the State one software package and user manual meeting a minimum of the above requirements. Minimum of two software tests and minimum of two joint hardware and software tests.
4:	One delivery and demonstration of final seismic data acquisition system and software.
5:	One report in State report format.

Tasks to be completed by State:

A. Work will be conducted with project oversight of TAP to support the successful completion of the project.
B. Provide access to pavement sections and traffic control for Task 4 demonstration in MN.
C. Provide standards and plans related to MN pavement construction, if needed.
D. Provide storage space and delivery needs for Task 4 demonstrations in MN.
E. Provide a workstation for processing needs for Task 4 demonstration in MN.
F. Provide geospatial support for Task 4 demonstration in MN.

THE BALANCE OF THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

PROJECT SCHEDULE

Task Plan Schedule

Task No.	Task Description	Quarters/Months after Notice to Proceed																						
		Q1			Q2			Q3			Q4			Q5			Q6			Q7			Q8		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Project Management & Administration	K		Q			P,Q			Q			Q			Q			Q			Q		P	
2	Hardware Development & Testing						H			H			J						H			J		HD	
3	Software Development & Testing						S												S					SD	
4	Delivery & Demonstration																							D	
5	Final Report																								R

Legend:							
	K	Kick-off Meeting	H/HD	Hardware - Field Test/Deliverable	D	Delivery & Demonstration
	Q	Quarterly Reports	S/SD	Software - Field Test/Deliverable	R	Final Report
	P	Oral Presentation (NRRA Meeting)	J	Joint Hardware/Software Field Test		Task Duration

THE BALANCE OF THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK