RESEARCH & DEVELOPMENT NEWS

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From the Manager

Welcome to the first issue of Research & Development News for 2018!

We want to let you know about updated Research and Development web resources.

Research and Development is in the process of improving and modernizing our electronic process. One of the first steps involved getting an updated connect page home. You can now find us right under the **Projects** tab on the public facing connect site:

https://connect.ncdot.gov/projects/research/Pages/default.aspx

This has resulted in our Projects Page moving to a new address:

https://connect.ncdot.gov/projects/research/Pages/ProjectSearch.aspx

The website is chock full of useful research related information.

- Interested in requesting funding for participation in a pooled fund study? Info and form is there.
- Have a short duration research or other need that can be handled in a couple of weeks? Check out the Technical Assistance Program.
- Need general information about the program? Check the Info and forms for submitting a research need for consideration during our next program cycle. Find it on the right side of the page.

Keep an eye out in the very near future as we begin moving to electronic Research Needs Solicitation, simplifying the process for everyone and keep reading to see highlights of recently completed projects and information from our Librarian.

Neil Mastin

Research & Development Unit Manager

Photo: Cyclists on NC 12

Table of Contents

Testing and Integration of Autonomous Vehicles Systems

A session at the Transportation Research Board 97th Annual Meeting entitled "Why You "Will" Own an Autonomous or Connected Vehicle, Part 2 (Part 1, Session 603)" could be specifically relevant for the North Carolina Turnpike Authority's autonomous vehicle proving ground.

The presentation, by Stantec Consulting Services, Inc., entitled "Testing and Integration of Autonomous Vehicle Systems" provided information on "testing and validation technologies and the lesson learned not only from a scientific technology effort but the hurdles to overcoming legal and design barriers."

The presentation focused on the Connected Vehicles Autonomous Vehicle Program – GoMentum Station located in Concord, CA. The facility is located on a retired Naval Station (5000 acres) with over 20 miles of paved roads. The presenter stated that this facility provides the opportunity experiment with AV/CV technologies in regards to vehicles and public transportation (shuttles). Along with the experimentation they also sought public engagement as well as striking a balance with public private partnerships.

There were many lessons that were presented, listed below are some of the highlights:

1. A potential barrier for AV/CV are the default disengage/decelerate capabilities. This is barrier could lead to traffic delays and challenges. Another factor that should be considered is the resiliency/recovery of the AV/CV once disengaged.
   a. The presenter suggested that the public sector dictate terms to OEMs according to what would be acceptable performance standards for the resiliency of CV/AVs.
2. Computer vs. Human behavior could become a challenge. The presenter introduced the concept of "AV Bullying," meaning human drivers engaging AVs in an aggressive manner (keeping in mind that the default of the AV is to disengage/decelerate).
3. It will be important for manufacturers to guard against adding more systems to compensate for performance failures.
4. It would be prudent to perform oppositional testing to identify unforeseen challenges with CV/AVs. This provides the opportunity to have multiple teams working to identify/introduce these challenges.
5. Finally, the role of regulation will be important moving forward.

This presentation is relevant for the NCTA as it identifies the advancements and lessons learned for AV/CV. It also outlines the gaps in testing including the opportunity for oppositional experiments. Finally, the emphasis for public engagement would be pertinent in moving to prepare for AV/CV technologies.

Dr. Curtis Bradley

Research Implementation Manager

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Recently Completed Research Projects

RP 2014-04 "Alternate Methods for Evaluation of Moisture Sensitivity of Asphalt Mixtures": Principal Investigator: Akhtar Tayebali, Ph.D., PE, North Carolina State University

The North Carolina Department of Transportation (NCDOT) requires that asphalt mixtures, used in pavement construction, meet the NCDOT moisture sensitivity specifications prior to approval of the job mix formula (JMF). Foaming based warm mix asphalt (WMA) mixes that use water injection WMA technologies such as Astec's Double Barrel® foamed technology, and use Zeolite additives such as Advera, tend to fail the current required tensile strength ratio (TSR) tests. However, pavements constructed with these same WMA mixes in the United States and in North Carolina have performed well to date. Either the current TSR test protocol needed to be modified or a new test(s) is needed for WMA mixes.

The objectives of the proposed research were: (1) to evaluate whether the residual trapped moisture in WMA mixes affects the TSR test results, and investigate if the curing of compacted specimens is required for WMA mixes that is different from the HMA mixes; (2) to evaluate the stiffness, fatigue performance, and rutting potential of the foaming-based WMA mixes in a moisture-conditioned state so that the actual degradation of these mixes can be compared directly to the results of TSR and indirect tensile (IDT) strength tests; and (3) to explore modifications to the current TSR test protocol or to develop alternative test methods such as impact resonance and colorimeter analysis that can be used in lieu of TSR tests for foaming-based WMA mixes.

Photo: CR 400 Colorimeter

These objectives were accomplished by performing IDT tests to obtain the TSR in the traditional manner and dynamic modulus (AASHTO TP79). Two new methodologies were used to evaluate moisture sensitivity of asphalt-aggregate mixtures. The first approach used a commercially available colorimeter to quantify adhesive failure in asphalt concrete using the boil test. The second approach involved using the impact resonance (AFV) test to measure the adhesive and cohesive structural integrity of the compacted mixtures

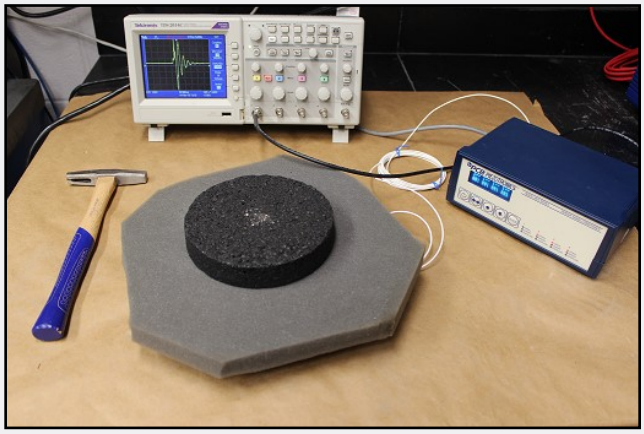


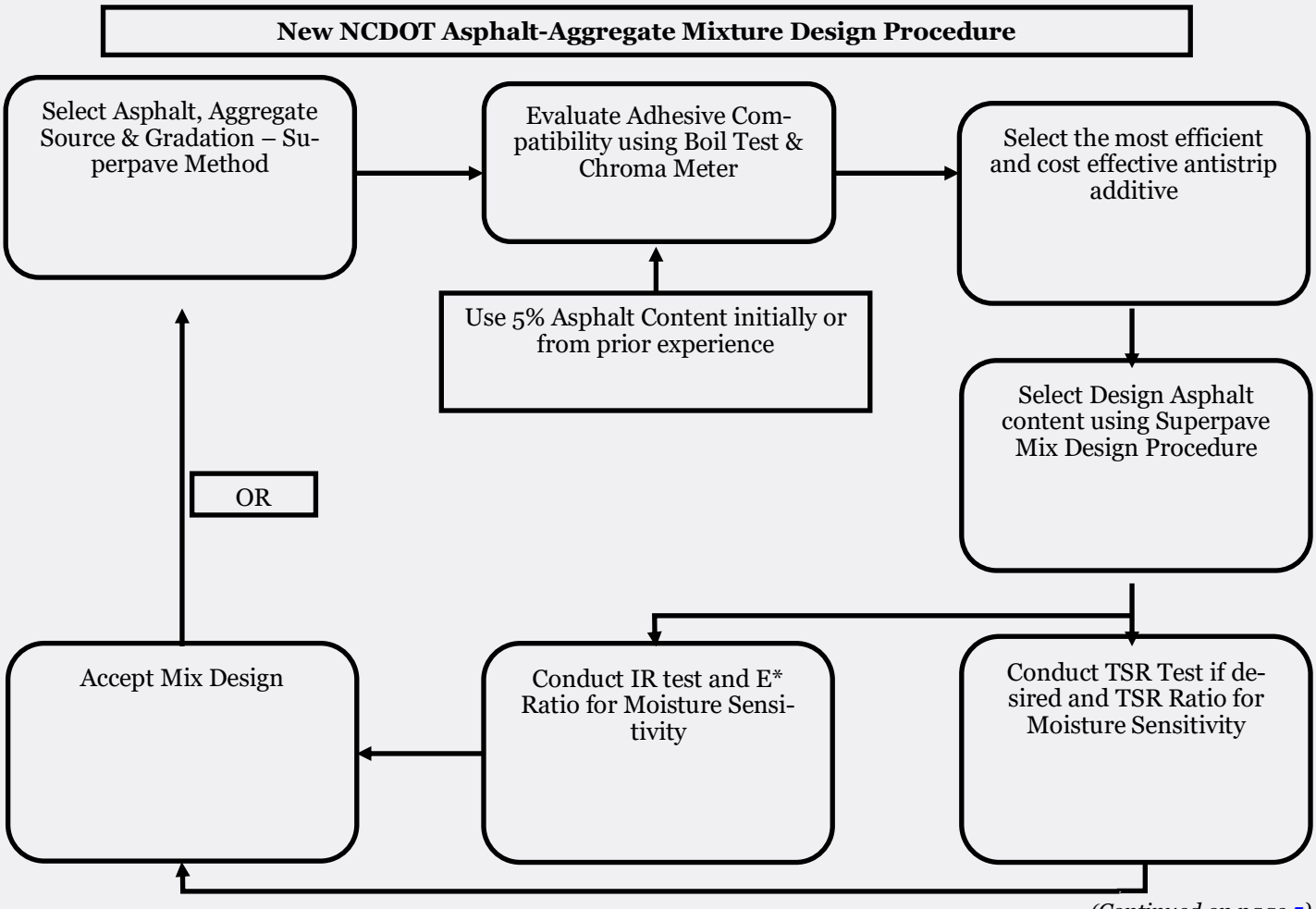
Photo: Impact Resonance Test setup

(Continued on page 4)

Recently Completed Research Projects (cont.)

through evaluation of the intrinsic and fundamental stiffness measurement. The colorimeter along with the boil test allows the control of adhesive failure between asphalt-aggregate due to moisture sensitivity of the mixtures even before a full-scale mixture design procedure is considered. The cohesive failure in a mixture that is predominantly based on the structural integrity of the compacted mixtures can be controlled by the AFV test. Separate or combined, these two tests are superior to the current TSR tests conducted using the AASHTO T283 test procedure currently followed in asphalt-aggregate mixture design.

The feasibility of impact resonance technology to quantify the effect of moisture damage was explored. These tests were performed on a WMA and three hot mix asphalt (HMA) mixtures using the modified AASHTO T283 procedure that is currently used by NCDOT. The percentage of stripping determined from the colorimeter analysis of the fractured surfaces of the specimens was used as a reference test method to indicate the level of stripping in WMA and HMA mixes. The feasibility of impact resonance technology to quantify the effect of moisture damage was explored. These tests were performed on a WMA and three hot mix asphalt (HMA) mixtures using the modified



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Recently Completed Research Projects (cont.)

AASHTO T283 procedure that is currently used by NCDOT. The percentage of stripping determined from the colorimeter analysis of the fractured surfaces of the specimens was used as a reference test method to indicate the level of stripping in WMA and HMA mixes.

In the past, asphalt technologists used to first test the compatibility of asphalt and aggregate source using tests such as Texas Boil Test and ASTM Test Method D3625. However, these tests fell out of favor since they were subjective in nature. Although, not part of the initial research objectives, a methodology evolved using colorimeter (Chroma meter) that now allows the boil test results to be quantified. This is the single most important breakthrough in evaluating the adhesive compatibility of asphalt and aggregate for any mixture design process.

This report presents a new approach to asphalt-aggregate mixture design process. Currently, the moisture sensitivity is evaluated as the final step in the mixture design process. This report suggests a methodology that first evaluates the moisture sensitivity or the adhesive compatibility of asphalt-aggregate in the presence of moisture before a mixture design process is even considered. The advantages are savings in time, material resources, and manpower.

Project overview by

Mustan Kadibhai, Research Engineer

RP 2016-14 "Coordinating Road Safety Reviews with Bicycle and Pedestrian Project Prioritization"
Principal Investigator: Libby Thomas, UNC Highway Safety Research Center

North Carolina continues to experience a high rate of pedestrian and bicycle injuries and fatalities, with 192 fatal pedestrian collisions and 23 bicyclists killed in 2015 alone. The State's Strategic Highway Safety Plan (NC-SHSP) goals are to reduce pedestrian and bicyclist fatalities and serious injuries by more than half by 2030 (2014, draft plan).

The research team at UNC-HSRC developed and tested a road safety assessment (RSA) process guide, the North Carolina Pedestrian and Bicycle Road Safety Assessment Guide, for use by North Carolina agencies. The Guide aims to foster a collaborative and data driven approach to identify pedestrian and bicycle safety problems, conduct interdisciplinary road safety assessments to diagnose the problems and identify potential countermeasures, and document the results.

From This

Photo: Typical Section of US 321 study corridor, Lenoir

(Continued on page 6)

Recently Completed Research Projects (conclusion)

To This

Photo: Potential safety countermeasures including midblock pedestrian crossing treatments to address multiple threat crash risk

The problem analysis, RSA results and documentation can be used as a detailed plan for potential safety improvements that can be used for both longer-range project development and more immediate improvements such as signal timing changes or enhanced enforcement.

The process aims to enhance safety practices by facilitating local agencies in using data to identify and prioritize pedestrian and bicycle safety problem locations; helping agencies investigate those problems through road safety assessment; and aiding agencies with documenting safety issues and potential solutions that may be used to develop and prioritize safety improvement projects. The Guide, especially if implemented into regular, recurrent activities, can be used to enhance practices to improve pedestrian and bicyclist safety in local communities and regions across the State.

Project overview by
John Kirby, Research Engineer

Librarian's Corner
by Lamara Williams-Jones

Did You Know?

* NCDMV's License & Theft Bureau was founded in 1921 and is the oldest law enforcement agency in the state.
* The North Carolina Department of Transportation (NCDOT) established the Adopt-A-Highway (AAH) program in 1988 in response to growing public concern regarding litter along the state's highways.
* The first "official" route of the North Carolina Ferry System was established in 1947, when a private ferry across Croatan Sound between Manns Harbor and Roanoke Island was purchased from T.A. Baum. Today, the Ferry System runs 22 boats on seven regular routes across five bodies of water: Currituck and Pamlico Sounds, and the Cape Fear and Neuse.

Library Notes

- Come across a resource you need that's not available in our Online Catalog? I may be able to get the item for you via Interlibrary Loan at minimal or no cost to you.
- Contact the NCDOT Librarian, Lamara Williams-Jones, for assistance: 919-508-1820, Monday through Friday from 8:30 to 4:30. Since there is only one Librarian, customers should call before visiting the Library.

New Publications from Transportation Research Board

TR Circular E-C228 : Rebuilding and Retrofitting the Transportation Infrastructure

This Circular documents the presentations from a conference of the same name held in Washington, D.C., in September 2017. This meeting was the 11th in a series of Spotlight Conferences funded by the U.S. Department of Transportation's (DOT) Office of the Assistant Secretary for Research and Technology, University Transportation Centers (UTC) Program.

This event provided an opportunity to share ideas and needs about transportation infrastructure and to explore opportunities to enhance transportation performance, offering an interactive format to engage in productive dialogue. It brought together those who generate new concepts and address transportation problems and opportunities and those who own and manage transportation systems. The conference, which was characterized by broad and active participation and discussion, considered potential research to address issues associated with rebuilding and retrofitting transportation infrastructure.

NCHRP Web-Only Document 243: Recommended Guidelines for Prefabricated Bridge Elements and Systems Tolerances and Recommended Guidelines for Dynamic Effects for Bridge Systems

This web-only document reports on the results of two studies that have produced guidelines to the American Association of State Highway and Transportation Officials (AASHTO) for adoption. The first study led to the development of guidelines for tolerances for Prefabricated Bridge Elements and Systems (PBES). The second study involved Dynamic Effects of Accelerated Bridge Construction (ABC) Bridge Systems.

These include dynamic friction effects of lateral bridge slides and dynamic effects for Self Propelled Modular Transporters (SPMT) bridge moves. ABC has become commonplace throughout the United States. Projects have been completed by virtually every state, and many ABC technologies have been researched and developed. However, this project is the first to provide specifications or guidelines for tolerances of prefabricated bridge elements or dynamic effects for construction and placement of bridge systems.

Many more publication links can be found at TRB Publications by Subject

Calendar of Events 2018

March 2018

- **NC DOT Board of Transportation Meeting, March 7-8,(Meeting will be held in Charlotte)**

April 2018

- **NC DOT Board of Transportation Meeting, April 4-5**

NCDOT Research and Development Unit General Information

How to find us:

We are located at 104 Fayetteville Street, Raleigh, in the Transportation Technology Center (formerly The Raney Building).

The Research & Development web page contains more information about the Unit and what we do.

The Research Library's catalog is also available on the web.

NCDOT RESEARCH AND DEVELOPMENT

The Research & Development Unit oversees transportation-related research that investigates materials, operations, planning, traffic and safety, structures, human environments, natural environments, and more. Please contact one of our engineers listed on this page if you have questions.

J. Neil Mastin, PE
Manager
(919) 508-1865; Email: jmastin@ncdot.gov

Steven J. Boylard
Mobility, Safety and Design
(919) 508-1874; Email: sjbolyard@ncdot.gov

Curtis T. Bradley, Ph.D.
Research Implementation Manager
(919) 508-1832; Email: cbradley8@ncdot.gov

Mustan Kadibhai, PE
Pavement, Maintenance, Materials and Structures
(919) 508-1819; Email: mkadibhai@ncdot.gov

John W. Kirby
Planning, Environment and Transit
(919) 508-1816; Email: jkirby@ncdot.gov

Lamara C. Williams-Jones
Research Librarian
(919) 508-1820; Email: lcwilliams2@ncdot.gov

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