RESEARCH & DEVELOPMENT NEWS

Winter 2019/2020 Vol. 5, no. 2

Photo: Cape Lookout Lighthouse

FROM THE MANAGER

NCDOT Research and Development Office

2019 Research Year in Review

2019 was an exciting year for the Research Program at NCDOT.

Highlights include:

- First ever Research and Innovation Summit held at NC A&T.
- Funded largest research program in NCDOT history.
- *NCHRP panel member selection was very high.* Many thanks for those that submitted applications to serve on panels. NCDOT sends over $1.2M per year to fund NCHRP and active participation in panels and idea submission helps us have a greater voice in how this funding is used.
- Moved to an entirely online process for all research ideas and research proposals.
- **Transportation Centers of Excellence Program Launched**
  - ◊ These centers, sponsored by, and developed in conjunction with the Office of the Chief Deputy Secretary, provide another avenue to engage in forward-looking, cutting edge research
  - ◊ Two centers were chosen to research Automated Vehicles including Technology, Safety and Policy.
  - ◊ One center is focused on Congestion Mitigation.
  - ◊ See the press release for more information.
  - ◊ Official Kick-off in early 2020.

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Recently Completed Research Projects

RP 2017-01 "Use of Moisture Induced Stress Test (MIST) to Determine Moisture Sensitivity of Asphalt Mixtures": Principal Investigator: Akhtarhusein A. Tayebali, Ph.D., P.E., Department of Civil, Construction, and Environmental Engineering+, North Carolina State University

Project Manager: Mustan Kadibhai, P.E., CPM

Photos: From left to right, CR 400 Colorimeter, Asphalt Compatibility Tester (ACT) Device and Moisture Induced Stress Tester (M.i.S.T) Device

Moisture damage is one of the major concerns in asphalt concrete mixtures. Moisture damage mostly occurs due to two mechanisms – adhesive failure between aggregate and asphalt, and cohesive failure within asphalt binder and mixture. The most commonly used test to evaluate moisture sensitivity, tensile strength ratio (TSR) test uses AASHTO T 283 conditioning which has been shown to mostly determine the adhesive failure. There is a need for a test method or conditioning procedure that can be used to measure both adhesive and cohesive behavior of mixtures.

The objectives of the research were: (1) to investigate possible modifications to the existing TSR test protocol or develop an alternate test method, and a conditioning procedure that can quantify the adhe sive and cohesive damage in asphalt mixtures due to moisture; (2) to quantify adhesive damage in asphalt mixture using the boil test along with colorimeter device; (3) to investigate the use of M.i.S.T conditioning procedure to quantify the cohesive damage in asphalt mixtures; (4) to explore the viability of the Impact Resonance test in assessing moisture damage in asphalt mixtures; (5) to evaluate the effect of different antistrip additives on asphalt mixtures and determine optimum antistrip additive content using the boil test with colorimeter device for different asphalt mixtures.

These objectives were accomplished by performing three different test methods to evaluate moisture sensitivity of asphalt concrete. The first test method is the boil test (ASTM D3625) with a colorimeter device (Colorimeter CR400) to measure loss of adhesion (stripping). Colorimeter was used to quantify stripping in asphalt mixtures.

The second test method presented in this study is Indirect Tensile Test (IDT) test to determine TSR value with two different types of conditioning – modified AASHTO T

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Use of Moisture Induced Stress Test (Cont.)

283 (currently used by NCDOT) and Moisture Induced Stress Tester (M.i.S.T) conditioning (proposed conditioned procedure). M.i.S.T conditioning procedure includes two conditioning cycle – specimen placed in hot water for 20 hours followed by application of hydraulic pumping. M.i.S.T conditioning is able to determine both adhesive and cohesive failure. The third test method conducted in this study is the Impact Resonance (IR) test, to explore the effect of different support conditions and its ability to detect moisture damage. All tests were done on six different HMA mixtures prepared using three different aggregate sources.

The Boil test (ASTM D3625) is very simple and easy method to determine stripping in asphalt mixtures but it was not widely accepted in the past because of its subjective nature. However, currently boil test results can be quantified using a colorimeter device. The Boil Test along with colorimeter device turns out be an effective test procedure in not only quantifying the striping potential in asphalt mixtures but also in determining the optimum antistrip additive content for any particular asphalt mixture. Also, this test method is helpful in selecting a more compatible and cost-effective antistrip additive for any particular asphalt mixtures.

This research presents a new approach to evaluate moisture sensitivity. Currently, NCDOT uses 85% TSR criteria based on modified AASHTO T 283 conditioning. This study proposes combining the use of two different test methods to detect the adhesive and cohesive failure due to moisture in asphalt mixtures – the boil test with colorimeter device and the M.i.S.T device.

The colorimeter device was used to determine the percentage stripping in asphalt mixtures due to loss of adhesion between asphalt and aggregate. Percentage stripping can be used to estimate the adhesive failure, and volume change from the M.i.S.T conditioning to determine the cohesive failure in the mixtures. This research presents a test method to determine optimum antistrip additive content for asphalt mixtures that can be used in selecting a more cost-effective antistrip additive.

NCDOT can start using the finding from this research by introducing Boil test (along with spectrophotometer device) in early stages of mix design process so as to identify moisture sensitive mixture at first place and take action accordingly – either disqualify the asphalt mixture from being used in construction or use proper amount of antistrip additive to increase the resistance against moisture damage; and also evaluate the aggregate gradation for cohesive damage. This methodology can also serve as a qualify control and quality assurance test in the asphalt plants. It will help the department to identify moisture sensitive asphalt mixture and eliminate or modify them before being used in the field. It will financially benefit the department by reducing the maintenance cost. Also using optimum amount of antistrip additive will help in reducing the cost of construction through premature failure of pavements.

The AASHTO T283 test takes about 5 to 10 days to conduct and uses a high amount of personnel time. The boil test reduces the effort to 1 day.

Ongoing Research Projects

RP 2019– 05: "Improved Approaches to Environmental Compliance During Highway Construction"

Principal Investigator: Richard A. McLaughlin Ph.D., Department of Soil Science

North Carolina State University

Project Manager: John Kirby

Photo: Silt Fence Installation

Road construction results in large areas of exposed soil which are susceptible to wind and water erosion. These areas are required to be kept under control and sediment should be retained on the project. An erosion and sediment control plan is required, and regular inspections are used to ensure that the plan is followed and practices in place are functioning properly. The objectives of this project include strategies to utilize UAVs to facilitate soil and erosion control inspections on active highway construction sites; assessments of currently available dust control products to reduce traffic, water use and costs; and an evaluation of silt fence posts designs to ensure design methods are enough to withstand typical pressures exerted by water and/or soil to prevent failure.

RP 2018-18: "Reducing Erosion Susceptibility of Coastal Highways using Biologically-Based Methods"

Principal Investigator: Brina M. Montoya, Ph.D., P.E., Department of Civil, Construction, and Environmental Engineering

North Carolina State University

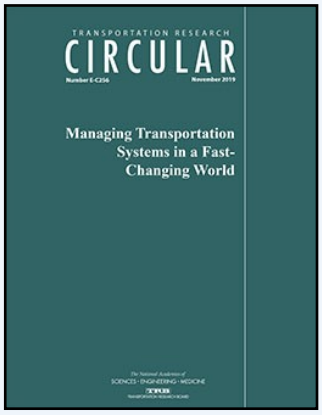
Project Manager: John Kirby

Photo: Storm damage along NC 12

Coastal highways in NC have experienced overwashing due to increasing frequency and intensity of coastal storm surges which has led to pavement damage and even highway closure. This study is examining bio-mediated soil improvement methods that can be used to stiffen sandy subgrade and reduce soils susceptible to erosion. Direct storm wave action on the seaward side of the highway and weir-flow damage on the landward side of the highway can undermine the roadbed, erode the supporting soil, and lead to pavement failure and road closure. By reinforcing vulnerable coastal subgrades and slopes, erosion potential can be reduced and vital infrastructure can be maintained.

New Publications from Transportation Research Board

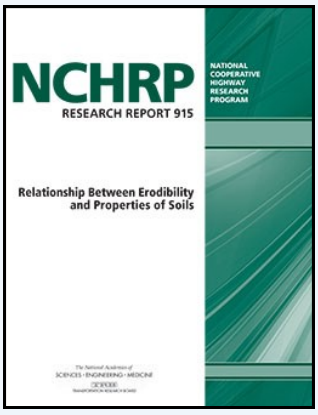
Managing Transportation Systems in a Fast-Changing World



Self-driving cars, rising temperatures and sea levels, increasingly strong weather events, changing citizen preferences, and innovations in technologies that are revolutionizing purchasing behavior, social interaction, financial transactions, communications, and travel—the transportation world is changing very rapidly.

This Circular explores questions such as how do we make choices about long-life investments in infrastructure in an era where we are facing extreme uncertainty?

Relationship Between Erodibility and Properties



The report presents detailed analysis of the erodibility of geomaterials is important for the study of problems related to soil erosion such as bridge scour, embankment overtopping erosion, and stream stability. Erodibility is the relationship between the soil erosion rate and fluid velocity or hydraulic shear stress. Since different soils have different geotechnical properties, their erosion rates vary. In addition, the project that developed the report also produced a searchable spreadsheet that uses statistical techniques to relate geotechnical properties to soil erodibility.

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

Calendar of Events

January 2020

- **TRB Annual Meeting, January 12-16, 2020, Washington, DC.**

February 2020

- **NC DOT Board of Transportation Meeting, February 5-6, 2020**

FROM THE MANAGER (Cont.)

A few reminders about programs and funding available from the Research and Development Office.
Please visit our website to learn more about:

- General information about the program, including timelines.
- Info and forms for requesting funding for participation in a pooled fund study.
- Check out the Technical Assistance Program for short duration research, white-paper or testing need that can be handled in a short timeframe.
- Info and forms for submitting a research need for consideration in the next program.
- Information on the Transportation Library and document procurement services.

As always, if you have any questions or research needs, you can reach me at jmastin@ncdot.gov or 919-707-6661

Neil Mastin,

Research & Development Unit Manager

New Publications from TRB (cont.)

The spreadsheet, NCHRP Erosion, includes a searchable database that includes compiled erosion data from the literature review and a plethora of erosion tests. It contains equations that may be used to estimate the erosion resistance of soil and determine whether erosion tests are needed.

Librarian's Corner
by Lamara Williams-Jones

Cape Lookout Lighthouse : A Brief History

The dangers of the shoals (shallow waters), convergence of currents and rapidly developing storms made Cape Lookout National Seashore particularly dangerous to mariners. A lighthouse was needed to warn ships. In 1804, The United States Congress authorizes the construction of a lighthouse on or the near the pitch of Cape Lookout. The first Cape Lookout Lighthouse is completed in 1812 at a cost of $20,678.54. It is a beacon for years though complaints about its height and reflector system make it evident that a taller and more stable lighthouse is needed. In 1857, Congress appropriates $45,000 to build a new lighthouse, the new lighthouse is completed in 1859; a red brick tower 150 feet tall. The distinctive diamond pattern paint scheme is approved three years later. Cape Lookout became the model for all subsequent lighthouse construction along the Outer Banks.

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: 919-707-6665, Monday through Friday from 8:30 to 4:30. Since there is only one Librarian, customers should call before visiting the Library.

NCDOT Research and Development Office General Information

How to find us:

We are located at:

1020 Birch Ridge Dr, Building B

Raleigh, NC 27610

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

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

NCDOT RESEARCH AND DEVELOPMENT

The Research & Development Office 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 or the transportation librarian listed on this page if you have questions.

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