

# RESEARCH INFORMER

— SUMMER 2020 —

A Newsletter by the Arkansas Department of Transportation Research Section

## Research Project Cycles and Problem Statements

BY KIM ROMANO, P.E.

**P**roblem Statements are developed on an annual cycle. Although the Research Section accepts Problem Statements throughout the year, staff are fully engaged in topic development and evaluations throughout the summer and autumn months. The Problem Statement development cycle begins a year before research studies can commence.

Anyone can submit problem Statements, but they usually come from academia and ArDOT employees. Research Section staff are actively involved throughout the process: preparing Problem Statements, assisting other Divisions with documenting needs, performing preliminary literature scans, evaluating and reviewing Problem Statements, and coordinating meetings to rank them.

As part of the process, the Research Section staff hosts Roundtable Meetings with ArDOT Divisions and Arkansas' academic research community. Additionally, Research Staff visits each of the ten Districts to discuss opportunities for Research to support the Districts.

University of Arkansas (UA) professors met with ArDOT staff in the Materials

Training room on July 30 for the 2019 Roundtable Meeting. The Roundtable, similar to speed dating, allows each professor a few minutes with staff from each Division to discuss what UA could offer. Likewise, the Divisions shared ongoing needs with the UA professors. Research staff at each table took notes and kept things moving.

The Maintenance Guidelines for MSE Walls (TRC2104) Problem Statement evolved through Roundtable discussions with Maintenance Division staff. Likewise, UA staff submitted many of the top ranking Problem Statements based upon topics discussed at the Roundtable meeting. Important topics selected for funding and introduced at the Roundtable include TRC2101 – Update of the ArDOT Workforce Forecasting System, and TRC2103 – Developing Guidelines for Evaluating Weathering Steel Bridges.

Research Section staff traveled to each of the ten Districts in late July and August to listen to their needs and ideas for Research topics. The most discussed topics included pavement, materials, and construction processes. A couple of Districts expressed concerns with Recycled Asphalt Pavement

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## Performance-Based Asphalt Mixture Design (PBD) for Arkansas

BY SANGHYUN CHUN PH.D., E.I.T.

**T**he current asphalt mix design procedure used in Arkansas, commonly referred to as the Superpave mix design system, is based on component specifications (i.e., quality and properties of asphalt binder and aggregates) and requirements of volumetric properties. However, there have been concerns that the existing mix design criteria, such as Voids in Mineral Aggregates (VMA), gradation control points, and effective asphalt content, may not capture all critical aspects of asphalt mixtures found to be most strongly related to rutting and cracking performance. Consequently, the performance of Superpave mixtures varied significantly among the mixtures that met all existing mix design criteria. Therefore, there is a need to develop a Performance-Based Mixture Design (PBD) procedure that includes performance tests to evaluate rutting and cracking potentials and moisture resistance during the mix design phase. The PBD procedure will provide a more direct evaluation of expected performance than the existing mix design method solely based on volumetric properties.

TRC1802, Performance-Based Asphalt Mixture Design (PBD) for Arkansas, primarily sought to develop and implement a laboratory cracking test for asphalt mixture design that

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## Spotlight On T<sup>2</sup>



### CONCRETE CONSTRUCTION BASICS

BY STACY WILLIAMS PH.D., P.E.



**T**he Technology Transfer (T2) program has added another new class to its list of course offerings. The latest addition is 'Concrete Construction Basics', also known as 'Concrete 101'. This class is good for every local agency because concrete is used in so many different applications. Whether it's roadways, bridges, box culverts, parking

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## NEW RESEARCH HIGHLIGHTS

### TRC2101

#### Update of ARDOT Workforce Forecasting System

To replace the current outdated system, TRC2101 - Update of ARDOT Workforce Forecasting System will re-estimate and expand the capabilities of the workforce prediction model and software. The project will develop new equations for the Construction Division's Workforce Forecasting System and find or write new software with the possibility of integrating artificial intelligence (AI) in a future interface. The project will also explore the possibility of using this workforce forecasting system for more than Construction office crews. ❗

### TRC2102

#### Effect of Aggregate-Binder Compatibility on Performance of Asphalt Mixtures in Arkansas

The primary objective of this study is to develop a draft specification including the implementable test protocols that ensure the use of durable and compatible aggregate-binder systems in the mix design phase for enhanced asphalt mixture performance in the field. This study will require comprehensive laboratory and field investigations that consider the multiple factors involved, including a range of aggregate and binder types used in Arkansas. The successful implementation of research findings obtained from TRC2102 will lead to potential cost savings for ARDOT due to increased longevity and constructability, and reduced premature failures for asphalt mixtures placed in the field. ❗

### TRC2107

#### Non-nuclear Moisture Content and Density Determination

TRC2107 is a project investigating Non-Nuclear Density measurement techniques for moisture content and density of soil. Currently, ARDOT utilizes nuclear density gauges for QA/QC for embankment and subgrade material compaction. The cost associated with these gauges includes annual maintenance, dosimeter badges, training for radioactive materials, as well as secondary costs associated with transporting and storing radioactive devices. TRC2107 will investigate any available technology that can accurately and quickly determine the density and moisture of materials, and only devices comparable to the nuclear gauge will be considered. The projected outcome of the project will be to replace the nuclear density gauge. ❗

## RESEARCH PROJECT CYCLES AND PROBLEM STATEMENTS

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(RAP) and Recycled Asphalt Shingles (RAS) being used in new pavements and suggested ideas to address those concerns. Other Districts were concerned with recruiting and retaining staff in rural Resident Engineer offices. Research Staff developed Problem Statements for both of these issues.

Over 40 Problem Statements were submitted in 2019 for the FY 2021 funding cycle. Some duplicates were removed, and two Problem Statements were combined. Research Section staff reviewed each Problem Statement, conducted cursory literature searches by scanning national libraries and the Transportation Research Board's Transport Research International Documentation (TRID) & Research in Progress (RiP), and documented findings using the Problem Statement Evaluation Form.

Seven Standing Subcommittees representing Construction, Design, Maintenance, Materials, Pavements, Planning, and Special Projects then rank the Problems Statements based on ARDOT needs. Some good ideas that are being explored on a national level may be ranked lower if research serving the same purpose is underway elsewhere. ARDOT participates in pooled fund studies and regional research consortiums that may cover a given topic.

Next, the Advisory Council reviews and ranks the Problem Statements. The Advisory Council is composed of stakeholders representing higher education, engineering, construction, and transportation, and business communities. The top ten topics get five-minute presentations to Transportation Research Committee (TRC). The top-ranked research topic of each Standing Subcommittee also

makes a five-minute presentation to the TRC if the topic is not part of the Advisory Council's top ten.

At the 2019 Fall TRC business meeting, presentations for thirteen topics were given and 38 Problem Statements were reviewed and ranked. Based on the available funding for FY2021, the top seven Problem Statements were developed into Requests for Proposals. The Project Subcommittee will review the proposals and select the Principal Investigators. Final funding of the projects will be approved at the Spring TRC business meeting, and the projects will begin on or after July 1, 2020. This year's top seven ranking Problem Statements are:

- Update of the ARDOT Workforce Forecasting System
- Effect of Aggregate-Binder Compatibility on Performance of Asphalt Mixtures in Arkansas
- Developing Guidelines for Evaluating Weathering Steel Bridges
- Maintenance Guidelines for Mechanically Stabilized Earth (MSE) Walls
- Innovative Countermeasures to Deter Wrong-Way Driving
- UAS LiDAR for Developing Small Project Terrain Models
- Non-nuclear Moisture Content and Density Determination

Do you have ideas for research? A notice of Problem Statement solicitation for FY 2022 will go out in July, but if you have ideas or needs, no need to wait! Contact the Research Section, and the staff will assist in either developing a Problem Statement or finding existing resources that may help. ❗

### TRC2104

#### Maintenance Guidelines for Mechanically Stabilized Earth (MSE) Walls

The objective of this research project is to determine Best Management Practices (BMP) for MSE walls, and the primary deliverable is to develop a maintenance inspector's guidebook, which could provide assistance to address potential signs of distress. A part of this guidebook is to include a Grading Level (A - F) scale to be applied per ARDOT Maintenance guidelines and provide appropriate repair options. The details for BMP would include routine inspections and frequency of inspections, the Level of Effort needed to repair or reconstruct problematic issues, and emergency inspections after significant weather events or

accidents that may have compromised MSE walls.

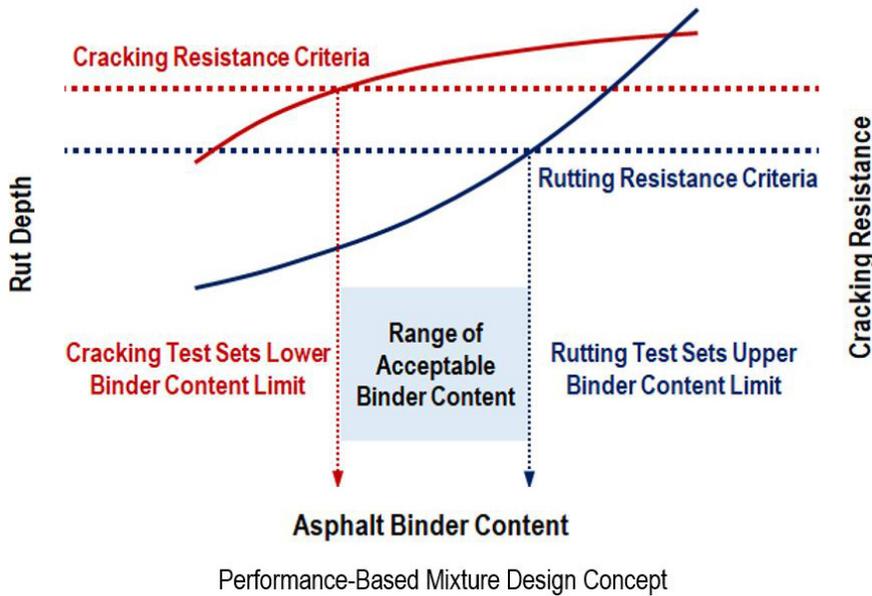
Another deliverable is to expand on an ArcGIS database to be provided by ARDOT Maintenance Division. This inventory would include all MSE and other specified wall types currently maintained by ARDOT. Within the database system, the metrics will be outlined and categorized for each wall type to include System/Type, Design Specifications, Materials, Performance, and Maintenance History. Having these metrics outlined in a formal layout will provide clearer guidance for all maintenance personnel when inspections are conducted. ❗

# PERFORMANCE-BASED ASPHALT MIXTURE DESIGN (PBD) FOR ARKANSAS

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can be used in conjunction with the current Asphalt Pavement Analyzer (APA) rutting test for a transition of the mix design system in Arkansas from solely volumetric-based to performance-based. In particular, the project compared laboratory cracking test results to field cracking performance for mixtures placed in Arkansas. It is recommended that the Indirect Tensile Cracking Test at Intermediate Temperature (IDEAL-CT) be used to assess cracking resistance during the asphalt mixture design phase. The research results indicated the ability of the CTIndex for use as a cracking performance

indicator of asphalt mixtures to differentiate relative cracking performance in the field. The preliminary criteria for acceptable cracking performance (CTIndex  $\geq 50$ ) were introduced based on the results obtained from this study. However, it is imperative that the recommended acceptance criteria be further validated through comprehensive field performance evaluation. The successful implementation of project findings procured from TRC1802 will result in consistently enhanced performance of asphalt mixtures placed in the field that will provide significant cost savings for ArDOT. ❄️



## SPOTLIGHT ON T<sup>2</sup>

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lots, curb and gutter, or sidewalk, it is rare for local agency personnel not to encounter concrete in some capacity.

The topics covered in this course include many of the best practices in concrete, beginning with the materials that make up the mixture to the final stages of finishing and curing. Concrete is an extremely versatile material, as long as best practices are followed. The first segment of the class discusses the aggregates, water, and cement that make up the concrete, and how the properties and proportions affect the ultimate strength of the final product. Test methods used for quality control and quality assurance are also described. Next, formwork and reinforcing steel are discussed, along with some practical checks that can be used by inspectors to ensure proper constructability, and why more is not always better. The class wraps up with a close look at finishing, jointing, and curing, and provides additional considerations for placing concrete in cold weather and hot weather.

The pilot offering of this course was held in January 2019, and several classes have been held in central and northwest Arkansas. Participants have given great feedback, and future classes are planned for the northeast and southwest areas of the state. The class covers many basic topics that are beneficial to new employees who are just learning the ropes but also provides a wealth of practical information that is important for supervisors and inspectors. The greatest feature of the class is the emphasis on practical and usable knowledge. Students really get a feel for the "tricks of the trade"!

This half-day class provides 4 hours of ROADS Scholar credit in the infrastructure and maintenance category and can be requested by any local agency. To find out more, or to request this class for your agency, visit [www.cttp.org/ardot/t2](http://www.cttp.org/ardot/t2). ❄️



**DO YOU HAVE A QUESTION OR PROBLEM YOU THINK RESEARCH COULD HELP WITH?**

SEND US AN EMAIL: [RESEARCH@ARDOT.GOV](mailto:RESEARCH@ARDOT.GOV) OR GIVE US A CALL AT 501-569-4922

## NEW RESEARCH HIGHLIGHTS

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### TRC2103 Developing Guidelines for Evaluating Weathering Steel Bridges

The objective of TRC2103 is to identify, develop, and implement a framework for evaluating weathering steel bridges in Arkansas. Doing so will allow ArDOT to identify if weathering steel bridges have any future potential for oxide film degradation. Also, the project will take into consideration the location (proximity to water, characteristics of the body of water, etc.) and function (overpass, hydraulic structure, etc.) of the bridges.

Weathering steel has improved corrosion-resistant behavior over conventional steel. However, it is not maintenance-free and will corrode if not used in the proper ambient conditions. While weathering steel retards corrosion, it may require future restoration

thorough cleaning and painting. ArDOT inspects 1192 weathering steel bridges yearly. Of those, 908 structures are state-owned and have an element level inspection per the AASHTO Manual for Bridge Element Inspection, 2nd Edition. Approximately 23% of those 908 are documented to have oxide film degradation of the steel protective coating, otherwise known as patina.

The proposed research will provide ArDOT with a final report and implementation plan. This plan will discuss how to incorporate inspection guidelines on evaluating patina corrosion conditions of weathering steel bridges either by a workforce training or developing a Technology Transfer Program course. ❄️

### TRC2105 Innovative Countermeasures to Deter Wrong-Way Driving

TRC2105 Innovative Countermeasures to Deter Wrong-Way Driving is being developed to research technologies to prevent wrong-way vehicle entry onto interstates and freeways. Wrong-way driving has been of concern since divided highways were first opened to traffic. Drivers encounter wrong-way vehicles head-on, and crashes are often severe.

Since 2011, annual reports of wrong-way driving crashes in Arkansas have been prepared, per Act 641 of the 87th Arkansas General Assembly, and applicable countermeasures have been implemented. In 2017, a statewide traffic safety job added signs and markings and upgraded devices at freeway entrance ramp intersections with surface streets.

This research will expand the toolbox of available countermeasures. Steps will include analyzing wrong-way crash data, reviewing emerging technologies and devices to deter wrong-way drivers, and testing the most promising countermeasures. ❄️



### TRC2106 UAS LiDAR for Developing Small Project Elevation Models



Of the many projects picked up in the FY21, by far one of the most exciting is TRC2106. The Department is always looking for ways to implement new technology while being more efficient and accurate in the work that we do; and what better way to do that than with aerial LiDAR?

The goal of this project is to take small size bridge projects and produce a 3D model using an Unmanned Aircraft System (UAS) mounted with a LiDAR sensor in order to extrapolate quantities and get precision surveys with literally millions of points accurate up to mere inches! To get a model with this many data points and to this accuracy using conventional surveying would take a lifetime, but with aerial LiDAR it could be done in as little as an evening! Results from this method will then be compared to current techniques to produce a cost/benefit analysis to illustrate the many advantages it could potentially provide to the Department. ❄️



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