RESEARCH INFORMER

— WINTER 2020 —

A Newsletter by the Arkansas Department of Transportation Research Section

Pavement Smoothness, Part 2

BY JD BORGESON, P.E.

Welcome back to our discussion about Pavement Smoothness! In Part 1, we talked about what it means for a pavement to be 'smooth,' a brief overview of how pavement smoothness has historically been measured, and what methods/metrics are being used to measure it today. At the heart of the previous discussion was the differentiation between PI and IRI, two very different metrics that attempt to quantify the smoothness/roughness of a surface. Profile Index (PI) values are mechanistic and meant to represent the actual, physical profile of the roadway; they were originally obtained by physically pushing a device called a profilograph the length of the project to obtain a trace of the actual surface. The international roughness index (IRI) is a newer metric for surface smoothness; it seeks to evaluate how smooth or rough a surface is by quantifying the user experience. A metric like this is only possible due to the development of the inertial profiler. These are digital systems, much more advanced than the profilographs of old and easier to use. The increased availability of inertial profilers in the last two decades and their ease of use has led to many states changing their smoothness specifications from PI requirements to IRI requirements (or other ride-based metrics like RN, HRI, etc.). The idea is to make the smoothness requirements better reflect how smooth the road feels versus measuring the literal deviations in the surface. However, anyone that has looked through other states' specifications knows just how variable they can be, even states in the same region. The story is no different for pavement smoothness.

So in what ways do other states' smoothness requirements differ, exactly? The requirements for smoothness are often affected by one of the first decisions a roadway designer must make: asphalt or concrete? The majority of the time, if a state has IRI smoothness requirements for both asphalt and concrete surfaces, the smoothness requirements for concrete will be less stringent. It just tends to be easier to get a smoother ride with asphalt (despite other flaws, which the concrete folks will be quick to point out, no doubt). However, states don't always have a smoothness requirement for both types of pavements, and there doesn't seem to be an obvious correlation as to why they choose to have one or the other

Continued on page 2

Spotlight On T²

TRAINING UPDATE DURING SOCIAL DISTANCING

BY LAURA D. CARTER

The Arkansas Technology Transfer (T2) Program continues to provide webinar training to our local and state partners. A "Stormwater Management" webinar was hosted in August, and a "How to Webinar" webinar was hosted in September,

Continued on page 2

Project Bundling

BY KIM ROMANO, P.E.

Project Bundling combines construction jobs at two or more locations into a single or smaller set of contracts. Research staff recently prepared the Draft Project Bundling Guidebook compiling best practices and next steps for wider implementation. FHWA's Every Day Counts program promotes Project Bundling for various project types and contract delivery methods, including Design-Build and Construction Manager/General Contractor. Currently, ARDOT is participating in a bridge bundling program with three different contracts. Many project types, including bridge maintenance and replacement, pavement preservation, signing, pavement markings, and roadside safety devices, are well suited to the process.

Innovative contracting and financing methods become feasible for smaller projects due to economies of scale. Scheduling and staffing efficiencies can be realized from streamlining similar projects into one contract, which leads to substantial cost savings. Project bundling has been proven by other State DOTs to increase the number of bidders and lower bid item unit costs.

Project Bundling is estimated by other State DOTs to save 25 to 50 percent in preliminary engineering and 5 to 15 percent in construction costs compared to traditional project development and construction. Full implementation could lead to a new way to program and deliver projects, with crosscutting implications across project types and jurisdictional boundaries. MoDOT used bridge bundling combined with a Design-Build contract to replace or rehabilitate 554 bridges over a three-year timeframe. At the same time, MoDOT completed 248 additional bridges in smaller project bundles using traditional Design-Bid-Build contracts. This innovative project development and delivery method, if fully implemented by ARDOT, could save millions of dollars in project costs and staff time each year.

SPOTLIGHT ON T²

Continued from page 1

bringing our total number of webinars while practicing social distancing to four with 320 class participants. Participants from various parts of Arkansas, as well as from numerous regions of the United States attended the webinars.

The "Stormwater Management" webinar covered guidance for sediment from construction and maintenance activities that can pollute waterways and lead to unnecessary fines. It also included the basics of stormwater management and best management practices for preventing erosion and controlling sediment. This training also included guidance for permit requirements.

The "How to Webinar" webinar was designed for individuals who were uncomfortable and not familiar with this software. This training covered basic interactive features of webinars and gave participants a chance to practice their new skills.

Dr. Stacy Williams, Director of the Center for Training Transportation Professionals (CTTP) at the University of Arkansas, is an expert in this field and was the instructor for these webinars, as well as the instructor for the instructor-led training for these classes. She is also the instructor for some of our additional infrastructure and safety classes.

Upcoming webinars include breakout sessions for Asphalt Pavement Maintenance, Asphalt Paving Basics, Basic Pavement Management, Communication, Defensive Driving Awareness, Erosion Mitigation for Unpaved Roads, Guide for Signs, Markings & Signals, Low Cost Safety Solutions, Stormwater Management, and Work Zone/Flagger Awareness training. Class participants will learn the most efficient approach for each training session.

Training through this program remains free to class participants. To view the list of available training sessions, class descriptions, or request a class for your local agency, visit www.cttp.org/ardot/t2.

PAVEMENT SMOOTHNESS, PART 2

Continued from page 1

when they do decide to split it up. The design/posted speed also often plays a role; many states have opted for less stringent IRI requirements for lower speed roads with the cutoff usually being around 45 mph. This makes sense because the effects of an unsmooth road are amplified at higher speeds (just think about hitting a bump at 35 mph vs. 75 mph). Lastly, some states specify IRI requirements based on the design of the pavement. Things like slab thickness and state-specified concrete categories affect the IRI requirements for PCC, while things like number of lifts and lift thickness can affect the requirements for asphalt.

How states define and deal with areas of localized roughness (ALR) vary greatly as well. In the days when PI was the standard measure of smoothness, the term area of localized roughness was not used. Instead states used terms like 'bumps' and 'dips,' defined by a specified deviation over a specified (short) length. Even after adopting IRI specs for smoothness, some states still stick with the bumps and dips definition. An area of localized roughness is defined as any 25' section with an IRI above a state-specified threshold. Not surprisingly these thresholds vary greatly from state to state, and some states even have variable ALR thresholds based on pavement type, design speed, etc. as listed above.

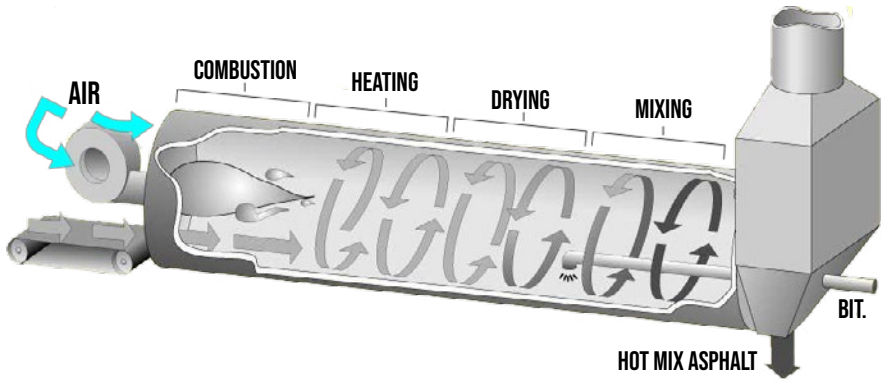
Regardless of how variable the thresholds may be state to state, they all tend to deal with issues with pavement smoothness in the same way: through pay incentives/disincentives, through grinding requirements, or most often a combination of the two. If a pavement barely misses the mark, the contractor often can decide not to correct it and take a pay cut. Most states do have a must-grind smoothness/ALR threshold, though, after which the contractor will be required to grind. The data can be a bit misleading, and grinding in some cases based on IRI numbers alone can cause the pavement to become less smooth. Because of this, many states opt for deferring to an engineer or project manager's opinion before requiring grinding. Some states even require the engineer to physically drive the job with the contractor to determine what the actual effect of the IRI/ALR deficient zones have on actual ride quality. This is a slippery slope, as it can lead to inconsistencies in pavement quality across a state. However, if the ultimate goal is a smooth pavement, it makes sense for a contractor to not be forced to correct an area that has little effect on ride quality. There is a price for this type of leniency, though, as the states that require an engineer/project manager opinion often have more stringent smoothness specifications overall.

Finally, the way that states process the smoothness data from the inertial profilers can vary as well. Most states that have IRI requirements require a ProVal analysis. ProVal is a program developed by FHWA/LTPP specifically designed to analyze raw data from inertial profilers. This program allows the user to set certain filters in order to get a consistent, comparable analysis across different pavement types. Because this software was developed on a federal level, many states do have similar requirements in regards to using ProVal and the filters applied within. ProVal's development also led to states being able to upgrade to the easier to use inertial profilers earlier even if the state was still specifying smoothness requirements based on PI. This is because ProVal has a PI simulation you can run with the raw inertial profiler data. Some states like Texas have opted to develop their own software for smoothness analysis, though, making their requirements difficult to compare.

So as you can see, due to the newness of this technology and a lack of federal guidance, states have all been slowly developing their smoothness specifications/guidelines individually to arrive at where they are today. With many states moving from PI requirements to IRI requirements, there has been much scrambling state to state to determine what specifications will result in the smoothest roads while being as fair as possible. As a result, the smoothness requirements vary enormously from state to state. The states that have conducted studies to determine their smoothness thresholds often only analyze the data for their roads, thus making their finding difficult to apply to other states; even with these studies, often the spec committees aren't required (and often don't) incorporate all of the studies' suggestions into their specs. IRI is the future of pavement smoothness though, and it will not be long before all states begin their shift to IRI requirements, if they haven't already. These requirements have to be based on the individual state, and either require an in-depth analysis of current smoothness data in that state or a few years of trial and error with special provisions to ensure fairness of the requirements.

Issues with the Use of Recycled Fuel Oil in Drum Mix Asphalt Plants

BY SANGHYUN CHUN



Recently raised economic and environmental issues have spurred interest in less expensive, alternative fuel oils used at asphalt plants, including recycled fuel oil. In response, many state agencies allowed the use of recycled fuel oil for asphalt mixture production at the plants. However, there have been common concerns associated with unburned fuel/incomplete combustion of recycled fuel oil, including (1) unstable mixtures produced that affect mixture properties and performance, (2) unburned oil residue in the mixtures that yield bad smell and contamination of mixtures, (3) excessive emission and reduction in a rate of production, and (4) other combustion byproducts such as char and ash that could result in stripping, excessive aging and stiffening effects on the binder and mixtures that increase the potential for cracking. Thereby, several state agencies have recommended or moved back to using natural gas only at asphalt plants.

In Arkansas, some asphalt plants have reported issues with the use of blended recycled fuel oil, likely related to the unburned fuel/incomplete combustion problems in their plant operation. Those problems included (1) complaints of being unable to get the plant to fire (i.e., a lack of proper preheating and efficient burning), (2) a strong smell of fuel oil, (3) excessive steam/emission during the mixture production, and (4) stripping problems in the mixture produced. For example, one plant had been having temperature problems when trying to run higher tonnages per hour. The plant foreman adjusted the burner by increasing the pressure of the fuel oil. Then, the plant was able to attain the required temperature while running faster. However, it is possible that by increasing the pressure on the fuel oil, some of the fuel oil is not being burned and is blowing onto the mixtures. The steam/emission could be fuel oil burning off, and this could leave the residue on the mixtures seen by the inspector in the Rice test samples. It may also be caused by trying to run the plant too fast, and the aggregates were not dried sufficiently before the asphalt concrete (AC) is introduced, causing the steam/emission in the mixtures. This could also cause many of the fines to not be sufficiently coated potentially leading to the stripping problems in the mixtures. Eventually, after being unable to find any appropriate solutions and returning to using natural gas only, no issues have been further reported.

Currently, the Arkansas Department of Transportation (ArDOT) Standard Specifications for Highway Construction Section 409.03(b)(5) states that "the dryer shall be capable of heating and drying the aggregates to the moisture and temperature requirements without leaving any visible unburned fuel or carbon residue on the aggregates when discharged from the dryer." However, no relevant specifications or requirements are specifically designated regarding the use of recycled fuel oil at asphalt plants.

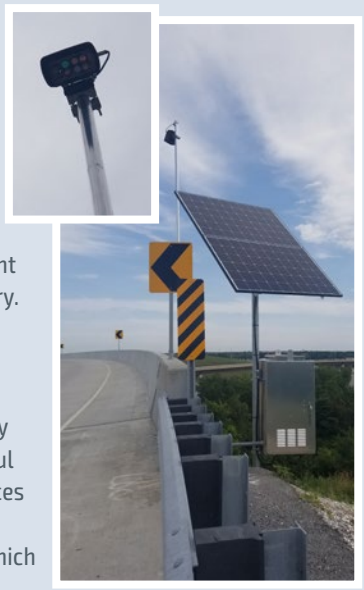
Based on the information of other state DOTs' experiences and practices searched in terms of the types of fuel oils, including the recycled fuel oils used at asphalt plants, most states have not experienced significant problems in practice due to different burner fuel types (i.e., the use of recycled fuel oils) and have not investigated this issue or regulated the fuel types in their specifications. The investigation of state experiences and practices has revealed that only two states (Georgia and Nevada) have implemented stringent restrictions on fuel types (i.e., particularly to disallow the use of recycled fuel oils) used at the asphalt plants. Even though all states searched have included relevant requirements in their specifications, those are mostly indirect limits through emissions or contamination of aggregates. Most states do not have specific tests or procedures to evaluate the issues with unburned fuel oils or incomplete combustion at the asphalt plants. Many state DOTs indicate that the use of alternative fuels might not be problematic if burner fuels are properly preheated and the plants are operating appropriately. However, due to the aforementioned issues with the use of recycled fuel oils related to unburned fuels/incomplete combustion, some states reported that many asphalt plants have been switching to natural gas, which burns cleaner than recycled fuel oil, to help mitigate the problems. The use of alternative fuels, including recycled fuel oils, may allow contractors to save money. However, it would only be a feasible option if there are no jeopardizing effects on plant operation, mixture quality produced, and field performance that should be evaluated and verified before the implementation.

Stationary Road Weather Information Sensor (StaRWIS)

BY GLORIA HAGINS

Winter weather in Arkansas can be unpredictable and treacherous. When winter weather becomes imminent, the Arkansas Department of Transportation (ArDOT) Districts will inform the Area Maintenance Headquarters they need to begin preparations to treat roadway surfaces for snow and ice. Currently, the Districts rely on manpower and vehicles equipped with Mobile Advanced Road Weather Information Sensor (MARWIS) to monitor road conditions and determine when and how to treat road surfaces.

ArDOT has begun to use the same technology in a stationary format for identifying trouble areas on bridge decks. Stationary Road Weather Information Sensor (StaRWIS) units, commonly referred to as weather stations, can be mounted to the side of a bridge 15 to 18 feet from the surface of the deck and can detect road surface conditions (dry, moist, wet, ice, snow, critically wet or chemically wet), water film height, dew point temperature, relative humidity, and freezing temperatures. StaRWIS is a relatively non-invasive and innovative tool that utilizes optical LED transmitters, photo receivers, infrared, and pyrometer technology to provide wireless data transfer without the use of moving parts. The weather stations can draw power from a solar panel if an AC power source is not readily available. ArDOT's Intelligent Transportation Systems (ITS) Management Section has acquired and has begun the installation of twenty-two weather stations across the state. Once the installations are complete, the Districts will be able to monitor the data remotely and better predict when surface treatment for winter weather is necessary.



While the weather stations' current main purpose is to determine when to pre-treat surfaces for snow and ice, they may provide information useful to Research for ongoing services and projects, such as Profiling and Next25 data collection, which can only be completed during certain weather conditions. By utilizing this technology, ArDOT could potentially extend the life of a bridge and save money on supplies used to treat the surface as well as costly repairs due to accelerated corrosion caused by overtreatment.

ARDOT Research Library

BY ROBIN RUSSELL

The ArDOT Research Library is a vast collection of publications, reports, and other documents from various organizations, databases, and other libraries around the nation. The Library supports the Department by helping staff locate relevant information to meet their needs. The Research Library currently has over 9,000 physical items cataloged. Some of the resources at the Library's disposal include publications from ArDOT and other state DOTs, USDOT, FHWA, as well as the Transportation Research Board (TRB), and PE exam reference materials. The Research Librarian is also the AASHTO Publications Gatekeeper with the ability to provide consistent access to AASHTO publications.

Many of the items are research-related, but not all. The Library keeps various publications from around the Department, including planning studies, design reports, and previous editions of Standard Specifications. The Library manages access to various databases for access to articles, reports, and other publications.

What does this mean for you? How often do you stumble across a reference to a publication and find a paywall blocks access to the publication? This frustration can be avoided by utilizing the Library's resources. When the Librarian has exhausted all search options, the Librarian can request to borrow publications from other libraries through InterLibrary Loan (ILL). The Librarian also maintains a relationship with a network of Transportation Librarians that often assist each other in locating publications.

To search the Library's catalog, go to **https://a94035.eos-intl.net/A94035/OPAC/Index.aspx**. This site contains helpful links to many resources, such as TRB, FHWA, USDOT, and NCEES. To find materials available in the Library for the PE Exam, select "Advanced Search" from the search menu, select "Collection Type" in the -Select field- box, then select "PE Exam Materials" from the criteria box. When you click search, the available materials related to the PE Exam will be listed.

Electronic resources are in the process of being cataloged. If you cannot find what you are looking for, contact the Research Librarian at library.research@ardot.gov.

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