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Asphalt
Technology News

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National Center for Asphalt Technology
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Message from the Director

Not a Fan of Recycled Binder Availability Factors

The ongoing research and application of recycled binder availability factors deeply concern me. The discourse surrounding RAP/RAS binder availability started decades ago, with some claiming that RAP is merely black rock, suggesting the aged binder within RAP/RAS isn't active in the mixture as a binding agent. I've never believed in the black rock theory. My early career involved designing mixes with RAP based on viscosity blending charts, which assumed complete blending of RAP binder with virgin binder to form a composite binder with properties roughly approximating a weighted average of both constituents. However, this approach seems flawed upon reflection. Thus, enters the partial binder availability concept.

I'm not opposed to the idea that a portion of recycled binder may remain inactive; however, I'm skeptical of applying a single number (percentage) to all recycled binders and situations due to various influencing factors affecting activation. One powerful combination of factors is time and temperature. Several studies have demonstrated that the diffusion rate of a RAP/RAS binder and virgin binder depends on time and temperature during production and transportation to the paving site. Moreover, diffusion will continue, albeit at a slower rate, as the mix cools and may even continue at ambient temperatures. Thus, "activation" isn't a single number but rather a process increasing over time. However, the time-temperature combination differs from mix to mix, even within a given day of mix production, so activation is not a constant.

The properties and compatibility of the recycled and virgin binders also play a crucial role in blending. Not all RAP is the same, and not all virgin binders are the same. Some RAP is much more aged than other RAP depending on how old the pavement was at the time of milling, the depth of milling, the type of mixes in the pavement, and whether or not a pavement preservation treatment has been applied to the pavement at some point in its life. Similarly, RAS properties can vary considerably depending on material type, age, and source.

Another limitation of recycled binder availability factors is their failure to fully capture the potential of recycling agents (a.k.a. mix rejuvenators) to restore the physical and chemical properties of recycled binders, thereby enhancing the field performance of high-recycled-content mixtures. Growing evidence from well-documented field trials show bio-based rejuvenators can help achieve long-lasting field performance and reduce a pavement's carbon footprint.

While recycled binder availability is an approach that may improve the cracking resistance of high RAP/RAS mixtures by adding more virgin binder, it has limitations, especially in specifying a universal binder availability factor across diverse materials and mix designs. A more effective approach lies in specifying mixture performance tests for various distresses, such as cracking, rutting, and moisture damage, as part of mix design and Quality Assurance. This is where the promise of balanced mix design shines— allowing the results of mix performance tests to guide decisions, acknowledging the intricate interactions of materials that defy simple predictions.

Randy C. West, Ph.D., P.E.
NCAT Director and Research Professor

Enhancing Performance with Reclaimed Asphalt Pavement in Florida

The Florida Department of Transportation (FDOT) is one of the nation's leading highway agencies using reclaimed asphalt pavement (RAP) in asphalt mixtures. According to the 2022 asphalt pavement industry survey, the estimated average RAP content of asphalt mixtures in Florida is 34%, surpassing the national average by 11.8%[1]. The successful use of RAP not only allows FDOT to stretch its resurfacing funds but also significantly conserves natural resources.

FDOT has adopted two key initiatives to ensure the satisfactory performance of RAP asphalt mixtures: establishing a statewide RAP stockpile database and requiring a softer asphalt binder for mixtures containing over 15% RAP. Recently, FDOT has been interested in further improving the cracking performance of RAP asphalt mixtures through the Corrected Optimum Asphalt Content (COAC) approach–an approach successfully employed in neighboring states Georgia and South Carolina.

The COAC approach recognizes the challenge posed by the high viscosity and stiffness of RAP binder, acknowledging that not all of it may be activated during mixing to coat and bind aggregates like virgin binder. The percentage of the activated RAP binder is defined as recycled binder availability (RBA), which varies from 0% to 100%, representing the most conservative and optimistic conditions, respectively. By compensating for inactive RAP binder with additional virgin binder, the COAC approach improves mixture durability and cracking resistance.

In December 2021, FDOT sponsored a pivotal research study at NCAT to evaluate the suitability of the COAC approach in Florida conditions[2]. The study recommended an 80% RBA limit based on an extensive literature review, considering the performance grade (PG) of RAP binders and mixing temperatures of RAP mixtures prevalent in Florida. With 80% RBA, it is assumed that 80% of the RAP binder can be activated while the other 20% cannot.

Laboratory experiments were then conducted to assess the impact of 80% RBA on the performance properties of existing RAP mixtures. Four Superpave SP-12.5 mixtures were tested, including two low-absorption granite mixtures and two high-absorption limestone mixtures at 20% and 40% RAP contents. The 20% RAP mixtures used a PG 76-22 polymer-modified asphalt (PMA) binder, while the 40% RAP mixtures used a PG 52-28 binder per FDOT specifications. Each mixture was tested at two asphalt binder contents: the volumetric optimum (V-OBC), and the RBA-adjusted optimum (A-OBC). A-OBC was calculated based on V-OBC, the RAP content of the mixture, the asphalt content of the RAP, and the recommended RBA limit (i.e., 80%). As shown in Table 1, A-OBC was approximately 0.2% higher than V-OBC for the 20% RAP mixtures, and about 0.45% higher for the 40% RAP mixtures.

The laboratory testing plan evaluated the rutting and cracking resistance of each RAP mixture at V-OBC vs. A-OBC using various balanced mix design (BMD) performance tests. Adding more virgin binders in consideration of 80% RBA significantly improved the cracking

Table 1. Comparison of V-OBC versus A-OBC

Mixture ID	RAP Content (%)	Asphalt Content of RAP (%)	V-OBC (%)	A-OBC (%)
20% RAP granite	20	5.94	5.40	5.62
40% RAP granite	40	5.94	5.40	5.85
20% RAP limestone	20	6.09	6.20	6.43
40% RAP limestone	40	6.09	6.20	6.66

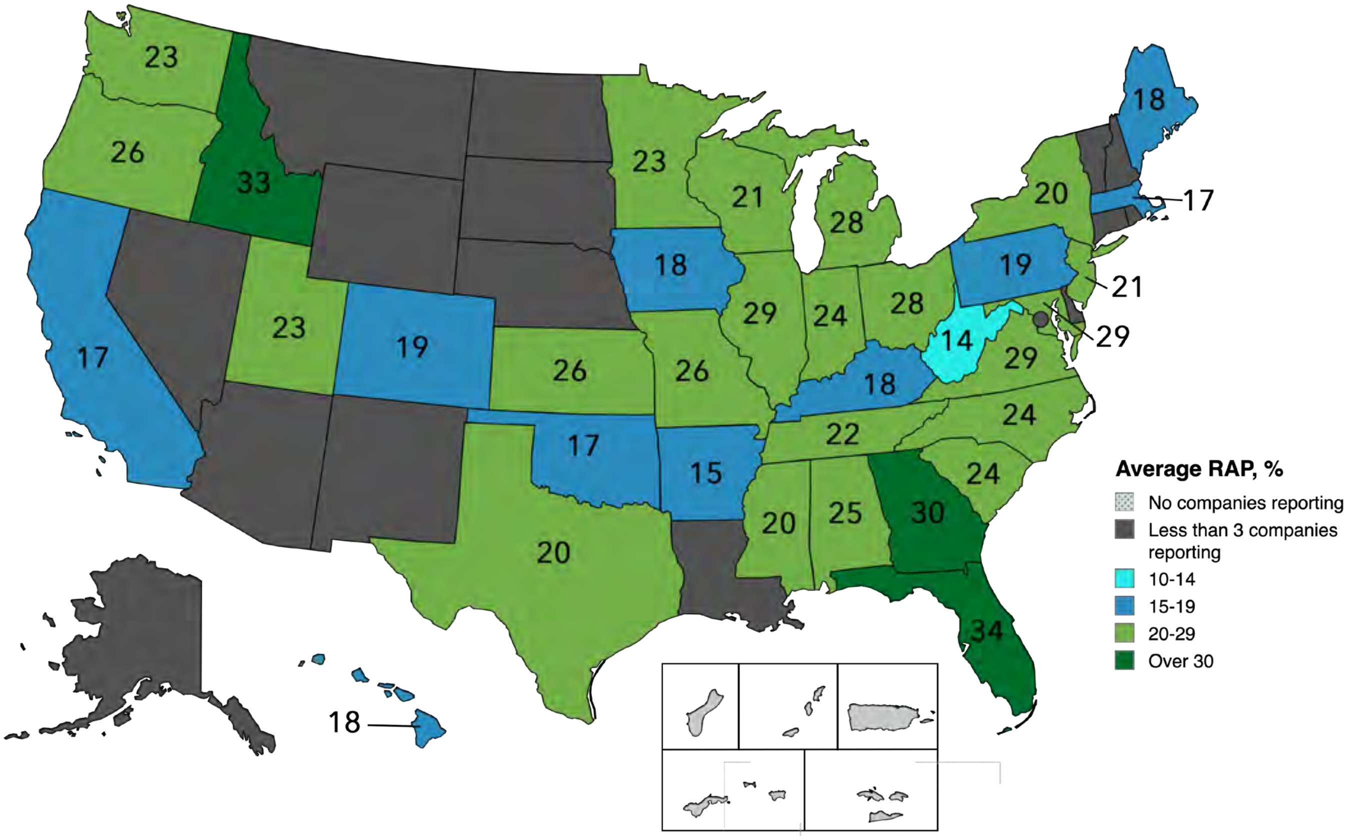


Figure 1. Estimated Average Percentage of RAP Used in Each State, 2017-2021[1]

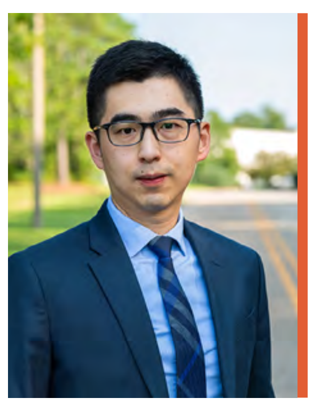
resistance of the RAP mixtures, especially for 40% RAP. The 40% RAP mixtures with PG 52-28 binder showed similar cracking resistance as the 20% RAP mixtures with PG 76-22 PMA binder after RBA adjustments for both mixtures. Adding more virgin binders was detrimental to the rutting resistance of the 40% RAP mixtures, but did not affect the 20% RAP mixtures with PG 76-22 PMA binder. This highlights the benefit of polymer modification, enabling the use of more asphalt binder while avoiding rutting issues in mixtures. Although the 40% RAP mixtures at A-OBC showed increased rutting potential based on laboratory testing, they are not expected to experience rutting in the field, given their use as non-surface layers in Florida. Overall, the test results showed that using the COAC approach with 80% RBA could improve the overall performance of RAP mixtures in Florida.

A comparative cost-benefit analysis concluded that a modest two-month extension in pavement service life (from 15 years) would suffice to justify the cost of the additional virgin binders in a 3-inch mill-and-resurface project utilizing RAP mixtures with 80% RBA.

The promising results obtained in the study position FDOT to potentially implement the COAC approach with 80% RBA, furthering the economic, environmental, and performance benefits of RAP asphalt mixtures in Florida.

1. National Asphalt Pavement Association (NAPA). *Asphalt Pavement Industry Survey on Recycled Materials and Warm-Mix Asphalt Usage*, NAPA Information Series 138, 2021.

2. Yin, F., A. Taylor, C. Chen, R. Moraes, J. Musselman, and N. Tran. *Determining the Effect on Asphalt Mixture Performance by Increasing New Asphalt Binder Content Due to Inactive RAP Binder in the Mixture*. Florida Department of Transportation BEC 79, Final Report, 2023.



Contact Fan Yin at f-yin@auburn.edu for more information about this research.

Advancing Asphalt Quality

Wisconsin DOT's Road to Balanced Mix Design

The Wisconsin Department of Transportation (WisDOT) has devoted significant research efforts in recent years toward implementing balanced mix design (BMD) to improve the performance of their asphalt mixtures. A 2021 benchmarking study by NCAT used HWTT and IDEAL-CT methods to test existing WisDOT-approved mix designs, determining the distribution of test results that satisfied preliminary performance criteria[1]. Since then, WisDOT has continued to refine these benchmarks, culminating in the latest criteria outlined in Table 1. The HWTT corrected rut depth at 20,000 passes is used to ensure robust rutting resistance, the HWTT number of cycles to the stripping number (LC_{SN}) is used to assess moisture susceptibility, and the IDEAL-CT CT_{Index} is proposed for resistance against load-related cracking in surface layers.

In 2023, NCAT completed another study for WisDOT focusing on two important steps in the BMD implementation process: (1) validating BMD tests and criteria by constructing BMD test sections, and (2) conducting shadow projects to assess the overall variability of BMD test results in mix production settings. This first step is crucial for establishing a robust correlation between test results and field performance, thereby facilitating the development of appropriate specification criteria for Quality Assurance and mix design approval. Similarly, the second step is essential for determining production variability statistics that are needed to set appropriate quality assurance specifications.

In the first phase of the study, the research team collaborated with WisDOT to design six test sections for the BMD validation experiment. It was critical to include sections with a diverse range of expected field performance to encompass BMD test results both above and below the proposed criteria. This is fundamental, as the ultimate objective of BMD is to enable agencies to specify mix criteria independent of mix composition. Table 2 shows the desired ranges for IDEAL-CT and HWTT results across the six Wisconsin test sections. BMD test results yielded CT_{Index} values spanning from 17 to 99, while HWT CRD_{20k} values ranged from 2.8 to 10.4 mm.

During construction of the test sections in October 2022, samples from each section were obtained and divided into three parts for BMD testing by the contractor, WisDOT's central lab, and NCAT. Results from these three laboratories are summarized in Table 4, which also includes mix design results for comparison. As evident from the table, there are significant discrepancies in the results of the three labs for both tests, indicating a need for improved instructions and training to reduce lab-to-lab variations. To address this issue, the National Asphalt Pavement Association (NAPA) recently published a *Guide on Asphalt Mixture Specimen Fabrication for BMD Performance Testing*[2].

Despite the notable differences in CT_{Index} and HWTT results among the labs, the ranking of the mixtures, shown in parentheses in Table 4, were similar. The range of resistance to rutting and cracking indicated by these results should provide a reliable correlation between laboratory testing and field performance. For instance, Section 1's mixture has a relatively high CT_{Index} and HWTT CRD_{20k}, suggesting greater resistance to cracking but increased susceptibility to rutting compared to other sections. Conversely, the mixture in Section 4 has the lowest CT_{Index}, indicating lower resistance to cracking but excellent resistance to rutting based on the HWTT results.

The second phase of the study entailed testing mixture samples sourced from ten WisDOT projects across the state to quantify production variability for the BMD test results. The shadow projects were selected to encompass variations in aggregate type, binder grade, and mix types. For each project, production samples were obtained from two or three lots. Typically, a Wisconsin lot is made of five sublots, providing 10 to 15 mix samples per shadow project.

Table 1. WisDOT BMD Criteria

Mixture Type	HWTT		IDEAL-CT
	Corrected Rut Depth (CRD) at 20,000 passes	Stripping Number (LCSN)	CT_{Index}
Low traffic (LT)	≤ 12.0 mm	≥ 3,000	≥ 30
Medium traffic (MT)	≤ 7.5 mm		≥ 30
High traffic (HT)	≤ 5.0 mm		≥ 30
Stone matrix asphalt (SMA)	≤ 4.0 mm		≥ 80

Table 2. Experimental Matrix with Six Test Sections

HWTT Corrected Rut Depth	IDEAL CT_{Index} After 6-hour Aging at 135°C	
	> 65	< 35
> 7.0 mm	①	③
< 3.5 mm	②	④
V-grade binder	⑤*	⑥†

* Section identical to mixture design 1 with "V" binder replacing "S" binder.
† Section identical to mixture design 3 with "V" binder replacing "S" binder.

Table 3. HWTT and IDEAL-CT Results and Ranking

Section	CT_{Index} After 6-hour Aging at 135°C					HWTT CRD_{20k}				
	Plan	Design	DOT	Contractor	NCAT	Plan	Design	DOT	Contractor	NCAT
1	> 65	69	60 (2)	80 (1)	51 (2)	> 7.5	10.4	6.5 (5)	12.2 (6)	14.4 (6)
2	> 65	99	37 (5)	59 (3)	38 (3)	< 3.5	3.4	3.4 (2)	5.5 (2)	6.4 (1)
3	< 35	29	42 (3)	42 (4)	33 (4)	> 7.5	8.1	6.6 (6)	10.5 (5)	13.8 (5)
4	< 35	21	24 (6)	20 (6)	22 (6)	< 3.5	2.8	3.0 (1)	4.4 (1)	7.1 (2)
5	> 65	56	79 (1)	71 (2)	63 (1)	*	3.7	5.8 (4)	8.7 (3)	11.0 (3)
6	< 35	17	38 (4)	32 (4)	28 (5)	*	3.2	5.2 (3)	8.7 (3)	12.4 (4)

* No specified HWTT criteria.

Table 4. Summary of Key Statistics for Overall Production Variability

Test	Parameter	Pooled within-lot standard deviation	50th percentile within-lot COV	Within-lab (single operator) COV	Reference for single operator statistics
IDEAL-CT	CT_{Index}	10.9	10.3%	20.5%	Rodezno, et al., 2023[3]
HWTT	CRD_{20k}	1.60 mm	10.0%	9.5%*	Rodezno, et al., 2023[3]
	LC_{SN}	1436	31.6%	Not available	None
	$N_{12.5}$	1837	17.3%	16.6%	Azari, 2014[4]
	SIP	1712	17.9%	23.9%	Azari, 2014[4]
HT-IDT	ITS	2.29 psi	13.5%	8.3%	Rodezno, et al., 2023[3]
T 308	Asphalt content	0.18%	2.5%	0.069%†	AASHTO T 309
T 269	Air voids	0.34%	10.1%	0.21%‡	AASHTO T 269

* Total rut depth at 20,000 passes.
† Single operator precision standard deviation.
‡ Single operator precision standard deviation using T 269 Method A.

Table 5. WisDOT Preliminary BMD Criteria and Recommended Production Targets

Mixture Type	HWTT CRD_{20k} (s=1.6 mm)		HWTT LC_{SN} (s=1436)		IDEAL-CT CT_{Index} (s=10.9)	
	Criteria	Target	Criteria	Target	Criteria	Target
Low traffic (LT)	≤ 12.0 mm	≤ 9.9 mm	≥ 3,000	≥ 4,441	≥ 30	≥ 44
Medium traffic (MT)	≤ 7.5 mm	≤ 5.4 mm				
High traffic (HT)	≤ 5.0 mm	≤ 2.9 mm				
Stone matrix asphalt (SMA)	≤ 4.0 mm	Not available*				

* SMA mixtures were not included in the shadow projects; therefore, standard deviations are unknown.

The test results were used to quantify production variabilities for the BMD test parameters. Crucial variability metrics were summarized and used to illustrate how contractors can align mix production to meet the desired quality standards and receive full pay, as per WisDOT's preliminary BMD specification criteria. Table 3 provides a concise summary of the production variability statistics for the BMD tests derived from the Wisconsin shadow projects, along with references to other studies documenting within-lab testing variabilities for these parameters.

The pivotal takeaway from this part of the research lies in guiding contractors on how to set their targets for mix production when these tests are used for acceptance quality characteristics. In the case of a percent within limits (PWL) specification with a 100% pay factor based on 90% compliance within specified limits, the population mean should target at least 1.282 times the within-lot standard deviation above a lower specification limit, or 1.282 times below an upper specification limit. Therefore, based on WisDOT's preliminary BMD criteria and the shadow project testing outcomes, contractors should target mix production with the results shown in Table 5.

WisDOT is monitoring the performance of the BMD test sections and the shadow projects as they may offer valuable insights into the effectiveness of the BMD test parameters in gauging the resistance of the mixtures to rutting, cracking, and moisture damage.

1. West, R., F. Yin, C. Rodezno, and A. Taylor. *Balanced Mixture Design Implementation Support*, WHRP Report No. 0092-20-04, Wisconsin Department of Transportation, 2021.

2. Moore, N., and A. Taylor. *Guide on Asphalt Mixture Specimen Fabrication for BMD Performance Testing*, IS 145, National Asphalt Pavement Association, 2023.

3. Rodezno, C., A. Taylor, and N. Moore. *NCAT Completes Second Mixture Performance Test Round Robin*. Asphalt Technology News, Spring 2023, *Vol. 35, No. 1*, National Center for Asphalt Technology at Auburn University, 2023.

4. Azari, H. *Precision Estimates of AASHTO T 324, Hamburg Wheel-Track Testing of Compacted Hot Mix Asphalt (HMA)*, Transportation Research Board, The National Academies Press, Washington, D.C., 2014.

Contact Carolina Rodezno at mcr0010@auburn.edu for more information about this research.

Driving Innovation

NCAT's Triennial Test Track Conference Attracts Asphalt Industry Leaders

The National Center for Asphalt Technology (NCAT) hosted its triennial Test Track Conference May 7-9 at the Auburn University Hotel and Conference Center. The event presented advancements in the design, construction, materials, maintenance and sustainability of asphalt pavements to over 300 industry professionals.

Highlighting the latest findings from the 8th cycle of accelerated pavement testing conducted at NCAT's Test Track, situated just 20 minutes east of Auburn University, the conference offered insights into the forefront of asphalt pavement research and development.

SETTING THE TONE

"Research means nothing if we do not implement," remarked Richard Willis, National Asphalt Pavement Association's (NAPA) vice president of engineering, research and technology, setting the tone for the conference in his opening address. The conference encouraged participants to move beyond exploration and actively implement proven technologies — a sentiment that echoed throughout the event.

With attendees from across the country and beyond, including representatives from Hawaii, Peru, Puerto Rico and Saudi Arabia, the conference served as a platform for knowledge exchange and networking within the asphalt industry. Among the participants were research sponsors, public agencies, contractors, asphalt paving associations, FHWA and various other asphalt professionals.

"The presentations revealed the depth, breadth and vastness of the different test sections/projects, the detailed and precise research parameters and the shared cooperation among so many different state and private organizations for a common and necessary goal were all so amazing," said Andre' Jenkins Sr., assistant bureau chief, research at Alabama Department of Transportation. "The details of the presentations really impressed me. The NCAT staff were seamless and cooperative with everyone and everything that me, as an attendee, felt welcome and warm, just like I feel being a part of the Auburn Family whenever I am on campus."

Participants at the Test Track Conference listen to Fan Yin's presentation.

Asphalt industry professionals and attendees during the tour of NCAT's Test Track at the 2024 conference.

PAVING THE WAY

Throughout the conference, attendees explored a myriad of topics, spanning from mixture additives to innovative pavement design methodologies. Research engineers from NCAT delivered presentations on recycling agents, innovative mix additives, crack prevention interlayer strategies, high polymer binders, cold recycling, pavement preservation treatments and more.

Ben Bowers presenting at NCAT's Test Track Conference.

Benjamin Bowers, assistant professor in the department of civil and environmental engineering at Auburn University and an NCAT researcher presented engaging information on cold recycling, balanced mix design and Life Cycle Assessments of asphalt pavements.

"This conference brings together all walks of asphalt-life, from agencies to industry, to hear about the research we've been conducting and discuss implementable outcomes," Bowers said. "I love that I now get to stand on stage as an Auburn University and NCAT representative to talk about the impactful work my team is doing for VDOT, TDOT, FHWA and our industry partners. I love the energy that the conference brings along with the community."

TEST TRACK TOUR

A highlight of the conference was the opportunity for participants to inspect the 1.7-mile test track, which features 46 200-foot test sections funded by highway agencies and industry sponsors.

David Timm, an NCAT researcher and Brasfield & Gorrie Professor in Auburn University's department of civil and environmental engineering, addresses Test Track visitors about various track sections during the Test Track Conference.

NCAT operates five semi-tractor trailers on the test track for 16 hours a day, five days a week to reproduce similar traffic levels and stress a typical interstate highway would experience in 5 to 7 years, or 10 million equivalent single axle loads (ESALs).

This unique real-world laboratory allows researchers to collect and analyze field performance data, pavement responses and laboratory test results for plant-produced mixtures sampled during construction.

"Being able to see, in-person, how the test sections have performed makes the experiments more meaningful," said Randy West, director of NCAT. "Conference participants get to see the cracking, feel the textures of the surfaces and see open trenches of sections to observe how damage progresses, is part of the experience that makes this conference unique."

ROAD TO PROGRESS

Since its inception in 2000, the test track has been instrumental in assisting agencies in refining asphalt pavement specifications and shaping mix design policies. The research conducted at the test track continues to yield dividends for many agencies.

With its unique ability to simultaneously test multiple instrumented asphalt pavements under natural environmental conditions with accelerated loading, the Test Track stands as a beacon of innovation and excellence in asphalt research.

Established in 1986 through a collaboration between Auburn University and the National Asphalt Pavement Association's Research and Education Foundation, NCAT was founded to address the needs of maintaining America's pavement infrastructure through practical research and development initiatives. The center's mission is to provide innovative, relevant and implementable research, technology development and education that advances safe, durable and sustainable asphalt pavements.

For more information about NCAT and its research initiatives, visit https://eng.auburn.edu/research/centers/ncat/.

NCAT Test Track Section N2.

Two New Resources for Fighting Bad Joints

Constructing long-lasting asphalt pavements requires meticulous attention to detail, especially when it comes to asphalt longitudinal joints. When constructed properly, these joints contribute to the longevity and resilience of roadways. However, poor execution can result in costly maintenance and repair issues.

The Consortium for Asphalt Pavement Research and Implementation (CAPRI) is pleased to introduce the launch of two new resources—

TECHBRIEF
Asphalt Longitudinal Joint Current and Best Practices Construction Methods, Materials, and Acceptance

TECHBRIEF OVERVIEW
Authored by Tom Harman, Randy West, and Mark Buncher (Asphalt Institute), these publications emphasize the crucial role of asphalt longitudinal joints in ensuring and maintaining the durability of asphalt pavements.

CAPRI is committed to advancing durability and innovation in pavement projects by showcasing cutting-edge methodologies, preferred material choices, and strategic planning approaches. These resources are essential guides for industry professionals seeking to evaluate their current methods and adopt best-in-class approaches.

Access the full TechBrief at capriasphalt.us/research/completed-research.html

Find out more about CAPRI at capriasphalt.us.

Contact Tom Harman at tph0029@auburn.edu for more information about this research.

Rehabilitating Concrete Pavements with Asphalt

When Portland cement concrete (PCC) pavements exhibit extensive distress such as joint faulting, slab cracking, spalling, or other issues that may affect ride quality, rehabilitation becomes imperative to restore service levels. However, this often requires lengthy lane closures, disrupting traffic flow, increasing user delay costs, and requiring substantial highway resources to ensure safety for both construction workers and the traveling public.

Using asphalt overlays to rehabilitate PCC pavements is a common practice owing to its cost-effectiveness and reduced construction time compared to alternatives like concrete pavement restoration (CPR) or concrete overlays. According to the Federal Highway Administration (FHWA), nearly two-thirds of concrete pavements in the U.S. have been overlaid with asphalt[1]. This process involves placing one or more layers of asphalt mix directly onto the existing PCC pavement or over a fractured PCC layer to improve functional or structural conditions.

However, the long-term functional performance of these overlays can be compromised by reflection cracking, which stems from concentrated stresses at cracks and joints in the PCC due to traffic loading and environmental factors. Several methods can mitigate this distress, including slab fracturing techniques or using special materials such as stress-relieving interlayers and special crack-resistant asphalt mixes. Significant advances have been made over the past three decades in refining these processes and materials.

NCAT recently updated NAPA's IS-117 *Guidelines for Use of Asphalt Overlays to Rehabilitate PCC Pavements* (originally published in 1995) to provide insights into the state of practice and offer guidance on slab fracturing, structural design, and overlay mix design.

Slab fracturing techniques aim to reduce stress concentration by breaking the slab into smaller segments to minimize movements that occur at joints or cracks of the concrete layer. Three commonly used techniques are crack and seat (C&S), break and seat (B&S), and rubblization. While the principles are similar, the methods differ in fragment sizes and equipment used.

C&S and B&S involve fracturing slabs into shorter lengths with a guillotine or impact hammer and seating them onto the base using pneumatic rollers. C&S is suitable for jointed plain concrete pavements (JPCP), while B&S is used for jointed reinforced concrete pavements (JRCP). The difference between the two lies in the level of effort required to fracture the PCC layer. C&S aims to produce slab fragments less than 30 inches in size with tight cracks that permit load transfer with minimal structural integrity loss. B&S requires more effort to break or debond the steel reinforcement in the JRCP, producing fragments 12 to 18 inches in size. In both cases, the fractured slabs must be properly seated using pneumatic rollers to prevent voids from forming under the fractured slabs, which could result in movement and premature reflection cracking of the overlay.

The rubblization process can be used on all types of PCC pavement. It involves breaking the slabs into smaller pieces, typically 3 to 8 inches, using specialized equipment such as multi-head breakers (MHB) or resonant pavement breakers (RPB) to produce a strong aggregate base. The MHB can rubblize a full lane width of pavement in a single pass using a low-frequency, high-amplitude mode. Conversely, the RPB uses high-frequency, low-amplitude resonant

Guillotine-style breaker. Photo provided by Antigo Construction, Inc.

energy to fracture the concrete by creating high tension at the top of the layer. The rubblization process usually begins at the outside edge of a pavement, continuing toward the centerline. Vibratory rollers are often used to settle the rubblized layer and provide a smooth surface for the asphalt overlay.

MHB badger breaker. Photo provided by Antigo Construction, Inc.

Following the fracturing and seating process, an asphalt overlay is applied to address structural and functional deficiencies. Structural overlay design can be performed using existing methodologies with minor adjustments. The AASHTO 1993 and mechanistic-empirical (ME) pavement design methods are the most commonly used. The AASHTO 1993 method utilizes the structural number concept to determine the overlay thickness and requires the layer coefficient of the fractured PCC layer as an input. This can be estimated using the AASHTO guide or by calculating the effective slab modulus based on non-destructive deflection testing using a Falling Weight Deflectometer (FWD) coupled with backcalculation procedures. Since FWD testing can only be done after the first asphalt layer is placed, this alternative can be used when field data from similar projects are available. For the ME design method, the elastic modulus of the fractured PCC layer is a critical input that can be assigned based on recommended ranges provided in the ME Pavement Design Guide or backcalculated from similar projects.


Three rollers. Photo provided by Antigo Construction, Inc.

Specialty mixes can further mitigate reflection cracking in the overlay. For example, gap-graded mixtures, which have a high coarse aggregate content and are rich in binder, provide a combination of stone-on-stone contact and added flexibility to minimize rutting and reflection cracking. Stone matrix asphalt (SMA) mixes have been widely used in the U.S. for this purpose since the early 1990s, with state agencies like Georgia and Wisconsin leading the effort. Similarly, asphalt-rubber gap-graded (ARGG) mixes have been used for decades to minimize reflection cracking in Arizona and California.

High polymer modification can also enhance the elastic properties of asphalt binder, resulting in improved cracking resistance and rutting performance. These mixtures are used in Florida, Oklahoma, and Virginia to mitigate reflection cracking and other distresses.

Special interlayer mixes have recently been developed to reduce reflection cracking. The Texas DOT developed a crack attenuating mix (CAM), while the New Jersey DOT developed a binder-rich intermediate course (BRIC). Both are fine-graded mixtures with a high binder content typically placed as an interlayer between the existing pavement and the asphalt surface layer. These mixes use high-quality aggregates and polymer-modified asphalt binders, and their performance is evaluated during the mix design process to ensure they meet specified rutting and cracking criteria. With the advancement of balanced mix design (BMD), more products are expected to arise thanks to its focus on performance and innovation potential rather than traditional volumetric requirements.

Interface materials such as geosynthetics are another option to reduce the reflection cracking potential in composite pavements. The material acts as reinforcement, developing tensile forces near existing cracks and joints and reducing strains in the asphalt overlay. Geosynthetics also relieve stress by absorbing some of the horizontal movement in the old pavement and acting as a hydraulic barrier, reducing the impact of water intrusion.

All of these options can help agencies cost-effectively and promptly rehabilitate their deteriorated PCC pavements. The updated IS-117 guidelines can be found at https://go.asphaltpavement.org/is-117.

1. Federal Highway Administration (FHWA), 2020. Office of Highway Policy Information: Highway Statistics. fhwa.dot.gov/policyinformation/statistics/2020/hm12.cfm. Accessed August 8, 2022.

Contact Adriana Vargas at vargaad@auburn.edu for more information about this research.

Specification Corner

FLORIDA DOT

Florida has a couple of changes to specifications coming into effect in July 2024.

First, contractors will have the option to apply a prime coat to the base layer if the base is completed or final prepped within 24 hours of paving. They must ensure the base moisture content is within an acceptable range, the base must be protected from rain, and it must adequately bond to the new lift of asphalt pavement.

Second, in the mix design approval process, if the contractor's mix design fine aggregate angularity (FAA) fails (less than 45.0) and falls between 42.0 and 45.0, they can opt to test samples in the Asphalt Pavement Analyzer (APA). If the rut depth is 4.5 mm or less, the failing FAA value will be waived.

OHIO DOT

We revamped our balanced mix design benchmarking for 2024. We're aiming to collect short-term (R 30) and long-term (using the new Method D AASHTO standard) for IDEAL-CT and Hamburg (rutting and moisture susceptibility) tests, alongside some 3-wheel polishing on select projects for mix design. We're also planning to collect production mix for creating hot-compacted pills and reheating mixtures to run IDEAL-CT and HT-IDT tests (as per ALDOT 458). We're planning test section trial projects based on the CAPRI *Guidelines and Recommendations for Field Validation of Test Criteria for BMD Implementation* report.

Furthermore, a rutting research project began in January to establish criteria for Hamburg testing and determine a rapid rutting test for QA with criteria based on field data.

We plan to fully implement PWL on core densities in 2026, following successful pilot projects from 2023 to 2025.

We're also exploring the potential implementation of paver mounter thermal profiling on projects, as we've conducted numerous shadow projects over the past decade.

UTAH DOT

UDOT is transitioning towards using the HiMod binder, specifically PG 76-34, for our dense graded HMA. This shift aims to achieve better density and durability by increasing our binder contents without the risk of rutting.

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