CASE STUDY

Cargill™ road construction case study: NCAT test track

Situation

In the road construction industry, there tends to be a lack of comprehensive performance studies being conducted on rejuvenated highly recycled HMA. Without such valuable research, many across the industry don't have the credible information necessary to understand the long term role rejuvenators have in the asphalt construction space and the value it brings.

As an industry leader in rejuvenator technology, Cargill™ funded a long-term test track research program with the National Center of Asphalt Technology (NCAT) at Auburn University in collaboration with the Virginia Department of Transportation.

After a completion of more than 20 million ESAL (equivalent single axle load) testing cycle at NCAT, which included half a year of design and construction and over six years of loading, monitoring and testing, there is a growing set of data that demonstrates reliability and consistency of high-RAP pavements using Cargill's Anova® biobased rejuvenator.

Goal

The team established this multi-year test to help answer critical questions surrounding how performance-based specifications can be used by agencies to allow and specify rejuvenated high-RAP mixes, while also demonstrating the viability, longevity and overall performance of High-RAP mixes using Cargill's Anova® Rejuvenator. The test, now well beyond the initial three-year period, and scheduled to be extended for a full nine years, is well positioned to serve as a national reference on rejuvenation tests long term performance and benchmarking for the industry.

The findings, shared freely with state agencies and businesses throughout the industry, will allow for more informed decision making when it comes to alternative pavement designs and performance-based specifications.

Cargill test sections on the NCAT Test Track being subjected to real environmental conditions with accelerated loading. The truck fleet applies over a decade of interstate-type traffic in only two years, and each driver circles the track approximately 200 times per day in order to damage experimental pavements.

In addition to the test with NCAT, Cargill has also completed a more than seven year evaluation of rejuvenated mix in cold weather climates at Minnesota Department of Transportation's MnROAD test track on a major interstate section just outside the Twin Cities metro area.

"Hats off to Cargill for funding such important research with results shared with 34 state agencies in the country," said now-retired Powell.

"This work adds so much credibility to the use of RAP and helps the entire industry move forward with proven technologies that brings greater value to our communities and road construction businesses as a whole."

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Solution

The team designed a comprehensive, research program assessing actual in-the-field pavement performance with a 45% RAP mix against a control mix at 30% RAP (9.5mm NMAS VDOT BMD mix).

At the lab scale, the team has analyzed plant produced mix from the test track at various conditions in terms of cracking, rutting, moisture resistance,and other properties at the NCAT testing facility in Alabama.

According to Dr. Buzz Powell, former Associate Director and Research Professor at NCAT, this type of testing is critical in advancing innovations in the road construction industry.

Results

Now, after seven years of testing and 20 million EASLs of loadings, test results show minimal cracking and no rutting damage. On average, the IRI index shows that the Anova® Rejuvenator section maintained ideal ride quality, perhaps even better than the control section. The impressive performance of the Anova 45% RAP section is shown in the following graphs.

The results of using Anova have shown a cost savings of at least $0.50 to $1.50 per ton on average compared to traditional mixes, which equates to approximately $750,000 in annual savings for a midsized contractor. These savings are achieved by using less virgin aggregate and less virgin asphalt. However, the benefits don't stop at cost savings. An overall increase in mix workability and ease of compaction with Anova® mixes enables contractors to maximize their reliability and consistency in achieving target densities and potential associated bonuses. Increasing RAP by 15%, can also reduce the total Global Warming Potential of the mix by 10-15%.

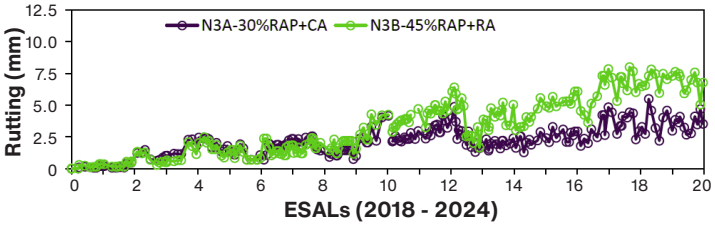
"These results are going to be very impactful for the industry," said Nam Tram, Assistant Director and Research Professor at NCAT. "These multi-generational results show that transitioning from standard volumetric to balance mix design asphalt should be considered as a consistent solution to meet industry performance, cost and environmental goals."

Table 1 *– Properties and performance test results for plant produced, lab compacted mixes.*

	Control/ Standard Mix	Anova Mix
Virgin binder grade	64-22	64-22
RAP percentage	30%	45%
Extracted mixture binder grade	76.7-14.6	75.9-22
Rutting test result (APA @ 64 °C)	2.51mm	2.55mm
Cracking test result (IDEAL CT) Target >70	124	100
Cracking test result (IFIT, flexibility index)	6.1	8.0
Cracking test result (DCT @ 12 °C, J/m^2	520	565
Cracking test result (Overlay NJDOT)	296	325

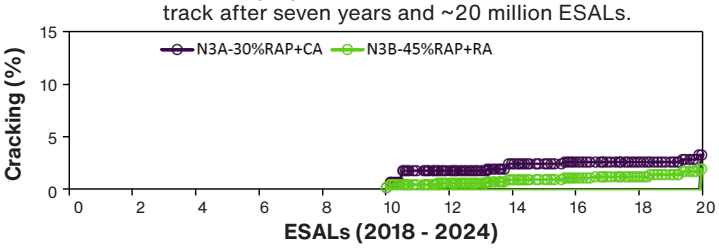
Field rut depth measurements

Pavement properties measured on the NCAT test track after seven years and ~20 million ESALs.



Field surface cracking measurements

Pavement properties measured on the NCAT test track after seven years and ~20 million ESALs.



"We've looked closely at cracking, rutting, and the macro texture over 7.5 years, and it's exceeding our expectations," added Tran. "Our evaluation shows no changes in texture to this date, with no raveling in and outside of the wheel paths. This is excellent with 45% RAP, which is outperforming other mixtures at lower levels of RAP tested on the Test Track."

Key learning

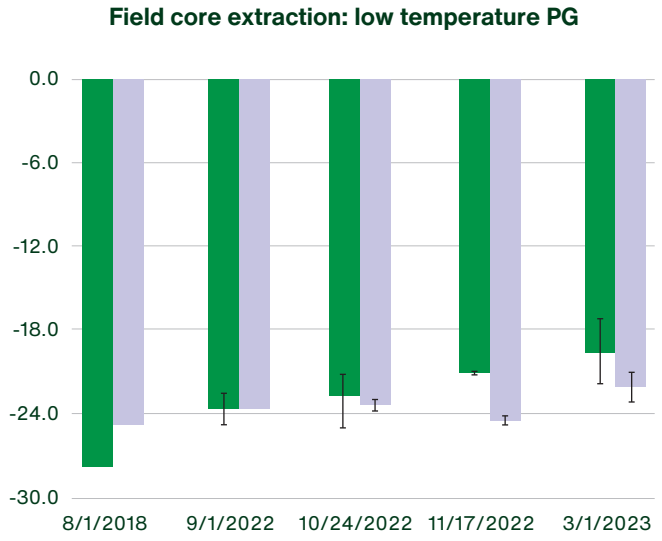
This testing, along with the MnDOT project in a cold weather climate, has become one of the longest, most comprehensive Rejuvenated high-RAP mix tests.

As stated by the now-retired Powell, “more than seven years of field aging demonstrate that this milestone has clearly been achieved, and the asphalt continues to show strong performance.”

The collaboration between the research facilities, state agencies and the private sector is providing a transparent, detailed assessment of the growing use of RAP nationwide, adding more credibility and trust in its use.

Monitoring field aging

One of the objectives of the study was to measure and demonstrate the superior aging stability of a rejuvenated asphalt mix in the field. The NCAT team collected cores from the pavement 4 times over the course of five years. The Cargill team analyzed the cores by extracting and recovering the binder and performing rheological analysis in comparison to the samples collected during the initial production in 2018. Figures – and – show that the low temperature grade, the primary measure for asphalt durability and cracking resistance, only shifted by a bout half a grade over the course of the analysis, actually showing higher age stability compared to the control section in terms of binder performance grade. The results are not unexpected based on the lack of any age-related distress observation in the field performance.



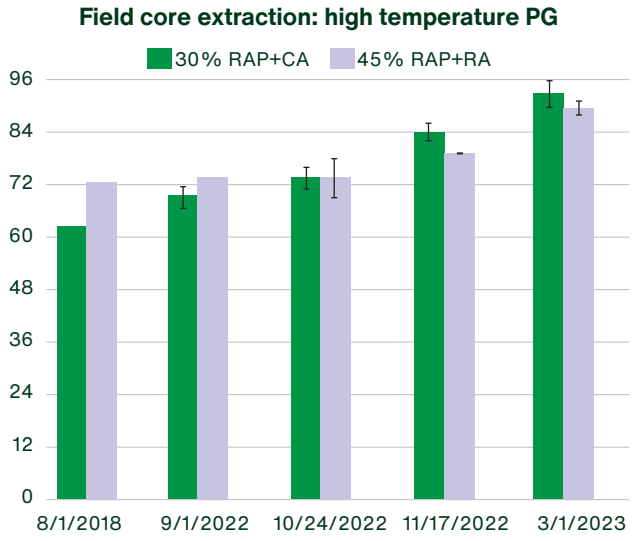


Figure 1 & 2 – *Comparison of the performance grade of the extracted core binders over time. The error bars show the variation in grade where multiple cores were collected and tested.*

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