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MnROAD and NCAT

Team Up for Hot and Cold Climate Pavement Tests

NCAT and MnROAD

Partnership Benefits State DOTs and Thousands of Cities Seeking Economical, Durable Pavements

By Paul Fournier

Asphalt mix for the MnROAD experiments was supplied by Hardrives Inc.'s portable Barber Greene drum mix plant.

The world's two largest full-scale accelerated pavement testing facilities have formed a partnership that promises to benefit state DOTs and thousands of cash-strapped cities and towns who seek economical, durable pavements for their roadways.

Alabama-based NCAT (National Center for Asphalt Technology) and Minnesota-based MnROAD are sharing resources and expertise under a newly formalized partnership that is experimenting with similar roadway construction materials under high- and low-volume traffic conditions to determine the effects of climatic differences on pavement performance. In general, NCAT and MnROAD evaluate new products, design technologies and construction methods. Their research leads to safer, more cost effective pavement designs that are adopted by state DOTs and municipalities who rely on DOT pavement specifications for local roads and streets.

In the past, some transportation officials in the northern states had concerns that findings from NCAT experiments were not directly applicable to the climate in their particular state. The new partnership experiments should allay these concerns with a broad range of findings that are implementable in both warm and cold climates. With regard to climate, winter in Minnesota is characterized by cold, heavy snowfall, with up to 170 inches of snow annually and temperatures as low as -60 degrees Fahrenheit. On the other hand, Alabama experiences mild winters and very warm to hot summers – the highest temperature ever recorded in the state was 112 degrees Fahrenheit in Centreville.

Extensive Proving Grounds

The two partners each have their own extensive proving grounds, sophisticated testing equipment and highly qualified staff for running experiments on many types of pavements.

NCAT, headquartered at Auburn University, conducts experiments at their Pavement Test Track in Opelika, Alabama. The 1.7-mile oval track is comprised of 46 test sections, each 200 feet in length. Sections are sponsored in three-year cycles by state DOT's, Federal Highway Association (FHWA) and industry who all have specific research objectives for their sections and shared objectives for the whole track. NCAT subjects test sections to two years of continuous trafficking by 70-ton tractor trailers, simulating up to 15 years of Interstate traffic.

The MnROAD pavement testing facility is located approximately 40 miles northwest of Minneapolis. Owned and operated by the Minnesota Department of Transportation (MnDOT), the facility encompasses 3.5-mile interstate (I-94), a 3.5-mile bypass for diverting interstate traffic when needed, and a controlled access 2.5-mile closed-loop, low-volume roadway simulating rural roads. MnROAD has 50 test cells each 400 feet in length. Research is sponsored by state DOTs, Minnesota Local Road Research Board, FWHA and industry. Principal staff for MnROAD include Ben Worel, Dave Van Deusen and Chelsea Hanson. Assisting them from MnDOT Materials Research are Jerry Geib, Paul Nolan and Jeff Bruner, who worked with Dr. R. Buzz Powell, P.E., the Assistant Director and Test Track Manager of NCAT, on the pavement preservation test sections.

This is not the first time the two internationally known testing centers have teamed up, according to Dr. Powell.

"Researchers from NCAT and MnROAD have informally collaborated for years through TRB's (Transportation Research Board) Committee on Full-Scale Accelerated Pavement Testing, but research programs at both facilities have been limited in the past to state DOTs with similar climates.

Parallel Tests

"Now we have a formal agreement covering parallel experiments under an exceptionally broad range of climatic conditions, with funding provided by 19 state DOTs through the national Transportation Pooled Fund that supports the NCAT Pavement Test Track."

Current MnROAD-NCAT group experiments focus on two areas, the validation of cracking tests and the effectiveness of pavement preservation treatments.

Dr. Powell went to the MnROAD facility in August 2016 to oversee the construction of cracking group and pavement preservation group treatments that he had managed previously at NCAT's track. The same contractor for the NCAT sections, East Alabama Paving, constructed the test cells at MnROAD. This was to ensure treatments at both facilities were designed and built identically.

Predicting Pavement Cracking

Dr. Powell explained that the cracking group experiments were undertaken to identify laboratory test methods that predict cracking in the field.

Cracking in asphalt pavements is generally recognized as a principal indicator of pavement failure due to fatigue from repeated loading, and is often manifested

A truckload of hot mix asphalt containing RAP and asphalt rejuvenator is delivered to a Roadtec Material Transfer Vehicle for roadway pavement experiment in Minnesota.

as alligator type cracking in the wheel paths. One type of fatigue cracking initiates at or near the pavement surface and propagates downward. In contrast, reflective type cracking commonly occurs in rehabilitated pavements near the junction with an underlying asphalt layer that is already cracked, and propagates upward to the surface of the overlay.

"Hot weather sections were built on the NCAT Pavement Test Track to study near-surface fatigue cracking and cold weather cells were built at the MnROAD facility to study low-temperature cracking. At both facilities, mixes were selected to incorporate various combinations of recycled asphalt pavement (RAP) and recycled asphalt shingles (RAS) and provide a broad range of cracking performance. An array of laboratory tests is being run on both lab-produced and plant-produced mixes in order to identify those tests that accurately predict field performance," he said.

NCAT and MnROAD are also working with sponsors to develop experiments to validate cracking tests. Reliable cracking tests that can be used during mix design and for quality assurance purposes during mix production are critically needed to eliminate mixes that are not durable.

East Alabama Paving installs experimental asphalt mix in Minnesota using a Roadtec Spray Paver.

Preservation Treatment Trials

The preservation group experiments are being held to measure the effectiveness of preservation treatments and treatment combinations in improving the condition of pavements and in extending their service life for both low- and high-traffic roadways.

"In order to meet this objective, test sections were built on local roadways near both facilities," said Dr. Powell. He pointed out that in the southern half of the experiment, low traffic test sections were built on Lee County Road 159 near the NCAT main office in Auburn, while high traffic sections were built on U.S. 280 near the NCAT Pavement Test Track in Opelika.

In the northern half of the experiment, low traffic sections were built on CR 8 and high traffic sections were built on U.S. 169. Both roads are in Pease, Minnesota, about 45 minutes north of the main MnROAD facility. Treatments installed in test cells by the contractor included chip seals, microsurfacing, scrub seals, cape seals and thin overlays.

These treatments are all recognized by the FHWA as effective methods to preserve pavements that are still in good condition and before the onset of serious damage. FHWA notes that applying such cost-effective treatments at the right time restores pavements almost to their original condition, postponing costly rehabilitation and reconstruction.

NCAT's Raymond "Buzz" Powell, third from left, collaborated on pavement experiments with MnDOT Materials Research staffers Jeff Bruner, Jerry Geib and Paul Nolan.

Rejuvenating RAP-RAS Mix

One of the MnROAD pavement preservation experiments involved applying a three-quarter-inch wearing course inlay of dense graded hot mix asphalt that contained RAP and RAS dosed with an asphalt rejuvenator.

With fewer new roads being built today, and more calls for reusing asphalt materials milled from existing roads, the DOT community is concerned that the use of RAP and RAS in asphalt mix designs may cause premature pavement cracking due to the brittle and oxidized condition of the recycled materials in the mix. While the manufacturing cost of hot mix asphalt offset by incorporating RAP and RAS to replace virgin aggregates and some virgin liquid asphalt binder is attractive, the potential impact of recycled materials on pavement performance is a major DOT concern.

MnROAD-NCAT managers are hoping to measure the performance advantage that asphalt rejuvenators can provide to asphalt mix designs, allowing higher RAP-RAS content for pavement preservation paving. For this experiment, they qualified Delta S for use in a pavement preservation paving application as an asphalt rejuvenator.

Supplied by Collaborative Aggregates LLC, an affiliate of Wilmington, Massachussets-based Warner Babcock Institute for Green Chemistry (WBI), the newly commercialized Delta S was invented by WBI researchers. The plant based, liquid chemistry is used in high RAP-RAS content asphalt mix designs to help prevent premature cracking of the pavement.

Applying Thin Inlay

The Delta S-dosed treatment was applied on the northbound slow lane of U.S. Route 169 following the milling out of three-quarter inches of existing wearing course.

The contractor applied a tack coat of asphalt emulsion at the rate of .23 gallons per square yard over the milled 400-foot cell. A portable 350-ton-per-hour Barber Greene drum mix plant owned and operated by Hardrives Inc. manufactured the asphalt mix.

As was done in Alabama, Delta S rejuvenator was piped in line with the liquid asphalt supply line. Finished asphalt mix was stored in three silos until needed for the treatment application. At the job, haul trucks deposited their loads into a Roadtec SB-2500 Material Transfer Vehicle, which fed the asphalt mix to a Roadtec Spray Paver.

A Sakai SW770 HF Roller in vibrator mode performed the initial breakdown compaction with a Sakai SW654 Static Roller doing the finish compaction. The rollers produced a nuclear density gage reading of 94 percent for the experimental mix.

Equipment and some materials used by East Alabama Paving for the experimental project were donated. Dillman Equipment supplied the silos, Sakai donated the rollers, and Collaborative Aggregates, LLC donated Delta S.

Findings for Broad User Base

Field performance of the cracking group and pavement preservation group experiments will be monitored with similar automated technologies at both locations, and data will be stored in a common database.

These parallel experiments are aimed at producing findings that can be directly implemented by a larger base of state departments of transportation who previously may have had concerns that findings from previous experiments were not directly applicable to their climate or pavement surface type.