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National Center for Asphalt Technology Pavement Test Track

Introduction

Research in the form of a road test track provides a logical method to test pavement behavior under typical roadway conditions. The most recent road test track, the National Center for Asphalt Technology (NCAT) Test Track, was constructed in 1998. The NCAT Test Track, located at Opelika, Alabama, was developed to conduct research focused on flexible pavement performance designs (Asphalt Technology News 1). Road tests conducted prior to NCAT track have produced valuable information on roadway design and construction procedures. Before discussing the details of the NCAT Test Track, it is important to understand several of the methods and objectives used in previous road test tracks.

The AASHO Road Test (American Association of State Highway Officials) was conducted in Ottawa, Illinois from 1958 to 1962 (Federal Highway Administration I-2). The American Association of State Highway and Transportation Officials (AASHTO), formerly known as AASHO, is a non-profit highway and transportation association that provides standard specifications for the operation and maintenance of the nations' transportation system (AASHTO 1). The AASHO Test focused on variables such as the effect of pavement thickness, environment, and the magnitude of the applied loads. The test area included four large and two smaller test loops. Results provided information about environmental and structural issues and were used to form the basis of the AASHTO Design Method (Warren 12,25).

The WesTrack Road Test was conducted from 1996 to 1999, southeast of Reno, Nevada. The WesTrack facility was constructed under a contract awarded by the Federal Highway Administration (FHWA), and the "Accelerated Field Test Performance-Related Specifications for Hot Mix Asphalt Construction" study was completed in 1999. The purpose of this test was to "evaluate the direct effects of deviations of materials and construction properties" (WesTrack 1). Many of the design and loading procedures used at WesTrack were modeled at the NCAT Test Track. WesTrack was a 1.8-mile oval track divided into thirty-four test sections. The track was loaded over a two-year period using driverless vehicle technology. Test results provided useful information in areas such as quality control/quality assurance (QC/QA) construction methods, pavement rehabilitation and materials specifications (WesTrack 2). However, there was some concern that the driverless vehicles did not provide a realistic effect of wear on the pavement surface. The computer controlled trucks continuously traveled in the same wheel path causing extreme wear in that path. Questions arose as to whether these results were an accurate indication of actual pavement performance under normal traffic conditions.

The most recent road test is currently underway in the state of Alabama. The NCAT Test Track was designed to explore optimum flexible pavement designs (Asphalt Technology News 1). The Alabama Department of Transportation (ALDOT) played a large role in

bringing the NCAT Test Track facility to the state of Alabama. Before the idea of the NCAT Test Track was considered, a location for the WesTrack road test was needed. Among various other possibilities, Alabama was under consideration as a site location. In the end, the WesTrack facility was placed on the Nevada Automotive Test Center proving grounds, southeast of Reno, Nevada (Westrack 2).

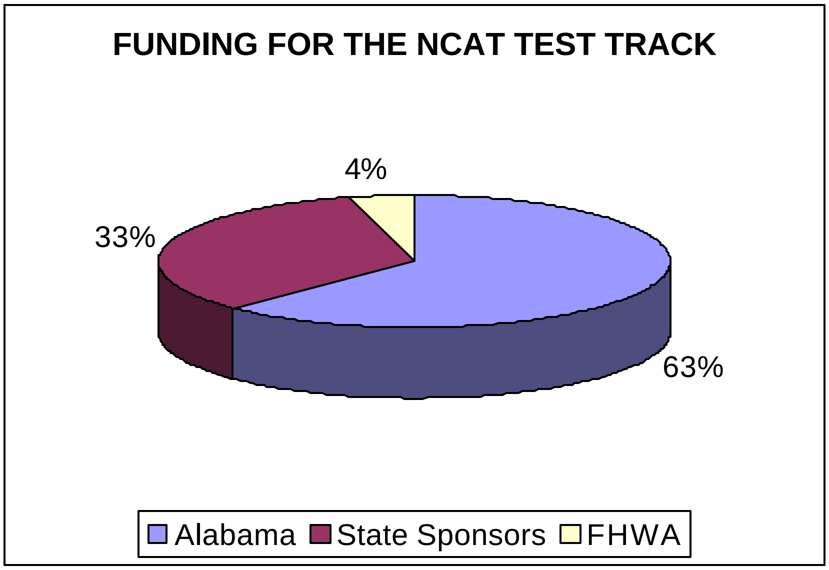
Mr. Mack Roberts, Alabama Director of Transportation at the time, was committed to bringing a test track facility to the state. He concluded that a test track in Alabama would be a valuable resource with potential benefits. A large amount of money is spent each year on asphalt pavements and results from track research through accelerated loading of various design mixes was expected to provide performance data so that the life cycle costs of asphalt pavements could be optimized.

Aside from the potential benefits of having the test track, Alabama had a valuable resource already available. The NCAT research and testing facility, then located at Auburn University, provided a logical site for conducting research on the test track. NCAT was developed in 1986, under an agreement between the National Asphalt Pavement Association (NAPA) Education Foundation and Auburn University, to focus on improving performance of HMA designs through practical research, education and information services (NCAT 1). Hot Mix Asphalt (HMA) industry contractors, product suppliers and equipment manufacturers

provided funding for the current NCAT facility, located near Auburn University. Both NCAT and NAPA were supportive of ALDOT's commitment to the test track. Mr. Jimmy Butts, who succeeded Mr. Roberts as Director of Transportation, followed up with the commitment to build the track. Chief Engineer, Ray Bass (a former Director), was and continues to be a strong supporter to the test facility and provided continued support as Mr. Roberts left and Mr. Butts assumed the position as Director. With strong support from ALDOT, NCAT, and NAPA construction of the NCAT Test Track broke ground in September 1998.

Auburn University purchased land for the new facility. David Volkert & Associates was the design consultant for the track. ALDOT provided approximately $7.5 million for construction of the facility, $6.2 million for the test track through the base mix and $1.4 million for the laboratory and truck maintenance buildings. Construction of the track was divided into two phases. W.S. Newell was awarded the contract for first phase which included clearing and grubbing and ending with completion of the sub grade (Asphalt Technology News 1). Couch-APAC was awarded the contract for the second phase of construction, which included the pavement structure and experimental mixes (Asphalt Technology News 1). The contract for laboratory and truck maintenance buildings was awarded to W.W. Dyar. Once the facility was constructed, NCAT was responsible for operation of the facility and for completing the performance studies conducted.

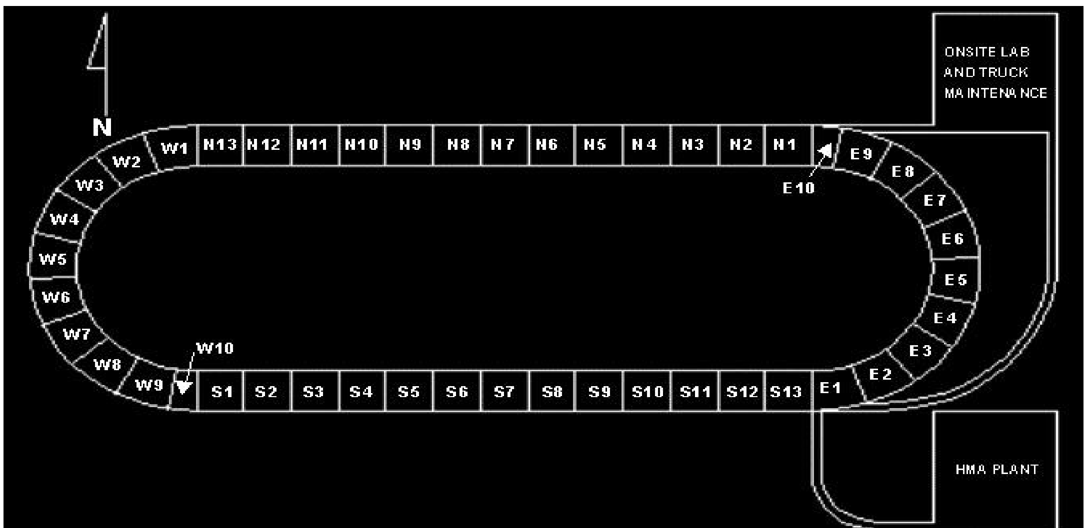
In addition to Alabama, nine states participated in the research at the test track. Florida, Georgia, Indiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, and FHWA are participants in the 2000-2002 research. "The states will fund track operation through the purchase of test sections and share in the costs associated with constructing, trafficking, collecting and analyzing data on its test section" (Hot Mix Asphalt Technology News 11).



CONSTRUCTION OF FACILITY	DOLLAR AMOUNTS
Alabama - Phase 1	$2,290,855.03
Alabama - Phase 2	$3,838,679.32
Alabama - Onsite Buildings	$1,418,262.59
Total	$7,547,796.94
POOL FUND STUDY	
Florida	$495,000.00
Indiana	$300,000.00
North Carolina	$495,000.00
South Carolina	$548,774.45
Georgia	$495,000.00
Mississippi	$495,000.00
Oklahoma	$495,000.00
Tennessee	$495,000.00
Purdue University	$195,000.00
Total Pool Fund	$4,013,774.45
TEA-21	
FHWA	$500,000.00
TOTAL COST	$12,061,571.39

Track Layout

The 2000 NCAT Test Track is divided into twenty-six tangent sections and twenty curve sections as seen in the picture below. Alabama sponsored four tangent sections and the twenty curve sections, while Florida, Georgia, Indiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee and the FHWA each sponsored two tangent sections. Pavement for each section was produced at the onsite HMA Plant. Pictured below is the layout of the track with a table that identifies each sponsor state, section numbers, and the mix design criteria for the tangent sections.



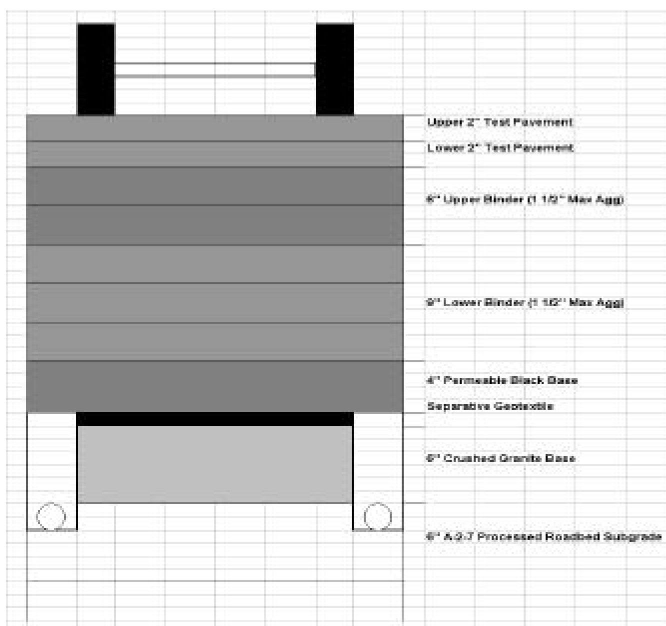
STATE	***SECTION***	***MIX***	***AGGREGATE***	***BINDER***
Alabama	N5	12.5 mm dense graded BRZ	Limestone/slag	PG67-22+
Alabama	N6	12.5 mm dense graded BRZ	Limestone/slag	PG67-22
Alabama	N9	12.5 mm dense graded BRZ	Limestone/slag	SBS mod. PG76-22
Alabama	N10	12.5 mm dense graded BRZ	Limestone/slag	SBS mod. PG76-22+
Indiana	N3	9.5 mm dense graded ARZ	Limestone/slag	PG67-22+
Indiana	N4	9.5 mm dense graded ARZ	Limestone/slag	PG67-22
Georgia	N11	12.5 mm dense graded	Granite	SBS mod. PG76-22
Georgia	N12	Stone Matrix Asphalt	Granite	SBS mod. PG76-22
Mississippi	S2	9.5 mm dense graded	Chert gravel	SBS mod. PG76-22
Mississippi	S3	9.5 mm dense graded	Limestone/gravel	SBS mod. PG76-22
Tennessee	S4	12.5 mm dense graded	Quartz gravel	SBS mod. PG76-22

Tennessee	S5	12.5 mm dense graded	Limestone	SBS mod. PG76-22
Florida	S6	12.5 mm dense graded ARZ	Limestone/RAP	PG67-22
Florida	S7	12.5 mm dense graded BRZ	Limestone/RAP	PG67-22
South Carolina	S8	12.5 mm dense graded	Granite	SBS mod. PG76-22
South Carolina	S9	12.5 mm dense graded BRZ	Granite	PG67-22
North Carolina	S10	12.5 mm dense graded ARZ	Granite	PG67-22
North Carolina	S11	9.5mm dense graded	Granite	PG67-22
Oklahoma	S12	12.5 mm dense graded (Hveem design)	Limestone	PG70-28
Oklahoma	S13	12.5 mm dense graded ARZ	Granite	PG70-28
FHWA	N7	12.5 mm dense graded BRZ	Limestone/slag	SBR mod. PG76-22+
FHWA	N8	12.5 mm dense graded BRZ	Limestone/slag	SBR mod. PG76-22

*ARZ – Above restricted zone (fine) gradation. Plus sign – optimum plus ½% binder
*BRZ – Below restricted zone (coarse) gradation.

Materials and Structure

The 1.7-mile track was constructed with a uniform structural buildup up to the placement of the experimental mixes (top 4 inches). The picture seen to the right is the typical cross-section layout used at the track. Looking from bottom to top, layers consist of 12 inches of improved roadbed, 6 inches of crushed granite base, 5 inches of asphalt treated permeable base, 9 inches of superpave lower base, 6 inches of superpave upper base, and 4 inches of experimental mix (NCAT 70).

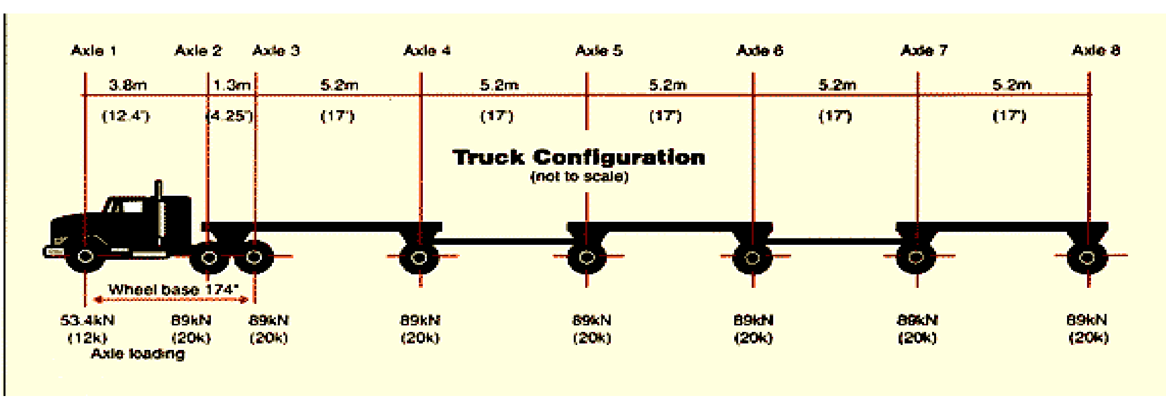


The only variation in the pavement structure of the track is found in the experimental surface mixes. The track is divided into 200-foot tangent and curve test sections, each made up of a mix selected by the sponsor. With a primary focus on rutting, sponsors were able to compare the effects of various mix design, aggregate, and binder options (Progress Report 2). Sponsors were responsible for provided the contractor with materials for the mix designs used on their sections

(Asphalt Technology News 1). All experimental mixes were produced at the onsite HMA Plant with NCAT responsible for Quality Control oversight (Hot Mix Asphalt Technology News 12). Experimental surfaces used on the track include Superpave, Stone Matrix Asphalt (SMA), and Open Grade mixes. Superpave stands for Superior Performing Asphalt Pavements and was developed under the Strategic Highway Research Program that began in 1987 (USDOT-FHWA I-1). Mixes contain coarse aggregates and are designed to withstand heavy loads and resist rutting (Hanson 2). SMA mixes originated in Europe and were first brought to the United States in 1991. This coarse mix was designed to resist rutting, raveling, and cracking. The Open Graded mix is also a coarse mix that provides good water drainage. This improves the pavement surface friction and reduces hydroplaning. Other advantages include reduced road spray and reduced noise (Warren 89). Several states chose to use their sections to compare different aggregates. "Aggregates are materials that have been specifically sorted or processed to achieve given properties" (Hanson 1). Aggregates compared on the test track include, granite, chert gravel, quartz gravel, limestone, and a limestone/gravel blend. Binder options were also compared on the track. In most cases, sponsors compared the performance of a binder at optimum and optimum plus ½%. For specific sponsor information on experiment surface mixes used and comparisons made, refer to the table on pages 6-7, under the Test Track Layout section.

Loading

In order to produce pavement fatigue, the track is loaded with 10-million Equivalent Single Axle Loads (ESALs) over a two-year period (HMAT News 11). In relation to the life of a pavement this is equivalent to approximately 15 years of wear (Asphalt Technology News 2). A trucking contract was awarded to Covenant Transport to provide truck tractors, drivers, and maintenance. Fuel for the trucks is supplied by NCAT and the usage is monitored in relation to pavement conditions (Progress Report 2). Loading on the track began in October 2000, with one truck. Addition trucks were phased in, and currently four trucks run on the track Tuesday through Sunday for 17 hours a day. Each truck is a tractor-trailer combination that weighs 20,000 pounds per axle, which is the Federal single axle weight limit on the interstate (USDOT-FHWA 4). The picture below is an example of the trucks used for loading at WesTrack. Although the trucks for the NCAT Test Track are not automated, the load design is the same. Trucks drive at a speed of 45mph in the outer lane, with the inside lane serving as a breakdown lane. Drivers work in 8-hour shifts with Mondays reserved for truck maintenance and data collection on the track. Laps completed by each vehicle are monitored by Vehicle Identification Systems (VIS) mounted in each truck (NCAT 136).



Performance Analysis

Each Monday track performance analysis is recorded for each section. Research templates for sections consist of two 25-foot buffer segments and three 50-foot replicate segments (NCAT 118). Surface distresses of pavement sections are documented on a weekly basis. The ARAN, mounted on the truck pictured below, measures rutting and roughness. Density profiles, random nuclear density, and random impedence density tests are performed every other week to monitor the mat densification in the wheel paths. Pavement cores are taken monthly and used in the lab to monitor additional compaction and reduction of air voids under truck traffic (NCAT 187).

In addition to monitoring the pavement performance on the track, mix designs are also subject to lab experiments. Tests used for the track study measure rutting susceptibility, tensile strength, and shear strength. Results from the lab experiments are then compared to track results. Correlation between results is used to determine which lab tests produce the most accurate performance predictions. Approximately five thousand beam specimens were made during construction for laboratory performance analysis (Asphalt Technology News 4). The Asphalt Pavement Analyzer, the Hamburg Loaded Wheel Tester and the Rotary Loaded Wheel Tester (pictured below from right to left) all produce loading simulations to predict rutting (NCAT 209-213).



Additional performance tests include Tensile Strength Ratio for Moisture Susceptibility Evaluations; Corps of Engineers Gyratory and Pine SGC Shear test; Static, Dynamic, Confined, Unconfined Triaxial tests; Dynamic Modulus via Triaxial at QC Voids (NCAT 207). In addition to performance analysis, property testing was also completed on binder and aggregate samples collected during production. Binder samples from the HMA plant were collected daily during construction and during the middle third of production. Samples were used to verify specified Performance Grades (PG) (NCAT 202). Aggregate characterization analysis for both fine and coarse grades was also performed. Coarse aggregate was characterized according to chemical components, unit weight, gradation, specific gravity, absorption, fractured faces, freezing and magnesium sulfate soundness, British polishing number, coarse aggregate flow, coarse aggregate angularity, flat and elongated count, and LA abrasion loss. Fine aggregate was characterized according to sand equivalency, chemical components, unit weight, gradation, specific gravity and absorption, fine aggregate angularity, freezing and magnesium sulfate soundness, and methylene blue. The table below gives a comparison between field results and simple laboratory performance tests (NCAT 218-219).

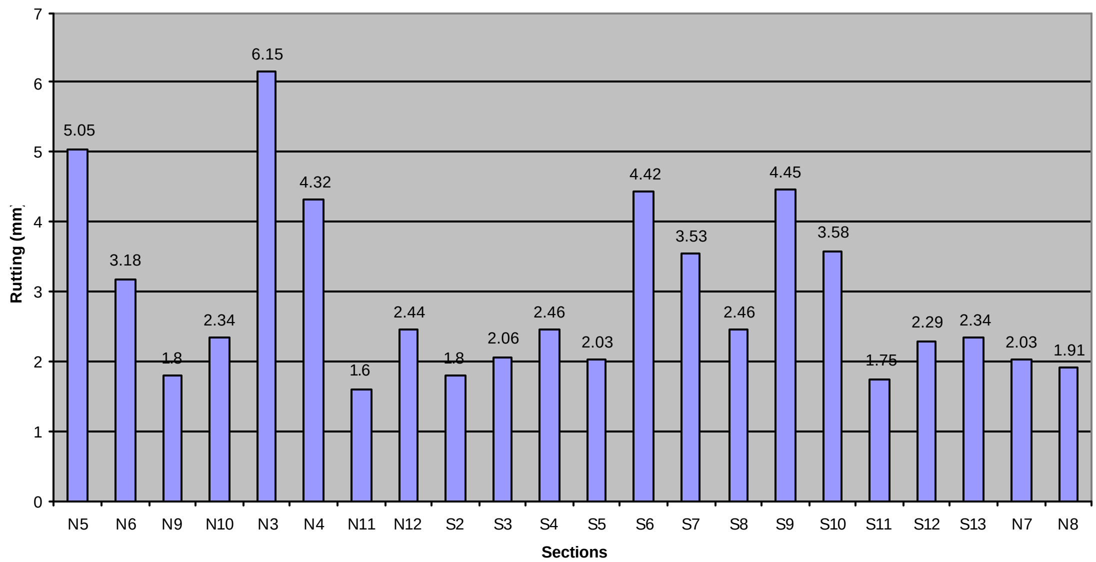
	Superpave – Slg/Lms	**SMA – Slg/Lms**
Surface Friction	0.38	0.34
Field Roughness	23 in/mi	24 in/mi
Field Rutting	1.91 mm	1.57 mm
APA	1.51 mm	2.43 mm
Hamburg	2.50 mm	4.85 mm
Rotary	1.43 mm	1.68 mm
SGC Shear	0.71 GSR	0.57 GSR
COE Shear	0.91 GSI	1.03 GSI

Preliminary Results

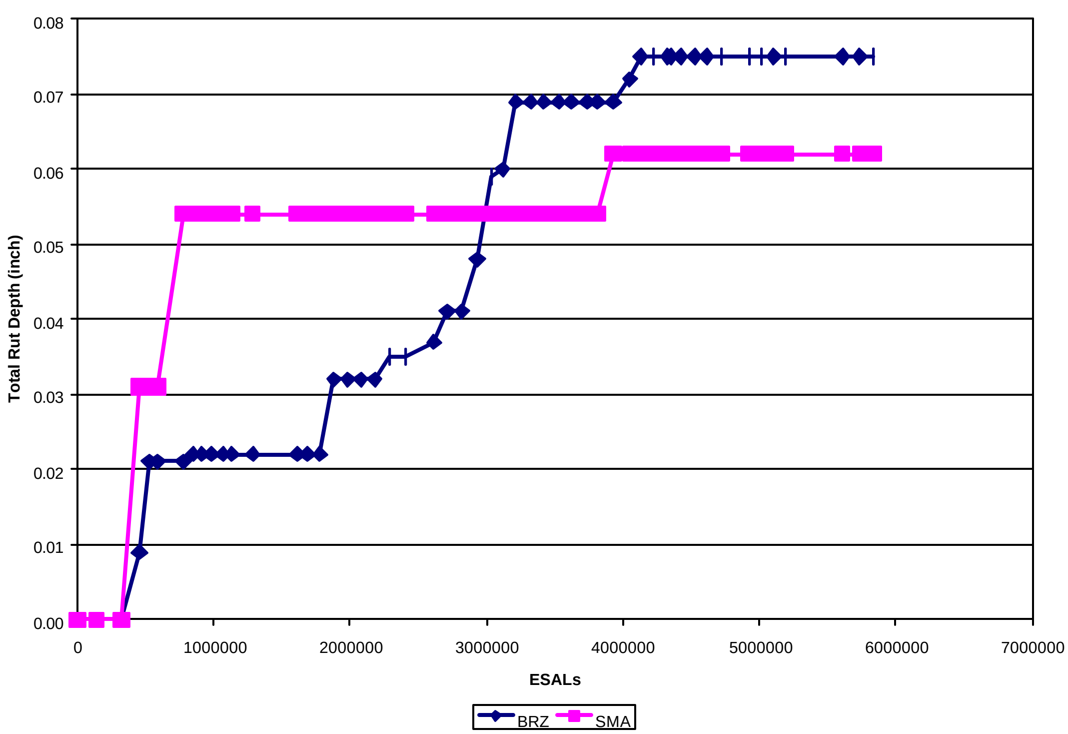
Although loading of the track will not be completed until November 2002, preliminary results are currently available. In general all sections have performed well under the loading conditions. Graphs on the following pages compare track performance in relation to rutting, surface friction and densification results.

The summer of 2001, brought mild temperatures and mixes experienced minimal rutting. Coarse mixes experienced about 21% less rutting than fine mixes. In terms of binder selections, aggregate blends with higher performance grades (PG76-22) experienced less rutting than lower performance grades (PG67-22). The modified binders (SBS modified PG76-22) rutted about 40% less than the unmodified binders (PG67-22) (NCAT 4). As shown in the following graph, the section that experienced the most rutting (section number N3) after the first summer of loading contained unmodified binder at optimum plus ½% (PG67-22+) (NCAT 2).

TOTAL RUTTING



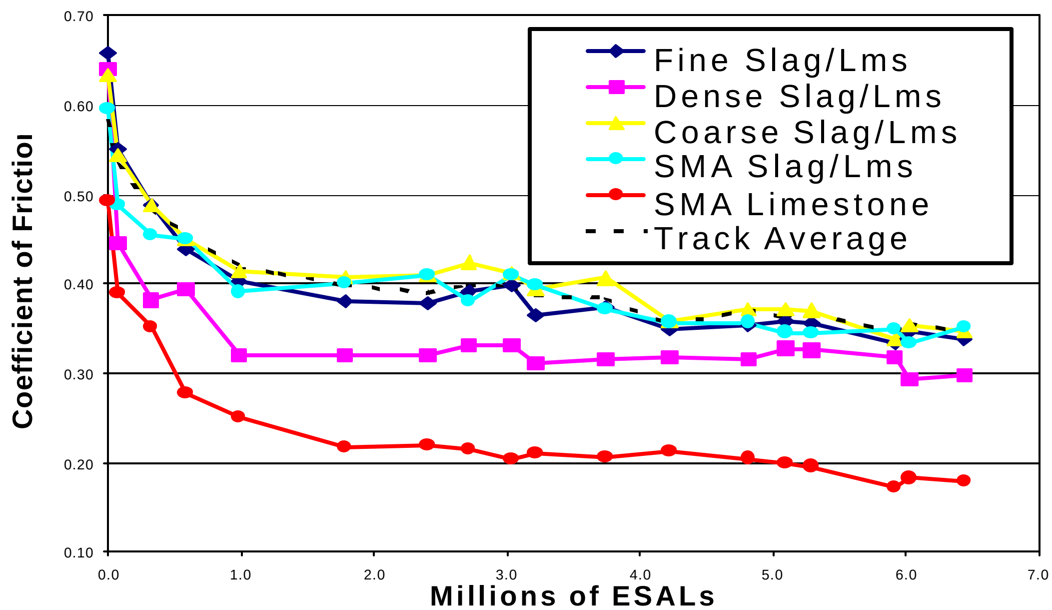
SUPERPAVE VERSUS SMA



* (NCAT 177)

Pavement surface friction is compared in terms of the coefficient of friction values. Surface friction varies according to the aggregate structure and asphalt binders of the mix design. As continual load is applied, aggregates become worn, and coefficients of friction decline (Progress Report 3).

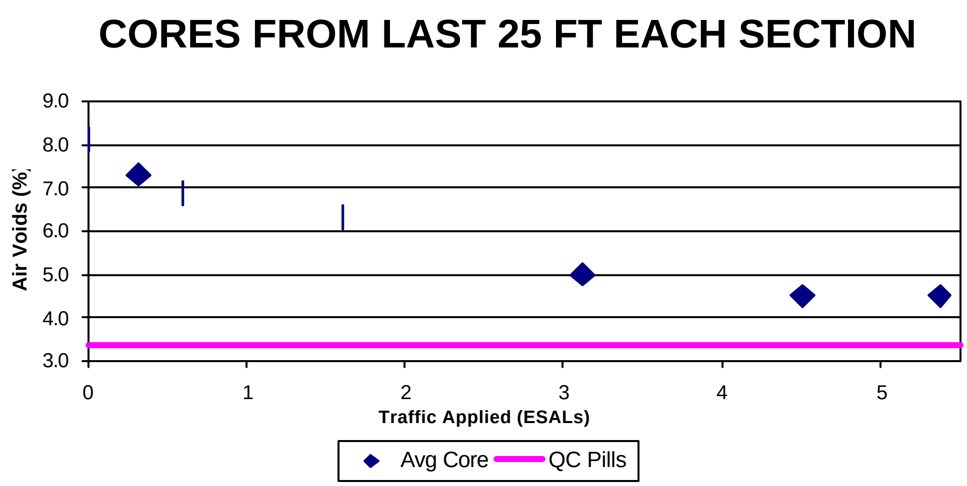
SURFACE FRICTION VS. MIX TYPE



*(NCAT 185)

In order to monitor the densification of mix designs, field tests and monthly coring is conducted. Measurements for the "reduction of air voids are recorded as truck traffic accumulates" (Progress Report 3).

MAT DENSIFICATION



*(NCAT 181)

Road spray on the track was also observed. Open graded friction coarse (OGFC) mixes were the most efficient in draining surface rainwater. Mix designs with coarse surface textures were also effective in reducing road spray. In general, the more surface voids in the mix, the more effective the pavement in reducing road spray (Progress Report 3).

Plans for 2003 NCAT Test Track

With research on the current test sections nearing completion, plans for the 2003 research are underway. The 2000 Test Track was a study on the performance of the surface layer of the track pavement. Several options for the 2003 Test Track are still under consideration. The first option allows for some of the 2000 Test Track sections to be left in place. Due to the mild weather conditions during the summer of 2001, many of the test sections have survived the loading with minimal effects. This option would be a continued surface performance study on the effects of an addition two-year loading period. Option two would follow a similar method to the 2000 Test Track. This option requires that forty-six sections be milled and inlayed with new mix designs. This study would also focus on surface performance. Option three is a structural study. Currently the track has a uniform structural base. If chosen, this option would require that the existing top thirty inches be removed. The sponsors would then determine structural buildup of the layers in each section. The last option involves structure and instrumentation used. Similar to option three, this choice would allow sponsors to determine the structural build up of their section. This would also allow sponsors to add additional test instruments in these layers. Currently, moisture and temperature gauges are found in all sub base layers (NCAT 237-240).

For additional information and updates, please visit the NCAT Test Track website at www.pavetrack.com.

Works Cited

Hanson, Douglas I. "Aggregate Gradation." Hot Mix Asphalt for the Undergraduate 2000.

"Loading of the NCAT Test Track Begun." Asphalt Technology News 12.2 (2000): 4-5.

National Center for Asphalt Technology (NCAT). 1999. NCAT. 17 June 2002. www.eng.auburn.edu

NCAT Pavement Test Track. 4 June 2002. NCAT. 17 June 2002. www.pavetrack.com

"NCAT Test Track Update." Asphalt Technology News 13.1(2001): 4.

"NCAT Test Track Update." Asphalt Technology News 13.2(2001): 3-5.

Powell, R.Buzz. "NCAT Pavement Test Track Accelerated Performance Testing" 16 March 1998.

"A Progress Report After One Year of Traffic on the 2000 NCAT Pavement Test Track." Online Posting. 17 June 2002. October 2001. www.pavetrack.com

"States to Evaluate Performance at NCAT Test Track." Focus on Hot Mix Asphalt Technology 3.3 (1998): 11-13.

"Track Takes NCAT to the Next Level." Focus on Hot Mix Asphalt Technology 3.3(1998): 14-17.

U.S. Department of Transportation – Federal Highway Administration. "SUPERPAVE for the Generalist Engineer and Project Staff Participant Manual" FHWA HI 97-031; July 1997.

U.S. Department of Transportation – Federal Highway Administration. "Bridge Gross Weight Formula" April 1984: 2-11.

Warren, Jim. "Design and Construction of SMA and OGFC Mixtures" NCAT Professors Training Course in Asphalt Technology. 8 March 2000.

Warren, Jim. "Modified Asphalt Binders" NCAT Professors Training Course in Asphalt Technology. 8 March 2000.

Warren, Jim. "Structural Designs of HMA Pavements" NCAT Professors Training Course in Asphalt Technology. 8 March 2000.

WesTrack Home Page. 1999. Nevada Automotive Test Center. 20 June 2002. www.westrack.com