NCAT Test Track Phase III

Quarterly Report
October – December 2006

Phase III of the NCAT Test Track Begins

After a few contractual delays, construction of the third phase of the NCAT test track began in August and was completed in October 2006. Ten state highway departments and the FHWA have sponsored the construction, trafficking, and pavement research evaluations of twenty-one new sections, including six new structural sections and fifteen new mix performance sections. Some agencies have also sponsored the continued evaluation of sections constructed in previous phases.

By the end of 2006, about 400,000 ESAL's had been applied with the NCAT truck fleet. As with the previous phase, loading is applied with five heavily loaded triple trailers. Each of the loaded axles carries approximately 21,000 pounds. Trafficking of the sections is accomplished with two shifts of drivers operating the vehicles five days a week. The test sections will be subjected to ten million ESAL's over the two year trafficking cycle.

<u>New Structural Sections</u>
The 2006 structural experiment is meant to build upon mechanistic-empirical findings from the 2003-2006 experiment and explore the perpetual pavement concept more fully. To that end, five test sections were left in place and six new test sections were constructed to comprise the 2006 structural experiment. Figure 1 shows the pavement cross sections with the section sponsor noted above each test section. Sections N3 through N7 were left in place while the remaining sections were constructed after a deep removal of the existing pavement. It should also be noted that section N5 had a shallow mill and inlay to mitigate the surface cracking prevalent through the section. A more detailed description of each sponsor's section(s) is provided in the subsections below.

Instrumentation similar to that used in the 2003 structural study was employed in the new test sections. Two notable changes include using lasers to measure the wheel position as the trucks pass over the gauge array and using wireless technology to collect and transfer data. Generally speaking, the gauge installation and survivability was a success and an improvement over the 2003 structural study. In 2003, after construction, there were 65% functional strain gauges. In 2006, the number of functional gauges was 87%. Both experiments had 100% functional pressure gauges after construction.

Weekly high speed data collection is being conducted on each test section. Three passes of each truck are collected and data are being processed to build a pavement response database. FWD testing is also being conducted; approximately three times per month. For each day of FWD testing, four random longitudinal locations are tested in the inside wheelpath, outside wheelpath and between wheelpath offsets. At each location, four impact loads (6, 9, 12, 15 kip) and three replicates at each load level are conducted. Backcalculation of layer moduli from the compiled data is scheduled for the next quarter.

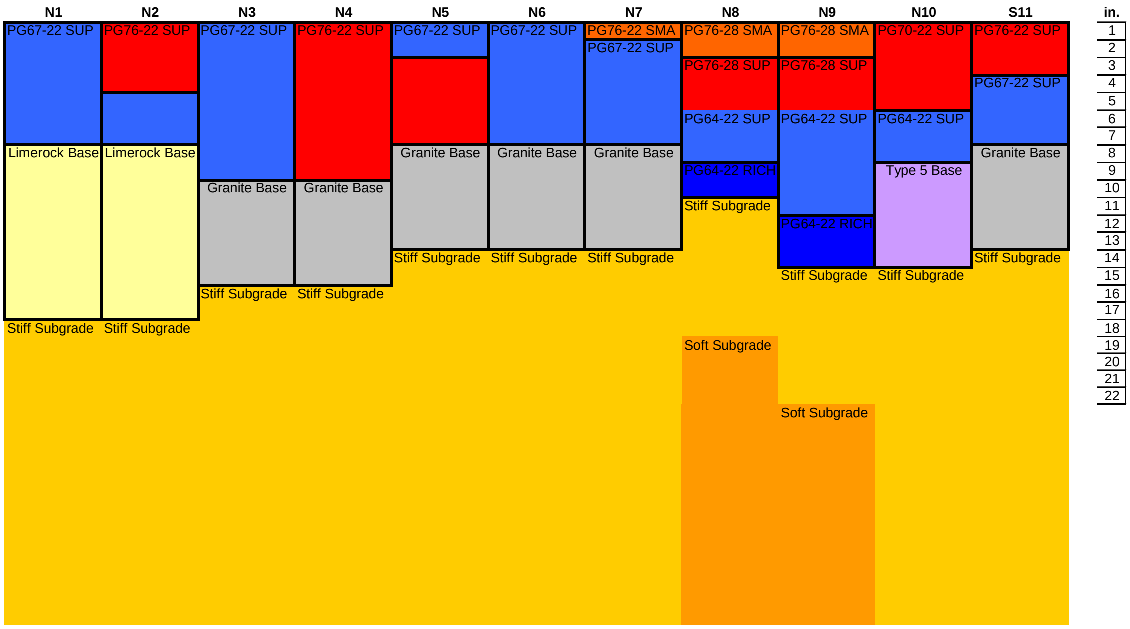

Figure 1. Structural Study Cross Sections.

Florida – The Florida DOT is sponsoring two structural sections (N1 and N2) consisting of seven inches of HMA over ten inches of Florida limerock base. The sections are located at the beginning of the north tangent where the trucks enter the track. The difference between the sections is that N2 included an SBS modified PG 76-22 binder in the upper four inches of HMA, whereas N1 used an unmodified PG 67-22 throughout the full seven inches of HMA. The upper lifts from the two test sections were designed to yield significantly different resistances to cracking as indicated by their IDT Energy Ratios. As of December 12, 2006, all strain and pressure gauges in these two sections were functioning properly.

Oklahoma – The Oklahoma DOT also is sponsoring two new structural test sections (N8 and N9). The Oklahoma sections feature a soft subgrade which was more representative of some of the soils in Oklahoma. An eight inch layer of the local stiff subgrade was compacted over the soft subgrade to simulate the chemical stabilization process often used in Oklahoma. Section N8, the first of the two OK sections, has ten inches of asphalt which is made up of a two inch rich bottom layer, six inches of Superpave mix, and capped with a 2 inch layer of SMA. The second section, located in adjacent N9, has a total HMA thickness of fourteen inches. The rich bottom layer was increased to three inches and an additional three inch Superpave lift was added for this section. As of December 12, 2006, 9 of 12 strain gauges were functioning properly in section N8. In section N9, 8 of 12 gauges were functioning properly. The pressure plates in both test sections were all functioning properly.

Missouri – The Missouri DOT is sponsoring a structural section at N10 which was designed to address the needs of mechanistic-empirical pavement design and features a Type 5 Missouri granular base material. The section has a total of eight inches of HMA. Each of the three layers was designed with 125 gyrations. The bottom layer has a PG 64-22 binder, and the upper two layers contain a PG 70-22 binder. As of December 12, 2006, this test section had both pressure plates working and 8 of 12 strain gauges functional.

Alabama – The Alabama Department of Transportation is sponsoring a new structural section, located on the south tangent at S11, as well as continuing to support four structural sections built in 2003 (N3, N4, N6 and N7). N3 and N4, which have nine inches of HMA, performed very well during Phase II, with no signs of cracking. N6 and N7 have seven inches of HMA and have some minor top down cracking and very limited fatigue cracking. The new Alabama structural section, is similar to the seven inch sections built in 2003 except that a PG 67-22 was used in the bottom four inches and a SBS modified PG 76-22 was used in the top three inches of HMA. The pavement foundation is the stiff local subgrade and six inches of granite aggregate base. As of December 12, 2006, this test section had both pressure plates working and 8 of 12 strain gauges functional.

FHWA – The Federal Highway Administration is supporting the continued evaluation of N5 which was built in 2003 as part of the first structural experiment. The top two inches of this section was milled and inlaid with a new Superpave mix to rehabilitate this seven inch section that had extensive top-down cracking after Phase II. FHWA is also sponsoring an additional investigation in section N9. Within this test section, the deepest HMA section in the study, strain gauges were placed not only at the very bottom of the HMA, but at each paving lift interface up to a depth of 5 inches. These strain gauges, coupled with temperature probes installed at the top, middle and bottom of each lift will enable a detailed examination of pavement response as a function of depth and temperature. As of December 12, 2006, this additional instrumented portion of N9 had 8 of 12 strain gauges functional.

<u>New Mix Performance Sections</u>

Georgia – The Georgia Department of Transportation is sponsoring three new test sections (N11, N12, and N13) for Phase III. Georgia's first two sections (N11 and N12) both consist of milling three inches of the old sections, followed by 1.5 inches of Georgia Superpave and a 1.25 inch layer of a Porous European Mix (PEM). The difference in the two sections is the aggregate source used in the PEM mixtures. N11 contained a granite aggregate from Lithia Springs, GA which has a lower percentage of flat and elongated particles compared to the granite aggregate from Columbus, GA used in N12. Georgia's other test section (N13) will evaluate the performance of the two layer open-graded pavement placed with the dual layer paver from Dynapac. The upper open graded layer is a 9.5 mm nominal maximum aggregate size OGFC mix, and the lower layer is a 12.5 mm NMAS PEM.

North Carolina, Alabama, FHWA, Oldcastle Materials – The transportation departments of North Carolina and Alabama, FHWA, and Oldcastle Materials are working together to sponsor six test sections (E5, E6, E7, W3, W4, and W5) to evaluate the construction and performance of high RAP mixes. Two of the test sections contain 20% RAP, one with a PG 67-22 binder, and the other with a PG 76-22 binder. Four sections contain 45% RAP, one with a PG 52-22, the second with a PG 67-22, the third with a PG 76-22, and the fourth with a PG 76-22 along with the warm asphalt additive Sasobit to enhance workability.

Mississippi – The Mississippi DOT is sponsoring two new test sections (S2 and S3). Section S2 is a 1.5 inch layer of 9.5 mm NMAS gravel-sand-RAP Superpave mix with PG 76-22. This mix was designed with 85 gyrations, the current MDOT standard for high traffic pavements. This new mix is replacing MDOT's original Superpave section placed in 2000 that had the lowest deformation of all track test sections, but had extensive surface cracking. That mix was designed with 100 gyrations and used the same aggregate sources as the new mix in section S2. Mississippi's other new section, S3, is a 9.5 mm gravel-limestone SMA covered with a 9.5 mm gravel open-graded friction course. The SMA was placed 1.5 inches thick and the OGFC mix was placed one inch thick. Both of these mixes also contained a PG 76-22 binder.

Tennessee – The Tennessee DOT is sponsoring a new section (S6) which is a 1.25 inch lift of 12.5 mm NMAS Superpave mix containing a blend of gravel, limestone, RAP, and sand. The performance of this new section will be compared to similar mixes designed with higher gyrations placed in 2000 and 2003. Tennessee also is supporting the continued evaluation of three test sections constructed at the beginning of Phase II. Those sections are a limestone SMA located at section E1, a gravel, limestone, and sand blend Superpave mix at S5, and an OGFC with limestone aggregate at S4.

Indiana – The Indiana DOT is sponsoring two test sections (S7 and S8) aimed at evaluating the performance of mixtures with low air voids. Both of their sections, S7 and S8, were subdivided into two parts, resulting in four small subsections. In section S7, low QC air voids were achieved by increasing the asphalt content; and in section S8, low air voids were achieved by changing the gradation.

Texas – The Texas DOT is sponsoring a section (S12) to evaluate the performance of a high VMA and high asphalt content mix, referred to as a rich bottom layer (RBL), designed to reduce reflection cracking. To prepare section S12 for this evaluation, the previous pavement was milled four inches, then a grid was sawn into the remaining pavement to simulate joints in a concrete pavement. The RBL was placed one inch thick, then a coarse-graded D-A TXDOT mix was placed on top at three inches thick.

The preliminary quality assurance (NCAT testing) results for all of the mixtures placed in the Phase III construction are shown in Table 1. Note that the VMA values are based on NCAT's aggregate specific gravity testing using AASHTO T84 and T85. Asphalt contents are based on the ignition tester method in accordance with AASHTO T308. These results are subject to revision pending verification testing.

Section	N1	N1	N1	N2	N2	N2	N5	N8	N8	N8	N8	N9	N9	N9	N9	N9
Layer	3	2	1	3	2	1	1	4	3	2	1	5	4	3	2	1
Sponsor	FL	FL	FL	FL	FL	FL	AL	OK	OK	OK	OK	OK	OK	OK	OK	OK
Mix Type	Super	Super	Super	Super	Super	Super	Super	RBL	S3	S3	SMA	RBL	S3	S3	S3	SMA
PG Grade	67-22	67-22	67-22	67-22	76-22	76-22	67-22	64-22	64-22	76-28	76-28	64-22	64-22	64-22	76-28	76-28
Ndes	60	100	100	60	100	100	60	50	100	100	50	50	100	100	100	50
QC Data																
25.0 mm	100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	100
19.0 mm	96	100	100	96	100	100	100	100	95	95	100	100	93	96	96	100
12.5 mm	85	97	97	86	91	97	97	97	85	83	93	96	81	84	86	94
9.5 mm	74	85	82	75	82	85	85	87	80	79	71	85	76	80	82	72
4.75 mm	53	61	59	54	62	61	65	61	64	64	31	59	61	66	67	32
2.36 mm	43	51	49	45	50	50	54	39	43	43	22	38	42	45	45	23
1.18 mm	36	39	39	36	41	39	42	26	31	31	17	26	30	32	32	18
0.6 mm	26	31	30	26	29	31	31	19	24	24	15	19	23	24	25	15
0.3 mm	14	22	22	14	16	23	17	15	17	17	13	15	17	17	17	13
0.15 mm	8	14	14	9	10	15	11	12	10	10	12	13	10	10	10	12
0.075 mm	5.4	8.7	8.8	5.6	6.6	9.6	6.8	10.5	7.0	6.7	10.5	10.5	7.2	6.5	7.0	10.9
Pb	4.5	5.2	4.8	4.6	4.9	4.7	5.8	6.4	4.3	4.6	6.1	6.4	4.1	4.4	4.6	6.1
Gmm	2.567	2.481	2.495	2.567	2.481	2.495	2.465	2.424	2.503	2.496	2.397	2.424	2.507	2.503	2.496	2.397
Gmb	2.415	2.384	2.431	2.424	2.384	2.429	2.393	2.374	2.393	2.426	2.276	2.384	2.411	2.419	2.422	2.279
Air Voids	5.9%	3.9%	2.6%	5.6%	3.9%	2.6%	2.9%	2.1%	4.4%	2.8%	5.0%	1.7%	3.8%	3.4%	3.0%	4.9%
VMA	15.7%	15.3%	13.2%	15.4%	15.1%	13.2%	15.9%	12.7%	11.2%	10.4%	15.5%	12.2%	10.4%	10.4%	10.5%	15.4%
VFA	62.3%	74.5%	80.6%	63.9%	74.1%	80.0%	81.6%	83.7%	60.9%	73.0%	67.4%	86.5%	63.0%	67.8%	71.9%	68.1%
D/A Ratio	1.29	1.78	1.95	1.34	1.37	2.13	1.22	2.29	2.38	2.10	2.22	2.29	2.57	2.17	2.18	2.31
In-Place Density (%)	92.1	92.2	94.6	94.9	94.2	95.0	94.8	97.2	92.9	93.6	91.8	94.4	93.9	95.1	92.9	93.0
NMAS																

Section	N10	N10	N10	N11	N11	N12	N12	N13	N13	N13	S2	S3	S3
Layer	3	2	1	2	1	2	1	3	2	1	1	2	1
Sponsor	MO	MO	MO	GA	GA	GA	GA	GA	GA	GA	MS	MS	MS
Mix Type	Super	Super	Super	Super	PEM	Super	PEM	Super	PEM	OGFC	Super	SMA	OGFC
PG Grade	64-22	70-22	70-22	76-22	76-22	76-22	76-22	76-22	76-22	76-22	76-22	76-22	76-22
Ndes	125	125	125	65	50 M	65	50 M	65	50 M	50 M	85	75	50
QC Data													
25.0 mm	100	100	100	100	100	100	100	100	100	100	100	100	100
19.0 mm	98	97	99	100	100	100	100	100	100	100	100	100	100
12.5 mm	88	83	96	99	92	98	95	98	96	100	100	100	100
9.5 mm	74	68	83	89	55	88	61	89	58	100	99	96	92
4.75 mm	48	41	52	63	18	58	16	61	12	41	76	51	31
2.36 mm	30	26	33	46	10	41	10	45	9	12	48	24	12
1.18 mm	19	17	21	34	9	32	8	34	8	8	33	17	9
0.6 mm	12	12	14	26	7	24	7	26	7	7	24	14	8
0.3 mm	9	8	9	17	6	16	5	17	6	6	13	12	6
0.15 mm	7	7	7	10	5	10	4	11	5	5	8	11	5
0.075 mm	6.3	5.6	5.4	6.3	3.4	5.7	1.8	6.8	2.6	4.2	6.0	10.3	3.8
Pb	5.4	4.9	5.8	6.3	5.7	5.1	5.5	5.1	6.6	5.6	7.4	6.3	6.8
Gmm	2.486	2.493	2.456	2.498	2.443	2.498	2.495	2.501	2.452	2.466	2.321	2.416	2.319
Gmb	2.383	2.383	2.318	2.402	1.971	2.393	1.999	2.423	2.119	2.031	2.266	2.328	1.813
Air Voids	4.1%	4.4%	5.6%	3.8%	19.3%	4.2%	19.9%	3.1%	13.6%	17.6%	2.4%	3.6%	21.8%
VMA	14.2%	13.7%	16.9%	15.8%	28.4%	15.0%	29.3%	14.0%	25.9%	27.5%	13.3%	16.8%	31.1%
VFA	70.7%	67.7%	66.7%	75.6%	32.0%	72.0%	32.1%	77.7%	47.5%	35.9%	82.2%	78.4%	29.8%
D/A Ratio	1.45	1.39	1.08	1.23	0.71	1.22	0.37	1.47	0.43	0.84	1.21	1.76	0.73
In-Place Density (%)	93.3	92.5	91.3	95.3	80.2	95.9	75.7	94.3	78.9	76.0	94.6	92.7	75.7
NMAS													

												20%	20%	45%	45%	45%	45%
Section	S6	S7A	S7B	S8A	S8B	S11	S11	S11	S11	S12	S12	W3	W4	W5	E5	E6	E7
Layer	1	1	1	1	1	4	3	2	1	2	1	1	1	1	1	1	1
Sponsor	TN	IN	IN	IN	IN	AL	AL	AL	AL	TX	TX	RAP	RAP	RAP	RAP	RAP	RAP
Mix Type	411-D	Super	Super	Super	Super	Super	Super	Super	Super	RBL	D-A	Super	Super	Super	Super	Super	Super
PG Grade	76-22	64-22	64-22	64-22	64-22	67-22	67-22	76-22	76-22	70-22	76-22	76-22	67-22	RA500	67-22	76-22	76-22
Ndes	65	60	60	60	60	60	60	60	60	75	50	60	60	60	60	60	60
QC Data																	
25.0 mm	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
19.0 mm	100	100	100	100	100	97	96	97	100	100	100	100	100	100	100	100	100
12.5 mm	96	98	100	97	98	88	85	89	100	100	100	97	97	97	95	97	97
9.5 mm	88	90	91	88	88	76	74	79	100	100	97	87	88	86	80	85	84
4.75 mm	69	71	76	66	63	56	54	60	85	79	65	65	66	58	53	59	59
2.36 mm	49	58	53	53	49	46	44	49	66	47	38	54	54	46	42	47	48
1.18 mm	36	45	42	41	38	37	35	39	51	29	36	43	43	37	34	38	38
0.6 mm	26	32	30	30	28	26	25	27	37	18	18	31	31	28	25	28	28
0.3 mm	14	18	17	18	18	14	13	15	22	12	11	18	18	18	15	17	17
0.15 mm	9	12	11	11	12	8	8	9	14	8	10	12	12	12	10	11	11
0.075 mm	7.3	8.0	7.4	7.5	7.8	5.5	5.4	5.7	8.9	6.2	7.4	7.5	7.6	8.3	6.2	7.3	7.2
Pb	6.0	6.4	6.0	6.0	5.9	4.9	4.8	5.3	6.8	7.5	6.7	5.6	5.8	4.9	5.1	5.0	4.9
Gmm	2.374	2.439	2.470	2.465	2.457	2.566	2.560	2.546	2.480	2.403	2.424	2.467	2.470	2.503	2.502	2.505	2.500
Gmb	2.322	2.405	2.418	2.415	2.432	2.437	2.442	2.441	2.385	2.341	2.357	2.420	2.418	2.460	2.422	2.418	2.410
Air Voids	2.2%	1.4%	2.1%	2.0%	1.0%	5.0%	4.6%	4.1%	3.8%	2.6%	2.8%	1.9%	2.1%	1.7%	3.2%	3.5%	3.6%
VMA	12.6%	16.2%	15.4%	16.0%	14.8%	15.2%	15.0%	15.5%	17.8%	17.9%	15.9%	14.2%	14.5%	12.5%	13.8%	13.9%	13.9%
VFA	82.7%	91.4%	86.3%	87.4%	93.1%	67.0%	69.4%	73.4%	78.5%	85.6%	82.7%	86.6%	85.4%	86.3%	76.9%	74.9%	74.2%
D/A Ratio	1.58	1.27	1.31	1.26	1.33	1.28	1.23	1.20	1.48	0.91	1.29	1.43	1.44	1.83	1.37	1.66	1.62
In-Place Density (%)	94.4	97.8	96.1	96.1	97.7	91.8	92.6	94.2	93.2	93.8	96.1	92.0	93.9	95.3	94	96	96
NMAS																	