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Maine Department of Transportation

Transportation Research Division

Technical Report 03-12

Experimental Placement of Stone Matrix Asphalt
Project STP-8724 (00) X South Portland
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Introduction

In September 2003 the Maine Department of Transportation used stone matrix asphalt and Superpave to renovate two intersections in South Portland, Maine. The experimental placement of stone matrix asphalt (SMA) and Superpave with modified binder was a part of pavement project STP-8724(00) X. The primary focus of this experiment is to look at the rutting resistance of SMA versus Superpave with modified binder.

SMA mixtures consist of a large coarse aggregate content, fine aggregate, high filler content, asphalt cement with or without a modifier and usually a cellulose or mineral fiber. These mixtures contain a large coarse aggregate content (approximately 70 percent) and enough fine aggregate to help fill the voids in the coarse aggregate. The strength of this mix is gained from stone on stone contact. This mix is designed to have 3-4 percent air voids, and it has a relatively high asphalt content due to the high amount of voids in the mineral aggregate. The mix contains a high filler content (approximately 10 percent passing the No. 200 sieve), and it typically contains a polymer in the asphalt cement or fiber (cellulose or mineral) in the mixture to prevent drainage of the asphalt cement. This mixture has a surface appearance similar to that of an open graded friction course, however it has low in-place air voids similar to that of a dense graded HMA. The high asphalt content produces a mixture that is easily compacted and that should be durable. If the asphalt content is excessive it will tend to push the aggregate apart and prevent stone on stone contact. An asphalt content that produces 3-4 percent air voids in laboratory compacted samples is desirable.

The intersections are at the junction of Route 1 and Turnpike Spur (703) and the junction of Route 1 and Westbrook Street. The pre-existing pavement conditions had moderate rutting and cracking. The goal of the experiment is to compare how the SMA and Superpave perform relative to each other.

Construction Procedure

The intersection of Route 1 and Turnpike Spur (703) consists of three different construction processes. The left side of the right lane of the T-section was milled 3 to 4 inches and then paved with SMA. The right side of the right lane of the T-section was redone using the modified Superpave. See Photo 6 in Appendix C for a view of the right lane of the T-section. The majority of the intersection of Route 1 and Turnpike Spur (703) was full-depth SMA. The existing pavement was removed and SMA was placed from station 11+160 to 11+260. A 150mm SMA base course, 19.0mm grading, followed by a 50mm wearing course, 12.5mm grading, was used between stations 11+160 to 11+260. A plan view of the SMA intersection is shown in Appendix B: Figure 4.

From sta. 11+050 to 11+160, 11+260 to 11+460 and the intersection of Route 1 and Westbrook Street used full depth reconstruction with a polymer modified Superpave mix. The Superpave consisted of a

150mm base course, 19.0mm grading, and a 50mm wearing course, 12.5mm grading. The required PGAB for the Superpave mixture will meet a PG 70-28 to PG 76-28 grading.

It should be noted that there were difficulties getting sufficient densities on the edges for the SMA. In order to maintain pavement shape, the edges were allowed to cool before compaction. When the SMA was being placed on the gravel there was more squatting then usual. Another note is that a small SMA shim was placed to account for a short dip in the intersection of Route 1 and Turnpike Spur, see Appendix C: Photo 8. The laboratory test results on both the SMA and the Superpave are located in Appendix A: Table 9 Laboratory Test Results. The SMA project specs are located in Appendix D.

Pavement Performance

Construction of the South Portland job was completed in October of 2003. FWD data was taken in the center lane from station 11+040 to11+460 in both the North and South directions. The FWD results are located in Appendix A. The modulus for the SMA varies from a low of 450,000 kPa to a high of 1,050,000 kPa. The structural number and sensor #1 normalized results were similar for both the SMA and Superpave pavements. See tables 3 – 8 in Appendix A for more statistical analysis of the FWD data.

Conclusions and Recommendations

Initial FWD results show that some sections of the SMA intersection have a lower modulus than expected. Field tests show that most of the 12.5mm SMA had poor gradation that did not meet MDOT specifications. One of the SMA cores that did not pass percent compaction correlated with an area of SMA that had a low modulus. This might suggest a connection between the density and modulus, however other areas where the cores did not pass percent compaction did not have low moduli. More testing is needed in order to determine a link between low densities and low moduli.

While the early test results are not promising, it is too soon to make any conclusions as to the effectiveness of SMA on this job or in general. Again further testing and observation is needed to determine if low densities are the cause of the low moduli. Continued monitoring is also needed to determine how the SMA resists rutting. On a previous SMA job in Auburn wheel path rutting was observed three years after construction. High asphalt content was thought to be the cause of the premature occurrence of rutting. In the Fall of 2004 FWD testing, visual observation and ARAN data will help to determine the effectiveness of the SMA. Additional cores at the areas of low moduli as well as Ground Penetrating Radar (GPR) or Seismic Pavement Analyzer (SPA) data would also be very useful in determining whether the problem resides in the pavement, subbase or both.

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South Portland Route #1/Turnpike Spur Intersection North Bound Lane			
Station (Meters)	Pavement Modulus (kPa)	Existing Structural Number (mm)	Sensor #1 Normalized
11+060	743,455	165	7.47
11+080	677,530	160	8.7
11+100	733,926	165	6.76
11+120	656,925	159	7.47
11+140	775,024	168	6.49
11+160	703,076	162	7.07
11+180	703,702	162	7.54
11+200	576,004	152	8.92
11+220	663,899	159	7.72
11+240	596,186	154	8.26
11+260	660,605	159	7.77
11+280	730,622	164	7.02
11+300	643,371	157	7.96
11+320	600,115	154	8.83
11+340	670,266	160	8.06
11+360	653,278	158	8.36
11+380	719,785	163	7.49
11+400	768,256	167	7.21
11+420	668,357	159	8.02
11+440	672,589	160	7.97
11+460	549,954	149	9.63

Table 1: North Bound FWD Data

SMA section highlighted.

South Portland Route #1/Turnpike Spur Intersection South Bound Lane			
Station (Meters)	Pavement Modulus (kPa)	Existing Structural Number (mm)	Sensor #1 Normalized
11+440	717,439	163	7.97
11+420	683,029	161	7.82
11+400	656,682	159	8.07
11+380	774,788	168	6.84
11+360	711,658	163	7.4
11+340	666,791	159	7.98
11+320	626,127	156	8.4
11+300	830,195	171	6.28
11+280	959,896	180	5.63
11+260	909,853	177	5.41
11+240	913,523	177	4.91
11+220	1,056,124	186	4.24
11+200	505,288	145	9.45
11+180	556,505	150	9.41
11+160	453,151	140	11.22
11+140	787,850	168	6.35
11+120	706,390	162	7.76
11+100	524,794	147	10.68
11+080	630,870	156	8.8
11+060	580,446	152	10.15

Table 2: South Bound FWD Data

SMA section highlighted.

Stone Matrix Asphalt	Northbound	Southbound
Average Modulus	650,579 kPa	732,407 kPa
Standard Deviation	52,621	256,746
Coefficient of Variation	8%	35%

Table 3: SMA Average Modulus Data

Superpave	Northbound	Southbound
Average Modulus	684,230 kPa	704,068 kPa
Standard Deviation	61,993	109,738
Coefficient of Variation	9%	16%

Table 4: Superpave Average Modulus Data

Stone Matrix Asphalt	Northbound	Southbound
Average Existing SN	158	163
Standard Deviation	4.15	19.71
Coefficient of Variation	3%	12%

Table 5: SMA Average Structural Number Data

Superpave	Northbound	Southbound
Average Existing SN	161	162
Standard Deviation	5.04	8.29
Coefficient of Variation	3%	5%

Table 6: Superpave Average Structural Number Data

Stone Matrix Asphalt	Northbound	Southbound
Average Sensor 1 Norm	7.83	7.44
Standard Deviation	0.64	2.93
Coefficient of Variation	8%	39%

Table 7: SMA Sensor #1 Normalized Data

Superpave	Northbound	Southbound
Average Sensor 1 Norm	7.83	7.87
Standard Deviation	0.83	1.40
Coefficient of Variation	11%	18%

Table 8: Superpave Sensor #1 Normalized Data

	Binder (%)	Air Voids (%)	VMA (%)	VFB (%)	Pass Gradation (%)
12.5mm SMA	6.2	5.3	19.8	73.4	20
19.0 mm SMA	6.4	4.8	20.0	76.4	80
9.5mm RAP	6.2	4.0	17.5	77.0	n/a
12.5mm RAP	5.6	3.1	16.2	80.7	62.5
19.0mm RAP	4.5	3.1	13.1	76.5	40

Table 9: Laboratory Test Result Averages RAP = Superpave SMA = Stone Matrix Asphalt

Pass Gradation refers to percentage of sieve analysis that meet MDOT specification.

Appendix B: Figures

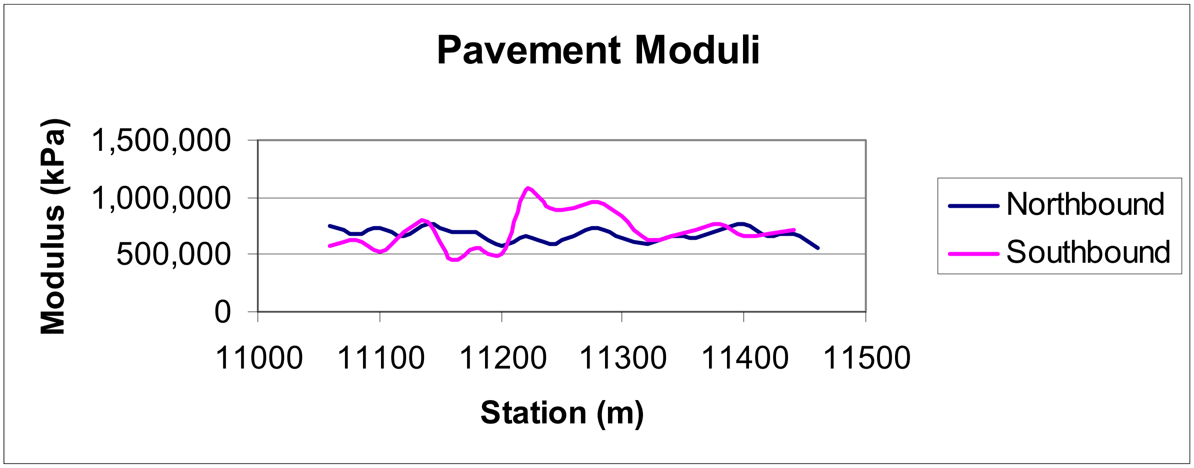

Figure 1: Pavement Moduli

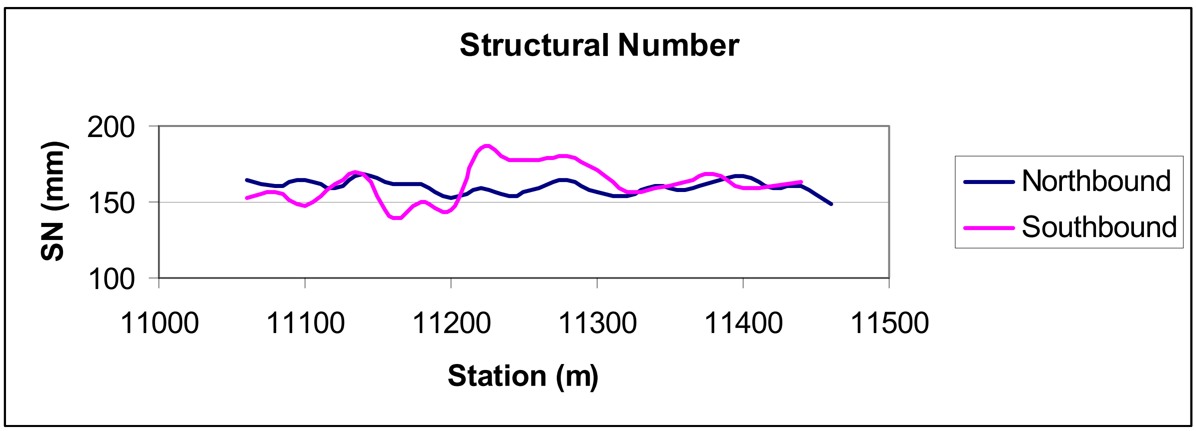

Figure 2: Structural Number

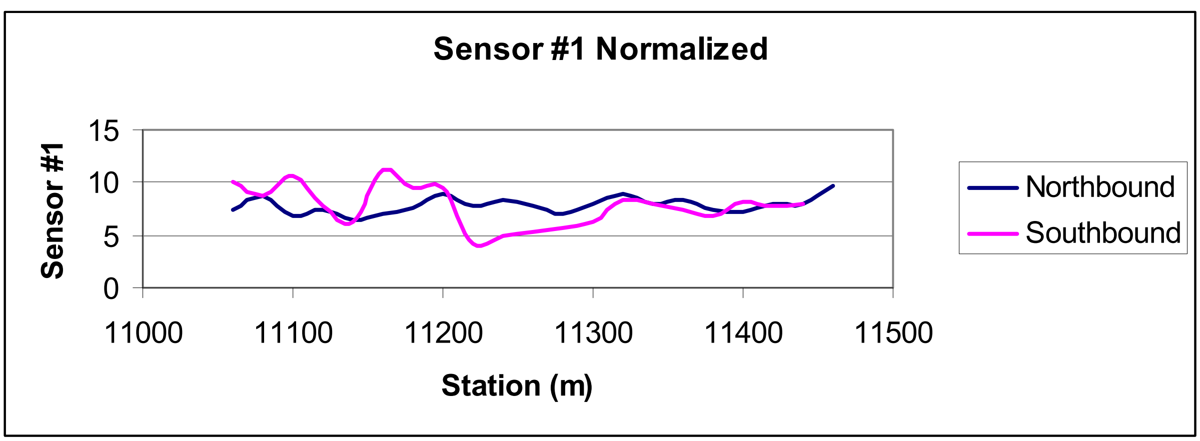

Figure 3: Sensor #1 Normalized

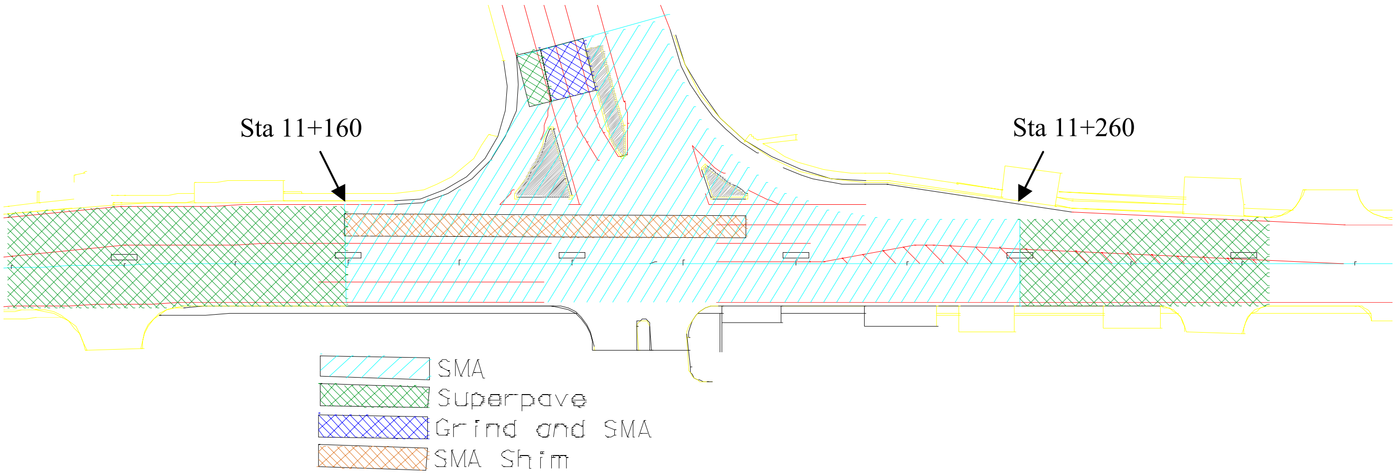

Figure 4: SMA Plan View

Appendix C: Photos

Photo 1: SMA Base

Photo 2: SMA Close-up (rolled)

Photo 3: Depth of SMA base


Photo 4: SMA squats on gravel

Photo 5: More Paving

Photo 6: Route 1 and Turnpike Spur, right lane of T-section


Photo 7: Some hand-place (same intersection as Fig 6)

Photo 8: SMA 12.5mm Shim

Photo 9: Finished SMA (same intersection and Fig 6 & 7)

Appendix D: Misc

The following are all located in the MDOT file, please contact Tim Soucie to obtain any of the information below.

- Standard Specs
- Mix Design
- HMA Testing Results
- FWD Testing Results