

GEORGIA DEPARTMENT OF TRANSPORTATION

# **Crumb Rubber Test Section on CSNHS-M003-00(560) 01 Houston Peach**

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Special Research Report  
# 2007-1

Office of Materials & Research  
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In the past, GDOT has placed several test sections of asphaltic concrete incorporating crumb rubber but new technology involves the inclusion of trans-polyoctenamer rubber (TOR) to improve the workability of the crumb rubber modified mixtures. As you are aware, Georgia Department of Transportation (GDOT) and many of its asphalt contractors are very interested in pursuing experience with this new crumb rubber modified asphaltic concrete technology. In an effort to achieve this knowledge, a request was forwarded by Reeves Construction Company and agreed to by our Office to the Federal Highway Administration for approval of a one-mile test section within this referenced interstate project's limits.

On August 8, 2007, the letter forwarded by the Office of Materials and Research was approved by Greg Mayo, GDOT Director of Construction and Gus Shanine with the FHWA Georgia Division. Reeves Construction, the contractor for project number CSNHS-M003-00(560)01 Houston and Peach Counties was notified the test section was approved pending acceptable laboratory test results.

This project was originally established as a research project because it consists of 15.634 miles of micro-milling, inlay and plant mix resurfacing on I-75 beginning south of SR-26 and extending to SR-96. More specifically, the existing Open-Graded Mix (approximately 1") is being micro-milled and then inlaid with 1-1/4" of Porous European Mix (PEM). Placed in the early 1990s, the Open-Graded Mix was deteriorated and is severely raveling throughout this section of I-75. Conventional rehabilitative costs were prohibitive and the Office of Maintenance approached the Office of Materials and Research for alternative recommendations. The micro-milling recommendation research project was suggested for a 5-7 year solution (given that the new material would be placed on 14 year old conventional "E" mix) for less than 1/10 the previously estimated cost. It was agreed that the one-mile Crumb rubber test section would be placed in northbound lane 3 beginning at mile post 137.

Reeves Construction volunteered to produce a blend of crumb rubber/TOR modified PEM mix at their asphalt plant located in Macon, Georgia for evaluation prior to placing the mix on the roadway. A volumetric feed system was set up at the asphalt plant to incorporate the blended crumb rubber/TOR material into the RAP collar at the drum (see photo 1, 2). On August 15, 2007, Reeves Construction produced 90 tons of the PEM with a portion of the material being modified by the crumb rubber/TOR blend. Samples of both blends of the PEM material (PG 76-22 modified and crumb rubber/TOR blend) were obtained for evaluation prior to it being wasted on the ground at the asphalt plant. The mix was brought to the Central Laboratory at Forest Park for testing.

On August 16, 2007 four 4-inch Marshall Pills were created from both mixture blends at 50 blows each and were subjected to the Cantabro test.

The Cantabro Test is used for porous or open-graded asphaltic concrete mixtures to evaluate the resistance to particle loss by abrasion and the mixture's potential to ravel. The percent loss during the Cantabro test is an important indicator for bonding properties between aggregate and asphalt binder. The test is conducted using either Marshall compacted or Superpave gyrated pills which are weighed and then placed in a Los Angeles Abrasion Test Machine without the steel

balls. After 300 revolutions, the remaining mass of material is then weighed again and the particle loss calculated.

The particle loss obtained for the 4-inch samples produced using PG 76-22 was disconcerting and so it was decided to gyrate two 6-inch Superpave gyratory pills from each mixture blend at 50 gyrations each on August 17, 2007. These pills were also subjected to the Cantabro test.

Table 1 shows the results obtained from the initial test conducted using the material obtained from the mix produced by Reeves on August 15, 2007.

**Table 1- Cantabro Test Results Plant Produced Mix on August 15 2007**

<b>Pill Type</b>	<b>No.</b>	<b>PG 76-22</b>	<b>Crumb/TOR</b>
		% of Loss	
4-inch Marshall Pills	1	65.1	20.2
4-inch Marshall Pills	2	33.9	10.8
4-inch Marshall Pills	3	44.8	22.6
4-inch Marshall Pills	4	77.7	22.4
<b>Average</b>		<b>55.4</b>	<b>19.0</b>

**Table 1A 6-inch Cores- Cantabro Test Results Plant Produced Mix**

<b>Pill Type</b>	<b>No.</b>	<b>PG 76-22</b>	<b>Crumb/TOR</b>
6-inch Superpave Gyrate Pills	1-A	32.6	12.2
6-inch Superpave Gyrate Pills	2-A	45.3	11.1
<b>Average</b>		<b>38.9</b>	<b>11.7</b>

Based on the excellent test results obtained from the crumb/TOR modified PEM mix produced at Reeves's asphalt plant, the final approval was given on August 17, 2007.

During the evening of August 19, 2007, Reeves construction produced and placed a total of 1150 ton of PEM. This mix was placed in northbound lane 3 on I-75. Reeves began the night's placement with the crumb rubber /TOR modified mix near milepost 137 for approximately 1 mile ending near milepost 138. A total of 562 tons of the crumb rubber/TOR modified mix was produced.

An initial observation made during the placement of this mix was the reduced amount of smoke and odor typically associated with this type of paving operation. It also appeared that the build-up left behind in the haul vehicles was less than characteristic for this kind of mix. During the actual placement of the material, no difference could be observed between this material and conventional PEM as far as difficulty in handling or lay-down (photo 3).

After the one mile test section, the contractor finished the night's placement with the conventional PEM. Quality Acceptance Samples were obtained of both mixtures and are included in Table 2.

**Table 2- Acceptance Samples for Plant Produced Mix on August 19 2007**

Sieve		¾"	½"	3/8"	N0. 4	N0. 8	N0. 200	AC
JMF		100	90	50	14	8.0	3.0	6.0
Load 13		100	88.9	53.4	13.6	8.2	2.8	6.26
Load 41		100	87.3	52.0	12.5	8.9	3.1	5.89
Load 64		100	84.6	47.2	11.9	8.7	3.0	5.90

The Acceptance Sample for Load 13 was taken from the mix produced using the crumb rubber/TOR blend while the samples for Loads 41 and 64 were taken from the conventional PEM mixture. Results for all samples show that the mix produced for this Lot was all within mixture control tolerances established within Section 828 of the Georgia Department of Transportation Specifications.

Additionally, samples were taken to the Central Laboratory for testing using the Cantabro Test. The Cantabro Test results of the mix placed on I-75 on the evening of August 19, 2007 are shown in Table 3.

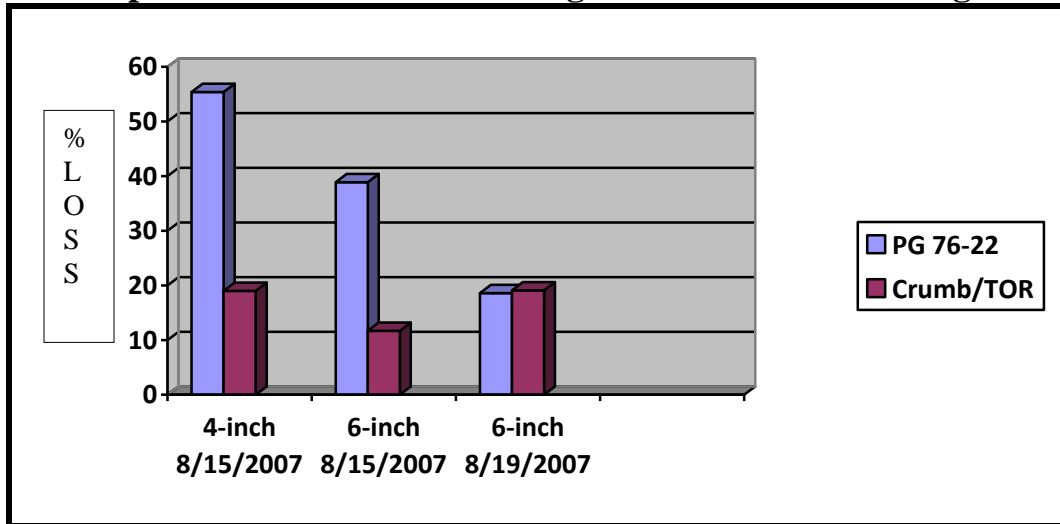
**Table 3- Cantabro Test Results for Plant Produced Mix on August 19 2007**

Pill Type	No.	PG 76-22	Crumb/TOR
6-inch Superpave Gyrated Pills	1	17.0	22.7
6-inch Superpave Gyrated Pills	2	17.9	17.0
6-inch Superpave Gyrated Pills	3	20.8	17.5
<b>Average</b>		<b>18.6</b>	<b>19.1</b>

The *Average % Loss* for all 3 sets of samples of the Cantabro testing conducted in relation to this test section are compiled for Graph 1. As indicated by the results, the mix produced on August 15, 2007 for evaluation only by Reeves Construction clearly indicates significant difference in the percent of loss material during the Cantabro Test. A possible rationale for this difference may be that the crumb rubber/TOR mixture acclimated better to the environment associated with the very limited mixture production during the trial run on August 15, 2007.

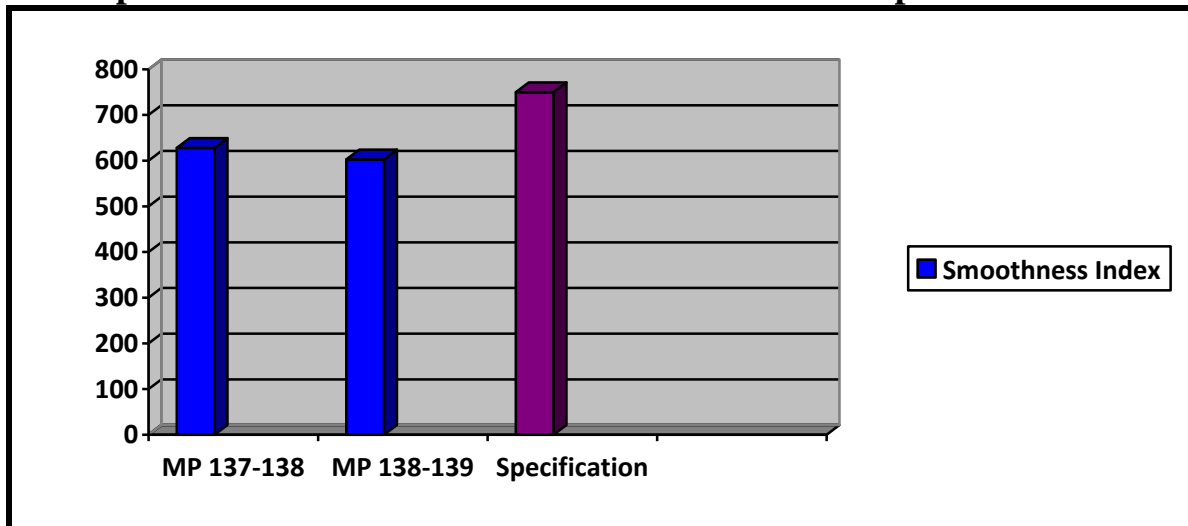
The Average % Loss results obtained from the mix actually produced and placed on the test section on I-75 on August 19, 2007 show no significant difference between the PG 76-22 PEM and crumb rubber/TOR modified PEM during the Cantabro Test.

**Graph 1 - Cantabro Test Average % Loss for All Testing**



On August 20, 2007, the Laser Road Profiler tested this section of I-75 for smoothness acceptance and the results are displayed in Table 4. Both one mile sections placed on August 19, 2007 that were evaluated were well within specification requirements.

**Graph 2 – Laser Road Profiler Test Results on PEM placed on 8/19/2007**



At this time, visual inspection of the in-place crumb rubber/TOR modified PEM mix appears acceptable and comparable to the conventional PEM. It should be noted that the conventional PEM mix appear to be bleaching out at a slightly increased rate when compared to the crumb rubber/TOR modified PEM.

For this project, 30 mesh size of crumb rubber was selected to be used. Ten percent crumb rubber, based on the weight of asphalt was included. TOR polymer was added at a 4.5% rate based on the weight of the crumb rubber, not the weight of the base asphalt.

The crumb rubber modified binder was analyzed at GDOT bituminous lab to determine the PG grade after modification. The crumb rubber and TOR was mixed with PG 67-22 base binder, and was stirred for 60 minutes at 340 degrees and then evaluated using the standard PG tests for original DSR, RTFO aged DSR, DSR on PAV, BBR studies on the modified asphalt to get the Superpave PG ratings. The test results are shown in Table 4:

**Table 4 – Superpave Binder Test Results**

	Flash Point	Viscosity (Pa-S)	Original DSR (kPa)	Phase Angle (Degree)	RTFO DSR* (kPa)	Mass Change (%)	PAV DSR (kPa)	BBR	
Spec for PG 76-22	Min. 230 °C	Max 3.0	Min. 1.0	Max 75.0	Min. 2.2	Max. 0.5	Max. 5,000	Max S 300MPa	Min m 0.300
Crumb Rubber + TOR	307 °C	1.396	1.43	83.7	4.5	0.29	2,630	150.5	0.309

\*it was found that crumb rubber modified asphalt came out of glass bottle during the rotation of RTFO. A second batch of binder was made and aged at TFO oven instead.

Obviously, the crumb rubber modified binder passed all Georgia’s requirements of PG 76-22, except the phase angle of the original DSR (max 75 °C). However, it does meet PG 76-22 of AASHTO M 320 specification requirements.

The test section will continue to be monitored for long term performance in the field. Roadside signs have been ordered from the GDOT sign shop and installed to mark the one-mile test section near Milepost 137, Northbound of I -75 (lane 3) to identify it’s limits.



Photo 1 Blended Crumb Rubber/TOR Feeder Container



Photo 2 Blended Crumb Rubber/TOR Being Added To Plant at RAP Collar



Photo 3 Crumb Rubber/TOR Modified PEM Mixture Behind Paver 8/19/2007



Photo 4 Crumb Rubber/TOR Modified PEM Mixture Behind Paver 8/19/2007

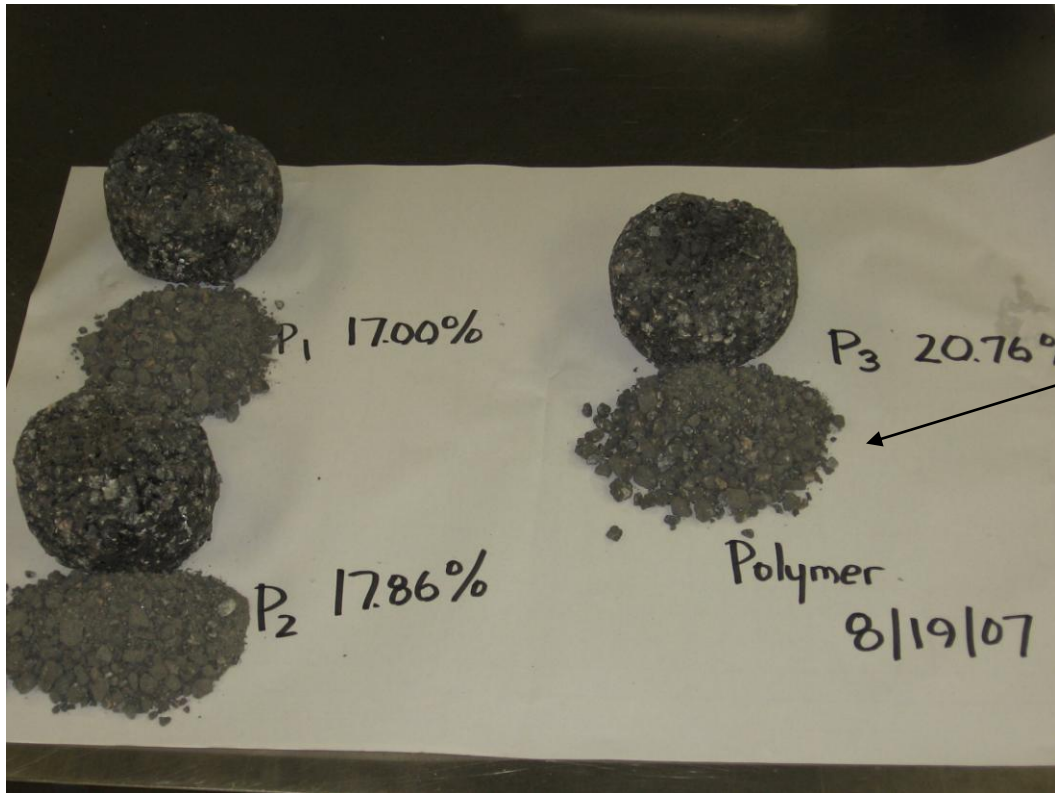




Photo 5 Crumb Rubber/TOR Modified PEM Mixture Joint with Conventional PEM

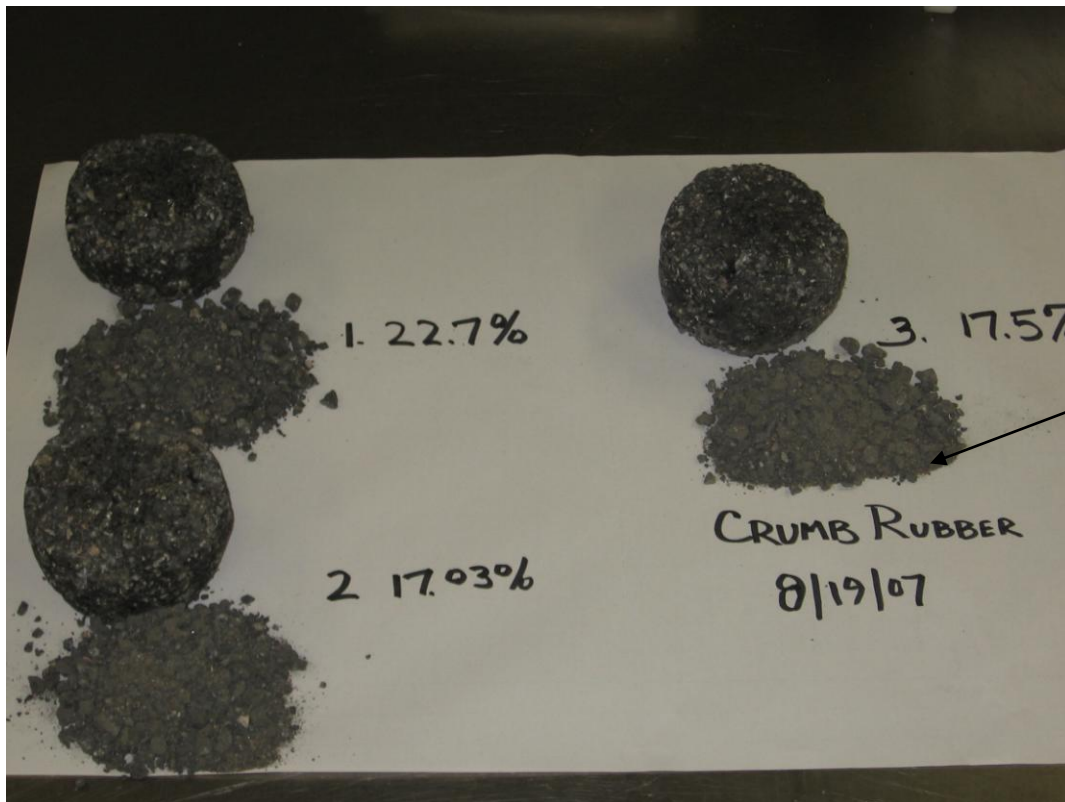


Photo 6 Crumb Rubber/TOR Modified PEM Mixture



Material Lost During  
Cantabro Testing  
(PG76-22)

Photo 7 Cantabro Test Photo of PG 76-22 PEM Mix Produced and Placed on 8/19/2007



Material Lost During  
Cantabro Testing  
(Crumb rubber/TOR)

Photo 8 Cantabro Test Photo of Crumb Rubber/TOR PEM Mix Produced and Placed on 8/19/2007