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National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

Evaluation of a Rubber Modified Mixture Designed Using a Balanced Design in Joe Wheeler State Park

Construction and Year 1 Field Evaluation

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1. INTRODUCTION

Asphalt mixtures have been primarily designed using the Superpave mix design methods where the proportioning of mixture components relies on volumetric property requirements. The increased use of recycled asphalt materials and other asphalt modifiers in asphalt mixtures, such as ground tire rubber (GTR), has triggered the implementation efforts of balanced mix design (BMD). BMD is defined as a mix design procedure that uses performance tests to address multiple modes of distress while taking into consideration mix aging, traffic, climate, and location within the pavement structure. A BMD mixture is designed to achieve an optimal balance between rutting resistance and crack resistance rather than relying on volumetric property requirements. Since BMD utilizes testing of the mixture rather than individual components, it motivates innovation for including new technologies, such as GTR products, to design quality asphalt mixtures.

Although it is evident that strong markets have developed for scrap tires in recent years, current estimates show that millions of scrap tires are left to be placed in landfills or stockpiles. Therefore, there is still potential to increase the use of GTR in asphalt pavements. The Alabama Department of Environmental Management (ADEM), through its Scrap Tire Program, is interested in promoting alternative uses of scrap tires in engineering applications. In 2023, ADEM decided to provide funding assistance to Joe Wheeler State Park for a demonstration project that included a GTR section.

2. OBJECTIVE

The objective of this project is to evaluate the performance of a rubber-modified mixture designed using a balanced mix approach compared with a conventional Superpave mix. To accomplish this objective, the Alabama Department of Conservation and Natural Resources (ADCNR) resurfaced the road into Joe Wheeler State Park using a balanced mix with a ground tire rubber (GTR) additive and another portion of the same road with a conventional Superpave mix.

3. PROJECT TASKS

Project Tasks

This project is divided into six tasks. The following paragraphs describe the tasks and the current progress.

Task 1. Conduct a verification of the balanced mix design (BMD) with a GTR additive designed by the selected contractor.

ADCNR helped coordinate with the selected contractor to deliver the materials and conduct the verification at NCAT. The contractor selected for this project was Grayson Carter & Son Contracting from Athens, Alabama. Grayson Cater provided the aggregates for the GTR mix design verification, and Liberty Tire Recycling provided the GTR. Grayson Carter also provided an ALDOT-approved 424 1/2” mix design to use for the project.

The preliminary BMD criteria required by ALDOT is to have an IDEAL-CT of at least 50 for A/B traffic roads and a Hot-IDT of at least 20 psi.

NCAT conducted an GTR BMD verification using the materials provided by Grayson Carter, with 0.6% of GTR added by the weight of the binder. Table 1 summarizes the mix design. After the verification, IDEAL-CT and Hot-IDT samples were prepared and tested. The GTR IDEAL-CT samples provided a CT_{index} of 58.0, and the Hot-IDT provided a strength of 44.7 psi. The results of these tests met the requirements for the ALDOT BMD criteria. Table 2 summarizes these results.

Table1. GTR Mix Design

Sieve	Design GTR Mix
$P_{1/2,}$ %	100
$P_{3/8,}$ %	96
$P_{\#4,}$ %	76
$P_{\#8,}$ %	53
$P_{\#16,}$ %	37
$P_{\#30}$ %	30
$P_{\#50,}$ %	16
$P_{\#100,}$ %	9
$P_{\#200,}$ %	6.9
Total Binder Content (P_b), %	5.5
Eff. Binder Content (P_{be}), %	5.3
Dust/Binder Ratio	1.26
RAP Binder Ratio	0.25
Air Voids, %	4.0

Table 2. GTR BMD Verification Results

Avg. CT_{Index}	58.0
St. Dev. CT_{Index}	9.1
Avg. HT-IDT	44.7
St. Dev. HT-IDT	2.8

Task 2. Monitor the production of the rubber-modified mixture and the construction of the test section.

The GTR sections were constructed on November 9, 2023. The construction activities were monitored by NCAT staff, and the plant mix was sampled for further testing. For this project, GTR was placed on all the roads, and a control section was paved with a dense graded mixture.

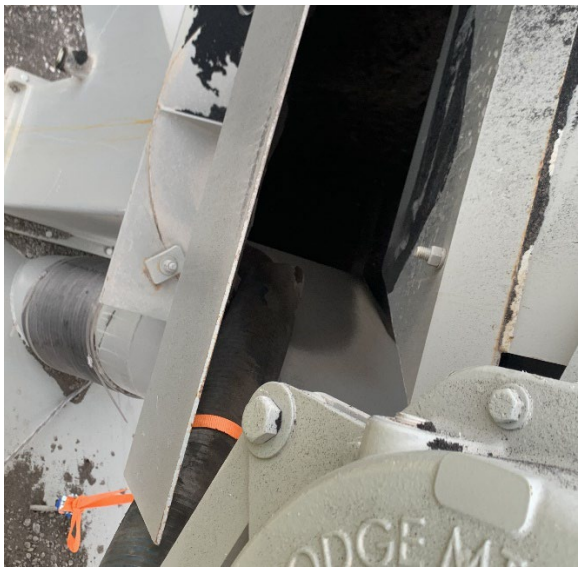

Figure 1. SmartMix Feeder and Hose System being Fed into Plant

Figure 2. GTR Mix Placement

Figure 3. GTR Mix Placement and Compaction

Figure 4. GTR Mix Compaction

Figure 5. Close-up of GTR Section after Placement and Compaction

Task 3. Conduct performance tests (rutting and cracking) using plant mix sampled during construction to determine its compliance with the performance requirements.

The plant mix sampled during construction was brought to NCAT for performance tests to determine if the plant-produced mix met the performance requirements of the cracking and rutting tests. Table 3 and Table 4 summarize the results of the IDEAL-CT and Hot-IDT tests. As can be seen from the test results, the plant-produced GTR mix did not meet the performance requirement of 50 for IDEAL-CT. The GTR mix had a CT_{Index} of 27.5. The GTR mix did have a higher CT_{Index} than the control mix CT_{Index} of 21.0. The GTR mix had a Hot-IDT of 42.2 psi, which exceeded the performance requirement of 20 psi. The GTR mix Hot-IDT was also higher than the control Hot-IDT at 40.5 psi.

Table 3. IDEAL-CT Results from Plant-Produced Mix for Control and GTR Sections

Mix ID	Average	St. Dev	Replicates	COV, %
Control	21.0	7.3	5	34.9
GTR	27.5	9.4	5	34.0

Table 4. Hot-IDT Results from Plant-Produced Mix for Control and GTR Sections

Mix ID	Average	St. Dev	Replicates	COV, %
Control	40.5	3.9	3	9.6
GTR	42.2	4.1	3	9.7

Task 4. Evaluate Field Performance of The Test Sections Every Year for Six Years.

This evaluation is conducted using an automated pavement condition survey vehicle, and laboratory testing will be conducted on field cores (cores taken as needed based on the performance of the test section).

The data collection vehicle used by NCAT is a fully automated PathRunner vehicle. The van is a class 1 inertial profiler with 3D automated crack and rutting detection system. Since testing can be conducted at normal highway speeds, the road will not have to be closed to facilitate data collection. The van includes an on-board laser package that measures smoothness, rutting, and macrotexture, in addition to front-facing super HD cameras, GPS, and 3D automated crack detection software providing a comprehensive pavement evaluation.

The performance of the sections after one year of performance is summarized as follows.

Condition Survey after 1 Year

The first field performance evaluation was conducted in December of 2024. The section of roadway evaluated was approximately 4.4 miles in each direction, with most of this pavement being the GTR mix. The control portion is a section approximately 200 feet long near the entrance of the park, as shown in Figure 6. These sections on McLean Drive were evaluated using NCAT's automated pavement condition survey vehicle, as shown in Figure 7. The purpose of this survey was to assess and compare the current pavement condition of the test sections in terms of IRI, rutting, texture, and cracking. Three data collection runs were made in each lane.

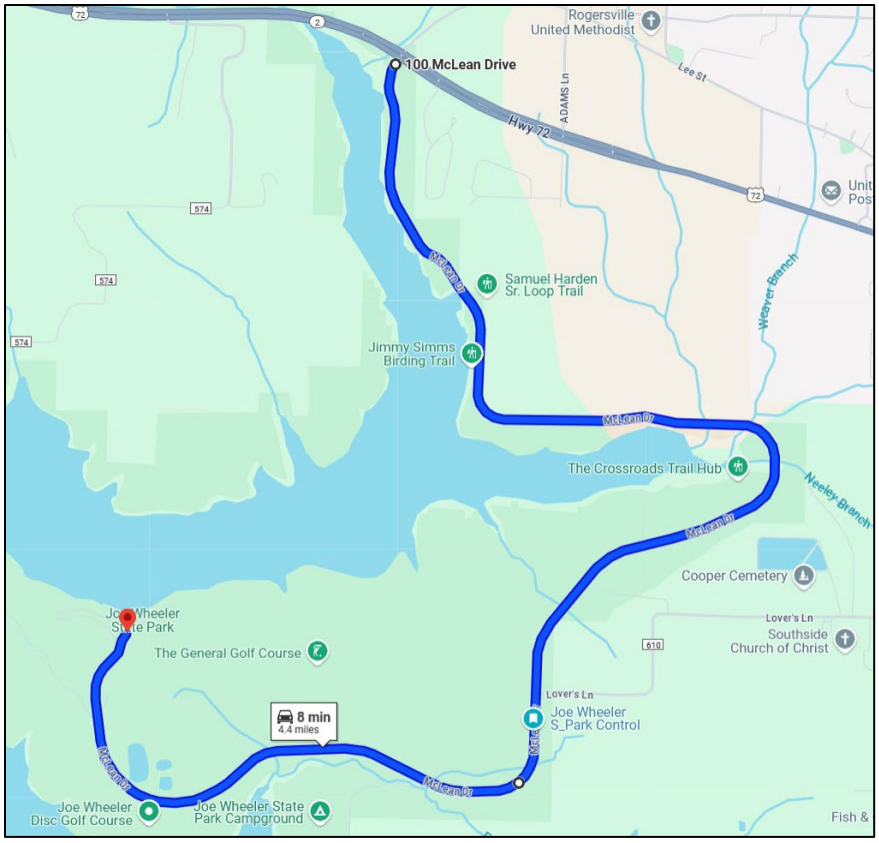

Figure 6. Pavement Condition Survey Location

Figure 7. NCAT's Automated Pavement Condition Survey Vehicle

The average performance data for IRI and texture are shown in Table 5. There was no measurable rutting. IRI for both mixes had a large range with high standard deviations. This is likely due to the

rolling terrain and winding nature of some portions of the roadway in the park, which can sometimes artificially inflate IRI values in those areas. Overall, the GTR mixture compares well with the control regarding IRI and macrotexture.

Table 5. Ride Quality and Texture Results at One-Year Inspection

Lane/Mix		IRI, in/mil		Macrotexture, mm	
Lane	**Mix**	**Average**	**Std Dev**	**Average**	**Std Dev**
NB	GTR	84	51	0.45	0.08
SB	Control	94	43	0.43	0.03
	GTR	92	53	0.44	0.06

Cracking was detected and classified using Pathway Service's software AutoCrack and AutoClass which classifies cracking by type. At the time of the one-year inspection, the Pathway system did not detect any discernable cracking in the mix sections. Figures 8 and 9 show overviews of the GTR and control sections, respectively. Figure 10 shows an example of the surface texture of both mixes. Both mixes were found to be performing well at the time of the one-year inspection.

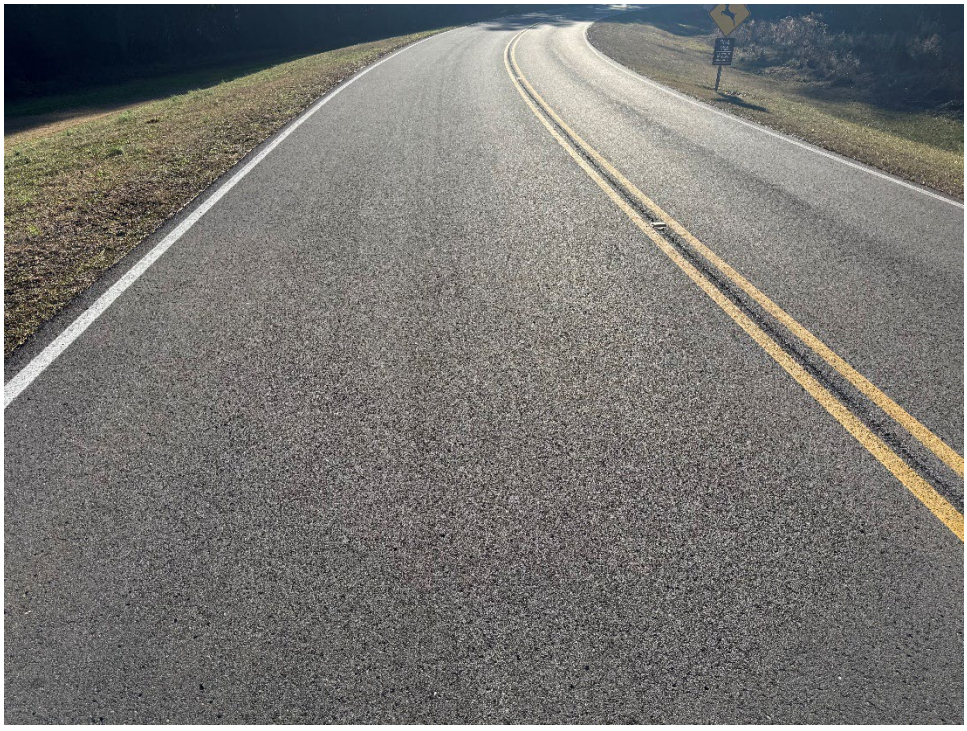

Figure 8. Example of the GTR Mix at One-Year Inspection

Figure 9. Example of the Control Mix at One-Year Inspection

Figure 10. Example of Surface Texture at One-Year (GTR on the left, control on the right)