STATE OF FLORIDA

LABORATORY MIXTURE AND BINDER RUTTING STUDY

Research Report
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STATE MATERIALS OFFICE

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INTRODUCTION

The Florida Department of Transportation, herein referred to as the Department, specifies several different asphalt binders for the various asphalt mixtures used throughout the state's transportation system. The most commonly used binder is a PG 67-22. The PG stands for performance grade and the two numbers (67 and –22) are the temperature ranges in degrees Celsius for which the binder meets specifications. Most other binders used in the state are derivatives of this type of binder. Friction courses in Florida use one of two types of blended asphalt rubber binders. Dense-graded friction courses are produced with ARB-5 (asphalt rubber binder). ARB-5 consists of a PG 67-22 blended with five percent ground tire rubber (GTR) by weight of asphalt. Open-graded friction courses are produced with ARB-12, which contains 12 percent GTR by weight of asphalt. A newer binder, designated as PG 76-22, has been used on some heavily trafficked roads in the past few years in Florida. This binder is a combination of PG 67-22 and one of two polymers blended together. The polymer modified binder increases the rutting resistance of the asphalt mix by remaining stiffer at higher temperatures.

The Department also specifies several different asphalt mixture types. All asphalt mixtures in the state, with the exception of open-graded friction courses, are designed with the Superpave criteria. In Florida, Superpave mixtures consist of three nominal maximum aggregate sizes (9.5, 12.5, and 19.0 mm) and can be either coarse or fine graded. Mixture size is determined by the lift, thickness, and location. The traffic level of the pavement governs the type of gradation. Pavements with a design life of less than 10 million equivalent single axle loads (ESALs) are designated as traffic level A, B, or C and have fine gradations. Pavements with a design life of more than 10 million ESALs are designated as either traffic level D or E and are required to have coarse gradations.

TESTING AND RESULTS

A study was performed to determine the effect of different binder types on rutting resistance in the laboratory. Four binders were evaluated in the study: PG 67-22, PG 76-22, ARB-5, and ARB-12. The rutting resistance was measured using the Asphalt Pavement Analyzer (APA). The APA is pictured in Figure 1. Each binder was used in three different mixture types: a fine-graded 9.5 mm mix, a fine-graded 12.5 mm mix, and a coarse-graded 12.5 mm mix. Each mixture was designed at traffic level D (10 to 30 million ESALs) and consisted of the same aggregates in different proportions. The mixture properties and gradations are shown in Table 1 and Figure 2. The PG 67-22 and PG 76-22 binders were obtained from the same producer. Type B ground tire rubber was blended with the PG 67-22 in the laboratory to accurately produce the ARB-5 and ARB-12 binders.

Figure 1 – Pictures of the APA

Table 1 – Mixture Properties

Mixture	9.5 mm Fine-graded	12.5 mm Fine-graded	12.5 mm Coarse-graded
% S-1-A (87-089, code 41)	0	12	13
% S-1-B (87-089, code 51)	33	25	55
% Screenings (29-361, code 20)	50	48	32
Local Sand (Starvation Hill)	17	15	0
% AC	8.7	8.2	8.2
N_{design}	100	100	100
G_{mb} at N_{design}	2.175	2.182	2.162
G_{mm}	2.264	2.269	2.253
G_{sb}	2.350	2.346	2.311
VMA	15.5	14.7	14.1
FAA	45	45	48

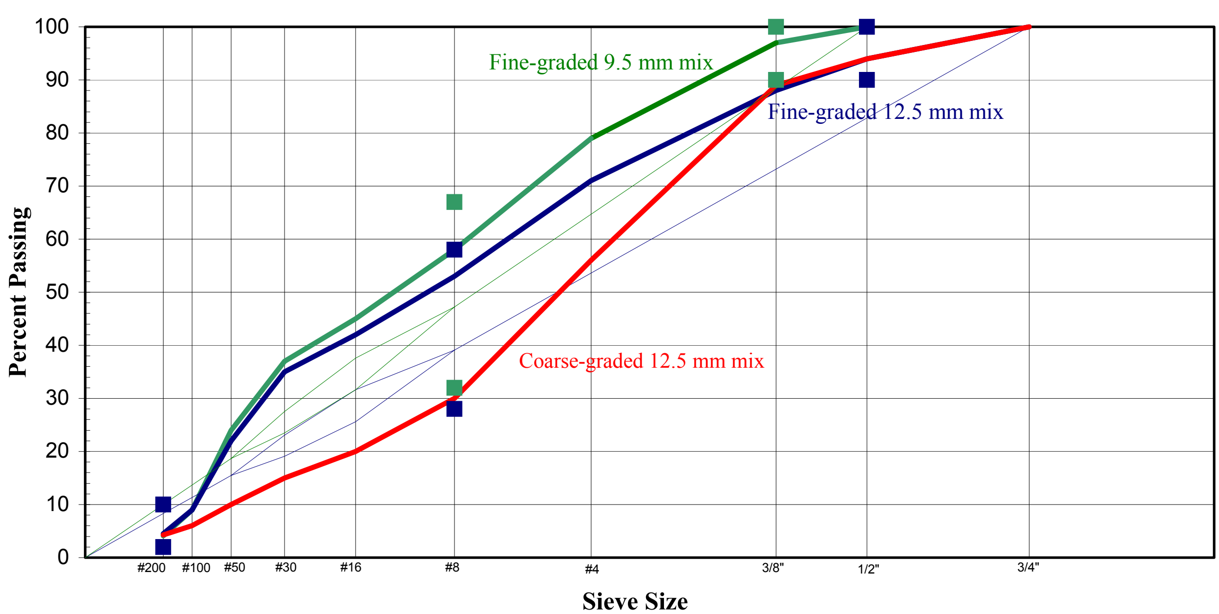

Figure 2 – Mixture Gradations

An attempt was made to determine the optimum asphalt content of each mixture with each binder according to normal mixture design procedures. Optimum asphalt contents were easily determined for each mixture with the PG 67-22 and PG 76-22 binders. More difficulty was encountered when attempting to determine the optimum binder content for the mixtures containing the ARB-5 and ARB-12 binders. Specimens compacted with either rubber binder "grew" significantly from the end of compaction until the bulk density was determined the next day. This "growth" or increased height ranged from 0.5 – 1.5 mm for the ARB-5 specimens and 1.5 – 3.0 mm for the ARB-12 specimens. Because of this "pill growth", the determined optimum binder content for the PG 67-22 mixes was also used for both rubber binders. This method is consistent with current design practices used for dense-graded friction courses, which contain ARB-5. However, this method may underestimate the optimum asphalt content for mixtures using ARB-12. Therefore, rutting samples were also prepared for both 12.5 mm mixes using ARB-12 at the optimum binder content of the PG 67-22 mixes + 0.5%.

All samples tested in the APA were cylindrical and were compacted to a height of approximately 75 mm and an air void content of 7.0 ± 1.0%. The air void tolerance for samples without rubber binder was 7.0 ± 0.5%. Because of the "pill growth", samples containing rubber binder needed the larger tolerance for air voids. All specimens were conditioned at 64°C for six to 24 hours prior to testing and were tested for 8000 cycles under the standard APA loading procedure. The results are shown in Table 2 and Figure 2. As expected, the mixture containing the PG 76-22 binder rutted less than the other mixtures containing the ARB-12, ARB-5, and PG 67-22 binders, respectively. The 12.5 mm coarse gradation performed the best followed by the fine-graded 12.5 mm gradation and then the 9.5 mm fine gradation. The 12.5 mm mixtures containing ARB-12 at two different asphalt contents performed about the same. Consequently, rut testing was not performed on the 9.5 mm fine-graded mix at an increased asphalt content.

Table 2 – Comparison of APA Rut Depths

	Rut Depth (mm)								
	PG 76-22			ARB 5			PG 67-22		
	Fine		Coarse	Fine		Coarse	Fine		Coarse
% AC	8.4	7.9	7.9	8.7	8.2	8.2	8.7	8.2	8.2
Specimen	9.5 mm.	12.5 mm	12.5 mm	9.5 mm.	12.5 mm	12.5 mm	9.5 mm.	12.5 mm	12.5 mm
1	2.1	2.2	1.3	3.9	4.3	2.6	5.8	4.6	2.5
2	2.6	2.2	0.9	3.8	3.9	2.4	6.7	3.4	3.1
3	2.1	2.1	1.3	4.4	3.8	2.2	6.0	3.6	2.7
4	2.4	2.1	1.0	4.6	4.2	2.4	5.3	3.2	2.8
5	2.6	2.3	1.5	4.2	3.3	2.4	5.8	4.1	3.7
6	2.6	2.3	1.0	3.8	3.2	2.4	5.6	4.6	2.8
Average	**2.4**	**2.2**	**1.2**	**4.1**	**3.8**	**2.4**	**5.9**	**3.9**	**2.9**

	ARB 12			ARB 12 (+0.5% AC)	
	Fine		Coarse	Fine	Coarse
% AC	8.7	8.2	8.2	8.7	8.7
Specimen	9.5 mm.	12.5 mm	12.5 mm	12.5 mm	12.5 mm
1	5.0	2.7	1.8	3.2	2.2
2	4.9	2.4	1.6	3.8	1.8
3	4.0	3.5	1.6	2.7	1.8
4	3.6	3.4	1.9	2.7	1.6
Average	**4.4**	**3.0**	**1.7**	**3.1**	**1.9**

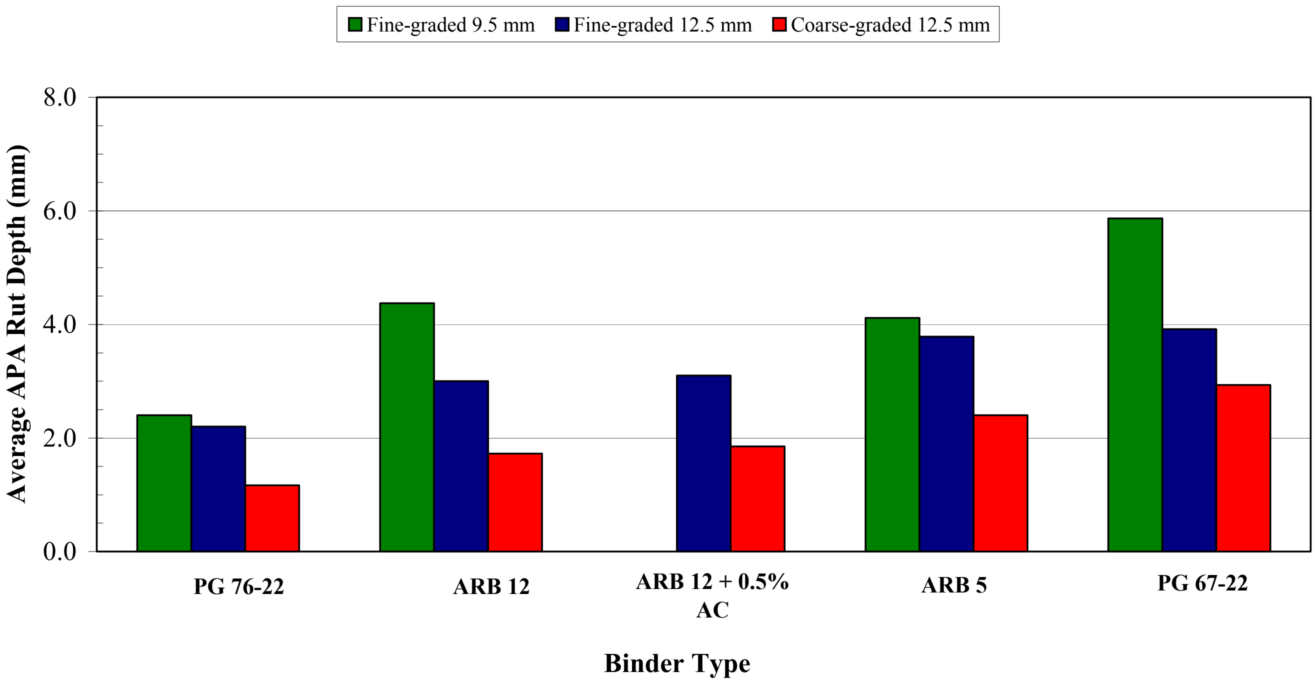

Figure 2 – Comparison of APA Rut Depths

CONCLUSIONS/RECOMENDATIONS

Based on data from this study, asphalt mixtures containing PG 76-22 performed the best in terms of rutting resistance in the APA. Use of polymer-modified asphalts should be considered on pavements that are expected to carry large volumes of heavy traffic. The data also supports the use of coarse-graded mixtures on high volume roadways, as is currently specified by the Department. While the specimens produced with ARB-12 performed better than the specimens containing ARB-5 and PG 67-22 binders, it is not recommended that it be used in any mixture other the open-graded friction courses. Too much difficulty was encountered trying to produce specimens containing ARB-12 for volumetric determination or performance analysis.

Polymer-modified, fine-graded mixtures performed slightly better than the unmodified coarse-graded mixture. Substituting a polymer-modified, fine-graded mixture for an unmodified coarse-graded mixture might be a valid option for traffic level D mixtures, where construction considerations justify the approach.

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