Asphalt Pavement Weathering System for Asphalt Mixtures

Junan Shen, Ph.D. Zhaoxing Xie, Ph.D Spencer Harp, M.Sc. Asphalt Research Laboratory, Georgia Southern University

ABSTRACT

Asphalt aging is one of the main factors deteriorating the durability of pavements. Many efforts have been made to simulate the asphalt aging in the pavement in the laboratory. In this study, a weathering system was built by following ASTM D 4799 – 03. The machine can simulate the asphalt aging by sunlight, rain, oxygen and heat through asphalt mixture samples instead of asphalt binder, as a result, with the effects of aggregate type and gradation on the aging. Porous European Mix (PEM) samples with SBS, Crumb Rubber Modifier (CRM) in dry process were aged in the weathering system for 1000 hrs. Selected properties of the aged samples and controls (no aging) were tested. Results indicated 1) Aged samples with SBS, crumb rubber in dry process have Cantabro loss of 18.3% and 24.7 %, respectively; 2) Aged samples with SBS, crumb rubber in dry process have rut depth of 1.75 mm and 1.73 mm after 8000 cycles in the APA, respectively

INTRODUCTION

Current methods of aging asphalt binder include Rolling Thin Film Oven Test (RTFOT) and Pressure Aging Vessel (PAV). However, these methods do not consider the aggregate-asphalt interactions. In addition, the field asphalt pavement was aged under the combined environment of light, water, and thermal cycling. The development of an advanced aging test method considering all these factors above will provide an useful tool for the assessment of the asphalt mixture aging. The objectives are to simulate the severe aging (light, oxidative and water induced) that occurs to the pavement in an accelerated manner, and to investigate the resistance to aging of PEM mixtures containing SBS and CRM.

ASPHALT PAVEMENT WEATHERING SYSTEM

- **Lighting**
  The Fluorescent lamps is of UV-B type as detailed in 6.1.3.3 of ASTM G154. Three ATI Dimmable SunPower T5 lighting ballasts of 47 inch long provide programmable lighting intensities.
- **Water**
  The asphalt pavement weathering system utilizes an 80 gallon, 42 gallon-per-day water distiller to ensure that the water quality is consistent, according to ASTM standard 4799
- **System Controller**
  At the heart of the Asphalt Pavement Weathering is the PLC Controller. This device activates and deactivates the lights, water pump, fans and water treatment devices. The parameters for this control come from the cycle requirements outlined in ASTM Standards 4799 and 4798.

Figure 1 Weathering device and control panel

RESULTS & DISCUSSIONS

1. Design of PEM mixtures

PEM mixtures were designed according to GDT 114. Rubberized PEM consists of 30 mesh crumb rubber at 10% of the weight of the asphalt cement, TOR polymer at 4.5% of the weight of the crumb rubber modifier, mineral fibers at 0.4% by weight of the total mix. Asphalt binder with PG 67-22, and crushed granite aggregates were used for the PEM. Optimum asphalt binder content (OAC) of rubberized PEM mixes in this report is found to be 6.0%. SBS asphalt mix consists of mineral fibers at 0.4% by weight of the total mix, SBS modified asphalt binder with PG 76-22, and crushed granite aggregates. OAC of SBS asphalt PEM mixes in this report is also found to be 6.0%.

2. Weathering test

The PEM samples containing SBS and CRM (added in dry process) were aged in the weathering device for 1000 hours, see Figure 2, left. Testing parameters used for this study are as follows: 51-min light exposure, 9-min light and water spray, sample temperature: 60C. Figure 2, right, is the sampled aged for 1000 hours.

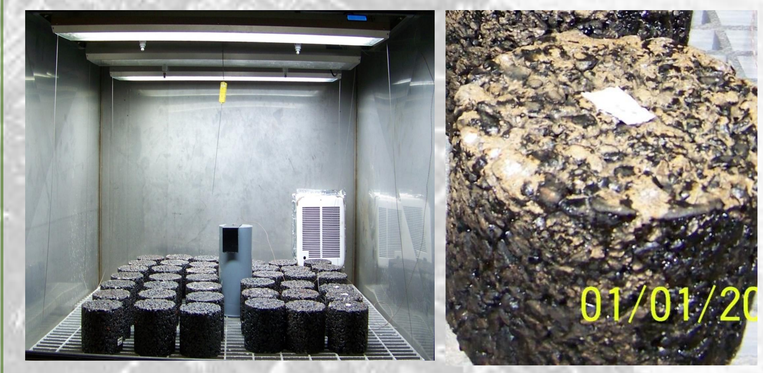

Figure 2 PEM samples in the weathering device and PEM sample after 1000 hours aging

3. Asphalt Pavement Analyzer (APA) test

Asphalt Pavement Analyzer (APA), Jr. from Pavement Technology, Inc., see Figure 3, was used to investigate the rutting susceptibility of asphalt mixtures containing SBS and CRM in dry process, according to GDT 115. Unaged samples were tested also. Figure 4 presented the testing results. The rutting depths of the samples unaged and aged after 1000 hours with SBS, crumb rubber in dry process are 1.70 mm and 1.72 mm , 1.75 and 1.73 mm after 8000 cycles in the APA, respectively. Overall, the rutting depths are very low, lower than the limit of 5 mm by GDOT. Having been Aged for1000 hrs, the samples did not change much of the rutting. In addition, the mixtures containing CRM in dry process performed equally to the mixtures with SBS with regarding to rutting resistance.

Figure 3 APA and samples after 8000 cycles

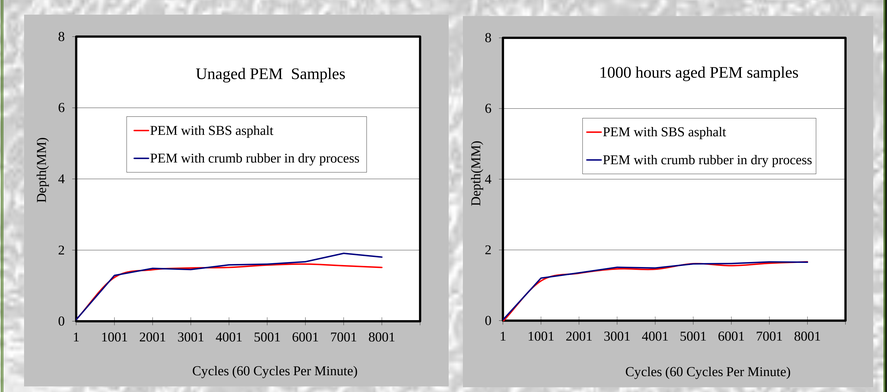

Figure 4 APA test results

4. Cantabro test

Three Superpave gyratory samples were used for Cantabro test. Cantabro loss was measured for the samples tested after 300 revolutions. Table 1 presented the testing results. The Cantabro loss was average 14.9% for unaged SBS samples, and is 17.7% for unaged CRM samples. The Cantabro loss increased to 18.3% for aged SBS samples, 24.7% for aged CRM samples. Aging of the PEM samples by the weathering for 1000 hrs increased the Cantabro loss 22.3% for SBS PEM samples, 39.0% for CRM PEM samples. In addition, the CRM had a higher Cantabro loss than SBS samples for both unaged and aged.

Table 1 Cantabro loss results

Sample No.	Cantabro loss %			
	SBS PEM		Crumb rubber PEM	
	Unaged	1000 hours aged	Unaged	1000 hours aged
Sample 1	10.3	15.9	19.7	29.5
Sample 2	16.4	22.2	18.6	26.1
Sample 3	18.1	16.7	15.0	18.5
Average	**14.9**	**18.3**	**17.7**	**24.7**

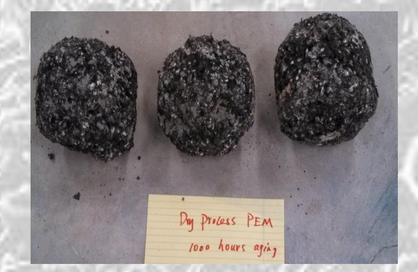

Figure 5 Aged CRM samples after Cantabro test

CONCLUSIONS AND FURTHER STUDY

1) All samples with SBS, crumb rubber in dry process have rut depth less than 2.0 mm, much less than 5.00 mm of the limit by GDOT after 8000 cycles in the APA. Weathering for the samples for 1000 hrs did not change the rutting.
2) The CRM samples have a higher Cantabro loss than SBS samples, for both unaged and aged samples. In addition, weathering has a bigger negative effect on the Cantabro loss.
3) Further Studies: A longer weathering time of 2,000 hrs will be applied for the samples before the evaluation of the mixture properties. Fatigue properties of PEM and SMA mixes after a standard weathering test will be performed using Asphalt Mixture Performance Tester (AMPT), see Figure 6.

Figure 6 AMPT

ACKNOWLEDGEMENT

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