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Laboratory Evaluation of Recycled Asphalt Pavement and Engineered Polymer Binder for Small Airfield Repairs †

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Abstract: Conducting small asphalt repairs on airfields in remote locations can be technically and logistically challenging. An alternative to cold patch products is using an engineered polymer binder (EPB) mixed with recycled asphalt pavement (RAP). This paper presents the results of a laboratory evaluation of EPB with both wet and dry RAP. Compacted specimens were tested for rut resistance, indirect tensile strength (ITS), and Cantabro mass loss (ML). The results indicate that RAP mixed with EPB exhibited substantial rut resistance with ITS and ML similar to that of conventional dense-graded asphalt. Overall, the EPB and RAP blend appears to be a promising alternative for airfield repairs.

Keywords: airfields; repair; laboratory; RAP; asphalt; maintenance

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1. Introduction

Conducting small-sized repairs on aged asphalt concrete on airfields in remote locations can be technically and logistically challenging, particularly if hot-mix asphalt (HMA) is utilized since it requires specialized equipment to produce. Cold patch products used on roadways are typically unable to support the high pass levels of aircraft with high wheel loads and tire pressures, particularly after only a few hours of curing [1,2]. Novel methods for producing small amounts of HMA quickly have been studied [3], including inductive HMA, which still requires specialized equipment, as well as a polymer-modified emulsion mixed with RAP that enables the repair product to be spray injected [4,5]. An alternative to HMA and cold patching is using an engineered polymer binder (EPB) mixed cold with recycled asphalt pavement (RAP) to produce a strong, durable repair with minimal equipment.

A recent research effort documented the use of 100% RAP millings stabilized with a specially designed polymer binder to produce a high-performing recycled asphalt mixture for roadway applications [6]. The proprietary EPB G5® is manufactured by Technisoil Inc. (Redding, CA, USA) and is liquid at room temperature, allowing it to be mixed with RAP millings, placed, and compacted, all without the addition of heat. Laboratory results indicated that the stabilized material showed high resistance to rutting and cracking [6]. A full-scale section consisting of RAP stabilized with G5® has also been constructed in Doha, Qatar, measuring 10 ft by 200 ft with traffic consisting of more than 1000 heavily loaded water trucks per day [7]. No construction related issues were reported, the material appeared to bond well, and visual surveys showed no pavement distress after 6 months of operations.

A mix design procedure was developed for determining the optimal Technisoil G5 content [6]. The procedure is a Marshall-based mix design procedure that begins with drying the RAP before compacting specimens at several binder contents for indirect tensile strength (ITS) and Marshall stability and flow testing. Once mixed, the specimens are compacted with 150 blows per side with a Marshall hammer before being cured and tested.

Anticipated usage in austere environments involves a scenario where only light compaction equipment may be available, so several changes to these procedures were implemented for the work described in this paper.

2. Materials and Methods

In order to evaluate RAP stabilized with EPB, RAP was first obtained from a local supplier and dried. The RAP source was a blend obtained from several asphalt milling operations in central Mississippi. The gradation of the RAP material was not obtained, but the gradation was likely similar to those provided in [8], who reported RAP gradations (without extraction) from several stockpiles in central Mississippi. The RAP material was screened over a 0.75 in sieve, and the oversize material was discarded before mixing with EPB. The EPB used was Technisoil G5®, the same product described previously.

EPB was added to the RAP and blended using a laboratory mixer capable of mixing materials in a 5 gal bucket before being batched and compacted in a gyratory compactor as shown in Figure 1. RAP was either used dry or moisture was added to achieve a RAP moisture content of 4% to represent "wet" RAP. In austere environments, RAP stockpiles could be exposed to moisture without a means of drying the material, so the effect of RAP moisture was important to this research effort. EPB binder contents of 3, 5, and 7% by dry weight of RAP were mixed with both dry and wet RAP. Specimens were compacted with 30 gyrations from a Superpave gyratory compactor. This 30 gyration compactive effort is notably less aggressive than that used by [6] and was selected to simulate light compaction equipment, as mentioned previously.

(**a**) (**b**) (**c**)

Figure 1. Batching, mixing, and compaction of RAP with EPB. (**a**) Addition of binder; (**b**) batching; (**c**) compacted specimen.

The weight of the mixed materials used to create each specimen was varied during preliminary testing so that compacted specimens would meet AASHTO T 340 dimensional criteria (approximately 75 by 150 mm) for evaluation via the asphalt pavement analyzer (APA). After compaction, specimens were cured in the mold in a 60 °C oven for 2 h, then extracted and placed back in the oven for an additional 22 h before being cured at room temperature for 24 h. Bulk density was measured via ASTM D6752, and average results are shown in Table 1.

After curing, all specimens were subjected to APA testing with an increased hose pressure (250 psi). However, after 8000 cycles, no measurable rutting was observed. Following APA testing, half of the specimens were subjected to Cantabro mass loss testing via ASTM D7064, and the other half were tested for indirect tensile strength (ITS) via ASTM D6931.

Table 1. Average G_{mb} results.

% Binder	% RAP Moisture	Avg G_{mb}
3	0	1.979
	4	2.079
5	0	2.038
	4	2.048
7	0	1.985
	4	1.986

3. Results and Discussion

As mentioned in the previous section, all specimens exhibited no measurable rutting after 8000 cycles of APA testing. Cantabro mass loss (ML) results are shown in Figure 2. For dry RAP, ML clearly decreased with increasing binder content. However, for wet RAP, ML increased when binder content increased from 3 to 5 percent, but then decreased at 7 percent. Historically, the Cantabro test was initially utilized primarily for open-graded friction coarse HMA mixtures, for which a maximum ML of 20% was suggested [9]. The results in Figure 2 were all well below 20% and were mostly similar to the dense-graded asphalt (DGA) Cantabro results [10–12].

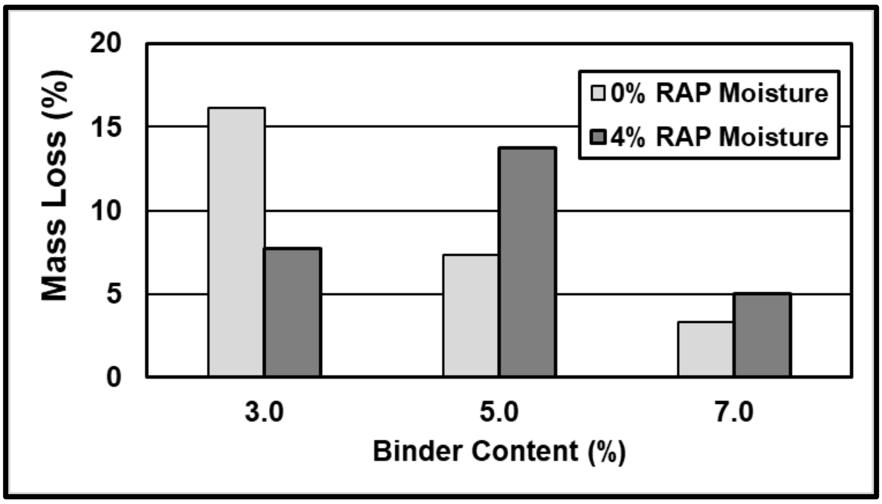

Figure 2. Average Cantabro mass loss results.

The ITS results are presented in Figure 3. The average ITS increased slightly with binder content for dry RAP, but ITS was similar for wet RAP at 3 and 5 percent binder contents. The ITS also decreased considerably at 7 percent binder content. Overall, with the exception of wet RAP at 7 percent binder content, the ITS results ranged from 149 to 226 psi. Other research groups reported a range of ITS for DGA at room temperature of approximately 150 to 200 psi, which is similar to the data presented in Figure 3 [13,14]. The ITS of a cold patch product averaged approximately 10 psi, which is much lower than the RAP–EPB mixture [1].

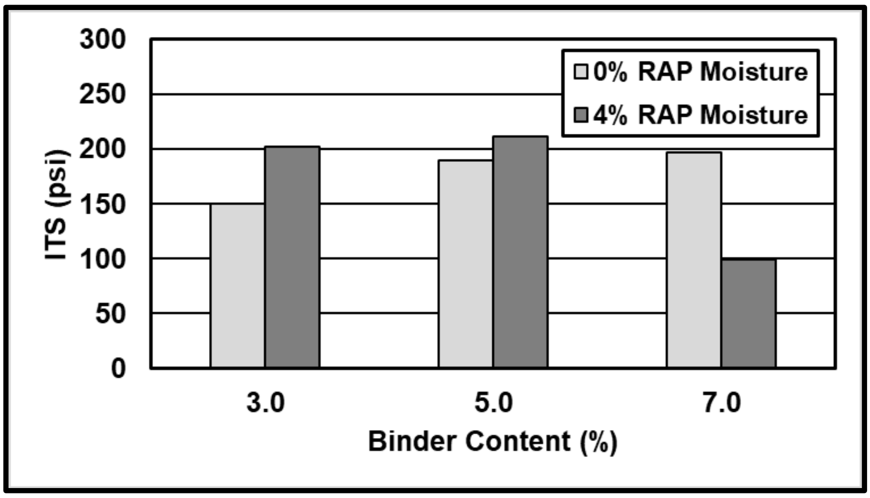

Figure 3. Average ITS results.

4. Conclusions and Recommendations

Overall, the results indicate that EPB mixed with RAP could be a suitable material for conducting small airfield repairs in locations where obtaining quality HMA from a plant is difficult. APA results indicate that once cured, this material should be able to resist rutting even when trafficked with high tire pressure aircraft. This initial investigation indicates that an EPB binder content of approximately 5% may be suitable for most RAP millings less than 0.75 in., with increased repair durability when dry RAP millings are utilized. Additional work is recommended to further investigate the effectiveness of the binder at various RAP moisture contents, as well as conducting a full-scale evaluation with simulated aircraft loads.

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