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Laboratory short-term aging protocol for plant-mixed and laboratory compacted samples

Soohyok Im *, Fujie Zhou

Texas A&M Transportation Institute, College Station, TX 77843-3135, United States

HIGHLIGHTS

- Laboratory aging protocol for plant-mixed and laboratory compacted samples.
- Impacts of laboratory oven aging conditions on engineering properties of asphalt mixes.
- Practical laboratory aging time and container size for sampling plant mixes.

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ABSTRACT

It is well known that oven aging conditions (temperature and time) have significant influence on both engineering properties and field performance of asphalt mixes, and they also affect volumetric properties. Correspondingly, the oven aging temperature and time are critical to asphalt mix design, quality control, and engineering properties used for pavement design and performance prediction. This paper presents a tremendous laboratory effort to make recommendations on laboratory short-term aging protocol for plant-mixed and laboratory compacted (PMLC) specimens. To this end, various laboratory tests, including Hamburg wheel tracking test, Overlay test, indirect tensile strength test, resilient modulus test, and dynamic modulus test were performed to compare the engineering properties of PMLC specimens to those of plant-mixed and field compacted (PMFC) field core specimens at different aging stages. The test results and recommended oven aging time were presented and discussed in this paper.

1. Introduction

The environmental factors such as temperature and moisture over time have significant impact on asphalt mix properties and field performance. Asphalt mixes experience aging through oxidation under various environmental conditions during their in-place service lives. Oxidation is a type of chemical reaction between asphalt binder and oxygen that changes the stiffness of the asphalt binder and engineering properties of asphalt mixes. Hardening (or aging) of the original asphalt binder due to oxidation is extremely complicated phenomena because of the various environmental factors involved. This issue is more complicated when reclaimed asphalt pavement (RAP) and recycled asphalt shingles (RAS) are used in asphalt mixes. However, it is generally understood that this hardening of the asphalt binder and asphalt mix makes the pavement more prone to cracking in the field. Many researchers have made tremendous efforts to investigate the effect of aging on asphalt mixes and field performance [1–7].

One way to account for the changes in the mix properties due to aging is to establish proper laboratory aging protocols, since the oven aging temperature and time are critical to asphalt mix design, quality control, and engineering properties used for pavement design and performance prediction. Samples should be fabricated in the laboratory as close as possible to core samples obtained from the field so that density and performance tests can be run with confidence. Current laboratory short-term aging procedures (such as AASHTO R 30) simply keep the mix at an elevated temperature for a period of time (typically 2 or 4 h) before compacting them to a known density, regardless of warm mix asphalt mixes or mixes containing RAP/RAS [8]. Dealing with more and more asphalt mixes either containing recycled materials or produced with warm mix technologies, many states of Department of Transportation (DOT) are increasing reliance on performance tests (such as Hamburg wheel tracking test, Overlay test, indirect tensile strength test, resilient modulus test, or dynamic modulus test) for mix design and mix acceptance. Additionally, many studies have used the plant-mixed and laboratory-compacted (PMLC) samples for calibrating and validating performance models (such as fatigue cracking model, rutting model, etc.). In order to have confidence

* Corresponding author.
E-mail addresses: s-im@tamu.edu (S. Im), f-zhou@ttimail.tamu.edu (F. Zhou).

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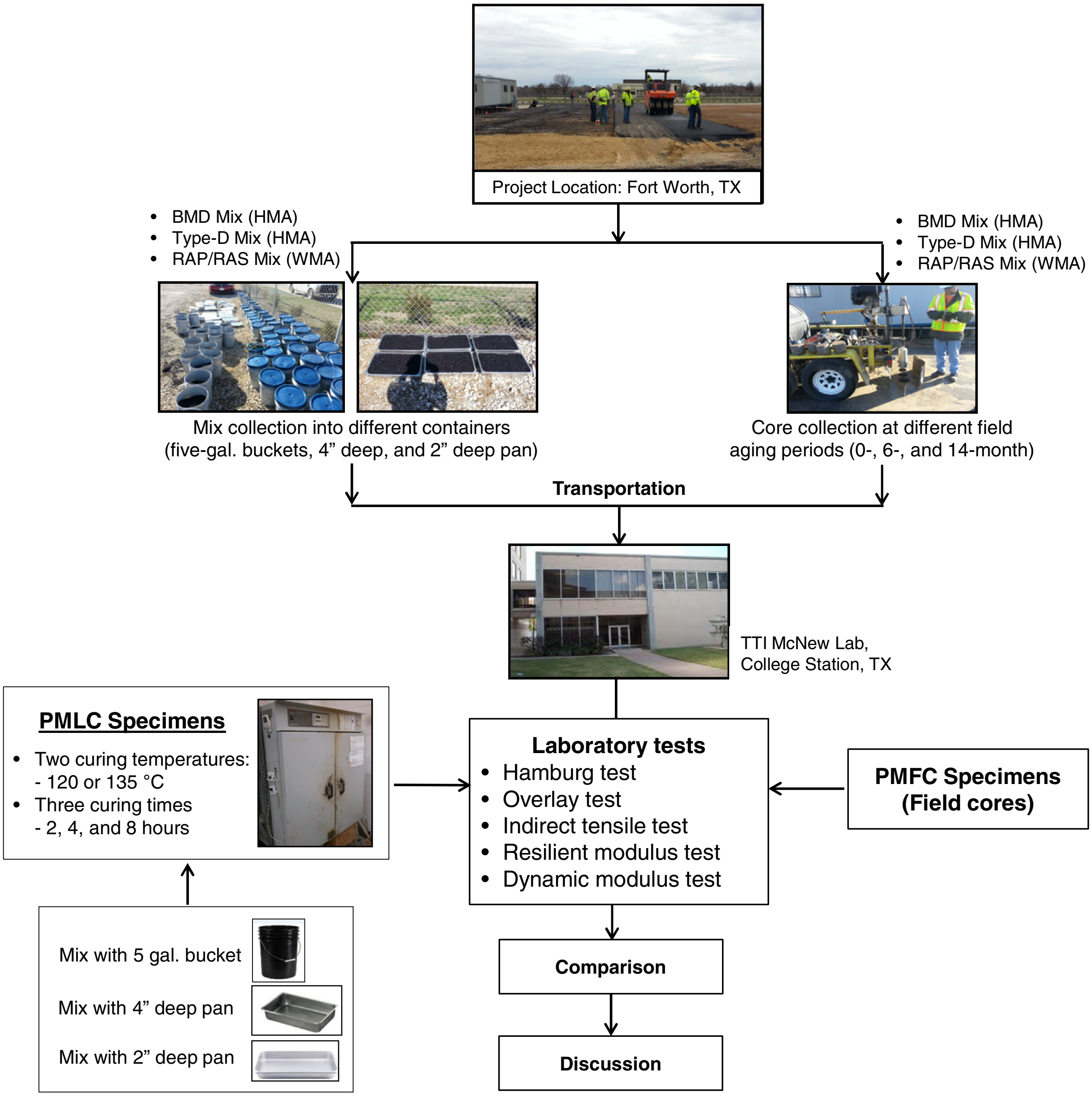

Fig. 1. Research methodology.

in the results obtained from these tests, it is critical to establish proper method of aging samples particularly for those obtained for the trial batch or those pulled from behind the paver. Past experiences have clearly indicated that large differences in test results can potentially occur, depending on the size of sampling container, aging and sample age at the time of testing. It is also critical for DOTs to have defensible aging protocols as the performance tests may be used in "remove and replace" decisions.

2. Research objectives

The main objective of this study was to establish a laboratory aging protocol for PMLC samples so that the PMLC samples can have similar engineering properties to plant-mixed and field compacted (PMFC) cores. To achieve such objective, it is critical to evaluate the relationship of the engineering properties of PMLC samples at different laboratory aging conditions, and then compare with the actual field cores taken soon after placement and different service ages. Additionally, this study investigated the effect of sampling container size on engineering properties of asphalt mixes.

3. Research methodology

Fig. 1 describes the research methodology employed in this study. Three dense-graded asphalt mixes were selected in this study: a virgin Type-D mix produced at hot-mix temperature, a Type-D mix with RAP and RAS produced at warm-mix temperature, and a Type-D mix with RAP and RAS designed using the balanced mix design method (BMD) and produced at hot-mix temperature. All plant mixes were sampled at the construction site during the construction time in February 2013. Plant mixes were brought back to the Texas A&M Transportation Institute (TTI) McNew lab and reheated to fabricate specimens at the field compaction temperatures. To investigate the effect of sampling