PROJECT SUMMARY REPORT

0-7061: Optimizing Laboratory Curing Conditions for Hot Mix Asphalt to Better Simulate Field Behavior

Background

The engineering properties of asphalt mixtures change with time. Shortly after placement, asphalt concrete (AC) layers become susceptible to rutting. As the pavement ages, the AC layer becomes stiffer, brittle, and thus more vulnerable to cracking. The Texas Department of Transportation (TxDOT) provides guidelines for the selection of materials, the determination of the material proportions (e.g., aggregates and binder content), and for the evaluation of the engineering properties (e.g., cracking and rutting potentials) of any given asphalt mix design. However, TxDOT specifications do not provide any check or guidance on the impact of long-term aging on the performance of mixtures.

The main goals of this study were to develop and implement optimized, representative, and practical laboratory aging protocols that improve the mix design process leading to the production and placement of long-lasting, stable, and durable asphalt mixtures. Additionally, to investigate the influence of mixture related factors on aging protocols and concomitant performance metrics.

What the Researchers Did

To achieve these objectives, a literature review was conducted to compile some of the most recent advancements and findings related to the aging of loose asphalt mixtures. Based on that review, the following protocols were selected for further evaluation in this study: Protocol 1: Loose mixture aging in a laboratory oven at a temperature of 95oC; Protocol 2: Loose mixture aging using a pressurized chamber; Protocol 3: Loose mixture aging using an oxidative environment.

A robust experimental analysis was formulated and corresponding aging indices, and acceptance limits to determine the variation in the engineering properties of different asphalt mixtures and associated asphalt binders after simulated long term aging were determined. The parameters for the above protocols were developed after extensive testing with different experimental variables and comparing mixture and binders results to established benchmarking tests. Lastly, Laboratory and field performance data was used to verify the simulated field-aging conditions of laboratory-produced, plant-produced, and field-compacted asphalt mixtures and concomitant asphalt binders.

What They Found

The main focus of this study was on long term aging and its impact on cracking performance. To that end it was found that Protocol 1 is a promising protocol for routine testing, but it is impractical to wait prolonged periods to determine a mixture's susceptibility to cracking. For Protocol 1, mixture and corresponding binder tests showed a consistent increase in aging related metrics with increased testing time. Figure 1 illustrates the comparison of NCHRP and their respective performance tests (Indirect Tensile - IDT, IDEAL-CT CT-Index, Overlay by measuring crack propagation - CPR and crack initiation - CFE).

The steady-state of aging i.e., the aging time and duration after which the relative rank order of cracking performance does not change for different mixes may be adequately reflected after a period of

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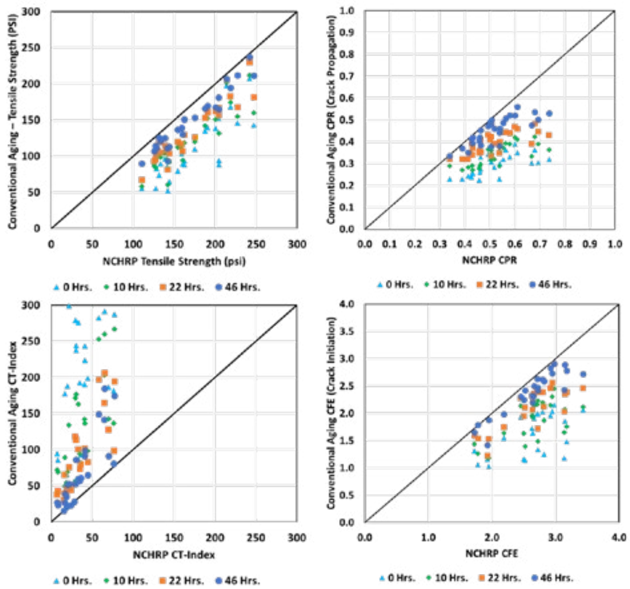

Figure 1 - Performance Test Results for Traditional Oven Aging of Mixtures Compared to NCHRP Results as Benchmark

24 hours under Protocol 1 (including 2 hours of short-term aging). Additionally, the rate of change of rutting characteristics are minimal beyond 2 hours of short-term oven aging.

The efficiency of Protocols 2 and 3, pressure aging and ozone gas, has been clearly demonstrated on the mix and binder respectively. Protocols 2 and 3 may be considered as a more efficient alternative for day-to-day operation of more realistically simulating long-term aging. Figure 2 illustrates the efficiency of the pressure device and can be used to more accurately characterize the performance of mixes under long-term aging within a time frame of 24 to 48 hours.

What This Means

Protocol 1 can be recommended as a testing method that can be employed during routine mixture study for

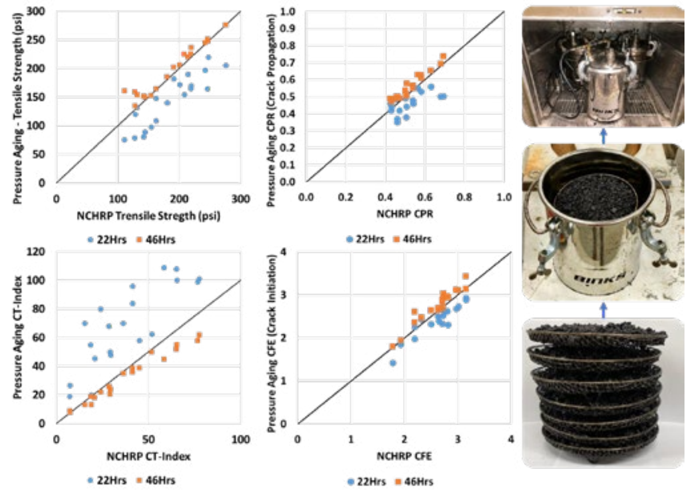

Figure 2 - Performance Test Results for Accelerated Pressure Aging of Mixtures Compared to NCHRP Results as Benchmark.

relative rank order of mixes. The steady state of aging for different mixes can be achieved after a period of 24 hours under Protocol 1 (including 2 hours of short-term aging).

Protocol 2 for mixtures and Protocol 3 for binder showed great promise for a more realistic longterm accelerated aging of mixtures within a short period. This effort is a large step in having laboratory specifications for predicting long term cracking. The accelerated aging process for mixtures that was developed under this research is ready with minor transformations to an advanced stage in terms of implementation readiness, and development of optimized laboratory specifications.

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