ALDOT-459

Alabama Cracking Test for HMA (AL-CT)

1. Scope

1.1. This method describes a procedure for testing laboratory prepared or plant mixed samples of Hot Mix Asphalt (HMA) for resistance to cracking via an indirect tensile method on a Marshall press.

2. Referenced Documents

2.1. AASHTO Standards

- AASHTO R 30 Mixture Conditioning of Hot Mix Asphalt
- AASHTO T 47 Reducing Sample of Asphalt Mixtures to Testing Size
- AASHTO T 97 Sampling Asphalt Mixtures
- AASHTO T 166 Bulk Specific Gravity (Gmb) of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens
- AASHTO T 209 Theoretical Maximum Specific Gravity (Gmm) and Density of Asphalt Mixtures
- AASHTO T 312 Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor

2.2. ASTM Standards

- ASTM D6931 Standard Test Method for Indirect Tensile (IDT) Strength of Asphalt Mixtures
- ASTM D8225 Determination of Cracking Tolerance Index of Asphalt Mixture Using the Indirect Tensile Cracking Test at Intermediate Temperature

2.3. NCHRP documents

- NCHRP IDEA Project 195 Development of an IDEAL Cracking test for Asphalt Mix Design, Quality Control and Quality Assurance

3. APPARATUS

3.1. A Gyratory compactor and accessories conforming to AASHTO T 312

3.2. Equipment for determining the theoretical maximum specific gravity (G_{mm}) conforming to AASHTO T 209

3.3. Balance and water bath conforming to AASHTO T 166

3.4. A load press such as a Marshall press that can maintain a displacement rate of 2in./min (50mm/min), and that records a graph of load vs displacement for the entire test at a minimum of 40 Hz. Digital recordings are preferred. A paper graph can be used; however, it makes the calculations considerably more difficult.

3.5. An indirect tensile strength loading fixture compliant with ASTM D6931

3.6. Calipers capable of measuring the height and diameter of the specimen to 0.01 in.

3.6.1. Height measurements may also be taken using the gyratory compactor's internal height measurement system.

4. Sample Preparation

4.1. Aging of mix

4.1.1. Laboratory prepared samples should be aged prior to compaction according to AASHTO R 30 7.2 Short-Term Conditioning for Mixture Mechanical Property Testing.

4.1.1.1. Spread the mixture in a pan to an even thickness between 25 and 50mm (1 and 2in.). Place the mixture and pan in the conditioning oven for 2 hours ± 5 minutes at a temperature of 135°C ± 3 °C (275°F ± 5°F).

4.1.1.2. Stir every 60 ± 5 min to maintain uniform conditioning

4.1.1.3. After 2 hours ± 5 min, remove the mix from the oven. The conditioned mixture is now ready for compaction.

4.1.2. Plant Mixed samples need no conditioning and should be compacted after being reheated to their compaction temperature.

4.2. Prepare 3 replicant specimens in accordance with AASHTO 312.

4.2.1. If the Maximum aggregate size is 1 ½ in. (37.5 mm) or larger prepare samples that are 150mm in Diameter and 95mm +/- 1mm height and at the laboratory designed air void content of 7% +/-0.5% as determined by AASHTO T 312.

4.2.2. If the Maximum aggregate size is less than 1 ½ in. (37.5 mm) prepare samples that are 150mm in Diameter and 62 mm ± 1mm height and at the laboratory designed air void content of 7% ± 0.5% as determined by AASHTO T 312.

5. Procedure

5.1. Measure and record the specimen height at 3 evenly spaced locations around the circumference. The specimen height reported by the gyratory compactor may also be used.

5.2. Measure and record specimen diameter for verification.

5.3. Condition the specimen at the test temperature 25°C ± 1°C (77°F ± 2°F) for 2 hours ± 10 minutes.

5.4. Remove each specimen from the conditioning chamber one at a time leaving the others to remain at the test temperature. Place the specimen carefully onto the lower loading strip. Slowly lower the top loading strip to bring it into contact with the specimen. Ensure that the loading strips are parallel and centered vertically on the diameter of the specimen on both sides. The specimen shall be tested within 4 minutes of removal from the chamber.

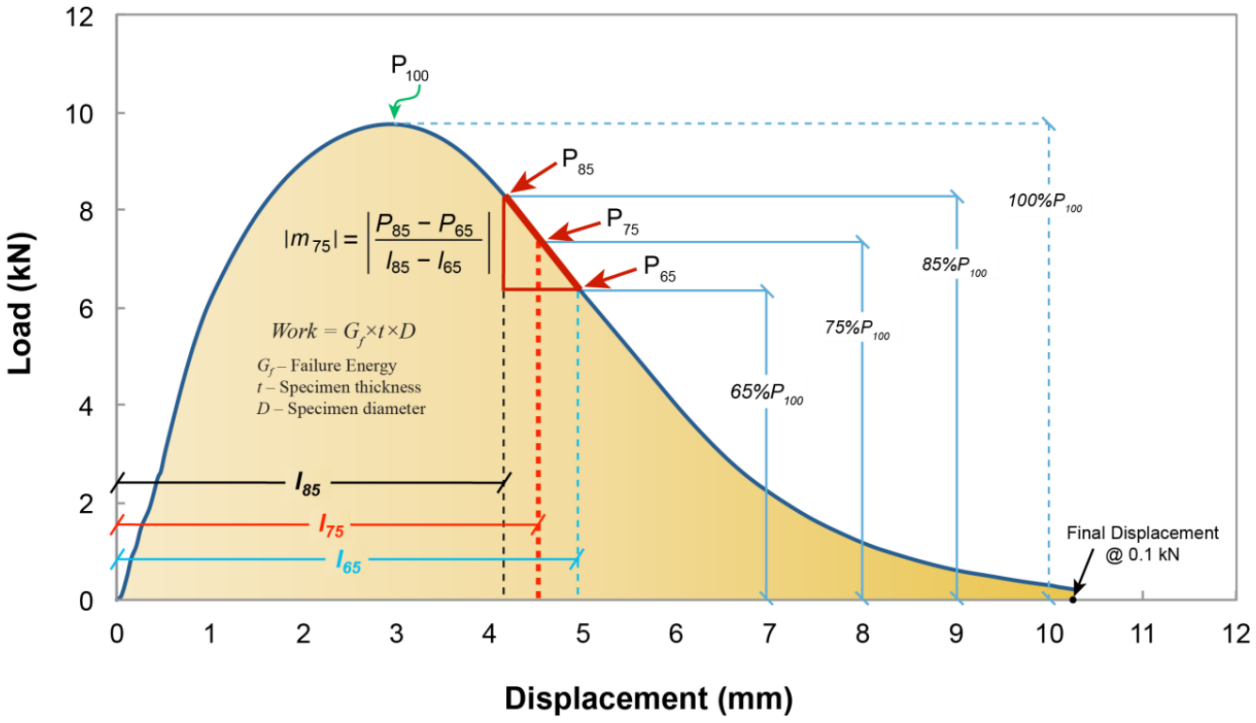
5.5. Apply a vertical load to the test fixture with a displacement of 2 in./min. until the applied force drops to 100 N (approximately 22.5 lbf)

5.6. Retain the graph of the force vs displacement curve.

6. Calculation

Note: it is recommended that a computer method such as a spreadsheet or testing software be used to make calculations for this test.

Illustration of the Load vs Displacement curve:



6.1. Calculate the Work of failure W_f as follows:

$$W_f = \sum_{i=1}^{n-1} \left((l_{i+1} - l_i) \times P_i + \frac{1}{2} \times (l_{i_1} - l_i) \times (P_{i+1} - P_i) \right)$$

Where:

P_i = applied load (kN) at the i load step application

P_{i+1} = applied load (kN) at the i+1 load step load step application

l_i = LLD (mm) at step i

l_{i+1} = LLD (mm) at step i+1

From NCHRP 195 appendix A

6.2 Calculate the failure energy G_f as follows:

$$G_f = \frac{W_f}{D \times t} \times 10^6$$

Where:

G_f = failure energy (Joules/m^2)

W_f = work of failure (Joules)

D = specimen diameter (mm)

T = specimen thickness (mm)

6.3 Post-peak slope (m_{75}) is the slope of tangential zone around the 75 percent peak load point (P_{75}) after the peak calculated by:

$$m_{75} = \frac{P_{85} - P_{65}}{l_{85} - l_{65}}$$

Were:
P_{85} = 85 percent of the peak load (kN)
P_{65} = 65 percent of the peak load (kN)
l_{85} = displacement at 85 percent of the peak load after the peak (mm)
l_{65} = displacement at 65 percent of the peak load after the peak (mm)

6.4 Deformation tolerance (l_{75}) is the displacement at 75 percent peak load (P_{75}) after the peak.

6.5 Cracking tolerance index (CT_{Index}) is calculated from the parameters obtained using the load-displacement curve, as follows:

$$CT_{Index} = \frac{t}{62} \times \frac{l_{75}}{D} \times \frac{G_f}{|m_{75}|} \times 10^6$$

Where:
CT_{Index} = cracking tolerance index
G_f = failure energy (Joules/m^2)
$|m_{75}|$ = absolute value of the post peak slope m_{75} (N/m)
l_{75} = displacement at 75 percent of the peak load after the peak (mm)
D = specimen diameter (mm)
t = specimen thickness (mm)

Note: t / 62 is a correction factor for specimen thickness. 10^6 is a scale factor.

7. Report

7.1. Report the following:

7.1.1. JMF number

7.1.2. Each measured and average height and diameter of the specimens to the nearest 0.1 mm

7.1.3. Test temperature to the nearest 1°C

7.1.4. Specimen air voids

7.1.5. m_{75} post peak slope N/mm

7.1.6. l_{75} deformation tolerance mm

7.1.7. G_f failure energy Joules/m^2

7.1.8. W_f work of failure Joules

7.1.9. CT_{Index} cracking tolerance index