**Evaluation of Asphalt Mixture Crack Propagation
using the Semi-Circular Bend Test (SCB)
DOTD Designation TR – 330-14**

I. SCOPE

A. This test method covers procedures for the preparation, testing, and measurement of fracture failure of semi-circular asphalt mixtures.

B. This standard may involve hazardous material, operations, and equipment. This standard does not purport to address all safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

II. Reference Documents

A. AASHTO STANDARDS

PP 2, Practice for Mixture conditioning of Hot Mix Asphalt (HMA)

T 67, Standard Practices for Load Verification of Testing Machines

T 166, Bulk Specific Gravity of Compacted Hot Mix Asphalt Using Saturated Surface-Dry Specimens

T 168, Sampling Bituminous Paving Mixtures

T 209, Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)

T 269, Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

T 312, Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

III. Summary of Test Methods

A semi-circular specimen is loaded monotonically until fracture failure. The load and deformation are continuously recorded and the critical strain energy rate, J_c, is determined.

IV. Significance and Use

A. The critical strain energy rate is used to compare the fracture properties of asphalt mixtures with different binder types.

B. This fundamental engineering property can be used as a performance indicator of fracture resistance based on fracture mechanics, the critical strain energy release rate, also known as J_c value.

V.   Apparatus

A.   Load Test System- A load test system consisting of a testing machine, environmental chamber, and data acquisition system. The test system shall meet the minimum requirements specified below.

B. Testing Machine- The testing machine should be a closed loop system capable of applying a 4.5kN load monotonically under a constant cross-head deformation rate of 0.5 mm/min in a three point bend load configuration

C. Environmental Chamber- A chamber for controlling the test specimen at the desired temperature is required. The environmental chamber shall be capable of controlling the temperature of the specimen at 25°C to an accuracy of +/- 1ºC.

D. Measurement System- The system shall include a data acquisition system comprising analog to digital conversion and/or digital input for storage and analysis on a computer. The system shall be capable of measuring and recording the time history of the applied load for the time duration required by this test method. The system shall be capable of measuring the load and resulting deformations with a resolution of 0.5 percent.

     a.   Load- The load shall be measured with an electronic load cell having adequate capacity for the anticipated load requirements. The load cell shall be calibrated in accordance with AASHTO T67.

     b.   Axial Deformations- Axial deformations shall be measured with linear variable differential transformers (LVDT).

     c.   Temperature- Temperature shall be measured with Resistance Temperature Detectors (RTD) accurate to within +/- 1ºC

E. Gyratory Compactor- A gyratory compactor and associated equipment for preparing laboratory specimens in accordance with AASHTO T 312 shall be used.

F. Saw- The saw shall be capable of producing three different notch sizes ranging from 0 – 50 mm. The width of the saw blade shall be 3.0mm.

G. Loading Frame- The loading frame shall consist of a loading rod and two sample support rods. The schematic of the test apparatus is shown in Figure x (need permission from ATM). The diameters of the loading and supports rods shall be 25.4 mm and the anvil span shall be 127.0 mm.

VI.   Test Specimens

A. Semi- circular bend testing may be performed on field cores or laboratory prepared test specimens.

B. Specimen Size- The test specimen shall be 150mm diameter and 57 mm thick

a. The semi-circular shaped specimens are prepared by slicing the 150mm by 57mm specimen along its central axis into two equal semi-circular samples

b. Field cores can also be used if pavement is at least 57 mm.

C. Notching- A vertical notch is introduced along the symmetrical axis of each semi-circular specimen. The three nominal notch sizes are 25.4 mm, 31.8 mm, and 38.1 mm. The notch depth tolerance is ± 1.0 mm. The width of the notch shall be 3.0 ± 0.5mm

D. Prepare four test specimens at the target air void content ±0.5%

E. aging- Laboratory-prepared mixtures shall be temperature-conditioned in accordance with the oven conditioning procedure outlined in AASHTO PP2. Field mixtures need not be aged prior to testing.

F. Air Void Content- Prepare four test specimens at the target air void content ±0.5%.

G. Replicates- Four specimen should be tested at each at each notch depth (25.4-, 31.8-, and 38.1-mm).

VII.   Procedure

A. Place the specimen on the bottom support, ensuring the support is centered and level (as shown in **Figure 1**), in the environmental chamber and allow it to stabilize to 25ºC. A dummy specimen with a temperature sensor mounted to its center can be monitored to determine when the specimen reaches 25ºC. In the absence of a dummy specimen, a minimum of 0.5 hours from room temperature is the required temperature equilibrium time.

B. After temperature equilibrium is reached, apply a preload of 10 lb to specimen to ensure the sample is seated properly. After ensuring the sample is level, release the load.

C. Begin to apply load to specimen in displacement control at a rate of 0.5 mm/min ensuring that time, force, and displacement are being collected and recorded. During the test have the load versus displacement plot visible, paying close attention to the peak load. Test may be terminated 120 seconds after peak load is reached.

VIII.   Calculations

A. The critical value of J-integral (J_c) is determined using the following equation:

$$J_c= -\left(\frac{1}{b}\right)\frac{dU}{da}$$

where:

b = sample thickness

a = notch depth

U = strain energy to failure.

Strain energy to failure, U is the area under the loading portion of the load vs. deflection curves, up to the maximum load measured for each notch depth (shown in

    a.   **Figure 2)**.

B.   The specimens are randomly clustered into 4 groups of three (one specimen at each notch depth within the grouping) before testing. Each cluster of three notch depths may be analyzed individually. The three values of U (one at each notch depth) are plotted versus their respective notch depths. The data is then modeled with a linear regression line.(shown in **Error! Reference source not found.**). The slope of the linear regression line represents the strain energy release rate.

C.   The critical value of J-integral (Jc) then computed by dividing the slope of the linear regression line (dU/da) by the specimen thickness, b.
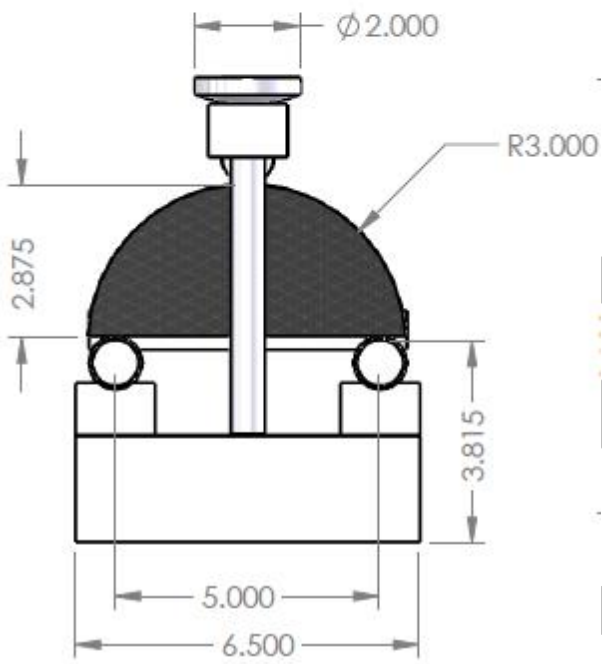
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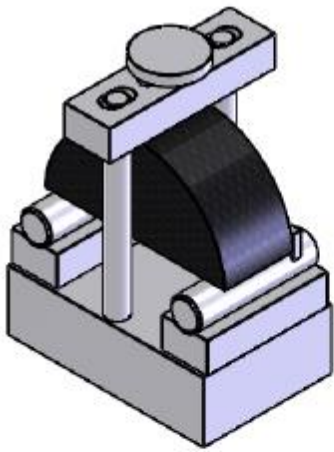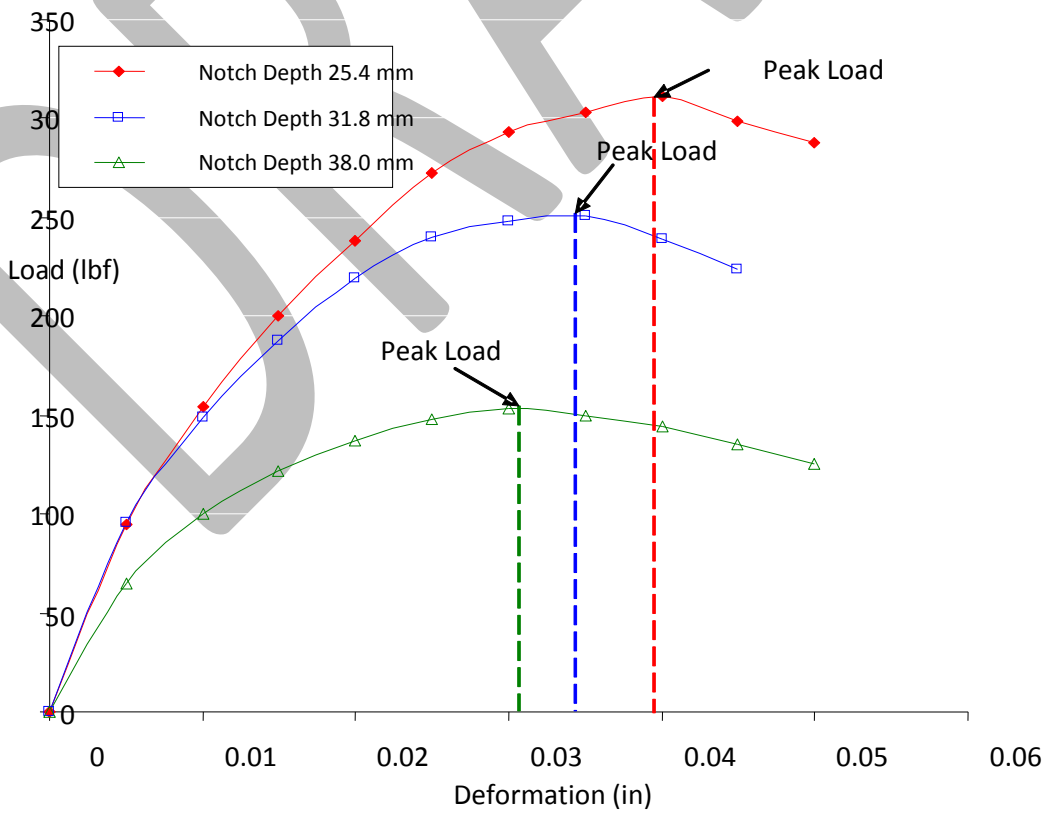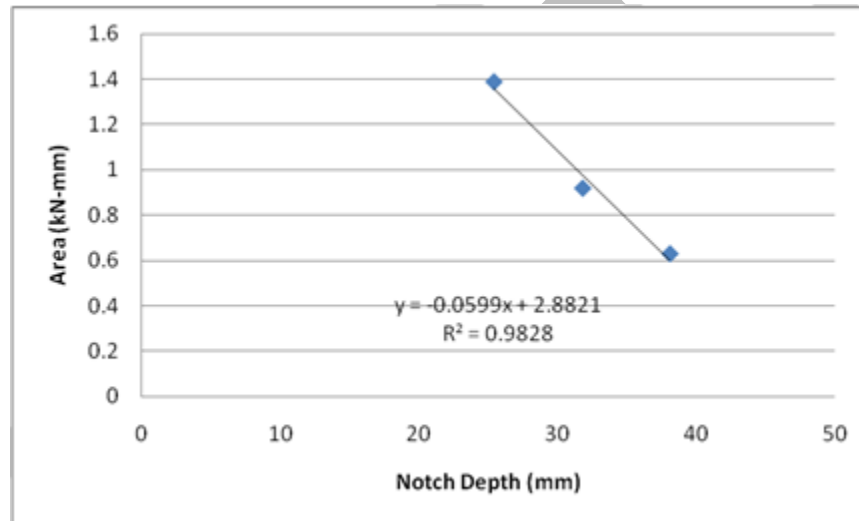2.875

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5.000

6.500

Figure 1: Loading Position

Figure 2: Deformation versus Load

Figure 3: Notch Depth versus Area

IX.   Report

A. *The report shall include the following parameters*:

   a. Asphalt Mixture Type
   b. Test Temperature, °C
   c. Specimen Air Voids, %
   d. Ic per Notch Depth, kJ/m^2;
   e. Coefficient of Determination, R^2
   f. Mean Jc Value, kJ/m^2;
   g. Standard Deviation of Jc;
   h. Coefficient of Variation,%.