

State of Nevada
Department of Transportation
Materials Division

METHOD OF TEST FOR TOUGHNESS AND TENACITY OF POLYMER MODIFIED ASPHALT

SCOPE

This method covers the procedure for measuring the toughness and tenacity of bituminous materials.

SUMMARY OF TEST METHOD

A tension head of specified size and shape is separated from an asphalt sample at a rate of 50 cm/min (20 in./min). A continuous record of the force versus elongation curve is made and used to calculate the toughness and tenacity of the sample.

SIGNIFICANCE

This test method is useful for confirming that asphalt cement has been modified with an elastomeric polymer. Elastomer modified asphalts can be characterized by their ability to be stretched to a large elongation while at the same time resisting further stretching. Toughness and tenacity are two parameters for measuring this ability.

APPARATUS

1. Containers, 89 mL (3 oz) cylindrical seamless metal containers, with an approximate diameter of 54 mm (2 1/8 in.) and depth of 33 mm (1 5/16 in.).
2. Tension Head, consisting of a polished stainless steel hemispherical head with an 11.1 mm (7/16 in.) radius. This is integrally connected to a 6.4 mm (1/4 in.) diameter stem, approximately 52.4 mm (2 1/16 in.) long, which is connected to the testing machine adaptor. The stem of the tension head shall be fitted with a small pin to prevent twisting of the head while adjusting the height. (See Figure 1)
3. Spider Assembly, this support for the tension head shall consist of a cylindrical center section through which the stem of the tension head may freely move parallel to the axis of the cylinder. The inner wall of the cylinder shall be grooved to receive the pin mounted on the stem of the tension head in order to prevent twisting of the head during height adjustment. The spider shall be fitted with three arms, equally spaced at 120°, extending from the center and notched to receive the lip of the sample container, thus centering the spider and the tension head in the sample container. (See Figure 1)

4. Lowering Screw, the tension head shall be fitted with a knurled lowering screw to permit accurate adjustment of the tension head height in the sample container. (See Figure 1)
5. Testing Machine, a tensile tester capable of separating the tension head from the asphalt sample at a uniform rate of 50 cm/min (20 in./min). The maximum load capacity shall be at least 22.7 kg (50 lb). The testing machine shall provide a continuous graphic recording of the force versus elongation curve. The tensile tester must have an effective pull length of 76 cm (30 in.) after installing the sample holder.
6. Water Bath, capable of maintaining a temperature of $25 \pm 0.1^{\circ}\text{C}$ ($77 \pm 0.2^{\circ}\text{F}$) is required. The bath shall have a perforated shelf supported in a position not less than 50 mm (2 in.) from the bottom and not less than 100 mm (4 in.) below the liquid level.
7. Oven, a thermostatically controlled, capable of maintaining temperatures up to 163°C (325°F).
8. Balance, conforming to the requirements of M231, G2.

PROCEDURE

Heat the sample in the original sample container to a temperature of 149 to 163°C (300 to 325°F). Stir the sample to achieve uniformity, taking care to avoid the entrapment of air. Pour 36 ± 0.5 g of the heated asphalt into the sample container. Brush the surface of the asphalt with the soft flame from a butane lighter (See Note 1). This is to facilitate the removal of any air bubbles that could be present. In order to avoid overheating, do not allow the flame to remain in contact with the asphalt for more than three to five seconds. A clean, dry, unheated tension head apparatus shall be placed onto the sample container. By using the knurled screw, lower the tension head until immersed in the hot asphalt even with the top of the hemispherical head.

Allow the sample containers to cool at room temperature for 60 to 90 minutes. Place the sample containers in a water bath maintained at $25 \pm 0.1^{\circ}\text{C}$ ($77 \pm 0.2^{\circ}\text{F}$) for 60 to 90 minutes. Remove the test specimen from the bath and immediately place in the testing machine. All charts, gears, and other parts of the testing machine shall have been prepared and placed in readiness before placing the specimen in the machine.

Separate the tension head from the sample at a rate of 50 cm/min (20 in./min) and record the force versus elongation curve. The pull shall be continued until the asphalt column breaks, the forces reach a measurable zero value, or the extension limit of the machine is reached.

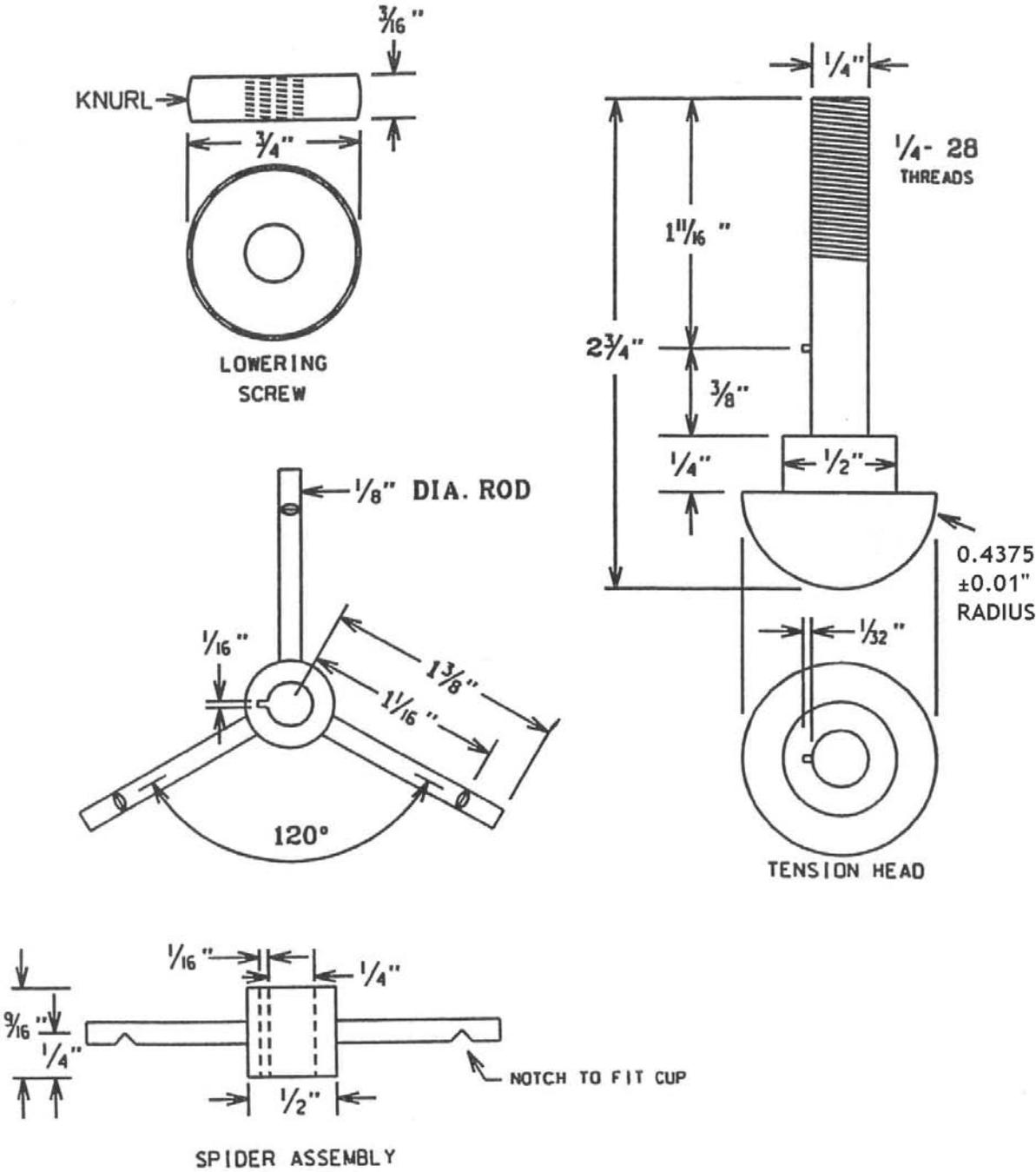
The tension head apparatus will be cleaned with a suitable solvent to remove asphalt residue. The stainless steel hemispherical head will then be cleaned with acetone prior to placement in the asphalt sample. Care will be taken not to touch the hemispherical head after cleaning with acetone and during placement in the asphalt sample.

Note 1 – A soft flame from a standard butane lighter should be used for removing air bubbles. A hard flame from a propane torch or wind-resistant lighter could overheat the sample.

CALCULATION AND REPORT (See Figure 2)

1. Toughness - The toughness of the asphalt is defined as the work required separating the tension head from the sample under the prescribed test conditions. Toughness is calculated as the total area under the force versus elongation curve.
2. Tenacity - The tenacity of the sample is defined as the work required stretching the sample after the initial resistance has been overcome. It is calculated by extending a tangent line from the force versus elongation curve as the force decreases from the initial maximum value until the tangent line intersects the zero force axis. The area under the curve and above or to the right of the tangent line (depending on tester) is the tenacity of the sample.
3. A variety of methods are available for calculating the area under a curve. Some tensile testers will perform this calculation automatically. Other methods to calculate the area under the force versus elongation curve include counting squares on gridded chart paper, using a planimeter, or other equivalent means.
4. The toughness and tenacity shall be reported to the nearest 0.01 Newton-meters (Inch-pounds to the nearest whole number).

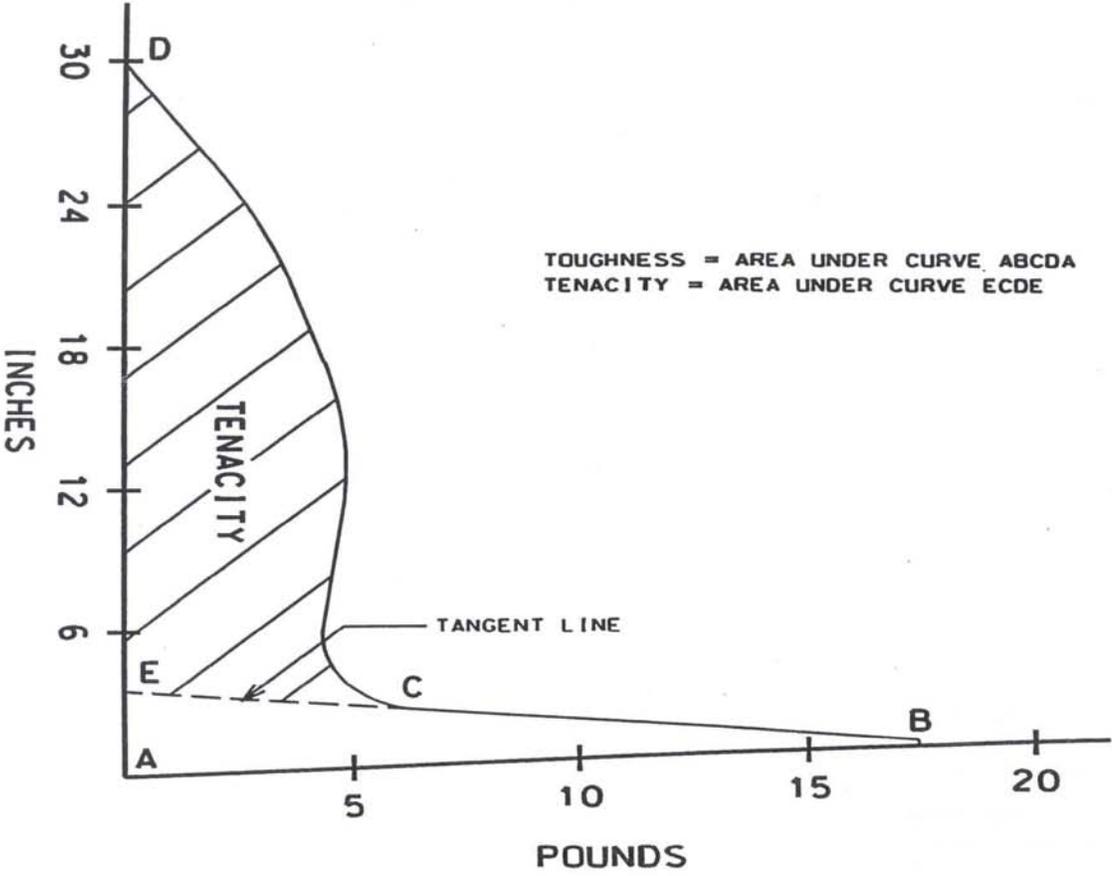
TOUGHNESS AND TENACITY TEST



DETAIL OF TESTING DEVICE

(FIGURE 1)

TOUGHNESS AND TENACITY TEST



TYPICAL TOUGHNESS AND TENACITY CURVE
FOR AN ELASTOMER MODIFIED ASPHALT

(FIGURE 2)