METHOD OF TEST FOR THE DETERMINATION OF INDIRECT TENSILE STRENGTH OF EXPANDED ASPHALT MIXES

1. SCOPE

1.1 This method covers procedures for indirect tensile strength testing of field samples of expanded asphalt mix.

2. RELEVANT DOCUMENTS

2.1 MTO LS-261 Method of Test for Preparation of Marshall Specimens

MTO LS-282 Method of Test for Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate From Bituminous Paving Mixtures

MTO LS-707 Method of Test for Moisture-Density Relationship of Soils using 4.5 kg Rammer and 457 mm Drop

2.2 ASTM D2041 Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D6931 Standard Test Method for Indirect Tensile (IDT) Strength of Bituminous Mixtures

ASTM E11 Standard Specification for Wire Cloth and Sieves for Testing Purposes

2.3 Wirtgen Cold Recycling Technology Manual, 3rd edition, 2010

3. DEFINITIONS AND ACRONOMS

Constant Mass — the mass of the sample when there is no change in mass in excess of 0.1% for successive 30 minute drying periods.

Prepared Mix — material that passes the 26.5 mm sieve that has a moisture content equal to 80% of w_{omc}.

$w_{labsample}$ — the percentage of moisture in the sample in the lab as determine prior to moisture conditioning, by mass.

w_{omc} — optimum moisture content determined during the mix design process in accordance with the Modified Proctor Test (LS-707).

π — 3.141593

4. APPARATUS

OVEN: of suitable capacity and capable of maintaining 110°C ± 5°C for drying samples

MARSHALL MOLDS: as per LS-261

COMPACTION HAMMER: as per LS-261

COMPACTION PEDESTAL: as per LS-261

FILTER PAPER: paper disc as per LS-261

WEIGH SCALE: as per LS-261

SIEVE: 26.5 mm opening sieve, meeting ASTM E11 specifications with a minimum surface area equivalent to a sieve with a 305 mm diameter frame

SPATULA: as per LS-261

METAL TROUGH: as per LS-261

CONTAINERS: as required for mixing and splitting samples

EXTRUSION JACK: as per LS-261

THERMOMETER OR TEMPERATURE PROBE: capable of measuring specified temperatures with a precision of 0.2°C

FORCED DRAFT OVEN: capable of maintaining 40°C ± 1°C for curing the specimens

TEMPERATURE CONTROL SYSTEM: an air cabinet, air bath or water bath capable of maintaining a temperature of 25°C ± 1°C

COMPRESSION LOADING APPARATUS AND BREAKING HEAD: able to uniformly load the specimen with a constant deformation rate of 50.8 mm/minute, see Figure 1

LOADING STRIPS: as per ASTM D6931, see Figure 1

5. PROCEDURE FOR PREPARING LAB SAMPLE

5.1 Manually screen the entire sample. Particles retained on the 26.5 mm sieve that are stuck together may be separated by hand. Oversize material shall not be crushed. Discard material retained on the 26.5 mm sieve.

5.2 Determine $w_{labsample}$ by following the procedure outlined in ASTM D2216, with the following exceptions: use a 1000 g representative portion, and record the mass, m to the nearest 0.1g.

5.3 When $w_{labsample}$ is greater than or equal to 80% of w_{omc}. proceed to step 6 and immediately prepare the briquettes.

5.4 When $w_{labsample}$ is less than 80% of $w_{omc,}$ determine the mass of water, m_{water} that needs to be added to the remaining screened material (for manufacturing briquettes as in Step 6) as follows:

5.4.1 Weigh the screened material that passed the 26.5 mm sieve to determine its mass, $m_{labsample}$ in g, in a tared flat pan.

5.4.2 Moisture condition the screened material, from $w_{labsample}$ to $0.8w_{\mathbf{omc}}$ by adding m_{water} of water as calculated by the following equation:

$$m_{water} = (0.8w_{omc} - w_{labsample}) \times m_{labsample}$$

The mass of water (m_{water}) can be added by spraying the sample with a spray bottle filled with distilled water and mixing the moisture into the screened material. The prepared mix shall be compacted into briquettes as soon as 80% of the optimum moisture content, $0.8w_{\mathbf{omc}}$ is achieved. Proceed to Step 6.

6. PROCEDURE FOR THE COMPACTION OF SPECIMENS (BRIQUETTE MANUFACTURE)

6.1 Prepare the Marshall mold and hammer by cleaning the mold, collar, base-plate, and face of the compaction hammer. Use 100 mm (4") Marshall molds for the briquettes.

6.2 Reduce the prepared mix using the splitting/quartering method in accordance with LS-282 to get sufficient material (approximately 6,600 g) for preparing 6 Marshall briquettes. Note that, to achieve a compacted height of 63.5 ± 2.5 mm, usually 1,100 g is sufficient for each briquette. The 6 briquettes will be divided into 2 sets of 3 briquettes each. One set of 3 briquettes will be tested as dry specimens and the other set of 3 briquettes will be tested as wet specimens.

6.3 Place a filter paper at the bottom of the Marshall mold.

6.4 Using the metal trowel for removing the prepared mix from the trough, place approximately 1,100 g into each of the tared molds. Make certain that the bottom of the trowel is in contact with the bottom of the trough so that the prepared mix is not removed in layers.

6.5 Using the spatula, rod the prepared mix in the mold 25 times – 15 around the outside, 10 around the centre. When rodding around the outside, keep the spatula blade flat against the inside the mold. When rodding around the inside, do not change direction of the blade, and finish by leaving a small cone of prepared mix in the centre of the mold.

6.6 Place another filter paper at the top of the Marshall mold.

6.7 The briquettes shall be compacted at room temperature. Each briquette shall receive 75 blows per side. Make sure the hammer is kept as vertical as possible and ensure free fall of the hammer during compaction.

Note 1: Placing filter paper at the bottom and top of the Marshall mold may be omitted, provided that the mold and the hammer are kept clean.

7. PROCEDURE FOR CURING THE SPECIMENS

7.1 After compaction, remove the mold from the base-plate, remove the top and bottom filter papers, and allow the specimen to cure for 24 hours in the mold in a force draft oven at 40°C.

7.2 Allow the molds to cool until warm to the touch, and extrude the briquettes by means of an extrusion jack.

7.3 Place the samples on their faces on a smooth flat tray and cure in a forced draft oven for a further 48 ± 4 hours at 40°C.

7.4 Remove the briquettes from the oven, and immediately determine each briquette mass (g) and record the mass in air.

7.5 Allow the briquettes to cool in air at room temperature for a minimum of 4 hours and a maximum of 20 hours. The use of fans or other methods of accelerating cooling of specimens is not permitted. When cooled, the diameter, d (mm) and the height, h (mm) around the circumference at 4 evenly spaced places shall be measured for each briquette to zero decimal places and the average height (h_{ave}) calculated. Use these measurements to calculate the volume of each briquette with the following formula:

$$V = \frac{\pi r^2 h_{ave}}{1000}$$

Where V = volume in cm^3

r = radius of specimen in mm to one decimal place (r = d/2)

h_{ave} = average height of specimen in mm to one decimal place

8. DETERMINATION OF SPECIMEN DENSITY

8.1 Calculate the Density of the compacted specimens using the following formula:

$$D = \frac{M}{V}$$

Where D = density in g/cm^3

M = Mass of briquette in g

V = Volume of briquette in cm^3

8.2 If the density of any one briquette is more than ± 0.015 g/cm^3 from the average density of all the specimens, recheck the calculations and, if necessary, re-weigh.

8.3 Group the 6 briquettes into two (2) sets of three (3) so that the average density of each set is essentially the same.

Note 2: Indirect Tensile Strength (ITS) requires 3 briquettes for dry conditioning and another 3 briquettes for wet (soak) conditioning.

9. DETERMINATION OF INDIRECT TENSILE STRENGTH (ITS)

9.1 The standard ITS test is used to test the briquettes under both dry and wet conditions. The ITS is determined by measuring the ultimate load to failure of a specimen which is subjected to a constant deformation rate of 50.8 mm/minute on its diametrical axis according to ASTM D6931.

9.2 The dry specimen procedure is as follows:

9.2.1 Bring the specimens to the test temperature of 25°C by placing the briquettes in a dry temperature control system at 25°C ± 1°C for at least 1 hour, but not for longer than 2 hours before testing.

9.2.2 Remove a specimen from the air cabinet and place it into the loading apparatus.

9.2.3 Centre the briquette on edge on the lower loading strip. Position the upper loading strip. Take note of the alignment marks on the loading apparatus and position accordingly.

9.2.4 Position the assembly centrally under the loading ram of the compression testing device.

9.2.5 Apply the load to the specimen, without shock, at a rate of advance of 50.8 mm per minute until the maximum load is reached.

9.2.6 Record this maximum load, P (in N), accurate to zero decimal place.

9.3 The wet specimen procedure is as follows:

9.3.1 Condition the 3 briquettes in a wet temperature control system (under a minimum of 25 mm of distilled water cover) for 24 hours. Alternatively, the 3 briquettes can be covered with water at 25°C ± 1°C in a vacuum according to ASTM D2041, with the exception that the vacuum pressure is only increased until the residual pressure manometer reads 50 mm mercury and then once the vacuum is achieved, continue the vacuum and agitation for 60 ± 1 minutes.

9.3.2 Remove the specimen and surface dry.

9.3.3 Test for the ultimate tensile load, as described above in steps 9.2.3 through 9.2.6.

9.4 Calculate the ITS for each specimen to the nearest 1 kPa using the following formula:

$$ITS = \frac{2000 \times P}{\pi \times h_{ave} \times d}$$

Where ITS = Indirect Tensile Strength in kPa

P = maximum applied load in N

h_{ave} = average height of the specimen in mm to one decimal place

d = diameter of the specimen in mm to one decimal place

9.4.1 Calculate the tensile strength ratio (TSR) for each set of specimens using the following formula:

$$TSR = \frac{ITS_{wet}}{ITS_{dry}} \times 100\%$$

Where ITS_{wet} = average ITS of all wet specimens in the set

ITS_{dry} = average ITS of all dry specimens in the set

10. REPORTING

10.1 Report the following measurements in the report, as well as any observations:

10.1.1 $w_{labsample}$ and $w_{\mathbf{omc}}$ of each specimen to the nearest 0.1%

10.1.2 Sample density variability observed

10.1.3 ITS of each specimen

10.1.4 TSR value

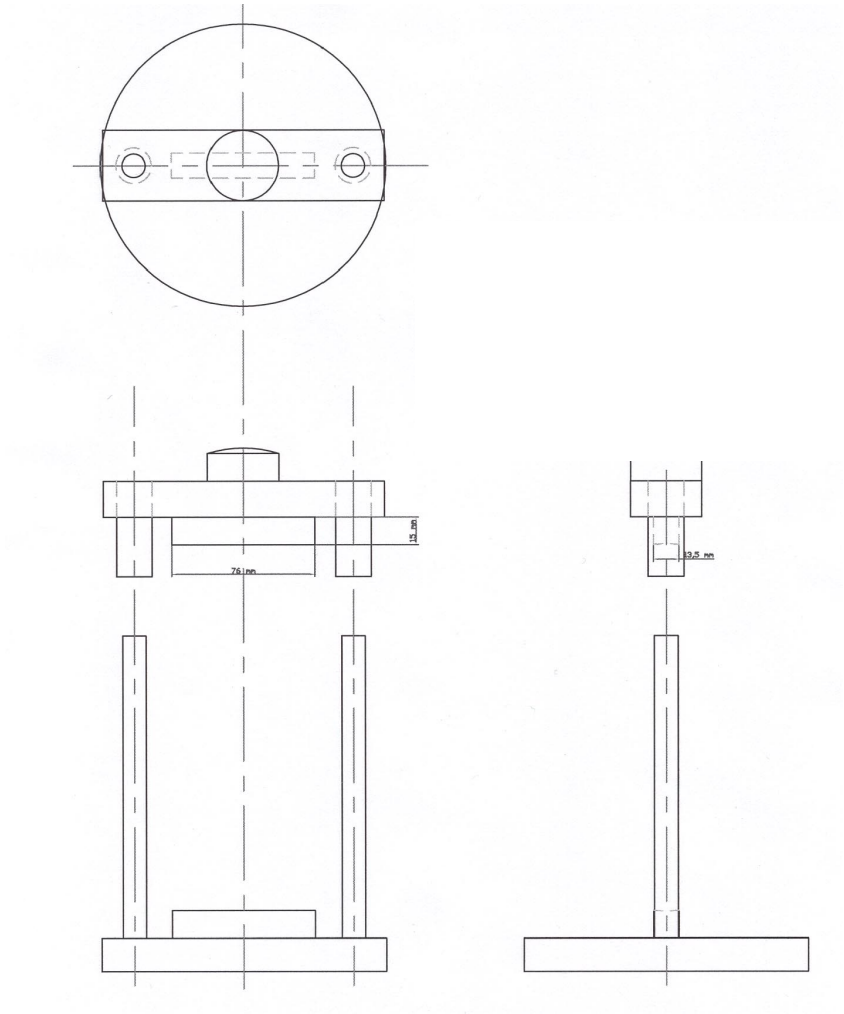

Figure 1
Humboldt Modified Lotman Breaking Head with Guide Rods and Loading Strips