EFFECT OF WATER ON STRENGTH OF COMPACTED, TREATED AND UNTREATED BITUMINOUS MIXTURES (IMMERSION COMPRESSION TEST) (A Modification of AASHTO T 165 and T 167)

Scope

1. This method covers measurement of the loss of strength resulting from the effect of water on compacted bituminous mixtures. A numerical index of retained strength is obtained by comparing the compressive strength of freshly molded and cured specimens with the compressive strength of duplicate specimens that have been immersed in water under prescribed conditions. Provisions are also given for testing specimens which have been treated with a mineral admixture. With some modifications this procedure may be used in testing recycled bituminous mixtures or emulsion mixes.

Apparatus

2. The apparatus shall consist of the following:

(a) Water Bath - An automatically controlled water bath of sufficient size to permit total immersion of the test specimens. It shall have a perforated false bottom or be equipped with a shelf. Either one shall support the specimens at least 1 inch above the bottom of the bath. The bath and shelf or false bottom shall be either lined with or constructed of a non-reactive material. It shall provide accurate and uniform control of a temperature of 140 ± 1.8 F.

(b) A separate, manually or automatically controlled water bath of sufficient size to permit total immersion of the test specimens, and which provides accurate and uniform control for bringing immersed specimens to a temperature of 77 ± 1.8 F. for the compression test. It shall have a perforated false bottom or be equipped with a shelf. Either one shall support the specimens at least 1 inch above the bottom of the bath. The bath and shelf or false bottom shall be either lined with or constructed of a non-reactive material.

NOTE: The water used in both of the above baths shall be distilled water. Only one set of specimens shall be in the 140 F. bath at one time. The 140 F. bath shall be emptied, cleaned, and refilled with fresh distilled water for each set of specimens. The 77 F. water bath shall be drained and cleaned on a regular basis.

(c) Molds - Molding cylinders, and top and bottom molding plungers; the cylinders shall be 4.000 ± 0.005 inches inside diameter by 7 inches in height. The top and bottom plungers shall be

3.985 ± 0.005 inches in diameter: the bottom plungers shall be approximately 2 inches in height and the top plunger shall be approximately 6 inches in height. A baseplate of sufficient size shall be provided to hold mold and plunger assembly.

(d) Support bars - Steel bars to raise mold cylinder during molding operation one inch above the baseplate.

(e) Testing Machine - 50,000-pound capacity minimum, and capable of a head speed of 0.2 inches per minute. For breaking the specimens, the readout shall have a maximum increment of 50 lbs.

(f) Ovens - One oven shall be capable of maintaining a temperature of 255 ± 5 F., one capable of 140 ± 5 F., and another capable of approximately 300 F.

(g) Air Bath - An automatically controlled air bath for storing the specimens at 77 ± 1.8 F.

(h) Transfer plates - A supply of flat transfer plates approximately 5" x 5" of glass or non-reactive material is required.

(i) Balance - A balance sensitive to 1 gram at the maximum weight to be determined.

(j) Mixer - A mechanical commercial dough mixer with a minimum 10 quart capacity and equipped with a wire whip.

Preparation of Samples

3. (a) Three aggregate samples of approximately 3400 grams each (when mineral admixture is used it is added to the aggregate weight), proportioned in that grading determined by design, are required for each test. Each 3400 gram sample will provide 2 specimens when mixed, split and compacted as described below. The weight of aggregate shall be adjusted, if necessary, to produce specimens with heights of 4.0 ± 0.1 inches. A method to adjust the sample weight, if the combined specific gravity of the coarse and fine mineral aggregate is known, which will normally provide specimens within the specified criteria is given in Section 4 of ARIZ 815.

(b) The percent and grade of asphalt, as determined by design tests, shall be used for all specimens prepared for testing.

(c) The temperature of the asphalt and aggregate (and mineral admixture when used) at the time mixing begins shall be in accordance with the following:

Asphalt Grade	Temperature Range
AC 20	300 ± 10 F
AC 30, AC 40	305 ± 10 F.

(d) The aggregates (and mineral admixture when used) shall be dried to constant weight at the temperature required as shown in paragraph 3 (c). Bring the samples to desired weight by adding a small amount of proportioned Pass No. 8 make-up material.

(e) The aggregate (and mineral admixture when used) and asphalt shall be mixed mechanically for 90 to 120 seconds and then hand mixed as necessary to ensure thorough coating.

NOTE: Before each batch is mixed, the mixing bowl and whip shall be at approximately the temperature specified in 3 (c).

(f) Each mixed sample shall be placed on a tarp or sheet of heavy paper and in a rolling motion thoroughly mixed. The material shall be spread into a circular mass 1 1/2 to 2 inches thick. The circular mass shall be cut into equal quarters and opposite quarters taken for each individual sample.

Compaction of Specimens

5. (a) Place the mixtures in an oven maintained at 255 ± 5 F. for 2 hours ± 10 minutes. A mold and bottom plunger for each mixture shall be heated to 255 ± 5 F.

(b) Remove bottom plunger and mold cylinder from oven, place mold assembly on baseplate (bottom plunger in place with mold cylinder supported on the two steel bars). Place paper disc on bottom plunger to prevent material from adhering to the plunger. Place 1/2 of the mixture into molding cylinder and spade mixture vigorously with a heated flat metal spatula with a blade approximately 1" wide and 8" long stiff enough to penetrate an entire layer of material, 15 times around the edge of the mold and 10 times at random into the mixture, penetrating mixture to the bottom of the mold. Place the remaining half of the mixture into the mold and repeat the spading process, being sure to pentrate mixture into the first lift. The top of the mixture should be slightly rounded to aid in firm seating of the upper plunger.

(c) Place a paper disc and then the upper plunger (which has been preheated) on the sample and compress the mixture under an initial load of 150 psi, to set it against the sides of the mold. Remove the support bars and permit full double-plunger action. Apply the load to the mixture at a rate of 0.2 inches per minute until a load of 2750 psi is reached. Hold the load at 2750 psi for 2 minutes.

NOTE: A load of 2750 psi will generally produce specimens that meet the criteria specified for bulk density in Section 6. The loading may be varied if necessary to a minumum of 2000 psi, however, in all cases the requirements for bulk density must be met. Record the load at which the specimens are prepared.

(d) Remove the specimen from the mold. Care shall be taken in extruding the specimen from the mold and after extrusion from the mold to maintain specimen's shape and to prevent tensile stresses in the specimen. Place specimen on a transfer plate.

NOTE: The specimen may be allowed to cool for a maximum of 10 minutes before removal from the mold.

(e) Place specimen and plate in an oven at 140 ± 5 F.

(f) Repeat paragraphs 5 (b) through 5 (e) for the other mixtures.

(g) Specimens shall be cured for 18 hours ± 1/2 hour in an oven at 140 ± 5 F.

Bulk Density Determination

6. (a) Remove specimens from the 140 F. oven and allow to cool on the plate.

NOTE: Cooling may be accomplished in 77 F. air bath, or if more rapid cooling is desired the specimen may be placed in front of a fan until cool.

(b) Determine and record the height and bulk density (ARIZ 415, Method A) of each specimen. The determination of weight in water and S.S.D. weight of each specimen will be completed before the next specimen is submerged for its weight in water determination.

NOTE: Specimens are assumed to be at constant weight after extrusion from the molds.

NOTE: The bulk densities shall not differ by more than 2.5 lbs/cu. ft. If this criteria is not met, the entire set of specimens shall be discarded and a new set prepared.

NOTE: The average bulk density for the specimens shall be between 95.0% and 97.0% of the laboratory determined density for the mixture, at the design asphalt content as determined in ARIZ 815. Some materials will compact to densities outside the above range when compacted at 2750 psi. If the average bulk density is outside the range, all specimens shall be discarded and the test procedure repeated, after determining the amount of load required to produce specimens in the acceptable density range.

(c) Sort the six specimens into two groups of three specimens each so that the average bulk density of the specimens in group 1 is essentially the same as for group 2. Test the specimens in group 1 as specified in Section 7. Test the specimens in group 2 as specified in Section 8.

Determination of Dry Strength

7. (a) Place the test specimens in 77 F. air bath for 4 to 5 hours.

(b) Test each specimen in axial compression without lateral support at a uniform rate of vertical deformation of 0.2 inches per minute. Record the load failure point for each specimen and the average load failure point. Determine the dry strength by converting the average load failure point to pounds per square inch.

NOTE: At least two of the individual load failure points shall be within ± 10% of the average load failure point for the three specimens. If this criteria is not met the entire set of 6 specimens

shall be discarded and a new set prepared. If only two of the three specimens meet this criteria, a new average load failure point is determined using the two values.

Determination of Wet Strength

8. (a) Immerse the test specimens in water on a transfer plate for 24 hours ± 1/2 hour at 140 ± 1.8 F. Make sure all specimens are totally immersed.

(b) Transfer specimens to 77 ± 1.8 F. water bath for 2 hours keeping them on the plates and making sure all specimens are totally immersed.

(c) Remove each specimen from water bath and test in axial compression without lateral support at a uniform rate of vertical deformation of 0.2 inches per minute. Record the load failure point at which each specimen fails and the average load failure point. Determine the wet strength by converting the average load failure point to pounds per square inch.

NOTE: AT least two of the individual load failure points shall be within ± 10% of the average load failure point for the three specimens. If this criteria is not met the entire set of 6 specimens shall be discarded and a new set prepared. If only two of the three specimens meet this criteria, a new average load failure point is determined using the two values.

Calculation

9. (a) The index of retained strength shall be expressed as the percentage of "dry strength" of the specimens. It shall be calculated as follows:

$$\text{Index of Retained Strength} = \frac{\text{Wet Strength of Specimens}}{\text{Dry Strength of Specimens}} \times 100$$

(b) The index of retained strength shall be reported to the nearest 1 percent.

Example

10. An example is shown in Figure 1, which illustrates the recording of test data and results.

ARIZ 802

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GRADE OF ASPHALT AC 40 % ASPHALT 4.6 ADMIXTURE 2% TYPE II CEMENT

DENSITY DETERMINATION OF DRY IMC SPECIMENS:

SPEC.#	HEIGHT	SSD WT.	H_2O WT.	AIR WT.	SP. GR.	DENSITY	AVERAGE SP. GR.	AVERAGE DENSITY
1	3.996	1765.9	967.2	1759.7	2.203	137.2	2.206	137.4
2	3.981	1760.1	964.9	1753.5	2.205	137.4		
3	3.992	1763.5	964.9	1756.9	2.200	137.1		
4	4.043	1770.8	968.2	1764.2	2.198	136.9		
5	4.012	1767.4	968.9	1762.2	2.207	137.5		
6	3.989	1762.1	971.1	1758.4	2.223	138.5		

DESIGN DENSITY OF STABILITY SPECIMENS = 141.7

% OF LAB DENSITY = $\frac{\text{IMC DENSITY}}{\text{STAB. DENSITY}}$ X 100 = $\left(\frac{137.4}{141.7}\right)$ X 100 = 97.0 %

LOAD: ☒ 2750 psi ☐ OTHER _____ psi

COMPRESSIVE STRENGTH OF DRY SPECIMENS:

SPEC.#	LOAD FAILURE POINT	AVG. LOAD FAILURE POINT	PSI
3	10,566	10,733	854
4	10,900	~~11,715~~	
* 6	~~13,680~~		

COMPRESSIVE STRENGTH OF WET SPECIMENS:

SPEC.#	LOAD FAILURE POINT	AVG. LOAD FAILURE POINT	PSI
1	6802	6770	539
2	6647		
5	6861		

INDEX OF RETAINED STRENGTH = $\frac{\text{PSI (WET)}}{\text{PSI (DRY)}}$ X 100 = $\left(\frac{539}{854}\right)$ X 100 = 63 %

REMARKS: * SPECIMEN #6 WAS DISCARDED BECAUSE ITS LOAD FAILURE POINT IS OUTSIDE OF THE SPECIFIED ± 10% RANGE.

FIGURE 1