

**METHODS OF SAMPLING AND TESTING**  
**MT 209-04**  
**METHOD OF TEST FOR**  
**RESISTANCE TO ABRASION OF SMALL SIZE COARSE AGGREGATE**  
**BY USE OF THE LOS ANGELES MACHINE**  
**(Modified AASHTO T 96)**

**1 Scope:**

- 1.1 This method covers a procedure for testing sizes of coarse aggregate smaller than 37.5 mm (1½ in.) for resistance to abrasion using the Los Angeles testing machine.

*Note 1 - A procedure for testing coarse aggregate larger than 19.0 mm (¾ in.) is covered in the Method of Test for Resistance to Abrasion of Large Size Coarse Aggregate by the Los Angeles Machine (ASTM C 535).*

**2 Referenced Documents:**

**2.1 AASHTO:**

T 2 Sampling Aggregates  
T 96 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

**MT Manual:**

MT 202 Sieve Analysis of Fine and Coarse Aggregates  
MT 405 Wire Cloth Sieves for Testing Purposes  
MT 607 Reducing Field Samples of Aggregate to Testing Size

**ASTM:**

C 535 Test for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine  
C 670 Practice for Preparing Precision Statement for Test Methods for Construction Materials

**3 Description of Terms:**

- 3.1 *Constant Mass*-Test samples dried at a temperature of  $110 \pm 5^\circ\text{C}$  ( $230 \pm 9^\circ\text{F}$ ) to a condition such that it will not lose more than 0.1 percent moisture after 2 h of drying. Such a condition of dryness can be verified by weighing the sample before and after successive 2 h drying periods. In lieu of such a determination, samples may be considered to have reached constant mass when they have been dried at a temperature of  $110 \pm 5^\circ\text{C}$  ( $230 \pm 9^\circ\text{F}$ ) for an equal or longer period than that previously found adequate for producing the desired constant mass condition under equal or heavier loading conditions of the oven.

**4 Apparatus:**

- 4.1 *Los Angeles Machine*-The Los Angeles abrasion testing machine equipped with a counter and conforming in all its essential characteristics to the design shown in AASHTO T 96 shall be used. The machine shall consist of a hollow steel cylinder, closed at both ends, having an inside diameter of  $711 \pm 5$  mm ( $28 \pm 0.2$  in.) and an inside length of  $508 \pm 5$  mm ( $20 \pm 0.2$  in.). The cylinder shall be mounted on stub shafts attached to the ends of the cylinder but not entering it, and shall be mounted in such a manner that it may be rotated with the axis in a horizontal position within a tolerance in slope of 1 in 100. An opening in the cylinder shall be provided for the introduction of the test sample. A suitable, dust-tight cover shall be provided for the opening with means for bolting the cover in place. The cover shall be so designed as to maintain the cylindrical contour of the interior surface unless the shelf is to be located that the charge will not fall on the cover, or come in contact with it during the test. A removable steel shelf extending the full length of the cylinder and projecting inward  $89 \pm 2$  mm ( $3.5 \pm 0.1$  in.) shall be mounted on the interior cylindrical surface of the cylinder, or on the inside surface of the cover, in such a way that a plane centered between the large faces coincides with an axial plane. The shelf shall be of such thickness and so mounted, by bolts or other suitable means, as to be firm and rigid. The

position

**4 Apparatus: (continued)**

of the shelf shall be such that the distance from the shelf to the opening, measured along the outside circumference of the cylinder in the direction of the rotation, shall not be less than 1.27 m (50 in.).

*Note 2 - The use of a wear-resistant steel, rectangular in cross-section and mounted independently of the cover, is preferred. However, a shelf consisting of a section of rolled angle, properly mounted on the inside of the cover plate, may be used provided the direction of rotation is such that the charge will be caught on the outside face of the angle. If the shelf becomes distorted from its original shape to such an extent that the requirements given in A1.2 of the Appendix to this method are not met, the shelf shall either be repaired or replaced before additional abrasion tests are made.*

**4.1.1** The machine shall be so driven and so counterbalanced as to maintain a substantially uniform peripheral speed. (Note 3). If an angle is used as the shelf, the direction of rotation shall be such that the charge is caught on the outside surface of the angle.

*Note 3 - Back-lash or slip in the driving mechanism is very likely to furnish test results which are not duplicated by other Los Angeles machines producing constant peripheral speed.*

**4.2** Sieves, conforming to the Specifications for Wire-Cloth Sieves for Testing Purposes (MT-405).

**4.3** *Balance*-The balance shall have a capacity over 2,000 grams thru 5,000 grams, sensitive to 1.0 grams, and with an accuracy of 1.0 gram or 0.1%.

**4.4** *Oven*-The oven shall be capable of maintaining a uniform temperature of 110 ± 5°C (230 ± 9°F).

**4.5** *Charge*-The charge shall consist of steel spheres averaging approximately 1 27/32 in. (46.8 mm) in diameter and each weighing between 390 and 445 g. (Note 4)

**4.5.1** The charge, depending upon the grading of the test sample as described in Section 8, shall be as follows:

Grading	Number of Spheres	Weight of Charge, g
A	12	5,000± 25
B	11	4,584± 25
C	8	3,330± 20
D	6	2,500± 15

*Note 4 - Steel ball bearings 1 13/16 in. (46.0 mm) and 1 7/8 in. (47.6 mm) in diameter, weighing approximately 400 and 440 g each, respectively, are readily available. Steel spheres 1 27/32 in. (46.8 mm) in diameter weighing approximately 420 g may also be obtainable. The charge may consist of a mixture of these sizes conforming to the weight tolerances of Sections 4.5 and 4.5.1.*

**5 Sampling:**

**5.1** The field sample shall be obtained in accordance with T 2 and reduced to test portion size in accordance with T 248.

**6 Test Sample:**

**6.1** The test sample shall be washed and oven-dried to a constant mass as described in Section 3 (Note 5), separated into individual size fractions, and recombined to the grading of Table 1 most nearly corresponding to the range of sizes in the aggregate furnished for the work. The weight of the sample prior to test shall be recorded to the nearest 1.0 g.

**7 Procedure:**

**7.1** Place the test sample and the charge in the Los Angeles testing machine and rotate the machine at a speed of 30 to 33 rpm for 500 revolutions. After the prescribed number of revolutions, discharge the material from the machine and make a preliminary separation of the sample on a sieve coarser than the 1.70 mm (No. 12). Sieve the finer portion on a 1.70 mm sieve in a manner conforming to MT-202. Wash the material coarser than the 1.70 mm sieve (Note 5), oven-dry to a constant mass, and weigh to the nearest 1.0 g (Note 6).

*Note 5 - If the aggregate is essentially free of adherent coatings and dust, the requirement for washing before and after test may be waived. Elimination of washing after test will seldom reduce the measured loss by more than about 0.2% of the original sample weight.*

*Note 6 - Valuable information concerning the uniformity of the sample under test may be obtained by determining the loss after 100 revolutions. This loss should be determined without washing the material coarser than the 1.70-mm sieve. The ratio of the loss after 100 revolutions to the loss after 500 revolutions should not greatly exceed 0.20 for material of uniform hardness. When this determination is made, take care to avoid losing any part of the sample; return the entire sample, including the dust of fracture, to the testing machine for the final 400 revolutions required to complete the test.*

**8 Calculation:**

**8.1** Express the loss (difference between the original weight and the final weight of the test sample) as a percentage of the original weight of the test sample. Report this value as the percent loss.

**Table 1 - Gradings of Test Samples**

Sieve Size		Mass of Indicated Sizes, % Grading			
Passing	Retained on	A	B	C	D
mm					
37.5 (1 1/2 in.)	25.0 (1 in.)	1,250± 25	---	---	---
25.0 (1 in.)	19.0 (3/4 in.)	1,250± 25	---	---	---
19.0 (3/4 in.)	12.5 (1/2 in.)	1,250± 10	2,500± 10	---	---
12.5 (1/2 in.)	9.5 (3/4 in.)	1,250± 10	2,500± 10	---	---
9.5 (3/4 in.)	6.3 (1/4 in.)	---	---	2,500± 10	---
6.3 (1/4 in.)	4.75 (No. 4)	---	---	2,500± 10	---
4.75 (No. 4)	2.36 (No. 8)	---	---	---	5,000± 10
Total		5,000± 10	5,000± 10	5,000± 10	5,000± 10

*Note 7 - The percent loss determined by this method has no known consistent relationship to the percent loss for the same material when tested by ASTM C 535.*

**APPENDIX****A1****Maintenance of Shelf**

- A1.1** The shelf of the Los Angeles Machine is subject to severe surface wear and impact. With use, the working surface of the shelf is peened by the balls and tends to develop a ridge of metal parallel to and about 32 mm (1¼ in.) from the junction of the shelf and the inner surface of the cylinder. If the shelf is made from a section of rolled angle, not only may this ridge develop but the shelf itself may be bent longitudinal or transversely from its proper position.
- A1.2** The shelf should be inspected periodically to determine that it is not bent either lengthwise or from its normal radial position with respect to the cylinder. If either condition is found, the shelf should be repaired or replaced before further abrasion tests are made. The influence on the test result of the ridge developed by peening of the working face of the shelf is not known. However, for uniform test conditions, it is recommended that the ridge be ground off if its height exceeds 2 mm (0.1 in.).

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