Colorado Procedure – Laboratory 4211-15

Standard Method of Test for

Resistance of Coarse Aggregate to Degradation By Abrasion in the Micro-Deval Apparatus

(This procedure is based upon AASHTO T 327-06. AASHTO T 327-06 or any subsequent revision may not be used in place of this procedure.)

1. SCOPE

1.1 This method covers a procedure for testing coarse aggregate for resistance to abrasion using the Micro-Deval apparatus.

2. REFERENCE DOCUMENTS

2.1 AASHTO Standards:
M 92, Standard Specification for Wire - Cloth Sieves for Testing Purposes.
T 11, Materials Finer Than 75-µm Sieve in Mineral Aggregates by Washing
T 27, Sieve Analysis of Fine and Coarse Aggregates

Colorado Procedures:
CP 31, Sieve Analysis of Aggregates

3. SUMMARY OF METHOD

3.1 The Micro-Deval Test is a measure of abrasion resistance and durability of mineral aggregates resulting from a combination of actions including abrasion and grinding with steel balls in the presence of water. A sample with standard grading is initially soaked in water for 15 to 19 hours. The sample is then placed in a jar mill with 2.0 liters of water and an abrasive charge consisting of 5000 grams of 9.5 mm diameter steel balls. The jar, aggregate, water, and charge are revolved at 100 rpm for 2 hours. The sample is then washed and oven dried. The loss is the amount of material passing the 1.18 mm sieve expressed as a percent by mass of the original sample.

4. SIGNIFICANCE AND USE

4.1 The Micro-Deval Test is a test of coarse aggregates to determine abrasion loss in the presence of water and an abrasive charge. Many aggregates are weaker when wet than when dry. The use of water in this test measures the reduction in resistance to degradation, in contrast to some other tests which are conducted on dry aggregate. It furnishes information helpful in judging the toughness / abrasion resistance and durability / soundness of coarse aggregate subject to abrasion and weathering action when adequate information is not available from service records.

4.2 The Micro-Deval test is a useful test for detecting changes in properties of aggregate produced from a source as part of a quality control or quality assurance process.

5. TERMINOLOGY

5.1 *Constant Mass* - Test samples dried at a temperature of 110°C ± 5° to a condition such that it will not lose more than 0.1 percent moisture after 2 hours of drying. Such a condition of dryness can be verified by weighing the sample before and after successive 2-hour 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°C ± 5° 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.

6. APPARATUS

6.1 Micro-Deval Abrasion Machine - A jar rolling mill capable of running at 100 ± 5 rpm.

6.2 Containers - Stainless steel Micro-Deval abrasion jars having a 5-liter capacity with a rubber ring in the rotary locking cover. External diameter is 194 202 mm, internal height is 170 to 177 mm. The inside and outside surfaces of the jars shall be smooth and have no observable ridges or indentations.

6.3 Abrasion Charge - Magnetic stainless steel balls are required. These shall have a diameter of 9.5 ± 0.5 mm. Each jar requires a charge of 5000 ± 5 g of balls.

6.4 Sieves - Sieves with square openings and of the following sizes conforming to AASHTO M 92 specifications: 19.0 mm, 16.0 mm, 12.5 mm, 9.5 mm, 9.0 mm, 6.3 mm, 4.75 mm, and 1.18 mm.

6.5 Oven - The oven shall be capable of maintaining a temperature of 110°C ± 5°.

6.6 Balance - A balance or scale accurate to 1.0 g.

7. TEST SAMPLE FOR INDIVIDUAL STOCKPILES

7.1 The test sample shall be washed and oven-dried at 110°C ± 5° to constant mass, separated into individual size fractions in accordance with CP 31, and recombined to meet the grading as shown in Subsection 7.2 below.

7.2 Gradation A

This gradation is to be used when the nominal maximum aggregate size is 16.0 mm or greater. An oven-dried sample of 1500 ± 5 g shall be prepared as follows:

Passing	Retained	Mass
19.0 mm	16.0 mm	375 g
16.0 mm	12.5 mm	375 g
12.5 mm	9.5 mm	750 g

7.3 Gradation B

This gradation is to be used when the nominal maximum aggregate size is 12.5 mm or greater, but less than 16.0 mm. An oven-dried sample of 1500 ± 5g shall be prepared as follows:

Passing	Retained	Mass
12.5 mm	9.5 mm	750 g
9.5 mm	6.3 mm	375 g
6.3 mm	4.75 mm	375 g

7.4 Gradation C

This gradation is to be used when the nominal maximum aggregate size is less than 12.5 mm. An oven-dried sample of 1500 ± 5 g shall be prepared as follows:

Passing	Retained	Mass
9.5 mm	6.3 mm	750 g
6.3 mm	4.75 mm	750 g

8. TEST SAMPLE FOR COMBINED SPECIMENS

8.1 This gradation is used when a combined gradation is to be tested. The test sample shall be washed and oven-dried at 110°C ± 5° to constant mass, separated into individual size fractions in accordance with CP 31, and recombined to meet the grading as shown in Subsection 8.2 or 8.3.

8.2 Gradation D

An oven-dried sample of 1500 ± 5 g shall be prepared as follows:

Passing	Retained	Mass
19.0 mm	16.0 mm*	250 g
16.0 mm	12.5 mm	250 g
12.5 mm	9.5 mm	500 g
9.5 mm	6.3 mm	250 g
6.3 mm	4.75 mm	250 g

* If the top size isn't a part of the mix gradation, add the mass to the 16.0 mm to 12.5 mm mass.

8.3 If the top size of the combined gradation is less than 12.5 mm, then Gradation B (Subsection 7.3) shall be used.

9. TEST PROCEDURE

9.1 Prepare a representative 1500 ± 5 g sample. Record the Mass 'A' to the nearest 1.0 g.

9.2 Saturate the sample in 2.0 ± 0.05 liters of tap water (temperature 20°C ± 5°) for 15 to 19 hours. This may be done in the Micro-Deval container or some other suitable container.

9.3 Place the sample in the Micro-Deval abrasion container with 5000 ± 5g of steel balls and the water used in Subsection 9.2 to saturate the sample. Place the Micro-Deval container on the machine.

9.4 For Gradation A (shown in Subsection 7.2) run the machine at 100 ± 5 rpm for 2 hours ± 1 minute or 12,000 ± 100 revolutions. For Gradation B (shown in Subsection 7.3) run the machine for 105 ± 1 minutes or 10,500 ± 100 revolutions. For Gradation C (shown in Subsection 7.4) run the machine for 95 ± 1 minutes or 9,500 ± 100 revolutions. For Gradation D (shown in Subsection 8.2) run the machine for 105 ± 1 minutes or 10,500 ± 100 revolutions.

9.5 Carefully pour the sample over two superimposed sieves: 4.75 mm and 1.18 mm. Take care to remove the entire sample from the stainless steel jar. Wash and manipulate the retained material with water, using a hand held water hose, and your hand until the washings are clear and all material smaller than 1.18 mm passes the sieve. Remove the stainless steel balls using a magnet or other suitable means. Discard material smaller than 1.18 mm.

9.6 Combine the material retained on the 4.75 mm and 1.18 mm sieves, being careful not to lose any material.

9.7 Oven dry the sample to constant mass at 110°C ± 5°.

9.8 Weigh the sample to the nearest 1.0g. Record the Mass 'B'.

10. CALCULATIONS

10.1 Calculate the Micro-Deval abrasion loss as follows, to the nearest 0.1%.

$$\text{Percent Loss} = \frac{(A - B)}{A} \times 100$$

11. REPORT

11.1 The report shall include the following:

11.1.1 The nominal maximum aggregate size of the aggregate tested and the gradation (A, B, C, or D) used.

11.1.2 The percent loss of the test sample to one decimal place.

12. CONTROL OF ABRASION CHARGE

12.1 Every 10 samples, but at least every week in which a sample is tested, the abrasion charge must be placed on a 9 mm screen to check for loss of size due to wear. Any balls that fall through the screen are out of specification and must be discarded.

13. PRECISION AND BIAS

13.1 The multi-laboratory precision has been found to vary over the range of this test. The figures given in Column 2 are the coefficients of variation that have been found to be appropriate for the materials described in Column 1. The figures given in Column 3 are the limits that should not be exceeded by the difference between the results of two properly conducted tests expressed as a percent of their mean.

Aggregate Abrasion Loss (%)	Coefficient of Variation (% of mean)[A]	Acceptable Range of Two Results (% of mean)[A]
5	10.0	28
12	6.4	18
17	5.6	16
21	5.3	15

[A:] These numbers represent, respectively, the [1s] and [d2s] limits as described in ASTM C 670.

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