METHODS OF SAMPLING AND TESTING
MT 233-07
METHOD OF TEST FOR RESISTANCE OF COARSE AGGREGATE TO DEGRADATION BY ABRASION IN THE MICRO-DEVAL APPARATUS
(*Modified AASHTO T 327*)

1 Scope

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

1.2 The text of this method references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the test method.

2 Referenced Documents

AASHTO

T 327 Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus

MT Materials Manual

MT 202 Sieve Analysis of Fine and Coarse Aggregates
MT 405 Wire-Cloth Sieves for Testing Purposes

3 Summary of Test 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 a minimum of 15 hours. The sample is then placed in a jar mill with 2.0 L 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 two hours depending on the particle size. 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 abrasion test is a test of coarse aggregates to determine abrasion loss in the presence of water and an abrasive charge. Many aggregates are more susceptible to abrasion when wet than dry, and the use of water in this test incorporates this reduction in resistance in degradation, in contrast to some other tests that are conducted on dry aggregate. The test results are helpful in evaluating the toughness/abrasion resistance of coarse aggregate subject to abrasion when adequate information is not available from service records.

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

5 Terminology

5.1 Constant mass – Test samples dried at a temperature of 230 ± 9ºF (110 ± 5ºC) 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 two 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 230 ± 9ºF (110 ± 5ºC) for an equal or longer period than that previously found adequate for producing the desired constant mass condition under equal or heaver loading condition of the oven.

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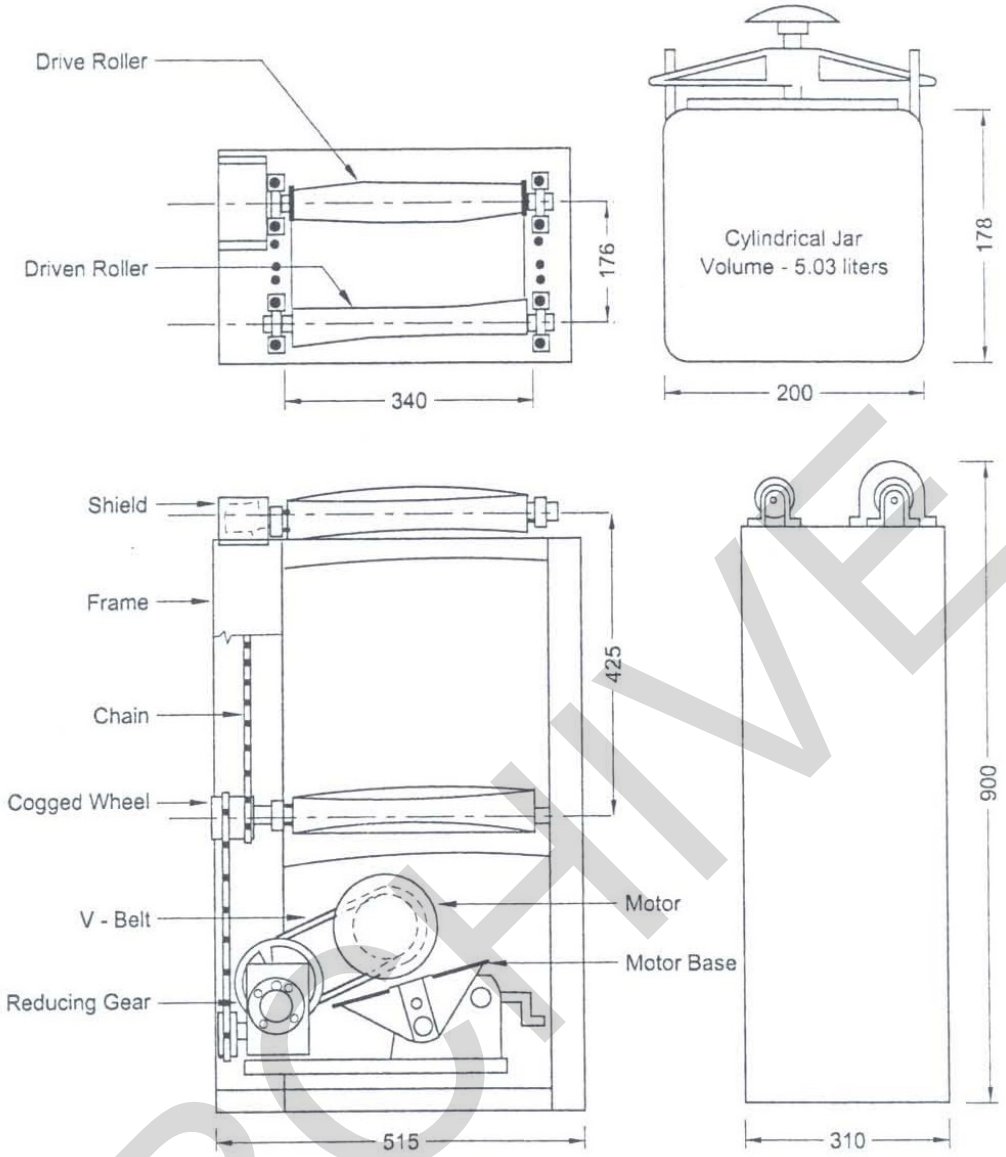

Note: All dimensions shown in millimeters unless otherwise noted.

Figure 1—Micro-Deval Abrasion Machine and Container

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6 Apparatus

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

Note 1 – Micro-Deval abrasion machine fitted with a counter may be used if the test is conducted on the basis of number of revolutions (Clause 9.4).

6.2 Containers – Stainless steel Micro-Deval abrasion jars having a 5-L capacity with a rubber ring in the rotary locking cover, an external diameter of 194 to 202 mm, and an internal height of 170 to 177 mm. The inside and outside surfaces of the jars shall be smooth and have no observable ridges or indentations. (Figure 1)

6.3 Abrasive Charge – Magnetic 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: 3/4 inch (19.0 mm), 5/8 inch (16.0m), 1/2 inch (12.5 mm), 3/8 inch (9.5 mm), 1/4 inch (6.3 mm), No. 4 (4.75 mm), No. 16 (1.18 mm).

6.5 Oven – The oven shall be capable of maintaining a temperature of 230 ± 9ºF (110 ± 5ºC).

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

7 Reference Aggregate

7.1 Laboratory Reference Aggregate: A supply of standard “Brechin Quarry No. 2” coarse aggregate available from the Soils and Aggregates Section, Materials Engineering and Research Office, Ministry of Transportation, 1201 Wilson Avenue, Downsview, Ontario, Canada M3m, 1J8.

7.2 Calibration Aggregate – An adequate supply of aggregate, established by the laboratory to use for calibration of the test method (see Section 11.1).

8 Test Sample

8.1 The test sample shall be washed and oven dried at 230 ± 9ºF (110 ± 5ºC) to constant mass, separated into individual size fractions in accordance with MT 202, and recombined to meet the grading as shown in Section 8.2.

8.2 Aggregate for the test shall normally consist of material passing the 3/4 inch (19.0 mm) sieve, retained on the 3/8 inch (9.5 mm) sieve. An oven dried sample of 1500 ± 5 grams shall be prepared as in Table 1.

Table 1 – Preparation of an Oven-Dried Sample of 3/4“ (19.0 mm)

Passing	Retained	Mass
3/4 “ (19.0 mm)	5/8 “ (16.0mm)	375 g
5/8” (16.0 mm)	1/2 “ (12.5 mm)	375 g
1/2 “ (12.5 mm)	3/8 “ (9.5 mm)	750 g

8.3 In a case where the maximum nominal size of the coarse aggregate is 1/2 “ (12.5 mm) or less, a sample of 1500 ± 5 g shall be prepared as in Table 2.

Table 2 – Preparation of an Oven-Dried Sample of Less Than 5/8” (16.0 mm)

Passing	Retained	Mass
1/2 “ (12.5 mm)	3/8 “ (9.5mm)	750 g
3/8 “ (9.5mm)	1/4 “ (6.3 mm)	375 g
1/4 “ (6.3 mm)	No. 4 (4.75 mm)	375 g

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8.4 In a case where the maximum nominal size of the coarse aggregate is 3/8 " (9.5 mm) or less, a sample of 1500 ± 5 g shall be prepared as in Table 3.

Table 3 – Preparation of an Oven-Dried Sample of Less Than 1/2" (12.5 mm)

Passing	Retained	Mass
3/8 " (9.5mm)	1/4 " (6.3 mm)	750 g
1/4 " (6.3 mm)	No. 4 (4.75 mm)	750 g

9 Test Procedure

9.1 Prepare a representative 1500 ± 5 g sample. Determine the mass "A" and record to the nearest 1.0 g.

9.2 Immerse the sample in 2.0 ± 0.05 liters of tap water at a temperature of 68 ± 9ºF (20 ± 5ºC) for a period of 15 to 19 hours either in the Micro-Deval container or some other suitable container.

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

9.4 Run the machine at 100 ± 5 rpm for 12,000 ± 100 revolutions for the grading shown in Section 8.2: for 10,500 ± 100 revolutions for the grading shown in Section 8.3: and for 9,000 ± 100 revolutions for the grading shown in Section 8.4.

Note 2 – Some equipment is not capable of measuring the total number of revolutions of the drum. If desired, instead of using revolutions, time can be used as follows:

Run the Micro-Deval machine at 100 ± 5 rpm for two hours ± 1 minute for the grading shown in Section 8.2. For the grading shown in Section 8.3, run the machine for 105 ± 1minutes. For the grading shown in Section 8.4, run the machine for 95 ± 1minutes.

9.5 Carefully pour the sample and steel balls over a No. 4 (4.75 mm) sieve superimposed on a No. 16 (1.18 mm) sieve. Take care to remove the entire sample from the stainless steel jar. Wash and manipulate the retained material on the sieves with water using a hand held water hose and the hand until the washings are clear and all the material smaller than No. 16 (1.18 mm) passes that sieve. Remove the stainless steel balls using a magnet or other suitable means.

9.6 Combine the material retained on the No.4 (4.75 mm) and No. 16 (1.18 mm) sieves, being careful not to lose any material.

9.7 Oven dry the sample to a constant mass at 230 ± 9ºF (110 ± 5ºC).

9.8 Weigh the sample to the nearest 1.0 g and record as mass "B".

10 Calculations

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

Percent Loss = (A – B) / A X 100

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11 Use of the Calibration Aggregate

11.1 Calibration Aggregate – The laboratory will establish an adequate supply of material to use for calibration of the test method. A suitable material with a loss of between 5 and 15 percent shall be established. From this material 10 sample will be taken randomly and tested. At the same time 10 samples of the reference aggregate from Brechin Quarry No.2 (see Section 7.1) shall also be tested. Provided the mean loss and variation of the Brechin Quarry No. 2 aggregate is within allowed tolerance of Section 11.1.1, the mean value obtained with the supply of in-house calibration aggregate shall be used thereafter. At any time a new supply is required, the calibration procedure shall be conducted.

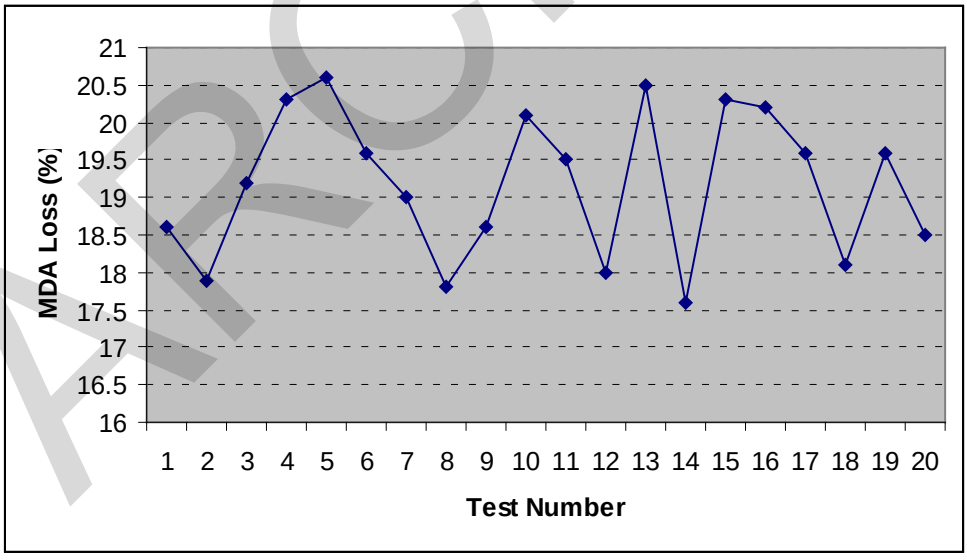
11.1.1 The mean loss of the Brechin Quarry No. 2 reference aggregate (see Section 7.1) in multilaboratory study of the Micro-Deval Test is 19.1 percent. For continued acceptance of data, in-house calibration aggregate test data must fall within the range 5 to 15 percent loss for 95 percent of the time.

11.1.2 When test data of the calibration aggregate is outside the limits, an investigation as to the probable cause shall be conducted. The equipment shall be re-calibrated and the testing technique re-examined to detect non-conformance with the test procedure.

11.2 Every 10 samples, but at least every week in which a sample is tested, a sample of the calibration aggregate shall be tested. The material shall be taken from a stock supply and prepared according to section 8. When 20 samples of calibration aggregate have been tested, and the results show satisfactory variation, the frequency of testing may be changed to a minimum of one sample every month.

11.3 Trend Chart Use – The percent loss of the last 20 samples of calibration aggregate shall be plotted on a trend chart in order to monitor the variation in results (Figure 2).

Micro-Deval Abrasion: Trend Chart
Brechin Control Aggregate #2



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12 Report

12.1 The report shall include the following:

12.1.1 The maximum size of the aggregate tested and the grading used;

12.1.2 The percent loss of the test sample to one decimal place;

12.1.3 The percent loss of the calibration aggregate, tested closest to the time at which the aggregate was tested, to the nearest 0.1 percent; and

12.1.4 The percent loss of the last twenty samples of calibration material on a trend chart.

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