METHOD OF TEST FOR THE RESISTANCE OF COARSE AGGREGATE TO DEGRADATION BY ABRASION IN THE MICRO-DEVAL APPARATUS

1. SCOPE

This method covers the testing of coarse aggregates to determine their abrasion loss in the presence of water and an abrasive charge. It furnishes information helpful in judging the suitability of coarse aggregate subject to weathering action when adequate information is not available from service records.

2. REFERENCES

MTO LS-602	Test for Sieve Analysis of Aggregates
MTO Report MERO-036	Aggregate and Soil Proficiency Sample Testing Program for 2009, January 2010
ASTM C136	Standard Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM E11	Standard Specification for Wire-Cloth Sieves for Testing Purposes
BNQ-2560-070	Détermination du coefficient d'usure par attrition à l'aide de l'appareil micro-Deval; Bureau de Normalisation due Québec (BNQ), Ministère de l'Industrie, du Commerce et du Tourisme, Québec G1R 4Z8

Chevassu, G.; Variation des résultats de l'essai Deval humide en fonction du nombre de pierres tendres; Bulletin Liaison Laboratoire Routières Ponts et Chausées, Paris, France, No. 41, pp.43-45, 1969

L'Haridon, R.; Essai Micro-Deval destiné a prévior à partir de petits échantillons, les qualitiés routières des roches carottées; Bulletin Liaison Laboratoire Routières Ponts et Chausées, Paris, France, No. 14, pp.1-17/1-21, 1965

Tourenq, C.; L'essai micro-Deval; Bulletin Liaison Laboratoire Routières Ponts et Chausées, Paris, France, No. 50, pp.69-76, 1971

3. APPARATUS

3.1 MICRO-DEVAL ABRASION MACHINE: A jar rolling mill capable of running at 100 ± 5 rpm (Figure 1).

3.2 CONTAINERS: Stainless steel, micro-Deval abrasion jars having a 5 L capacity with a rubber ring in the rotary locking cover. External diameter = 194-202 mm, internal height = 170-177 mm. The inside and outside surfaces of the jars shall be smooth and have no observable ridges or indentations.

Note 1: Occasionally, concentric grooves may be worn into the inside of the jar by the steel balls. These grooves are not objectionable provided that the distance between crest and trough is not more than 3 mm and the control aggregate test data meets the requirements given below.

3.3 ABRASION CHARGE: 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.

3.4 SIEVES: Sieves with square openings, and of the following sizes conforming to ASTM E11:

19.0 mm, 16.0 mm,
13.2 mm, 9.5 mm,
6.7 mm, 4.75 mm,
1.18 mm

3.5 OVEN: An oven capable of maintaining a temperature of 110 ± 5°C.

3.6 BALANCE: A balance or scale accurate to 1.0 g.

3.7 LABORATORY CONTROL AGGREGATE: A supply of standard Drain Brothers Stoney Lake Quarry coarse aggregate available from the Soils and Aggregates Section, Ministry of Transportation, 1201 Wilson Avenue, Downsview, Ontario M3M 1J8, Fax (416) 235-4101.

4. PREPARATION OF TEST SAMPLE

4.1 Prepare the coarse aggregate in accordance with LS-600, the Method for Preparation of Coarse Aggregate, to meet either Grading A, B, or C.

4.2 Grading A: Aggregate for the test shall normally consist of material passing the 19.0 mm sieve, retained on the 9.5 mm sieve. An oven-dry sample of 1500 ± 5 g shall be prepared as follows:

Passing	Retained	Mass
19.0 mm	16.0 mm	375 g
16.0 mm	13.2 mm	375 g
13.2 mm	9.5 mm	750 g
	Total	1500 g

4.3 Grading B: In cases where the maximum nominal size of the coarse aggregate is less than 16.0 mm, a sample of 1500 ± 5 g shall be prepared as follows:

Passing	Retained	Mass
13.2 mm	9.5 mm	750 g
9.5 mm	4.75 mm	750 g
	Total	1500 g

4.4 Grading C: In cases where the maximum nominal size of the coarse aggregate is less than 13.2 mm, a sample of 1500 ± 5 g shall be prepared as follows:

Passing	Retained	Mass
9.5 mm	4.75 mm	1500 g
	Total	1500 g

Note 2: In cases where it is desired to test material that is substantially coarser than 19 mm (for instance, 37.5 mm concrete paving aggregate), the material can be crushed, sieved, and prepared to the A grading. Care will need to be taken that the material is not crushed so much that substantial amounts pass the 4.75 mm sieve. Care should also be taken that the crusher reduction ratio selected does not produce excessive amounts of flat and elongated or flakey particles. Such particles will give a material a higher loss in this test than when cubical particles of the same material are tested. When reporting results obtained from such aggregate, note the method of preparation and report the percent flat and elongated particles using a 4:1 ratio in LS-608.

5. TEST PROCEDURE

5.1 Wash the sample.

5.2 Oven-dry the sample to constant mass.

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

5.4 Saturate the sample in 2.0 ± 0.05 L tap water (temperature 20 ± 5°C) for a minimum of 1 h.

5.5 Place the sample in the micro-Deval abrasion container with 5000 ± 5 g of steel balls and the water. Place the micro-Deval container on the machine.

Note 3: It is permissible to saturate the sample in the water within the micro-Deval abrasion container rather than in a separate container.

5.6 Run the machine at 100 ± 5 rpm for the following times based on the preparation of the test sample (refer to Para. 4.2, 4.3, or 4.4):

Time	Test Sample
120 ± 1 min	Grading A
105 ± 1 min	Grading B
95 ± 1 min	Grading C

5.7 Carefully pour the sample over 2 superimposed sieves: 4.75 mm and 1.18 mm. Take care to remove the entire sample from the stainless steel jar. Wash the retained material with water (a hand-held spray will be found useful) until the washings are clear. Remove the stainless steel balls using a magnet or other suitable means.

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

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

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

6. CALCULATIONS

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

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

7. USE OF LABORATORY CONTROL AGGREGATE

7.1 Every 10 samples, but at least every week in which a sample is tested, a sample of the standard reference aggregate shall also be tested. The material shall be taken from a stock supply and prepared according to 4.2.

7.2 Trend Chart Use: The percent loss of the last 20 samples of reference material shall be plotted on a Trend Chart in order to monitor the variation in results.

7.3 The mean loss of the Drain Brothers Stoney Lake Quarry standard reference aggregate prepared to the grading shown in 4.2 is 13.1%. Individual test data should not normally be greater than 14.8%, or less than 11.4% (MERO-036, 2010).

8. REPORT

The report shall include the following:

8.1 The percent loss of the test sample to 1 decimal place;

8.2 The maximum size of the aggregate tested;

8.3 The percent loss of the reference sample, tested closest to the time at which the aggregate sample was tested, to 1 decimal place; and

8.4 The percent loss of the last 20 samples of reference material on a control chart.

9. PRECISION

For 19.0 mm maximum size aggregate with abrasion losses in the range from 5% to 23%, the single operator coefficient of variation has been found to be 3.4%[A]. Therefore, results of two properly conducted tests on samples of the same aggregate by the same operator using the same equipment are not expected to differ by more than 9.6%[A] of their average, 95% of the time. The multi-laboratory coefficient of variation has been found to be 5.5%[A]. Therefore, the results of two properly conducted tests by different laboratories on samples of the same aggregate are not expected to differ by more than 15.4%[A] of their average, 95% of the time.

[A]These numbers represent, respectively, the (1s) and (d2s%) limits as described in ASTM C670. The data are based on the analyses of the test results from 60 to 77 laboratories that tested twelve pairs of fine aggregate proficiency test samples covering an twelve year period from 2000 to 2011.

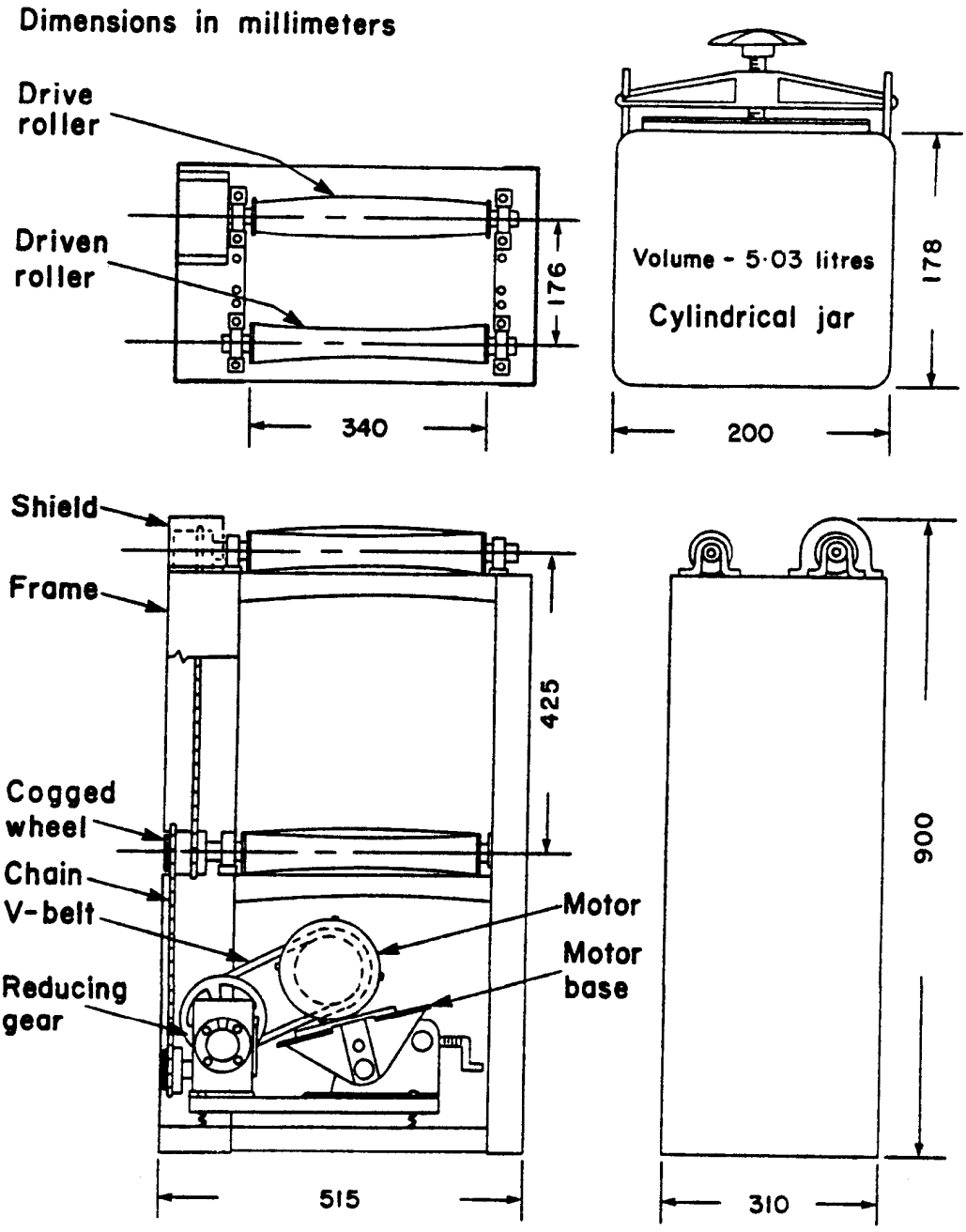

Figure 1 - Micro-Deval Abrasion Machine and Container