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

1. SCOPE

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

2. REFERENCES

2.1 MTO Test Methods

LS-601 Test for Materials Finer than 75 µm Sieve in Mineral Aggregates by Washing

LS-602 Test for Sieve Analysis of Aggregates

LS-618 Test for the Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus

2.2 ASTM Standards

C117 Standard Test Method for Materials Finer Than 75 µm Sieve in Mineral Aggregate by Washing

C136 Standard Method for Sieve Analysis of Fine and Coarse Aggregates

E11 Standard Specification for Wire-Cloth Sieves for Testing Purposes

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.

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 1250 ± 5 g of balls.

Note 1: Prior to use, new containers and new steel balls should be conditioned. Conditioning is accomplished by running the equipment with a charge of 500 g of silica sand with 750 ml of water for a period of 4 h. At the end of 4 h, this procedure must be repeated with a new sand sample. From time to time, it may be necessary to recondition the containers and steel balls. The need for this will be indicated by significant change in loss with the control material. It has been found that reconditioning is usually needed when the equipment has been used for testing carbonate coarse aggregate in LS-618, which leads to polishing of the container and ball surfaces.

3.4 SIEVES: Sieves with square openings, and of the following sizes conforming to ASTM E11 specifications: 2.36 mm
1.18 mm
600 µm
300 µm
150 µm
75 µm

A minimum 200 mm diameter 75 µm sieve is to be used for washing the aggregate. A 6.7 mm sieve will be found useful for separating the steel balls from the aggregate.

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

3.6 BALANCE: A balance or scale accurate to 0.1 g.

3.7 LABORATORY CONTROL AGGREGATE: A supply of standard Sutherland sand is available from the Soils and Aggregates Section, Ministry of Transportation, 1201 Wilson Avenue, Downsview, Ontario M3M 1J8, Phone (416) 235-3735, Fax (416) 235-4101.

4. SAMPLE PREPARATION

4.1 Aggregate for the test shall consist of material passing the 4.75 mm sieve (fine aggregate). Split a representative 725 ± 25 g sample for the micro-Deval test and place in a sealed container.

5. PROCEDURE

5.1 Wash the sample over a 75 µm sieve until the wash water is clear, as described in LS-601, Method of Test for Materials Finer Than 75 µm Sieve in Mineral Aggregates by Washing.

5.2 Oven-dry the sample to a constant mass at a temperature of 110 ± 5°C.

5.3 The sample shall be sieved into separate sizes. The sample shall be made up to a fineness modulus (FM) of 2.8 using the gradation given below and then tested. Record the Mass 'A' to the nearest 0.1 g.

Pass	Retained	Mass
4.75 mm	2.36 mm	50 g
2.36 mm	1.18 mm	125 g
1.18 mm	600 µm	125 g
600 µm	300 µm	100 g
300 µm	150 µm	75 g
150 µm	75 µm	25 g
	TOTAL	500 g

Note 2: Where prior testing has shown the loss of a material from a source to be less than 17%, a representative 500 ± 5 g sample from the original 700 g sample may be tested without sieving into individual fractions. Testing of low micro-Deval loss material without sieving into separate fractions

has a small effect on the measured loss and may considerably reduce the complexity of the testing. If testing shows this loss to be greater than 17%, then a further sample shall be tested, which has been prepared to an FM of 2.8 using the gradation specified in 5.3. This loss shall be reported as the final test result.

5.4 Saturate the sample in tap water for 24 ± 4 h.

5.5 Pour off the excess water and place the sample in the micro-Deval abrasion container with 1250 ± 5 g of steel balls and 750 ± 25 ml of tap water. Place the micro-Deval container on the machine.

5.6 Run the machine at 100 ± 5 rpm for 15 min ± 10 sec.

5.7 Remove the balls from the sample by passing the sample and water through a 6.7 mm sieve over a pan. Wash the aggregate over a 75 µm sieve, according to the procedure described in LS-601, being careful not to lose any retained 75 µm material.

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

5.9 Weigh the sample to the nearest 0.1 g. Record the Mass 'B'.

6. CALCULATION

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

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

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 the following procedure. The material shall be sieved into separate sizes, and each size fraction thoroughly washed and dried to a constant mass. The reference sample shall be made up using the following gradation:

Passing	Retained	Mass
4.75 mm	2.36 mm	40 g
2.36 mm	1.18 mm	115 g
1.18 mm	600 µm	180 g
600 µm	300 µm	120 g
300 µm	150 µm	38 g
150 µm	75 µm	7 g
	TOTAL	500 g

7.2 Control Chart Use: The per cent loss of the last 20 samples of reference material shall be plotted on a control chart in order to monitor the variation in results. The average loss of the control

material should be 16.8%. Individual test data should not normally be greater than 18.4% or less than 15.2%.

8. REPORT

The report shall include the following:

8.1 The per cent loss of the test sample to 1 decimal place.

8.2 The per cent loss of the reference sample tested closest to the time at which the aggregate sample was tested, to 1 decimal place.

8.3 The per cent loss of the last 20 samples of reference material on a control chart.

9. PRECISION

9.1 For fine aggregate with abrasion losses in the range from 7% to 18%, the single-operator coefficient of variation has been found to be 3.0%[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 8.5%[A] of their average, 95% of the time. The multi-laboratory coefficient of variation has been found to be 7.7%[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 21.8%[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.

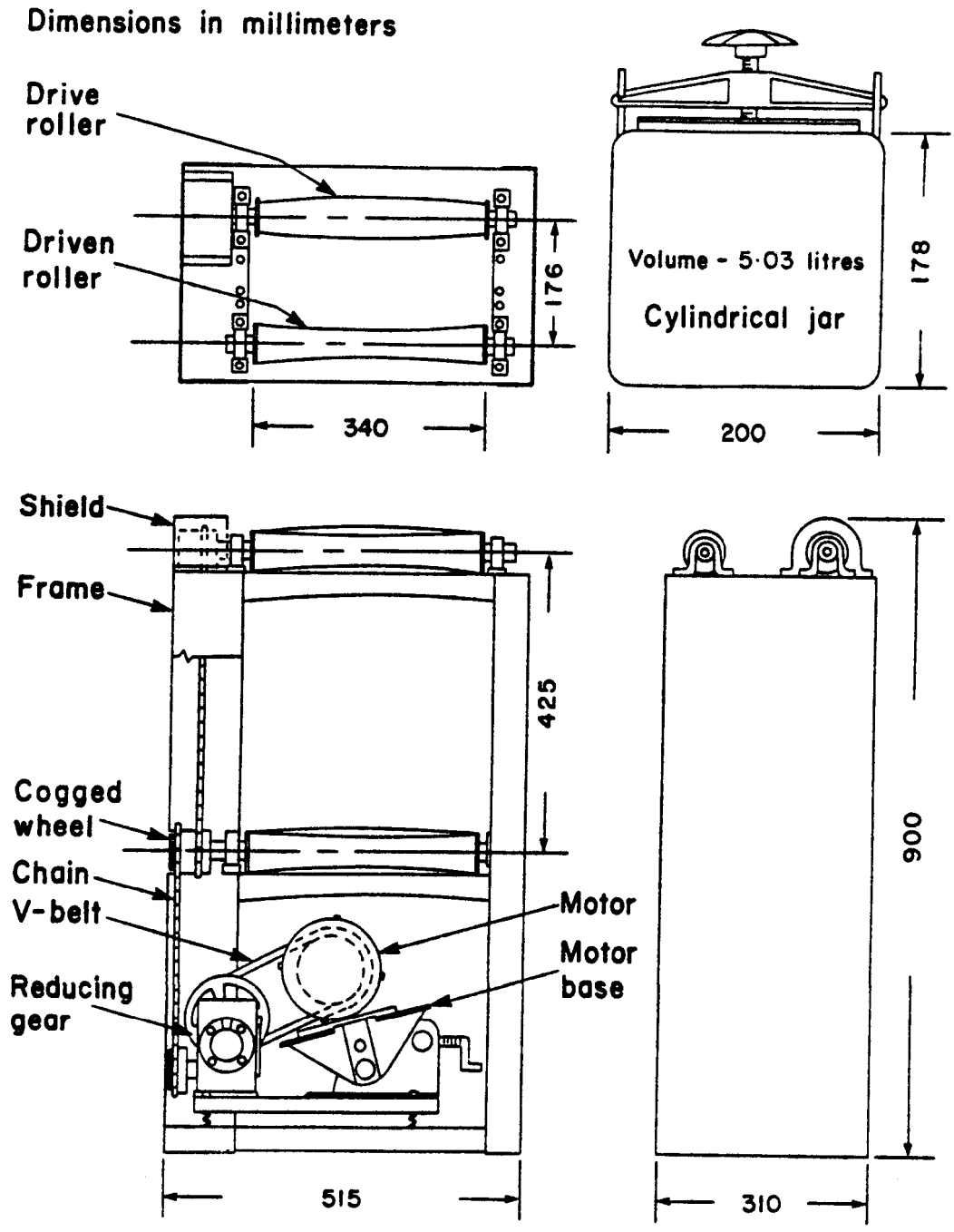

Figure 1

Micro-Deval Abrasion Machine and Container

Ministry of Transportation
Ontario

MICRO - DEVAL ABRASION TEST

LAB. NO.	DUE DATE	ORIGINAL MASS g	MASS AFTER TEST g	LOSS g	PERCENT LOSS	PASS 4.75 F.M.

DATE _____ OPERATOR _____ CONTROL NO. _____

REMARKS

PH-CC-446 90-08

Figure 2

Test Data Card