PROCEDURE FOR THE PETROGRAPHIC ANALYSIS OF COARSE AGGREGATE

LS-609 R33

1. SCOPE

1.1 This procedure outlines the method to be employed in the petrographic analysis of coarse aggregate proposed for use in construction. The test method is subdivided into Parts A and B. In Part A, the procedure appraises the quality of coarse aggregate and provides a numerical means in terms of a petrographic number (PN) of expressing and comparing the quality of material from the same or different sources. Part B outlines the procedure for petrographic identification of coarse aggregate extracted from either reclaimed asphalt pavement (RAP) or asphaltic concrete.

1.2 This procedure does not attempt to describe the techniques used in the geological classification of the aggregate particles, since it is assumed that the examination will be performed by persons qualified to do so by experience and training. The subsequent classification of aggregate particles into quality types employs index tests, e.g., hardness, strength.

1.3 This test method is intended to be applied only to aggregate derived from natural mineral materials such as gravel and crushed bedrock. It is not intended for the assessment of quality or suitability of artificial or man-made materials. This may include but is not limited to industrial co-products such as slags and other recycled or reclaimed materials such as asphaltic concrete, Portland cement/hydraulic concrete, glass, ceramic whiteware etc. For the purposes of this test method, these materials are considered contaminants.

1.4 This system of evaluation of aggregate type and quality is based on laboratory studies and in-service performance for intended uses and prevailing conditions in Ontario. The factors may not apply under other conditions and in other areas.

3. DEFINITION

3.1 SILICEOUS AGGREGATES: means rock particles containing or composed of silica (SiO_2) or minerals with silica in the crystal structure as silicate (SiO_4). Siliceous aggregates include the following Type Numbers given in the Appendix and shown on MTO form PH-CC-343a : 03, 22, 06, 04, 05, 08, 07, 09, 10, 30, 29, 25, 34, 27, 28, 46, 56, 50, 55, 51, 48, 63, 81, 82, 73, 74, 86, 84, 97, 87, 32, and 64.

3.2 CARBONATE AGGREGATES: means rock particles composed predominantly of minerals containing the carbonate ion ($[CO_3]^{2-}$) in its chemical formula. The most abundant carbonate aggregates are limestones and dolostones, the former composed of the mineral calcite ($CaCO_3$) and the latter of dolomite ($Ca,Mg(CO_3)_2$). Carbonate aggregates include the following Type Numbers given in the Appendix of the LS and shown on form PH-CC-343a: 01, 20, 02, 21, 23, 35, 41, 42, 40, 24, 26, 43, 44, 49, and 45.

4. APPARATUS

4.1 HAND LENS: 10x magnification..... _____

4.2 MAGNET..... _____

4.3 KNIFE: Good quality with a blade hardness of between 5½ and 6 on Moh's scale..... _____

4.4 ANVIL & HAMMER: Suitable for breaking aggregate particles..... _____

4.5 HYDROCHLORIC ACID: Technical grade, 5 % by volume..... _____

4.6 BINOCULAR MICROSCOPE: 4x to 25x magnification or higher, with appropriate illumination source..... _____

4.7 SCALE: Accurate to 0.1 g and of sufficient capacity..... _____

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PART A

5. PREPARATION OF SAMPLE

5.1 Examine the sample in the as-received condition and record any significant features regarding particles that may be affected by sample preparation such as soaking, washing and sieving..... _____

5.2 Determine the gradation of the coarse aggregate portion (material retained on the 4.75mm sieve) according to LS-602. Record the percentage of each fraction of the as-received sample as a percentage of the total coarse aggregate on MTO form PH-CC-343a (see Appendix in the LS) ..... _____

5.3 Weigh out representative quantities of the different sizes present in the sample to the minimum masses shown below: ..... _____

Pass	Retained	Minimum Mass, g
75 mm	19.0 mm	10,000
53 mm	19.0 mm	5000
37.5 mm	19.0 mm	4000
26.5 mm	19.0 mm	3000
19.0mm	13.2 mm	1500
13.2 mm	9.5 mm	500
9.5 mm	4.75 mm	200

5.4 Begin the examination on the coarsest fraction that comprises at least 10 percent of the coarse aggregate portion of the sample..... _____

Continue with examination of progressively finer fractions until at least 90 percent of the coarse aggregate portion of the sample has been examined..... _____

5.5 Consider all material retained on the 19 mm as a single fraction with the quantity of material to be examined determined by the largest sieve through which all the aggregate passes, e.g., if 100% of the aggregate passes the 53 mm sieve, then the fraction of material retained on the 19 mm sieve will consist of 5000 g..... _____

Proportion the quantity of material within this fraction according to the coarse aggregate gradation of the as-received sample..... _____

6. TEST PROCEDURE

6.1 Follow the procedure given below for each fraction to be examined..... _____

6.2 Spread the sample out on a clean tray or other clean, flat working surface..... _____

6.3 Visually examine the sample for angularity and shape characteristics and make an estimate of the percentage of crushed particles. Record the information on MTO form PH-CC-343a..... _____

6.4 Examine all aggregate particles for coatings (such as clay), cementations and encrustations which may affect bond with asphalt or Portland/hydraulic cements. Note the type of coating and the degree of adhesion to the aggregate and record this in the Additional Information section on MTO form PH-CC-343a..... _____

6.5 Separate all particles that may break down in water or with normal handling, e.g., clay balls. Classify these particles according to paragraph 6.9 below (do not soak) ..... _____

6.6 Wash the remaining material to remove clay and dust coatings. Place the washed material in a bowl or other suitable container and cover with water. Soak the sample for a minimum of 12 hours... _____

Note 1: Soaking will cause particles with clay, shale, shaley, slightly shaley or micaceous content to soften, making them easier to recognize.

6.7 Pour off the water from the sample. Remove the sample from the bowl and spread it out on a clean tray or other clean, flat working surface covered with either paper or a cloth towel to absorb excess water..... _____

6.8 Examine and classify each particle into separate groups according to rock type and quality using the information provided in the Appendix of the LS..... _____

Note 2: MTO form PH-CC-343a only provides listing of the most common rock type and quality designations that may be expected and is not exhaustive. MTO form PH-CC-343a may be amended with additional rock types from the Appendix as applicable.

Note 3: Index tests and a microscopic examination are usually sufficient to classify an aggregate particle. If not, refer the particle to a Petrographer for additional information and identification, i.e., possibly requiring a detailed petrographic study.

6.9 In the classification of each particle, the following features may be relevant: ..... _____

6.9.1 Scratch hardness..... _____

6.9.2 Strength..... _____

6.9.3 Density..... _____

6.9.4 Shape..... _____

6.9.5 Texture..... _____

6.9.6 Colour..... _____

6.9.7 Mineralogy..... _____

6.9.8 Structure..... _____

6.9.9 Reaction with hydrochloric acid..... _____

6.9.10 Weathering..... _____

6.9.11 Magnetism..... _____

6.10 On completion of the examination, record the mass of classified particles to the nearest 0.1 g in the appropriate columns shown on MTO form PH-CC-343a..... _____

6.11 Repeat the procedure for the next fraction..... _____

7. CALCULATIONS

7.1 For each fraction, calculate the percentage of each rock type to the nearest 0.1 percent..... _____

Calculate the percentage of good, fair, poor and deleterious particles as a percentage of the entire sample (including contaminants) ..... _____

7.2 Calculate the PN for each fraction as the sum of the products of the percentage of each petrographic category (good, fair, poor and deleterious) and the appropriate factor (1, 3, 6, and 10, respectively)_____

Note 4: Do not include contaminant particles when calculating the PN or the weighted average PN.

7.3 When the test is performed on more than one fraction, calculate a weighted average PN as follows: compute the percentage of each fraction of the coarse aggregate portion of the as-received sample_____

Multiply each of these calculated percentages for each of the fractions by their respective petrographic numbers for those fractions..... _____

Divide the sum of the products by 100..... _____

Enter the information in the appropriate sections of MTO form PH-CC-343a..... _____

7.4 For the purpose of calculating the weighted average PN, consider any sizes of the coarse aggregate fractions that were not tested to have the same value as the next larger or smaller size fraction, whichever is present..... _____

8. REPORTING OF RESULTS

8.1 Include the following in the examination report (MTO form PH-CC-343a) ..... _____
8.1.1 Information regarding contract, aggregate, source and sampling as applicable..... _____
8.1.2 Contact information of the testing laboratory and the sample number..... _____
8.1.3 The date the examination was completed and the name of the analyst performing the examination..... _____
8.1.4 The coarse aggregate gradation of the as-received sample..... _____
8.1.5 The masses of each type (including contaminants) to one decimal place for each fraction tested..... _____
8.1.6 The percentages (to the nearest 0.1 percent) of each type and of good, fair, poor and deleterious particles for each fraction tested..... _____
8.1.6 The PN for each fraction tested (to the nearest whole number) ..... _____
8.1.7 The weighted average PN (to the nearest whole number), when the test is performed on more than one fraction..... _____
8.1.8 Other information as required, such as the percentage of individual or combined rock types or contaminants by mass, e.g., percent by mass of carbonate or siliceous aggregate rock types..... _____

9. GENERAL NOTES

9.1 In the event that there are a number of highly absorptive aggregate particles, air-dry the particles before weighing so that excess water absorbed during washing/soaking will not significantly influence the mass..... _____
9.2 Petrographic factors used for classification take only the physical properties of the aggregate into account. The possibility of the aggregate producing excessive expansion through alkali-aggregate reactions or other adverse reactions and/or staining in asphaltic or hydraulic cement concretes due to the presence of components such as silica or siliceous minerals, sulphide minerals, free lime, free magnesia or gypsum is not considered here..... _____

PART B

10. SAMPLE PREPARATION

10.1 Extract sufficient aggregate material from the RAP or asphaltic concrete using LS-282, or as specified in the contract documents, to obtain a minimum of 1 kg of clean, dry, coarse aggregate _____
Examine the material for residual asphalt cement and if present, repeat the extraction..... _____
10.2 Determine the gradation of the extracted aggregate according to procedures given in LS-602_____
10.3 Prepare individual fractions from the coarse aggregate proportion as shown in the following table:
..... _____

Pass	Retained	Minimum Mass, g
-	9.5 mm	entire sample
9.5 mm	4.75 mm	200

Note 5: Where the mass of the pass 9.5 mm/retained 4.75 mm fraction is more than 25% of the mass shown in this table, reduce the mass by splitting to meet this requirement.

11. PROCEDURE

11.1 Follow the procedure given below for each sieve fraction to be examined..... _____

11.2 Place the material in a bowl or other suitable container and cover with water. Soak for a minimum of 12 hours..... _____

11.3 Pour off the water from the sample. Remove the sample from the bowl and spread it out on a clean tray or other clean, flat working surface covered with either paper or a cloth towel to absorb excess water..... _____

11.4 Examine and classify each particle according to rock type, mineral type or material and quality using the information provided in the Appendix of the LS. Refer to Part A, 6.9 of this test method for relevant features..... _____

Note 6: Classify each rock, mineral and material type individually, e.g., granite, diorite, gabbro, gneiss, schist, sandstone. DO NOT group rock types together into broad classifications, e.g., granite-diorite-gabbro.

11.5 Determine the appropriate Category for each rock type, mineral type or material identified and record the classification as a separate entry on MTO form PH-CC-343b (Appendix of the LS)..... _____

Note 7: Rock type quartzite (formerly Category 4) is now included in Category 1.

11.6 Upon the completion of the examination, weigh and record the mass of each group of classified particles to the nearest 0.1 g. Enter this information on MTO form PH-CC-343b..... _____

12. CALCULATIONS

12.1 Calculate the proportion of each different rock, mineral or material type tested as percentage of each sieve fraction tested as follows: ..... _____

12.1.1 For each fraction, calculate the percentage of each different rock, mineral or material type by dividing the mass of individual types by the total mass of the tested fraction and multiply by 100 _____

12.1.2 For each category, sum the individual masses of each type tested..... _____

Divide this sum by the total mass of the tested fraction and multiply by 100..... _____

12.2 Calculate the weighted average of each different rock, mineral or material type tested and for each category as a percentage of the total sample as follows: ..... _____

12.2.1 For each type, multiply the percentages within each fraction obtained in 12.1.1 by the portion represented by that fraction as determined by coarse aggregate gradation of the as-received sample..... _____

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13. REPORTING OF RESULTS

13.1 Include the following in the examination report (MTO form PH-CC-343b): ..... _____
13.1.1 Information regarding contract, aggregate, source and sampling as applicable..... _____
13.1.2 Contact information of the testing laboratory and the sample number..... _____
13.1.3 The date the examination was completed and the name of the analyst performing the examination..... _____
13.2 The coarse aggregate gradation of the as-received sample, as determined by LS-602..... _____
13.3 For each fraction tested, report the following: ..... _____
13.3.1 The percentage of the same fraction in the as received sample..... _____
13.3.2 The mass of each different rock, mineral or material type recorded to one decimal place.. _____
13.3.3 The percentage of each different rock, mineral or material type to one decimal place..... _____
13.3.4 For each Category, the total mass of each rock, mineral or material type found within that Category and the percentage that it represents in the tested fraction..... _____
13.4 The weighted average percentage that each different rock, mineral or material type represents in the as-received sample..... _____
13.5 The weighted average percentage that all of the components within each designated Category represents in the as-received sample..... _____

COMMENTS