

METHOD OF TEST FOR QUANTITATIVE EXTRACTION OF ASPHALT CEMENT AND ANALYSIS OF EXTRACTED AGGREGATE FROM BITUMINOUS PAVING MIXTURES

1. SCOPE

1.1 This method covers the quantitative determination of asphalt cement in a bituminous paving mixture. The paving mixture is extracted with trichloroethylene or methylene chloride solvent (see Note 1) or normal propyl bromide (nPB) and the extract is corrected for mineral fines content using high speed centrifuge or ashing methods.

Note 1: The Ministry of Transportation of Ontario plans to discontinue the use of chlorinated solvents for extraction testing in Quality Assurance and Referee laboratories starting April 1, 2010.

1.2 The extracted aggregate is washed to remove fines smaller than 75 µm and the remaining aggregate is used for sieve analysis.

1.3 This standard may involve hazardous materials, operations, and equipment, and does not purport to address all of the safety concerns associated with their use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. RELEVANT DOCUMENTS

- 2.1 AASHTO T 164 Standard Method of Test for Quantitative Extraction of Asphalt Binder from Hot-Mix Asphalt (HMA)
- 2.2 ASTM C702 Standard Practice for Reducing Samples of Aggregate to Testing Size
- 2.3 ASTM D2172 Standard Test Methods for Quantitative Extraction of Bitumen From Bituminous Paving Mixtures
- 2.4 ASTM E11 Standard Specification for Wire Cloth and Sieves for Testing Purposes

3. REAGENT

3.1 Trichloroethylene: Reagent grade chemical or grade of sufficiently high purity to permit use without lessening the accuracy of the determination.

3.2 Methylene chloride: Reagent grade chemical or grade of sufficiently high purity to permit use without lessening the accuracy of the determination. If this reagent is used, substitute 'methylene chloride' for the word 'trichloroethylene' throughout the method.

3.3 Normal propyl bromide (nPB): Reagent grade chemical or grade of sufficient high purity to permit use without lessening the accuracy of the determination.

4. APPARATUS

4.1 BALANCES: Of sufficient capacity and sensitivity for miscellaneous weighing, with associated accessories such as balance pans.

4.2 DRYING PANS: Seamless enamel, stainless steel, or aluminum pans with a minimum of 10 square mm horizontal surface area per gram of sample, shall be used for drying the extracted aggregate as well as the washed aggregate. Rectangular metal pans of nominal size 250 x 400 x 50 mm have been suitable for the determination of moisture content.

4.3 CENTRIFUGE EXTRACTOR: Either electrically or hand operated, complete with 1000 g minimum capacity bowl. For the electrically operated extractor, it is necessary to have a controlling device that will allow the speed to be set at 1800 r.p.m.

Note 2: Rotarex extractors have been found to be suitable for this test. Larger test sample sizes may be too large for some extractors and therefore require the sample to be done in two portions. Due to the nature of the solvent used, this equipment must be installed in a properly ventilated location (i.e. a fume hood or equivalent).

4.4 DRAIN TUBE: Neoprene, preferably with a 150 mm long glass insert.

4.5 FILTER PADS: Smooth, heavy weight, medium fast, low ash, qualitative type paper - E & D Grade 627 or equivalent.

4.6 MISCELLANEOUS ITEMS: 0.5 L container, 150 mm spike, 80 mm x 12 mm stainless steel spatula, stiff brush, a rubber spatula and a 75 mm wide blade scraper. Wider blades have been used successfully for quartering (1.6 x 100 x 400 mm).

4.7 TORQUE WRENCH: 9.5 mm drive, calibrated in N-m with a capacity of approximately 22 N-m. This can be used either with a 19.1 mm socket with two slots milled out of the sides to fit over the steel rod in the extractor unit funnel, or with a 9.5 mm drive socket brazed into the middle of the funnel.

4.8 EXTRACT CONTAINERS: Any suitable containers which will permit the quantitative transfer of extract and mineral fines to the high-speed centrifuge. The containers should have a capacity sufficient to accommodate the volume of extract from each rotarex cycle.

4.9 TACHOMETER: A strobe type tachometer capable of determining rotational speeds in the range of 1,000 to 10,000 r.p.m.

4.10 GRADUATED CYLINDER: 500 ml capacity to measure the rate of flow of the extract during the recovery of mineral fines. Use 2000 ml cylinders if they are being used as receivers for the total volume of extract.

4.11 HIGH-SPEED CENTRIFUGE: As described in ASTM D2172 Section 11.6.2.1.

4.12 RIFFLE SPLITTER: For splitting hot mix samples. Recommended width of the individual chutes is approximately 38 mm for all types of paving mix.

5. SAMPLE SIZE

5.1 The size of the test sample shall be governed by the 'Designated Large Sieve' size of the mix/mix type and shall conform to the requirements as shown in the following table (see Note 3).

Size of Test Sample

Mix Type	Designated Large Sieve Size (mm)	Minimum Mass of Sample (kg)
HL 2	2.36	0.5
SMA 9.5, Superpave 9.5	4.75	1.0
HL 1, HL 3, HL 3A, DFC, OFC, SMA 12.5, Superpave 12.5, 12.5FC 1, 12.5FC 2	9.5	1.5
HL 4 (Binder and Surface)	13.2	1.5
Superpave 19.0, SMA 19.0	12.5	2.0
HL 8, MDBC, HDBC	16.0	2.0
Superpave 25.0	19.0	3.0
Superpave 37.5	25.0	4.0

Note 3: The Designated Large Sieve is a sieve size specifically designated for testing purposes.

5.2 For moisture content, a minimum sample size of 1000 g is required for all types of paving mix.

6. SAMPLE PREPARATION FROM LOOSE PAVING MIXTURES

6.1 Obtain loose field samples in accordance with specified procedures. Plate or loose mix samples shall be reduced to the proper size. Two methods of reducing the field sample to the testing size are acceptable: quartering or splitting using a riffle splitter.

6.1.1 Quartering: Warm the field sample to achieve sufficient workability for quartering. A conventional oven maintained at 110°C or a microwave oven (see Note 4) may be used for this purpose. The surface upon which the sample is to be reduced should be flat, non-abrasive, non-absorptive and of sufficient area to provide for uniform quartering. Heat lamps may be used to keep the surface warm (see Note 5). The sample shall be mixed on the surface until uniform, then quartered, and opposite quarters removed. This process is to be repeated until the testing size is obtained.

Note 4: Caution: Frequent mixing may be necessary to prevent localized overheating when using a microwave oven to heat paving mixtures. Also, the presence of metal particles in some mixtures may render the microwave oven unsafe for the heating of these mixtures. Mixes made with polymer modified asphalt cement will have to be heated to a temperature higher than 110°C to achieve

sufficient workability. The actual temperature should be the minimum required to achieve this and should be determined by trial and error.

Note 5: If required, 'Pam' or equivalent used in minimal quantities has been found suitable in preventing the sample from adhering to the surface. Motor oils must not be used for this purpose.

6.1.2 Riffle Splitter: Warm the field sample to achieve sufficient workability for splitting. A conventional oven maintained at 110°C or a microwave oven (see Note 4 above) may be used for this purpose. The mix may agglomerate if it is too cold or stick to the splitter if too hot. A temperature range of 90°C to 110°C has been found to be generally satisfactory. Heat lamps may be used to keep the walls of the splitter box warm (see Note 5 above). Chutes shall be cleaned after each split. The use of a putty knife or a 25 mm diameter wire brush used to clean glassware has been found suitable.

7. SAMPLE PREPARATION FROM COMPACTED PAVING MIXTURES

When testing core samples for asphalt cement content and sieve analysis, the core shall be warmed just sufficiently to enable the trimming of the curved surface to remove particles which were cut during the coring process. The depth trimmed shall be equivalent to the 'Designated Large Sieve' size for the particular mix type, except for HL 2 mix when the depth trimmed shall be approximately 4.75 mm. Dry the trimmed core to constant mass (see Section 8) to remove moisture.

8. DETERMINATION OF MOISTURE CONTENT

8.1 In extraction test calculations, asphalt cement content is obtained by subtracting the extracted aggregate mass from the original mass of the test sample. If moisture is present in the original sample, it will appear as asphalt cement in the final calculation unless a correction is made. This is done by determining the amount of moisture in a separate 1000 g portion and adjusting the mass of the extraction test portion or, if time permits, heating the extraction test portion to a constant dry mass. The first method has the advantage that the two procedures can be run concurrently. Either method is acceptable.

8.2 Weigh the test portion obtained for moisture content determination and record the mass to 0.1 g. Place the test portion in an oven maintained at 110 ± 5°C and dry to a constant mass.

Note 6: Constant mass is defined as no change in mass in excess of 0.1% or 1 g, whichever is less, for each 30 minute drying period.

8.3 Reweigh the test portion and calculate its moisture content rounding off to the nearest 0.01% as follows:

$$\% \text{ Moisture Content, (Z)} = \frac{(M_a - M_d)}{M_d} \times 100$$

where: M_a = Original mass of mix, g

M_d = Mass of oven dry mix, g

8.4 Adjust the original mass of the test portion used for extraction in accordance with Section 11.2.

8.5 If the method of drying the original test portion is followed, then use the dried mass as the original mass in subsequent calculations.

9. EXTRACTION PROCEDURE

9.1 Measure and record the mass of the test portion to the nearest 0.1 g (W_1).

9.2 Carefully transfer the mix from the balance pan to the extractor bowl keeping the funnel in place during the transfer.

9.3 Fill the 0.5 L container with the extraction solvent and wash any of the mixture remaining in the balance pan into the extractor bowl. Put the remaining solvent into the bowl, while gently breaking down the mix with the spike or spatula. Distribute the mix evenly around the bowl to avoid off-balance loading. Clean all fines and asphalt off the spike or spatula with solvent and ensure all aggregate particles are covered by the solvent (see Note 5).

Note 7: For larger size bowls, increase the amount of solvent to ensure total coverage of the aggregate.

9.4 Dry the filter paper at 110°C to constant mass, to the nearest 0.1 g (M_f). The filter paper should be weighed immediately after drying. Filters may be preweighed, i.e. an established dry mass for each filter (hot) may be determined prior to using the filter. This dry, hot mass may then be used as the "original mass of the filter" in the calculations. After pre-drying, the filters must be kept in a dust proof container until used. Place the filter paper, with fine side up, on the bowl. Place the cover on the bowl (and over the filter paper) and tighten with the torque wrench. Apply a torque of 11.3 N-m to the funnel (Note 8). Allow the sample to soak for 15 minutes.

Note 8: For larger size extractor bowls, the laboratory shall have a written protocol to ensure uniform tightening of the lids.

9.5 At the end of the 15 minute soak period, with the bowl in the extractor and the cover in place, start the extractor slowly.

9.6 With the hand operated extractor, turn the handle slowly, gradually increasing the speed of the handle to 60 r.p.m. (which is equivalent to 1800 r.p.m. of the bowl for the electrically powered extractor). With the electrically powered extractor, start the machine slowly, allowing it to increase to a maximum of 1800 r.p.m. (see Note 9). Maintain this rate until the solvent ceases to flow and just drips. Collect and retain the extract in the extract containers.

Note 9: Operate larger size extractors in accordance with manufacturer's instructions.

9.7 Stop the extractor and remove the small cover over the funnel (if applicable). Pour 0.5 L of solvent through the funnel into the bowl (see Note 5 above) and rotate the bowl back and forth by hand to dislodge any material adhering to the side of the bowl. Replace the funnel cover, allow the sample to soak for 10 minutes, and repeat centrifuging as described in Section 9.6.

9.8 Repeat this procedure, reducing the soaking period to 5 minutes (see Note 10). Be sure that the solution coming through the drain tube is a light straw colour. Spin until the dripping ceases and continue for an additional 2 minutes thus ensuring a fairly dry aggregate sample.

Note 10: RHM, RAP, and samples containing slag or absorptive aggregate may require a 15 minute soak period for each repeat of the procedure.

9.9 The extract container may now contain the total extract and washings from each rotarex cycle to be used for the determination of mineral fines in the extract in accordance with Section 10.

9.10 Remove the extractor bowl and set it on a suitable stand under adequate ventilation. Carefully remove the cover leaving the filter in place. Tap the filter surface all around with the metal spatula so that any loose material drops into the bowl. Lift the filter pad from the bowl and carefully invert the filter over a drying pan to avoid loss of fines. Brush or scrape the fines from the filter into the drying pan. Loosen the aggregate from the sides of the extractor bowl with a rubber spatula (while keeping the bowl tilted) and, using a stiff brush, transfer the remainder of the material from the bowl into the drying pan. Any fines adhering to the bowl must be brushed into the drying pan. Any fines adhering to the brush must also be transferred to the drying pan. Bend the filter pad into a tent shape and place it on the drying pan. Place the drying pan in the oven. Dry to a constant mass at $110 \pm 5^{\circ}\text{C}$ taking care not to char or burn the filter pad.

9.11 Provided low ash filter rings are used, an alternative procedure for the determination of mineral fines in the filter ring may be used (see Section 9.17).

9.12 At the end of the drying period remove the pan from the oven.

Note 11: Because dry aggregate absorbs moisture when exposed to air, determine the mass of the extracted aggregate immediately after cooling to 90 to 100°C to avoid damage to the balance. A dial thermometer tared with the weighing pan has been found to be useful in determining when a suitable weigh temperature is reached.

9.13 Immediately after drying, determine the mass of the filter pad to the nearest 0.1 g and record. This mass is the total of the original tared mass plus the mass of the fines trapped in the filter fibres.

9.14 Calculate the mineral fines in the filter as follows:

Mass of mineral fines in filter, (W_3) = $M_{ff} - M_f$

where: M_{ff} = Mass of filter after extraction, g

M_f = Mass of filter, g

9.15 Immediately after drying, carefully transfer the hot aggregate from the drying pan into the balance pan, brushing any fines adhering to the drying pan into the balance pan. Determine the mass of the dried aggregate (M_{ba}), while still warm, to 0.1 g, and record (see Note 11 above).

9.16 Calculate the mass of dried aggregate as follows:

$$\text{Mass of dried aggregate, } (W_4) = M_{ba} - M_b$$

where: M_{ba} = Mass of balance pan plus dried aggregate, g

M_b = Mass of balance pan, g

9.17 If low ash (ash residue not greater than 0.2%) filter pads are used, dry to constant mass as required by Section 9.4, then carefully fold the filter pad and stand it on the aggregate in the weighing pan. Burn the pad by igniting it with a match or Bunsen burner. Determine the mass of the dried aggregate and filter pad mineral fines (M_{baf}).

9.18 Calculate the mass of the dried aggregate plus filter pad mineral fines as follows:

$$\text{Mass of dried aggregate plus filter pad mineral fines } (W_3 + W_4) = M_{baf} - M_b$$

where: M_{baf} = Mass of balance pan, dried aggregate and filter pad mineral fines, g

M_b = Mass of balance pan, g

9.19 As an alternate to the rotarex extraction method, the reflux method can be utilized. Refer to ASTM D2172-95, test method B for a complete description of this method.

10. DETERMINATION OF MINERAL FINES IN EXTRACT

10.1 This procedure uses a high speed centrifuge as described in ASTM D2172, Section 11.6.2.

10.2 Transfer extract from containers to high speed centrifuge receiving funnel and correct for fines. The high speed centrifuge should be operated as per manufacturer's instructions.

10.3 Calculate mineral fines in the extract as follows:

$$\text{Mass of mineral fines in extract, } (W_5) = M_{cf} - M_c$$

where: M_{cf} = Mass of cup plus fines, g

M_c = Mass of cup, g

10.4 For an alternative procedure for the determination of mineral fines (Ashing Method), refer to ASTM D2172, Section 11.6.1.

11. ASPHALT CEMENT CONTENT CALCULATION

11.1 Calculate the asphalt cement content in the test portion to two decimal places making use of appropriate work sheets.

11.2 If moisture is present in the mix and the sample has not been dried to constant mass to eliminate moisture, adjust the original mass of the mixture for the test portion or test increments as follows:

$$\text{Dry mass of mixture, } (W_2) = \frac{W_1}{(100 + Z)} \times 100$$

where: W_1 = Original mass of test portion, g

Z = Moisture content, %

11.3 For the test portion calculate the total mass of the dry aggregates as follows:

Total mass of dry aggregate, $(W_6) = W_3 + W_4 + W_5$

where: W_3 = Mass of mineral fines on the filter

W_4 = Mass of dry aggregates

W_5 = Mass of mineral fines in the extract

11.4 The mass of the asphalt cement can be determined for the test portion as follows:

Mass of asphalt cement, $(W_7) = W_2 - W_6$

where: W_2 = dry mass of mixture, g

W_6 = dry mass of aggregate, g

11.5 The asphalt cement content expressed as a percentage of the moisture free mix is calculated as follows:

$$\text{Asphalt cement content, \% } (W_8) = \frac{W_7}{W_2} \times 100$$

11.6 If an extraction test is carried out in two portions, the results shall not be averaged but shall be combined to calculate a single asphalt cement content.

12. ANALYSIS OF EXTRACTED AGGREGATE

12.1 WASHING OF AGGREGATE: After the mass (W_4) of the test portion of dried aggregate has been determined, return the sample to the drying pan and cover the sample with water. Add a sufficient amount of wetting agent (see Note 10) to ensure a thorough separation of materials finer than 75 μm from the coarser particles. The contents of the container shall be agitated vigorously taking care not to splash out any material, and then the wash water shall be immediately decanted over the nest of two sieves consisting of a 1.18 mm sieve superimposed on a 75 μm sieve. The use of a hand, a metal spoon or a spatula to stir and agitate the aggregate in the wash water has been found to be satisfactory (see Note 11).

Note 12: Wetting agents such as Calgon or Alconox may be pre-mixed with water at 50 g/L. 100 ml of this solution is then added to the first wash of each test. One drop of liquid dishwashing detergent in the first soak has been found to be a suitable alternative. It has been found advantageous to allow the first wash to soak for five minutes after the addition of the wetting agent and preliminary agitation.

Note 13: The agitation shall be sufficiently vigorous to completely separate the particles finer than 75 μm from the coarser particles and bring them into suspension, in order that they may be removed by decanting the wash water. Care shall be taken to avoid, as much as possible, decanting of the coarse particles of the sample. The operation shall be repeated until the wash water is clear.

12.2 Return all the material retained on the nested sieves by flushing into the washed sample in the drying pan. The washed aggregate shall be dried to a constant mass at a temperature of $110 \pm 5^\circ\text{C}$ and the mass determined to the nearest 0.1 g (W_9) (see Note 9 above).

12.3 SIEVE ANALYSIS: Transfer cooled aggregate into the nest of coarse and fine sieves. Agitate on a mechanical sieve shaker. A satisfactory end point in sieving is considered to have been reached when an additional 1 minute of sieving by hand fails to change the mass on any sieve by more than 1%. This is usually about twelve minutes. On completion of the sieving operation, separate the sieves. Each sieve shall be placed within a round stainless steel bowl and shaken manually, checking to see if additional material passes through. Any additional material should be transferred to the next smaller sieve size. When emptying the sieves, gently strike the rim of the inverted sieve with the wooden handle of the sieve brush. This helps to dislodge aggregate particles from the cloth. Individual particles stuck in coarser sieves may also require help. Following this, brush the bottom surface of the sieve cloth with a circular motion. In no case should the particles be turned or manipulated through the sieves by hand. Weigh and record cumulatively (e.g. each successive size is to be added to the previous total) on the appropriate work sheet, the mass of the fraction retained on each sieve.

12.4 CALCULATION OF AGGREGATE FRACTIONS: Calculate the percent passing on each sieve in the test portion as follows:

$$\% \text{ passing on sieve } x = 100 - \frac{W_x \times 100}{W_6}$$

where W_x = cumulative mass retained on that sieve

W_6 = total mass of dry aggregate

12.5 When the extraction test is done in two portions, the gradation analysis shall be performed on the total sample.

13. EXAMPLE CALCULATIONS

13.1 MOISTURE CONTENT:

i) Percent moisture in sample of mix:

Mass of sample plus moisture (M_a) 1000.3 g

Mass of dried sample (M_d) 998.1 g

$$\% \text{ Moisture (Z)} = \frac{1000.3 - 998.1}{998.1} \times 100$$

$$= 0.22\%$$

ii) ADJUST ORIGINAL MASS OF TEST PORTION:

Original mass of test portion (W_1) 1020.4 g

$$\text{Dry mass of test portion (W}_2\text{)} = \frac{1020.4}{100 + 0.22} \times 100$$

$$= 1018.2 \text{ g}$$

13.2 ASPHALT CEMENT CONTENT:

i)	Dry mass of test portion (W_2)		1018.2 g
ii)	Dry mass of Aggregate:		
	Dry mass of aggregate plus pan (M_{ba})		1160.8 g
	Mass of pan (M_b)	-	<u>200.0</u> g
	Dry mass of aggregate (W_4)	=	960.8 g
iii)	Dry Mass of Mineral Fines in Filter:		
	Mass of filter after extraction (M_{ff})		15.2 g
	Mass of filter (M_f)	-	<u>14.4</u> g
	Mass of mineral fines in filter (W_3)	=	0.8 g
iv)	Dry mass of Aggregate and Mineral Fines in Filter if Filter is Burned:		
	Mass of aggregate, mineral fines and pan (M_{baf})		1161.6 g
	Mass of pan (M_b)	-	<u>200.0</u> g
	Mass of aggregate plus fines ($W_4 + W_3$)	=	961.6 g
v)	Mass of Mineral Fines in Extract (High Speed Centrifuge)		
	Mass of cup and mineral fines after centrifuging (M_{cf})		142.3 g
	Mass of cup (M_c)	-	<u>141.1</u> g
	Mass of mineral fines (W_5)	=	1.2 g
vi)	Total Dry Mass of Aggregate if Filter Weighed:		
	Dry mass of aggregate (W_4)		960.8 g
	Mass of mineral fines in filter pad (W_3)		0.8 g
	Mass of mineral fines in extract (W_5)	+	<u>1.2</u> g
	Total dry mass of aggregate (W_6)	=	962.8 g
vii)	Total Dry Mass of Aggregate if Filter Burned:		
	Dry mass of aggregate plus mineral fines ($W_4 + W_3$)		961.6 g
	Mass of mineral fines in extract (W_5)	+	<u>1.2</u> g
	Total dry mass of aggregate (W_6)	=	962.8 g
viii)	Mass of Asphalt Cement:		
	Mass of dry test portion (W_2)		1018.2 g
	Mass of dry aggregate plus fines (W_6)	-	<u>962.8</u> g
	Mass of asphalt cement (W_7)	=	55.4 g

$$\text{Percent asphalt cement } (W_8) = \frac{55.4}{1018.2} \times 100 = 5.44\%$$

13.3 AGGREGATE FRACTIONS:

Total dry mass of aggregate (W_6) 962.8 g

$$\% \text{ passing 9.5 mm sieve} = 100 - \frac{(213.3)}{(962.8)} \times 100 = 77.8$$

$$\% \text{ passing 600 } \mu\text{m sieve} = 100 - \frac{(689.4)}{(962.8)} \times 100 = 28.4$$

13.4 SWING BACK GRADING (Optional): This is the grading of the coarse aggregate and fine portions of the aggregate (retained and passing respectively on the 4.75 mm sieve) when either fraction is considered to be the total sample. For the fine aggregate the calculation is as follows:

13.4.1 The percent passing the 4.75 mm sieve in the total grading, divided into the percent passing each subsequent sieve and the result multiplied by 100, will give the fine aggregate gradation expressed as a percent passing each sieve.

13.4.2 Example:

Given for the full gradation:

% passing the 4.75 mm sieve is 52.1

% passing the 2.36 mm sieve is 40.9

% passing the 1.18 mm sieve is 33.0

then for the fine gradation:

$$\% \text{ passing the 2.36 mm sieve} = \frac{40.9}{52.1} \times 100 = 78.5$$

$$\% \text{ passing the 1.18 mm sieve} = \frac{33.0}{52.1} \times 100 = 63.3$$

13.4.3 To "swing back" the grading of the coarse aggregate fraction of the extracted aggregate, the following procedure is used. The percent retained on the 4.75 mm sieve in the total grading, is divided into the percent retained on each of the coarse aggregate sieves in the total gradation and the result is multiplied by 100, to give the coarse aggregate grading expressed as the percent retained on each sieve.

13.4.4 Example:

Given for the full gradation:

% passing the 13.2 mm sieve is 92.5

% passing the 9.5 mm sieve is 75.4

% passing the 4.75 mm sieve is 52.4

then for the coarse gradation

$$\% \text{ ret'd on the 13.2 mm sieve} = \frac{(100 - 92.5)}{(100 - 52.4)} \times 100 = 15.8$$

$$\% \text{ ret'd on the 9.5 mm sieve} = \frac{(100 - 75.4)}{(100 - 52.4)} \times 100 = 51.7$$

14. REPORTING OF RESULTS

14.1 The results will be based on a single test and shall be reported as follows:

14.1.1 The asphalt cement content shall be reported as a percentage of the total mass of the mix to two decimal places.

14.1.2 The cumulative mass and the cumulative percentages passing for each sieve shall be reported to one decimal place. As well, the cumulative percentage may be recorded as a graph on the appropriate semi-log grading chart.

14.1.3 The swing back gradings, if required, shall be recorded as percentage retained or passing for each sieve, accurate to one decimal place, and shall be reported as described in Section 11.4.

14.2 Where the test sample requires splitting to satisfy minimum mass requirements and two tests are carried out, results will be based on the sums of the values from the two test portions or increments, using two bowls. Results shall be reported with the following changes in calculations:

14.2.1 The asphalt cement content shall be expressed as the cumulative percentage content for the two test increments, to two decimal places.

Example:

	<u>Bowl A</u>	<u>Bowl B</u>
Dry mass of sample (W ₂)	1018.2 g	1023.8 g
Mass of A.C. (W ₇)	56.7 g	56.9 g
$\text{A.C. Content, \%} = \frac{(56.7 + 56.9)}{(1018.2 + 1023.8)} \times 100$ $= 5.56$		

14.2.2 The cumulative mass and the cumulative percentages passing each sieve shall be calculated as follows:

Example:

	<u>Bowl A</u>	<u>Bowl B</u>
Total Dry mass of Aggregate (W ₆)	962.7 g	968.3 g
Cumulative Dry Mass on 9.5 mm Sieve	213.3 g	214.4 g
$\% \text{ Passing the 9.5 mm Sieve} = 100 - \frac{(213.3 + 214.4)}{(962.7 + 968.3)} \times 100$ $= 79.0$		

15. GENERAL NOTES

15.1 When testing cold mix such as SC 800 Patching Material, the sample must be dried at 110 ± 5°C to a constant mass to remove all solvents before testing.

15.2 Aggregates in the pans and the SMM cups are weighed while still warm to avoid absorption of moisture. In order to avoid undue variation in this process it is recommended that on removal from the drying oven all samples be weighed at 90 to 100°C.

15.3 Extreme care must be exercised when transferring aggregates from one container to another to avoid any loss of particles.

15.4 Prior to using, check each sieve for the condition of the mesh, the soldered edges, and the nest for correct order of descending sizes.

15.5 Calibrate the r.p.m. of the centrifuge extractor and high speed centrifuge using a strobe tachometer at least once per construction season.

15.6 All balances should be calibrated at least once a year, at the start of the construction season.

15.7 If some asphalt remains in the aggregate after the third washing, repeat the extraction process until the solution is a light straw colour.

15.8 The extractor bowl cover must be fastened to the bowl tightly enough to minimize the loss of fines. Uniform torquing of the bowl lids will prevent varying loss of the fines. In order to tighten the cover on the extractor bowl with a torque wrench, the extractor funnel units have been modified as in Section 9.4. Marks should be made (using a hacksaw, paint, etc.) on the steel rod to ensure that the torque wrench is centred.

15.9 All extractor bowls and covers must be matched to ensure a tight fit and permanently marked to prevent mismatching.

15.10 Ensure that the funnel is in place in the bowl when the mix is being transferred from the balance pan to the bowl in order to prevent clogging of the threads with material.

15.11 Non-uniform colour and texture of the flow patterns, which continue beyond the inner rim of the extractor bowl on the filter indicate an excess loss of fines. Check for a tight fit of the cover. Burrs on the bowl or cover can cause a poor fit. Do not strike the machined surface of the bowl when using the brush to dislodge particles of aggregate sticking to its surface. Overfilling the bowl with solvent can cause a loss of fines through the cover air vents.

15.12 All equipment and testing for LS-282 including DETERMINATION OF MINERAL FINES IN EXTRACT (Section 10) shall be located in one laboratory building only.

16. PRECISION AND BIAS

16.1 Single operator precision for asphalt cement content is considered acceptable if the difference in asphalt cement content between two replicate mix samples is 0.20% or less.

16.2 The bias for asphalt cement content is considered acceptable if the content for each of two mix samples used to determine precision is within 0.20% of the known asphalt cement content.

17. SAFETY

- 17.1 Solvents should be used only under a hood or with an effective surface exhaust system in a well-ventilated area, since the solvents are all toxic to some degree.
- 17.2 Respiratory protection is required if airborne concentration exceeds TLV (Threshold Limit Value). Air respirators for organic fumes are advised.
- 17.3 Safety goggles, protective clothing, and impervious gloves are recommended.
- 17.4 Solvent manufacturers' recommendations listed in the product MSDS should be followed.
- 17.5 In case of spills of trichloroethylene or methylene chloride or nPB, appropriate personal protection equipment must be worn. Refer to the product MSDS.
- 17.6 Eating, drinking, and smoking are not allowed in the working area of the laboratory.