DETERMINATION OF DETRIMENTAL MATTER CONTENT IN COARSE AGGREGATE (Abbreviated Petrographic Analysis)

1.0 SCOPE

1.1 This Test Method specifies the standard procedure to be employed to determine the detrimental matter content of +5000 μm coarse aggregates that will be used in the production of wearing surface aggregates. This method appraises the quality of coarse aggregate and provides a method of quantifying the amount of detrimental matter

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 by experience and training. The subsequent classification of aggregate particles into quality types is a function of durability, strength and hardness.

1.3 Detrimental matter is defined as any material, which, if present in sufficient quantities, would be harmful or damaging to the overall integrity of the pavement. Deleterious is a classification of a Rock Type, which can be easily scratched by a penny, sometimes leaving trace amounts of copper on the aggregate, or can sometimes be scratched with a fingernail.

1.4 The Abbreviated Petrographic Analysis will identify detrimental matter as those rock types classified as deleterious. All other rock types and classifications will be reported as "other aggregate". The percent detrimental matter will be based on the total mass of the combined aggregates.

2.0 APPLICABLE DOCUMENTS

2.1 ASTM C294 Descriptive Nomenclature of Constituents of Natural Mineral Aggregates

2.2 Ministry of Transportation Ontario LS-609 Procedure for the Petrographic Analysis of Coarse Aggregate

3.0 APPARATUS

3.1 HAND LENS: 10X Magnification

3.2 ALNICO MAGNET

3.3 POCKET KNIFE: Good quality with a blade hardness of between 5.5 and 6 on Mohs' scale.

3.4 ANVIL & HAMMER: Suitable for breaking aggregate particles.

3.5 HYDROCHLORIC ACID: Technical grade, 5% by volume.

3.6 BOTTLE: Squeeze type, polyethylene with spout.

3.7 BALANCE: Capacity of 1000 g, accurate to 0.1 g.

4.0 SAMPLE

4.1 A representative sample of oven dried coarse aggregate (+5000 μm) of each component shall be prepared to the following minimum masses:

Sieve Sizes
-16000 μm to + 12500 μm = 1000 grams
-12500 μm to + 10000 μm = 500 grams
-10 000 μm to + 5 000 μm = 250 grams

4.2 It is desirable that a minimum of 200 particles in each size range (fraction) be present in the sample being examined. The minimum weights required will typically yield a sufficient number of pieces.

4.3 Material passing the 5000 μm sieve for each component is inspected for deleterious material. The type and quality of each shall be estimated and noted under comments as outlined on form MAT 5-730 for an Abbreviated Petrographic Analysis.

5.0 PROCEDURE

5.1 The sample, shall be spread out on a flat working surface.

5.2 The aggregate shall be examined for coatings such as clay, cementations and encrustations that may affect the bond with cement paste or asphalt cement. The type of coating and degree of adhesion to the aggregate shall be noted under comments as outlined on form MAT 5-730 for an Abbreviated Petrographic Analysis.

5.3 If clay balls or other particles that may break down in water or with normal handling are present, these particles shall be separated out at this stage of the procedure and their mass measured. The mass of the remaining aggregate particles shall also be determined.

5.4 On completion of the steps outlined in steps 5.1 through 5.3 the remaining sample should be washed on an 80 μm sieve to remove any clay or dust coatings. Dry the sample and determine the mass of the material lost by washing and add this to the mass of the clayballs determined in step 5.3.

5.5 Each particle in the sample shall be identified and classified into the rock type group listed on form MAT 5-730 for an Abbreviated Petrographic Analysis.

Note: Index tests such as strength, scratch hardness and acid tests will, with

visual examination, be sufficient to classify most rock particles.

5.6 On completion of the examination, the mass of each rock type group shall be determined to the nearest 0.1 gram and recorded on the appropriate place on form MAT 5-730.

6.0 CALCULATION

(Instructions for Completing Form MAT 5-730)

6.1 Complete Title Block

6.2 From the average field sieve analysis of each component determine the % retained for each fraction and enter this value on line "A", "% retained".

The sum of the individual fractions will equal the total % retained on the +5000 μm for each component.

For the purpose of calculating the weighted average (6.6), consider any sizes (not tested) that contain less than 5 percent of the 'as received' sample to have the same value as the average of the next smaller and the next larger size or, if one of these sizes is missing, to have the same value as the next larger or smaller size, which ever is present.

6.3 Enter the deleterious mass of each rock type determined in 5.5 in the appropriate rock type heading. In the case of deleterious sandstone enter the mass determined in 5.5 in b_1 and then using the adjustment factor calculate the adjustment mass and enter this value into b_2. Enter the remaining mass of aggregate for each fraction not identified as deleterious on line “C”, “Other Aggregate”.

Note that on form MAT 5-730 a note explains the requirement on how additional information should highlight the presence of the detrimental matter that would otherwise not be noted.

Examples

Carbonate Encrustments .....Trace
Chert .....High
Quartzite .....High

6.4 Total the mass of all deleterious rock types for each fraction and enter on line “B_1 and B_2”, “Deleterious Materials”.

6.5 Combine the mass of Line “B_1” “Deleterious Material” with Line “C” “Other Aggregate” for each fraction and enter on line “D” “Total Mass”.

6.6 Calculate the “% Deleterious Material by Fraction” by dividing line “B_2”, “Deleterious Material”, by Line “D”, “Total Mass”, and multiply by Line “A” “% Retained” for each fraction to the nearest 0.1 percent.

This calculation will provide a weighted average of deleterious material for each fraction. The sum of all fractions within each component would provide

the total amount of deleterious material for each component for the % +5000 μm material.

6.7 Enter the Recommended Individual Component Proportions on Line "F".

6.8 To calculate Line "G", "% Deleterious by Component" for each component, sum the results in Line "E", "% Deleterious Material "By Fraction", and multiply by the corresponding proportion divided by 100 and report to the nearest 0.1 percent.

6.9 The Total Percentage of Deleterious Particles will be the sum of Line "G" reported to the nearest 0.1 percent on Line "H".

7.0 REPORT

7.1 For an abbreviated Petrographic Analysis report the detrimental matter content as the total percent of deleterious particles to the nearest 0.1 percent based on the total mass of the combined sample.

8.0 GENERAL NOTES

8.1 In the event that there are a significant number of particularly absorptive particles, they should be dried before weighing so that water absorbed during washing will not unduly influence the mass.

II. ABBREVIATED COARSE AGGREGATE PETROGRAPHIC ANALYSIS

MAT 5-730

ALBERTA TRANSPORTATION

PIT NAME: _____ LOCATION:_____ CONTRACT_____

SAMPLE NO.: _____ REPORT DATE: _____ DES/CLASS:_____

PROJECT: _____ REPORT TO: _____

CLASS	* NO	DELETERIOUS ROCK TYPE DESCRIPTION	COMPONENTS								
			COARSE			NATURAL FINES			MANUFACTURED FINES		
			- + 16 05 00 00	- + 12 05 00 00	- + 1 05 00 00	- + 16 05 00 00	- + 12 05 00 00	- + 1 05 00 00	- + 16 05 00 00	- + 12 05 00 00	- + 1 05 00 00
		(A) % RETAINED (Fraction)									
		TOTAL % RETAINED By Component									
DELETERIOUS	60	OCHEROUS MATERIALS (Iron Concretions) b									
	61	SHALE (Fissile and/or Weathered) b									
	63	VOLCANIC OR SCHIST (Decomposed) b									
	62	CLAY (Balls or coating) b									
	32	ARGILLITE-TUFF ARGILLITE-SLATE-GREYWAKE (Weathered) b									
	96	CARBONATES (Shaley,Clayey,Sandy) b									
		SANDSTONE (Friable) b_1									
		$b_2 = (b_1 * 0.5)$									
		0THER									
(B) DELETERIOUS MATERIAL		$B_1 = \sum(b)+b_1$ g									
		$B_2 = \sum(b)+b_2$ g									
(C) OTHER AGGREGATE		g									
(D) TOTAL MASS (B_1 + C)		g									
(E) % DELETERIOUS BY FRACTION ((B_2/D) * A)		%									

(F) RECOMMENDED INDIVIDUAL COMPONENT PROPORTIONS

(Blend Sand _____%) Coarse _____% Natural Fines _____% Manufactured Fines _____%

(G) % Deleterious By Component (Sum of "E" * (F / 100))	_____%	_____%	_____%

(H) Total Deleterious Matter by Total Mass of Combined Aggregate (Detrimental Matter Content) (Sum of "G") = _____%

NOTE: Additional comments on possible detrimental material are to be included on an attached sheet. These comments will be under the general heading of coarse, natural fines, manufactured fines, etc. and blend sand. Each of the headings will be further divided into size fractions (eg. -16 000 μm /+12 500 μm). Any -5000 μm material will be evaluated as having high >7%, medium >3%≤7%, low >1%≤3% or trace <1% amounts of possible detrimental material.

* From Ministry of Transportation, Ontario (LS - 609) TESTED BY/COMPANY NAME: _____

COARSE:

-16 000 / +12 500

-12 500 / +10 000

-10 000 / +5 000

-5 000

NATURAL FINES:

+5 000

-5 000

MANUFACTURED FINES:

+5 000

-5 000

BLEND SAND

+5 000

-5 000

FRACTION	BEFORE WASH	AFTER WASH	DIFFERENCE
-16 000 / +12 500			
-12 500 / +10 000			
-10 000 / + 5 000			
NATURAL FINES			
MANUFACTURED FINES			

LEGEND
HIGH = > 7 %
MEDIUM = 3 - 7 %
LOW = 1 – 3 %
TRACE = < 1 %

NOTE:

This page is reserved for material of notable quantities that cannot be covered on page 1.

II. ABBREVIATED COARSE AGGREGATE PETROGRAPHIC ANALYSIS

MAT 5-730

ALBERTA TRANSPORTATION

PIT NAME: *Alberta Transportation Example* LOCATION: *SW-01-001-01-04* CONTRACT *500/94*
SAMPLE NO.: _____ REPORT DATE: *94.01.01* DES/CLASS: *1-12.5*
PROJECT: *01:01* REPORT TO: *P. Manager*

CLASS		DELETERIOUS ROCK TYPE DESCRIPTION	COMPONENTS								
			COARSE			NATURAL FINES			MANUFACTURED FINES		
			- + 1 1 6 2 0 5 0 0 0 0	- + 1 1 2 0 5 0 0 0 0 0	- + 1 0 5 0 0 0 0 0	- + 1 1 6 2 0 5 0 0 0 0	- + 1 1 2 0 5 0 0 0 0 0	- + 1 0 5 0 0 0 0 0	- + 1 1 6 2 0 5 0 0 0 0	- + 1 1 2 0 5 0 0 0 0 0	- + 1 0 5 0 0 0 0 0
	* NO	(A) % RETAINED (Fraction)		25	64		3	8			5
		TOTAL % RETAINED By Component		89			11			5	
DELETERIOUS	60	OCHEROUS MATERIALS (Iron Concretions) b			1.6			1.8			0.2
	61	SHALE (Fissile and/or Weathered) b		2.2							0.4
	63	VOLCANIC OR SCHIST (Decomposed) b		2.2	2.1						
	62	CLAY (Balls or coating) b		6.3	15.7		2.8	4.5			6.8
	32	ARGILLITE-TUFF ARGILLITE-SLATE-GREYWAKE (Weathered) b			2.6						0.2
	96	CARBONATES (Shaley,Clayey,Sandy) b		2.6	3.2		2.1	1.5			1.4
		SANDSTONE (Friable) b_1		6.7	9.8		3.7	4.7			0.3
		$b_2 = (b_1 * 0.5)$		3.4	4.9		1.9	2.4			0.2
		0THER									
(B) DELETERIOUS MATERIAL		$B_1 = \sum(b)+b_1$ g		20.0	35.0		8.6	12.5			9.3
		$B_2 = \sum(b)+b_2$ g		16.7	30.1		6.8	10.2			9.2
(C) OTHER AGGREGATE		g		621.2	772.7		102.1	164.0			331.9
(D) TOTAL MASS (B_1 + C)		g		641.2	807.7		110.7	176.5			341.2
(E) % DELETERIOUS BY FRACTION ((B_2/D) * A)		%		0.7	2.4		0.2	0.5			0.1

(F) RECOMMENDED INDIVIDUAL COMPONENT PROPORTIONS

(Blend Sand *13* %) Coarse *40* % Natural Fines *12* % Manufactured Fines *35* %

(G) % Deleterious By Component (Sum of "E" * (F / 100))	*1.2* %	*0.1* %	*Trace* %

(H) Total Deleterious Matter by Total Mass of Combined Aggregate (Detrimental Matter Content) (Sum of "G") = *1.3* %

NOTE: Additional comments on possible detrimental material are to be included on an attached sheet. These comments will be under the general heading of coarse, natural fines, manufactured fines, etc. and blend sand. Each of the headings will be further divided into size fractions (eg. -16 000 μm /+12 500 μm). Any -5000 μm material will be evaluated as having high >7%, medium >3%≤7%, low >1%≤3% or trace <1% amounts of possible detrimental material.

* From Ministry of Transportation, Ontario (LS - 609) TESTED BY/COMPANY NAME: *F. Example/ Alberta Transportation Testing*

COMMENTS AND VISUAL EVALUATION

COARSE:

-16 000 / +12 500

-12 500 / +10 000

Chert, slightly weather (7.6 g)	- Low
Carbonate encrustment	- Trace

-10 000 / +5 000

Quartz, Crystalline (10.6 g)	- Low
Chert, slightly weather (12.8 g)	- Low
Flat & elongate	- Trace

-5 000

Clay & silt balls	- Trace
Sandstone deleterious	- Low

NATURAL FINES:

+5 000

Carbonate encrustment	- Low

-5 000

Clay and silt balls	- Medium
Chert, slightly weathered	- Trace
Coal, deleterious	- Trace

MANUFACTURED FINES:

+5 000

Flat & elongate	- Low
Sandstone, poor	- Trace

-5 000

Flat & elongate	- Trace
Sandstone, poor	- Trace

BLEND SAND

+5 000

-5 000

Carbonaceous shale	- Trace

FRACTION	BEFORE WASH	AFTER WASH	DIFFERENCE
-16 000 / +12 500			
-12 500 / +10 000	641.2	621.2	20.0
-10 000 / + 5 000	807.7	772.7	35.0
NATURAL FINES	110.7/176.5	102.1/164.0	8.6/12.5
MANUFACTURED FINES	341.2	331.9	9.3

LEGEND
HIGH = > 7 %
MEDIUM = 3 - 7 %
LOW = 1 – 3 %
TRACE = < 1 %

NOTE:

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