

04010 Asphalt Mix

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04010-1 General**1.1 Description**

This section specifies requirements for labour, machinery, plant, equipment and materials required to produce hot mix asphalt concrete.

1.2 Related Work

Specification: Section 04005 Bituminous Binder.

1.3 Definitions**1.3.1 Asphalt Cement**

The bituminous material that is used to bind the asphalt mix aggregate.

1.3.2 Asphalt Aggregate

The individual crushed and processed aggregate fractions before combining to produce the asphalt mix aggregate.

1.3.3 Asphalt Mix Aggregate

The mix after combining the asphalt aggregate fractions including filler or blending sand to produce the specified mix gradation.

1.3.4 Asphalt Mix

The mix produced by combining asphalt cement with the asphalt mix aggregate.

1.3.5 Reclaimed Asphalt Pavement (RAP)

Asphalt millings or processed asphalt pavement removals, handled and characterized for RAP to be incorporated into asphalt mix.

1.3.6 Top Lift

The asphalt concrete wearing course.

1.3.7 Bottom Lift

All asphalt concrete courses below the Top lift.

04010-2 Materials**2.1 Specific Requirements****2.1.1 Asphalt Cement**

Asphalt Cement 150/200 A and polymer modified asphalt cement to meet the requirements of Section 04005 Bituminous Binder.

2.1.2 Asphalt Mix Aggregate**2.1.2.1 Fines Composition**

Asphalt mix aggregate, retained on the 5.0 mm plus sieves, shall be composed of fragments of durable rock and shall not contain more than 2% by weight of deleterious materials such as shale, ironstone, and coal. The maximum permissible organic content of the material passing the 5.0 mm sieve is 1.0%.

2.1.2.2 Physical Properties

Physical properties for aggregate shall meet the following requirements:

Table 1: Physical Properties for Asphalt Mix Aggregate

Requirement	Test Designation	Asphalt mix type		
		A2, A9 & T9	1, 2 & M2	M1 & 3
Sand Equivalence	ASTM D2419	45 min.	45 min.	45 min.
Los Angeles Abrasion (% loss)	ASTM C131	30 max.	35 max.	35 max.
Organic Content (% Passing 5.0 mm)		1.0 max.	1.0 max	1.0 max.
Crush Count (1) (% Retained 5.0 mm Sieve)		80 min. 2 faces	70 min. 1 face	70 min. 1 face
Manufactured Fines (2) (% Passing 5.0 mm Sieve)		70 min.	-	-

Notes:

- Crush Count is the percentage of the crushed aggregate retained on the 5.0 mm plus sieves having either 1 or more fractured faces or 2 or more fractured faces, created by the crushing operation.
- Manufactured fines are the percentage by mass of crusher run manufactured sand passing the 5mm sieve. For mixes incorporating RAP, 50% of the RAP passing the 5.0 mm sieve shall be considered manufactured sand.
- Asphalt mix aggregate shall meet the gradation requirements stated in Table 2, when tested to ASTM designations C-136 and C-117.

Table 2: Gradation for Asphalt Mix Aggregate

Sieve Designation	Asphalt mix type							
	A2	1	M1	2	M2	3	9 & A9	4
20.0 mm	100	100	-	-	-	-	-	-
16.0 mm	98-100	98-100	100	-	-	-	-	-
12.5 mm	82-89	82-89	83-94	100	100	100	100	-
9.0 mm	67-78	69-80	69-87	76-89	78-89	80-89	98-100	-
5.0 mm	49-59	49-59	50-75	50-60	52-62	59-69	85-95	100
2.0 mm	32-54	29-48	29-48	30-48	30-48	36-56	49-59	45-65
900 µm	22-42	18-38	24-41	19-38	19-38	24-41	32-42	22-44
400 µm	12-24	10-26	11-29	10-26	10-26	11-29	15-26	12-28
160 µm	3-10	3-10	3-12	3-10	3-10	3-12	6-15	6-15
71 µm	2-5	2-5	2-6	2-5	2-5	2-6	3-7	4-10

Percent Passing by Weight

2.1.3 Asphalt Concrete Mix

2.1.3.1 Homogeneous

Asphalt mix shall consist of a homogeneous mixture of asphalt mix aggregate, RAP, and asphalt cement mixed in a central plant.

2.1.3.2 Job Mix Formula

Marshall Mix designs are to be completed in accordance with the latest edition of the Asphalt Institute Manual Series No. 2 (MS-2), ASTM D6927 and ASSHTO T-245 unless otherwise modified by City of Saskatoon requirements.

The Contractor shall provide the Project Engineer a Job Mix Formula (JMF) for each type of hot mix to be supplied. The Contractor will only supply hot mix for which the Project Engineer has approved the JMF.

The JMF is developed through a multi stage process based on the Contractor's quality control testing of aggregate fractions, laboratory preparation of a mix design, and the setting of the JMF after evaluating the mix properties of the different plant trials.

The Contractor shall arrange for a laboratory to evaluate the proposed aggregate fractions to be used in the hot mix so a theoretical blend of the asphalt mix aggregate can be determined. Using the theoretical blend of the asphalt mix aggregate the laboratory prepare briquettes at various asphalt contents (minimum three briquettes prepared at five different asphalt contents) to determine design curves for the mix.

The design curves are analyzed to determine the "design asphalt content" that will provide mix properties meeting specifications. The Contractor shall submit the proposed mix design and supporting test documentation to the Engineer for review, and upon approval shall undertake plant trials.

The aggregate gradation for the plant trials shall be within ± 2 percent of the mix design target gradation for material above the 2 mm sieve and within ± 1.5 percent for material on or below the 2 mm sieve. The plant will produce runs of HMA at the design asphalt content, one plant run at both 3 tenths above and below the proposed design asphalt content.

From these plant trial production runs the Contractor will set the JMF. The JMF and supporting test results from the plants trials are to be submitted to the Engineer for approval.

2.1.3.3 Anti Stripping Agent

Anti stripping agent, if required, shall be added to achieve a stripping potential of less than five percent (5%) as determined by the Saskatchewan Ministry of Highways and Infrastructure Stripping Potential Test. The Contractor shall provide test results identifying the type and amount of anti-stripping agent required to meet this requirement. The contractor shall provide the brand name and technical literature of the product to be used. The cost of the anti-stripping agent, if required shall be included in the unit prices under the contract.

2.1.3.4 Physical Properties

Physical properties for the mix shall meet the following requirements at the design asphalt content and gradation:

Table 3: Physical Properties for Asphalt Mix

Property	Notes	Asphalt mix type					
		A2 PG 76-28	A2 PG 70-28	A2 PG 64-37	A2 150 / 200A	2 PG 64-37	1 & 2 150 / 200A
Marshall (blows per face)		75	75	75	75	50	50
Marshall Stability (KN) at 60°C min	(1)	16	15	14	11	11	8
Retained Stability (%) (minimum)		75	75	75	75	75	75
Marshall Flow Index (mm)	(1)	2-5	2-5	2-5	2-4	2-5	2-4
Air Voids in Mixture	(2)	3.5-5.5	3.5-5.5	3.5-5.5	3.5-5.5	3-5	3-5
Voids filled with Asphalt (%)	(2)	67-75	67-75	67-75	67-75	70-80	70-80
Min. Film Thickness (µm)	(3)	7.5	7.5	7.5	7.5	8.0	8.0

Table 4: Physical Properties for Asphalt Mix

Property	Notes	Asphalt mix type				
		M1	M2	3 & 4	A9	9
Asphalt Grade		150 / 200A	150 / 200A	150 / 200A	PG 64- 37	150 / 200A
Marshall (blows per face)		50	50	50	75	50
Marshall Stability (KN) at 60°C min	(1)	7	8	6	11	8
Retained Stability (%) (minimum)		75	75	75	75	75
Marshall Flow Index (mm)	(1)	2-4	2-4	2-4	2-5	2-4
Air Voids in Mixture	(2)	2-4	2-4	2-4	3-5	3-5
Voids filled with Asphalt (%)	(2)	75-85	75-85	75-85	75-85	75-85
Min. Film Thickness (µm)	(3)	8.5	8.5	8.5	8.0	8.0

Notes:

1. Marshall Stability and Flow Index shall be determined according to ASTM Designation D6927 with the exception that briquettes shall be fan cooled as per Note 5 of D6927. A mechanical compactor, calibrated by a certified hand hammer, shall be used to prepare briquettes.
2. The percentage of air voids and percentage of voids filled with asphalt shall be determined in accordance with ASTM D3203 with ASTM C127 and C128.
3. The minimum asphalt content by dry mass of aggregate, inclusive of the virgin asphalt cement and the asphalt cement contributed by the RAP, are as follows:
 - 5.0% for A2 mixes
 - 5.3% for Type 1 and Type 2 mixes
 - 5.7% for M1, M2 and Type 3 mixes
 - 6.5% for Type 9 and Type 4 mixes
 - 6.3% for Type A9 mix

4. Maximum allowable binder contribution from RAP for top and bottom lifts are as follows:
- Top lifts with PMA: 10%
 - Top lifts without PMA: 15%
 - All bottom lifts: 20%

The methodology used to determine the percent allowable RAP is as follows:

$$\% \text{Allowable RAP} = \frac{(\% \text{ Binder Contribution})(\% AC_{mix})}{(\% AC_{Rap})}$$

Equation 1: Percent Allowable Reclaimed Asphalt Pavement

where:

- % Binder Contribution = selected to a maximum value specified above in Note 4,
 - %AC_{mix}= target asphalt content of the selected mix type (% mass by total mix),
 - %AC_{Rap}= asphalt content of the RAP, as determined by laboratory testing (% mass by total mix), and
 - % Allowable RAP = the maximum RAP addition rate (% mass of total mix).
5. Temperature: Mix temperature at point of plant discharge shall not vary from that specified in the job mix formula by more than 10°C.
6. Moisture in mix: Maximum permissible moisture at point of plant discharge is 0.2 % by weight of mix.

2.1.4 Tolerances

All asphalt mix shall be supplied to the approved job mix formula within the range of tolerances specified. Where tolerances are not specified, the values stated under this section shall be considered absolute, minimums, maximums or allowable ranges. Unless otherwise stated specification limits are based on single tests and include sampling, testing, and process variance.

Tolerances stated in this section shall apply to all asphalt concrete mix types unless otherwise specified.

The job mix formula, as originally established, shall remain in effect until modified in writing. Should a change of aggregate(s) be made, or when unsatisfactory results or other conditions make it necessary, the Contractor shall submit a new mix design for approval.

2.2 Compliance with Specifications

2.2.1 General

For contract administration and enforcement, testing for quality control of the mix to determine compliance with specification during production (process control), and quality assurance to determine acceptance and payment adjustments to material supplied and placed will be carried out by the City. This is not intended to relieve the contractor of the responsibility of maintaining their own quality control testing programs for the mix, or preventing them from initiating shutdown of production for material that will be out of specification as determined from their own testing program.

2.2.2 Quality Control

After the job mix formula gradation and proportioning of various aggregate sizes have been established and approved, no alteration will be permitted. The working ranges outlined in Table 5, Table 6, Table 7 and Table 8 will be used to assess compliance with specification.

The Contractor shall cease operations when:

1. two consecutive three point moving average points for any property or characteristic fall in the borderline zone or,
2. two or more tests in four consecutive tests are in the borderline zone or,
3. any individual test for any property or characteristic fall in the plant shutdown zone.

When the asphalt falls in the shutdown zone, the Contractor shall assume the responsibility of ceasing operations on his own even in the absence of City personnel on site. When asphalt meets the four consecutive or two three point moving average criteria for shutdown, shutdown will be initiated at the instruction of the Engineer. Production shall not commence again until two consecutive tests are within specification

limits or it has been demonstrated to the satisfaction of the Engineer that corrective action has been taken.

The aforementioned procedure shall not prevent the City from rejecting specific batches or production runs of asphalt concrete mix that from visual inspection or associated testing do not meet the requirements of this Section.

Table 5: Type A2 - Maximum Permissible Variation*

Property or Characteristic	Acceptable Zone	Borderline Zone	Plant Shutdown Zone	Asphalt Type
Asphalt Cement (%)	(+/-) 0.2	(+/-) 0.3 to 0.4	> (+/-) 0.4	All A2 Types
Air Voids (%)				
Lower Limit	3.5	3.0 to 3.4	< 3.0	All A2 Types
Upper Limit	5.5	5.6 to 6.0	> 6.0	
Marshall Stability (kN)	(>=) 11.0 (>=) 14.0 (>=) 15.0 (>=) 16.0	10.5 to 10.9 13.5 to 13.9 14.5 to 14.9 15.0 to 15.9	< 10.5 < 13.5 < 14.5 < 15.0	A2 w/ 150/200A A2 w/ PG 64-37 A2 w/ PG 70-28 A2 w/ PG 76-28
Flow Index (mm)				
Lower Limit	2.0	1.5 to 1.9	< 1.5	All A2 Types A2 w/ 150/200A A2 w/ Polymer
Upper Limit	4.0	4.1 to 4.2	> 4.2	
Upper Limit	5.0	5.1 to 5.3	> 5.3	
Film Thickness (µm)				
Lower Limit	7.5	7.0 to 7.4	< 7.0	All A2 Types
Upper Limit	9.5	9.6 to 10.0	> 10.0	
Gradation	Maximum Permissible Variation % by Weight Passing			
20.0 mm				
16.0 mm	(+/-) 1.0	(+/-) 1.1 to 2.0	> (+/-) 2.0	All A2 Types
12.5 mm	(+/-) 3.0	(+/-) 3.1 to 5.0	> (+/-) 5.0	
9.0 mm	(+/-) 4.0	(+/-) 4.1 to 6.5	> (+/-) 6.5	
5.0 mm	(+/-) 4.0	(+/-) 4.1 to 6.5	> (+/-) 6.5	
2.0 mm	(+/-) 4.0	(+/-) 4.1 to 6.0	> (+/-) 6.0	
900 µm	(+/-) 3.0	(+/-) 3.1 to 4.5	> (+/-) 4.5	
400 µm	(+/-) 3.0	(+/-) 3.1 to 4.5	> (+/-) 4.5	
160 µm	(+/-) 2.0	(+/-) 2.1 to 3.0	> (+/-) 3.0	
75 µm	(+/-) 1.5	(+/-) 1.6 to 2.0	> (+/-) 2.0	

Note: The % asphalt cement and gradation are listed as variation from the job mix formula rather than an upper or lower limit.

*Adjustments can occur in the acceptable zone for mix designs that are at minimum levels.

Table 6: Types 1, 2, T1 & T2 - Maximum Permissible Variation*

Property or Characteristic	Acceptable Zone	Borderline Zone	Plant Shutdown Zone	Asphalt Type
Asphalt Cement (%)	(+/-) 0.2	(+/-) 0.3 to 0.4	> (+/-) 0.4	All Types 1 & 2
Air Voids (%)				
Lower Limit	3.0	2.5 to 2.9	< 2.5	All Types 1 & 2
Upper Limit	5.0	5.1 to 5.5	> 5.5	
Marshall Stability (kN)	(>=) 8.0 (>=) 11.0	7.0 to 7.9 10 to 10.9	< 7.0 <10.0	T1 & T2 T2 w/ PG 64-37
Flow Index (mm)				
Lower Limit	2.0	1.5 to 1.9	< 1.5	All Types 1 & 2
Upper Limit	4.0	4.1 to 4.2	> 4.2	T1 & T2
Upper Limit	5.0	5.1 to 5.3	> 5.3	T2 w/ PG 64-37
Film Thickness (µm)				
Lower Limit	8.0	7.5 to 7.9	< 7.5	All Types 1 & 2
Gradation	Maximum Permissible Variation % by Weight Passing			
20.0 mm				
16.0 mm	(+/-) 1.0	(+/-) 1.1 to 2.0	> (+/-) 2.0	Type 1 only
12.5 mm	(+/-) 3.0	(+/-) 3.1 to 5.0	> (+/-) 5.0	All Types 1 & 2
9.0 mm	(+/-) 4.0	(+/-) 4.1 to 6.5	> (+/-) 6.5	
5.0 mm	(+/-) 4.0	(+/-) 4.1 to 6.5	> (+/-) 6.5	
2.0 mm	(+/-) 4.0	(+/-) 4.1 to 6.0	> (+/-) 6.0	
900 µm	(+/-) 3.0	(+/-) 3.1 to 4.5	> (+/-) 4.5	
400 µm	(+/-) 3.0	(+/-) 3.1 to 4.5	> (+/-) 4.5	
160 µm	(+/-) 2.0	(+/-) 2.1 to 3.0	> (+/-) 3.0	
71 µm	(+/-) 1.5	(+/-) 1.6 to 2.0	> (+/-) 2.0	

Note: The % asphalt cement and gradation are listed as variation from the job mix formula rather than an upper or lower limit.

*Adjustments can occur in the acceptable zone for mix designs that are at minimum levels.

Table 7: Types 3, M1 & M2 - Maximum Permissible Variation*

Property or Characteristic	Acceptable Zone	Borderline Zone	Plant Shutdown Zone	Asphalt Type
Asphalt Cement (%)	(+/-) 0.2	(+/-) 0.3 to 0.4	> (+/-) 0.4	Types 3, M1, M2
Air Voids (%)				
Lower Limit	2.0	1.5 to 1.9	< 1.5	Types 3, M1, M2
Upper Limit	4.0	4.1 to 4.5	> 4.5	
Marshall Stability (kN)				
Type 3	(>=) 6.0	5.0 to 5.9	< 5.0	
Type M1	(>=) 7.0	6.0 to 6.9	< 6.0	
Type M2	(>=) 8.0	7.0 to 7.9	< 7.0	
Flow Index (mm)				
Lower Limit	2.0	1.5 to 1.9	< 1.5	Types 3, M1, M2
Upper Limit	4.0	4.1 to 4.2	> 4.2	
Film Thickness (µm)				
Lower Limit	8.5	8.0 to 8.4	< 8.0	Types 3, M1, M2
Upper Limit	10.5	10.6 to 11.5	> 11.5	
Gradation	Maximum Permissible Variation % by Weight Passing			
20.0 mm				
16.0 mm	(+/-) 1.0	(+/-) 1.1 to 2.0	> (+/-) 2.0	Type M1
12.5 mm	(+/-) 2.0	(+/-) 2.1 to 3.0	> (+/-) 3.0	Types 3, M1, M2
9.0 mm	(+/-) 3.0	(+/-) 3.1 to 5.0	> (+/-) 5.0	
5.0 mm	(+/-) 4.0	(+/-) 4.1 to 6.5	> (+/-) 6.5	
2.0 mm	(+/-) 4.0	(+/-) 4.1 to 6.0	> (+/-) 6.0	
900 µm	(+/-) 3.0	(+/-) 3.1 to 4.5	> (+/-) 4.5	
400 µm	(+/-) 3.0	(+/-) 3.1 to 4.5	> (+/-) 4.5	
160 µm	(+/-) 2.0	(+/-) 2.1 to 3.0	> (+/-) 3.0	
75 µm	(+/-) 1.5	(+/-) 1.6 to 2.0	> (+/-) 2.0	

Note: The % asphalt cement and gradation are listed as variation from the job mix formula rather than an upper or lower limit.

*Adjustments can occur in the acceptable zone for mix designs that are at minimum levels.

Table 8: Types 9 & A9 - Maximum Permissible Variation*

Property or Characteristic	Acceptable Zone	Borderline Zone	Plant Shutdown Zone	Asphalt Type
Asphalt Cement (%)	(+/-) 0.2	(+/-) 0.3 to 0.4	> (+/-) 0.4	All Type 9 & A9
Air Voids (%)				
Lower Limit	3.0	2.5 to 2.9	< 2.5	All Type 9 & A9
Upper Limit	5.0	5.1 to 5.5	>5.5	
Marshall Stability (kN)				
	(>=) 8.0 (>=) 11.0	7.0 to 7.9 10.0 to 10.9	< 7.0 < 10.0	Type 9 Type A9
Flow Index (mm)				
Lower Limit	2.0	1.5 to 1.9	< 1.5	All Type 9 & A9
Upper Limit	4.0	4.1 to 4.2	> 4.2	
Upper Limit	5.0	5.1 to 5.3	> 5.3	Type 9 Type A9
Film Thickness (µm)				
Lower Limit				
Upper Limit				
Gradation	Maximum Permissible Variation % by Weight Passing			
20.0 mm				
16.0 mm				
12.5 mm				
9.0 mm	(+/-) 1.0	(+/-) 1.1 to 2.0	> (+/-) 2.0	All Type 9 & A9
5.0 mm	(+/-) 3.0	(+/-) 3.1 to 4.5	> (+/-) 4.5	
2.0 mm	(+/-) 3.0	(+/-) 3.1 to 4.5	> (+/-) 4.5	
900 µm	(+/-) 3.0	(+/-) 3.1 to 4.5	> (+/-) 4.5	
400 µm	(+/-) 3.0	(+/-) 3.1 to 4.5	> (+/-) 4.5	
160 µm	(+/-) 2.0	(+/-) 2.1 to 3.0	> (+/-) 3.0	
75 µm	(+/-) 1.5	(+/-) 1.6 to 2.0	> (+/-) 2.0	
71 µm	(+/-) 1.5	(+/-) 1.6 to 2.0	> (+/-) 2.0	

Note: The % asphalt cement and gradation are listed as variation from the job mix formula rather than an upper or lower limit.

*Adjustments can occur in the acceptable zone for mix designs that are at minimum levels.

2.2.2.1 Process Control and Charting

The Contractor shall maintain the following charts:

- IBar control charts for Process Control

- Moving average charts for Specification Compliance

These charts shall be maintained for the following parameters:

1. Mix parameters:
 - a. Asphalt Cement Content
 - b. Air Voids
 - c. Marshall Stability
 - d. All sieve designations
2. Aggregate during crushing and production:
 - a. All sieve designations for each aggregate fraction processed into separate stockpiles

A current copy (continuously updated to the most recent test results to next page specification compliance) of the Asphalt Control charts for mix parameters shall be kept at the asphalt plant control centre and be made available for inspection at the engineer's request.

Process Control Charting

1. Charting shall consist of the following:
 - a. IBar Control Chart complete with:
 - b. Upper and Lower Warning Limits: 95% confidence limit (+2 sigma)
 - c. Upper and Lower Control Limits (CUL/LL): 99% confidence limit (+3 sigma)
 - d. Centreline
 - e. All limits re-calculated following data shifts or N=10, N=20, N=30,... as appropriate chart maintenance.
 - f. All lines are to be labelled with their numerical values.

Note: Upper and Lower warning and control limits and the centreline are statistically calculated from individual tests, given our current sampling methodology.

Specification Compliance

2. Moving Average Chart complete with:
 - a. Line showing specification warning Zone
 - b. Line showing specification shutdown zone
 - c. Centreline
 - d. Numerical values entered on all lines

2.2.2.2 Alternate Charting

The contractor can make an alternate charting proposal complete with the following:

1. Charted parameters
2. Testing method summary
3. Minimum one month correlation to Marshall Properties

The Engineer can then decide to substitute the alternate charting in place of one, or all of the contracted requirements with the following stipulations:

If the Contractor fails to maintain a weekly update of his chart, he will revert back to all contract defaults.

2.2.2.3 Plant Shutdown

The Contractor shall terminate asphalt production when:

1. The asphalt does not comply with the specifications as outlined in Division 4, Section 04010-2.2.2 Quality Control, and/or,
2. The Contractor's process is out of control based on the IBar control chart. The process shall be defined as out of control if it meets one or more of the following criteria:

- a. Test result is on or outside the upper or lower control limit.
- b. There are seven consecutive points above or below the centreline.
- c. Upward or downward trend.
- d. An obvious repetitive or cyclical pattern.
- e. The average of any seven consecutive tests runs at 0.3, or less, above the lower specification limit.

2.2.3 Quality Assurance

2.2.3.1 Payment Adjustment Factors

Payment adjustment factors will be used to adjust the contract unit price for material not complying with specification limits. All adjustment factors will be determined on the basis of individual test results. The quantity of material represented by a single test will not exceed 300 tonnes.

For Example: Asphalt mix production of 800 tonnes will require an individual test for the first 300 tonnes, one test for the second 300 tonnes, and one test for the remaining 200 tonnes. Tests will be taken at random within each representative sample section.

2.2.3.2 Multiple Payment Adjustments

Reduced payment for more than one deficiency on any one test sample will be based on the reduced payment, and not the original price.

2.2.3.3 Adjustment Calculation

Adjustment to the unit bid price for non-compliance equals the unit bid price times the payment adjustment factor.

2.2.3.4 Air Void Payment Adjustment Factors

Air Voids Payment Adjustment Factors (by individual sample tests) are presented in Table 12.

Air voids shall be determined from bulk samples or cores taken from the roadway. Where cores are used to determine air voids, field air voids shall be corrected to 100% Marshall using the following formula (Field Air voids) - (100 - Field density as percentage of Marshall).

For Example: Field air voids is 5.4%, density is 98% of Marshall Density, Corrected air voids is $5.4\% - (100 - 98) = 3.4\%$

This calculation for correcting the air voids to 100% of Marshall Density will be used where the field density is less than 100% of Marshall Density and shall be used for the purpose of payment adjustment. Where field density is greater than 100% of Marshall Density, the air voids determined from the cores will be used for the purpose of payment adjustment.

2.2.3.5 Marshall Stability Payment Adjustment Factors

Marshall Stability Payment Adjustment Factors (by individual sample test):

Table 9: Marshall Stability Payment Adjustment Factors

Adjustment Factor (%)	TYPE A2				TYPE 2	
	PG 76-28	PG 70-28	PG 64-37	150/200A	PG 64-37	150/200A
100	> 15.6	> 14.7	> 13.7	> 10.7	> 10.7	> 7.9
98	15.5-15.6	14.6-14.7	13.6-13.7	10.6-10.7	10.6-10.7	7.8 - 7.9
95	15.2-15.4	14.3-14.5	13.3-13.5	10.3-10.5	10.3-10.5	7.6 - 7.7
90	14.9-15.1	14.0-14.2	13.0-13.2	10.0-10.2	10.0-10.2	7.3 - 7.5
80	14.6-14.8	13.7-13.9	12.7-12.9	9.8 - 9.9	9.8 - 9.9	7.1 - 7.2
65	14.4-14.5	13.4-13.6	12.4-12.6	9.6 - 9.7	9.6 - 9.7	6.8 - 7.0
50	14.1-14.3	13.1-13.3	12.1-12.3	9.3 - 9.5	9.3 - 9.5	6.5 - 6.9
0*	< 14	< 13	< 12	< 9.3	< 9.3	< 6.5

*No Payment or Remove and Replace as directed by City of Saskatoon Engineer

Table 10: Marshall Stability Payment Adjustment Factors

Adjustment Factor (%)	TYPE 1, M2	TYPE M1	TYPE A9	TYPE 9	TYPE 3
	150/200A	150/200A	PG 64-37	150/200A	150/200A
100	> 7.9	> 6.9	> 10.8	> 7.9	> 5.9
98	7.8 - 7.9	6.8 - 6.9	10.6 - 10.7	7.8 - 7.9	5.8 - 5.9
95	7.6 - 7.7	6.6 - 6.7	10.3 - 10.5	7.6 - 7.7	5.6 - 5.7
90	7.3 - 7.5	6.3 - 6.5	10.0 - 10.2	7.3 - 7.5	5.3 - 5.5
80	7.0 - 7.2	6.0 - 6.2	9.9 - 9.8	7.1 - 7.2	5.1 - 5.2
65	6.8 - 6.9	5.8 - 5.9	9.6 - 9.7	6.8 - 7.0	4.8 - 5.1
50	6.5 - 6.7	5.5 - 5.7	9.3 - 9.5	6.5 - 6.7	4.5 - 4.7
0*	< 6.5	< 5.5	< 9.3	< 6.5	< 4.5

*No Payment or Remove and Replace as directed by City of Saskatoon Engineer

2.2.3.6 Asphalt Cement Content Payment Adjustment Factors

A payment adjustment factor for asphalt cement content payment will be applied to all mix represented by the test that fails to meet the minimum asphalt cement content as outlined in the Contractor's approved Job Mix Formula (JMF). The adjustment will be:

Table 11: Asphalt Cement Content Payment Adjustment Factors

Asphalt Content Deviation from JMF value	Type A2	Types 1, 2, 9 & A9	Types M1, M2 & Type 3
+/- 0.1%	1.0	1.0	1.0
+/- 0.2%	1.0	1.0	1.0
+/- 0.3%	0.90	1.0	1.0
+/- 0.4%	0.75	0.90	0.95
+/- 0.5%	0.50	0.70	0.80
+/- 0.6%	Reject	0.50	0.65
+/- 0.7%		Reject	0.50
+/- 0.8%			Reject

Change in asphalt content based on dry mass of aggregate.

"Reject" at the discretion of the Project Engineer shall mean either zero payment, or remove and replace.

2.3 Certification**2.3.1 General**

Material certification outlines the material testing and mix design test data submission requirements that the Contractor is responsible to carry out as part of the production of asphalt concrete.

The Contractor shall retain and pay an independent testing consultant approved by the Engineer to perform all materials certification tests and mix designs.

Submission of test data reports shall be made to the Engineer.

At least 1 week prior to contemplated changes in source of asphalt cements or aggregates provide written notification to the Engineer and provide new material certification in accordance with requirements of this section.

Table 12: Air Void Payment Adjustment Factors

Deviation (Note 1)	H.M.A. Type			
	9	A2 & A9	1, 2 & M2	3 & M1
+1.6				
+1.5	REJECT	REJECT	REJECT	REJECT
+1.4	0.30	0.30	0.30	0.30
+1.3	0.50	0.50	0.50	0.40
+1.2	0.60	0.60	0.60	0.50
+1.1	0.65	0.65	0.68	0.55
+1.0	0.75	0.75	0.75	0.60
+0.9	0.80	0.80	0.80	0.68
+0.8	0.85	0.85	0.85	0.77
+0.7	0.90	0.90	0.90	0.84
+0.6	0.93	0.93	0.93	0.89
+0.5	0.95	0.95	0.96	0.94
+0.4	0.98	0.98	0.98	0.98
+0.3	1.00	1.00	1.00	1.00
+0.2	1.00	1.00	1.00	1.00
+0.1	1.00	1.00	1.00	1.00
0.0	1.00	1.00	1.00	1.00
-0.1	1.00	1.00	1.00	1.00
-0.2	1.00	1.00	1.00	1.00
-0.3	1.00	1.00	1.00	1.00
-0.4	0.95	0.95	0.95	0.95
-0.5	0.90	0.90	0.90	0.925
-0.6	0.85	0.85	0.85	0.90
-0.7	0.65	0.65	0.65	0.85
-0.8	0.50	0.50	0.50	0.80
-0.9	REJECT	0.25	0.25	0.75
-1.0		REJECT	REJECT	0.65
-1.1				0.50
-1.2				REJECT
-1.3				

Note 1: Deviation in % air voids at 100% Marshall from mix specifications.

2.3.2 Asphalt Cement

Submit test data reports for the asphalt cement for the said properties and frequency in accordance with Section 04005 Bituminous Binder during the course of asphalt concrete production and with the submission of the asphalt mix design.

Submit temperature viscosity charts for the asphalt cement over a temperature range of 105°C to 175°C.

2.3.3 Aggregates

Submit one complete sieve analysis report (including crush count) for every 750 tonnes for each aggregate fraction processed into separate stockpiles or one complete analysis per material for each production day when production rate is less than 750 tonnes. For Type 9, one complete sieve report is required for every 300 tonnes of aggregate processed.

Submit test data reports that the physical properties of the aggregate meet the requirements of this section.

2.3.4 Reclaimed Materials

Submit all aggregate gradation, asphalt content and fracture quality control information for RAP use in Asphalt Mix.

Submit all binder rheology quality control information as per Section 04020 "Reclaimed Asphalt Pavement".

2.3.5 Asphalt Concrete Mix

Submit job mix formula and corresponding plant trial results to the Engineer for review and approval at least 1 week prior to the first production day.

Submit new mix designs at least 1 week prior to contemplated changes in source of asphalt cement or aggregate.

The following data shall be included in the mix design submission:

1. Aggregate gradation for each aggregate fraction processed and stockpiled separately and their blend proportions.

2. Mix design submissions containing RAP shall include the RAP source name(s) and stockpile designation, all RAP asphalt content and gradation test results, the bulk specific gravity of the RAP aggregate, the percentage by weight of RAP to be used in the mixture, and all RAP rheological test results.
3. Mix design submissions containing RAP shall include the percent asphalt cement contribution of the RAP.
4. Aggregate bulk specific gravity and bitumen absorption.
5. Air voids as determined by ASTM designation D3203 and ASTM C127 and C128.
6. Maximum theoretical density of trial mixes.
7. Marshall characteristics and design curves.
8. Stripping potential without agents and, stripping potential with agents if the requirements for stripping under this section cannot be met without an agent.
9. Film thickness.
10. Retained stability.
11. Asphalt cement properties including mixing and compaction temperatures based on temperature viscosity properties of the asphalt cement.

2.3.6 Asphalt Plant Trial Mix

The Engineer or City Representative shall witness the plant trial mix and laboratory works prior to beginning the paving portion of the contract. The Engineer or City Representative shall be notified at least three working days in advance of when the plant trial mix is to be done.

04010-3 Equipment

All tools, machinery, plant and equipment used in handling materials and executing any part of the work shall be subject to the approval of the Engineer. All such equipment shall be maintained in efficient working order and where any of the machinery plant or

equipment is found to be unsatisfactory; it shall be improved or replaced by the Contractor to the satisfaction of the Engineer.

04010-4 Execution

4.1 Aggregates

Deliver and stockpile aggregates in accordance with the requirements of this section.

Segregate aggregate stockpiles by each aggregate fraction processed using substantial dividers or stockpile far enough apart to prevent intermixing.

Stockpile minimum of 50% of total aggregate fractions contracted before commencing trial mix designs. This quantity shall include aggregate stockpiled at both the processing site and asphalt plant site.

Stockpile at the plant site during production at least 15% of the total contracted amount for each size fraction processed.

When hauling into stockpiles after plant mixing has commenced do not deposit material against working face of stockpile.

Construct stockpiles in uniform lifts avoiding segregation by spillage of materials over the ends of previously placed lifts. Do not use stationary conveyors in stockpile construction.

Provide a previously stabilized stockpile base not less than 300 mm in depth to prevent contamination.

Aggregates from intermixed or contaminated stockpiles will be rejected and must be removed or disposed of as directed by the Engineer within 24 hours of rejection.

4.2 Asphalt Plant Operation

The asphalt plant and auxiliary equipment shall be such as to combine, dry and heat the asphalt mix aggregate, heat the asphalt cement and accurately proportion the asphalt cement and asphalt mix at a centrally located plant to the requirements of this section.

When combining aggregates during asphalt concrete mix production at no time shall two processed aggregate fractions share the same mechanical cold feed bin.

The asphalt plant shall meet the requirement of ASTM designation D995 for Bituminous Mixing Plant requirements.

The maximum planned storage time for Types 1, M1, 2, M2, 3, 4, 9 and A9 HMA shall be no more than 24 hours.

The maximum planned silo storage time for Type A2 and any polymer modified mixes shall be no more than 8 hours.

04010-5 Testing

The City of Saskatoon shall appoint an independent testing consultant to perform all tests for quality control of the mix to determine compliance with specification during production (process control), and quality assurance to determine acceptance and payment adjustments to material supplied and placed.

Sampling for quality assurance will be done using a random sampling procedure as identified by the Engineer. Where there is continuous production uninterrupted by plant shutdown due to quality control only the predetermined random sampling frequency will be used to determine payment adjustments to the unit bid price.

The quality assurance random sampling will also be the basis for quality control for generating control charts and determining plant shutdown. In addition to the quality assurance sampling the Engineer may also initiate supplementary tests independent of the quality assurance random sampling procedure to supplement the quality control tests for determining process control. These additional tests will not be used for payment adjustment factors unless it results in plant shutdown prior to the sampling for quality assurance in that specific lot of material. The supplementary test in this case will then be used for payment adjustment on that portion of the untested lot. If the supplementary test results in termination of production the contractor will be required to pay for the test.

The Contractor shall retain and pay an independent testing consultant to perform all materials certification tests and mix designs required in this section.

End of Specification 04010