
**Construction Specification for
Hot Mixed, Hot Laid Asphaltic Concrete Paving****Table of Contents**

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TS 310.01 SCOPE

This specification covers the requirements for placing and compacting of hot mixed, hot laid asphaltic concrete.

TS 310.02 REFERENCES

This specification refers to the following standards, specifications or publications:

City of Toronto Standard Specifications

TS 3.20	Construction Specification for Tack Coat
TS 206	Amendment to OPSS.MUNI 206 – Construction Specification for Grading
TS 1003	Material Specification for Aggregates – Hot Mixed, Hot Laid Asphaltic Concrete
TS 1101	Amendment to OPSS.MUNI 1101 (Nov 2016) Material Specification for Performance Graded Asphalt Cement
TS 1151	Material Specification for Superpave, Stone Mastic and Warm Mix Asphalt

Ontario Provincial Standard Specifications, General Conditions

OPSS 102	Weighing of Materials
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Ontario Provincial Standard Specifications, Construction

OPSS.MUNI 314	Untreated Granular Sub base, Base, Surface, Shoulder and Stockpiling
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Ontario Provincial Standard Specifications, Material

OPSS.MUNI 1103	Emulsified Asphalt
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Ontario Provincial Standard Specifications, Special Provision

SP 112S07	Amendment to OPSS 1212 (Nov 2003) Hot Poured Rubberized Asphalt Joint Sealing Compound
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Ontario Ministry of Transportation, Laboratory Testing Manual

LS-264	Theoretical Maximum Relative Density of Bituminous Paving Mixtures
LS-287	The Determination of Percent Compaction of Compacted Bituminous Paving Mixture (MRD Method)
LS-282	Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-292	Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures

American Association of State Highway and Transportation Officials (AASHTO)

T40	Sampling Bituminous Materials
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TS 310.03 DEFINITIONS

For the purpose of this specification, the definitions given in TS 1003, TS 1101 and TS 1151, and the following definitions apply:

Advisory Clause means the information provided [Note:] to assist Contractors.

Binder Course means an asphalt course between a surface course and either a base course (aggregate base, stabilized base, etc.), an existing pavement or another asphalt binder course.

Designated Large Sieve (DLS) means the sieve size specifically designated for each mix type for gradation testing according to Table 1.

Fat Spot means an area of pavement substantially blacker than the surrounding acceptable pavement due to high asphalt cement content and/or dust content.

Hot Mix Miscellaneous means hot mix asphaltic concrete which is placed in areas other than the roadway, and is designated as hot mix miscellaneous in the Contract Documents.

Hot Mix Padding means a hot mix layer used for correcting crossfall and profile deficiencies in the existing pavement before placing the levelling, binder, and/or surface course.

Hot Mix Patching means a hot mix surface course placed over segments of distressed pavement generally for the purpose of improving strength, ride ability or safety.

Hydraulic Strike-off means an extension of the paver mould board and strikeoff which can be extended beyond the screed while the paver is operating, to place, shape and strike off mixtures in narrow widenings of variable width.

Joint means a contact between an asphalt pavement course and any asphalt pavement, or any rigid object which exists at the time the course is laid, other than such contacts as occur on the underside of the course.

Levelling Course means a course of variable thickness used to eliminate irregularities in the contour of an existing surface prior to placing an asphalt binder and/or surface course.

Lot means a specific quantity of material or a specific amount of construction normally from a single source and produced by the same process.

Mean means the arithmetic average of the test results within a lot.

Modified Mixes means those mixes which conform to the requirements specified in this specification but for which some aspect of the mix has been altered. These deviations would be specified in the Contract.

MTO means the Ministry of Transportation of Ontario.

Paving in Echelon means the situation when the trailing paver is not more than 60 m behind the lead paver and uses a joint matching shoe to match the undisturbed mat laid by the lead paver when placing the mixture in the adjacent lane.

Random Number means a number generated by chance and obtained from a random number table.

Random Sample means a sample from a location chosen by the Contract Administrator based on random numbers, such that any portion of a lot or subplot, as appropriate, has an equal probability of being selected.

Range means the numerical difference between the maximum and minimum test results within a lot.

RAP means processed reclaimed asphalt pavement.

Recycling Ratio, Ratio means the percentage relationship between the reclaimed asphalt pavement (RAP) and new (virgin) aggregate which make up the recycled hot mix. For example, a 20/80 ratio is 20 per cent RAP and 80 per cent new (virgin) aggregate.

Screed means the unit of the paver which strikes off and imparts an initial compaction to the mix.

Screed Extension means the sections of screed plate, mould board, tamper bar/vibrator, and spreading screw which are used to extend the basic screed to the desired paving width.

Segregation means a lack of surface uniformity where areas of pavement are either too coarse or too fine in relation to the surrounding acceptable pavement. Segregation is visually classified as:

- Slight: An area where the matrix is in place between the coarse aggregate, however there is locally, slightly more coarse aggregate in comparison with the surrounding acceptable pavement.
- Medium: An area which has significantly more coarse aggregate than the surrounding acceptable pavement and usually exhibits some lack of matrix.
- Severe: An area which appears very coarse, with coarse aggregate against coarse aggregate and little or no matrix.

Special Mixes means those mixes occasionally used for special purposes such as patching, padding, levelling, the paving of shoulders, boulevards and sidewalks, and the construction of curb, gutter, or combination curb and gutter, and may not fall within the normal gradation and mix design requirements. Special mixes, if any, will be designated as 'Hot Mix Used in Sidewalks, Boulevards and Driveways' in the Contract Documents and specified through a special provision.

Stone Mastic Asphalt (SMA) means the gap-graded, dense, surface course hot mix with a large proportion of coarse aggregate and a rich asphalt cement/filler mastic.

Sublot means approximately equal divisions or portions of a lot.

Superpave means an acronym for Superior Performing Asphalt Pavements. It is an alternative system to the Marshall method for specifying material components and asphalt mix design method using the Superpave gyratory compactor.

Surface Course means the top course of an asphalt pavement, sometimes called a wearing course.

Warm Mix Asphalt (WMA) means warm mixed, warm laid asphaltic concrete produced using technologies that allow for the mixing, handling, and compaction of the asphalt concrete mixture at a temperature typically 20 to 50 °C lower than conventional hot mix asphalt.

TS 310.04 DESIGN AND SUBMISSION REQUIREMENTS

Any required submissions shall be in writing. All information and test data forms must be legible. Faxed or electronic copies are acceptable provided the original is submitted to the Contract Administrator within three Working Days following receipt of the fax or e-mail.

TS 310.04.01 Material Safety Data Sheets

At least five Working Days prior to starting the Work, the Contractor shall supply the Contract Administrator with Material Safety Data Sheets (MSDS) for all materials to be incorporated in the Work.

TS 310.04.02 Frames and Appurtenances

At least five Working Days prior to the commencement of any adjustment work indicated in the Contract Documents and Pricing Form, the Contractor shall notify the Contract Administrator as to how frames and appurtenances will be adjusted. This information will be reviewed jointly by the Contractor and Contract Administrator so that they are all familiar with the methods to be used in the Work.

Note: Contractors should note that in some cases, the appropriate utility must be notified before adjusting an appurtenance(s) or the utility will be responsible for completing the necessary adjustment(s) or both.

TS 310.04.03 Grade and Slope Control of Paver(s)

At least two Working Days prior to the commencement of the asphalt paving work, the Contractor shall notify the Contract Administrator as to the number of pavers, type of grade and transverse slope control and all pertinent information with respect to setting grades and controlling the pavers to follow these grades. This information will be reviewed jointly by the Contractor and the Contract Administrator so that they are all familiar with the methods to be used in the Work.

TS 310.05 MATERIALS

TS 310.05.01 Asphaltic Concrete

Asphaltic concrete (hot mix asphalt) shall be according to TS 1151.

TS 310.05.02 Tack Coating Material

Tack coating material shall be SS-1 emulsified asphalt and shall be according to OPSS.MUNI 1103. The tack coat application shall be according to TS 3.20. Reduction of volatile organic compound (VOC) emissions shall be according to TS 3.20.

TS 310.05.03 Hot Poured Rubberized Asphalt Joint Sealing Compound

Hot poured rubberized asphalt joint sealing compound shall be according to OPSS Special Provision 112S07.

TS 310.06 EQUIPMENT

TS 310.06.01 Spreading Equipment

TS 310.06.01.01 *Mechanical Pavers*

Asphalt pavers shall be self-propelled and capable of laying a consistent, satisfactory mat which is true to the specified geometrics, cross-section and alignment. Pavers shall be equipped with hoppers and distributing screws capable of placing the hot mix evenly in front of the screeds. Pavers shall be capable of simultaneously placing the shoulder asphalt pavement and roadway asphalt pavement where the shoulder asphalt pavement is at the same or different crossfall from the roadway pavement and the shoulder pavement is placed coincidentally with the adjacent lane.

In all cases, asphalt pavers shall be equipped with automatic longitudinal and transverse grade and slope controls which are capable of being operated from either side of the paver. The longitudinal grade control shall be readily adjustable for mat thickness in small increments without the necessity of stopping the paver and shall be equipped to operate from either a 12 m ski or floating beam, a 3 m ski, or a joint matching shoe, as required. Where the ski is a flexible unit, it shall be equipped with a spring-tensioned wire extending between brackets fitted on and slightly above each end of the ski. The sensing grid shall ride on the wire, not on the ski.

Screeds shall be capable of being heated and adjusted for crossfall and crown.

Plows or other edge ramping devices which are attached to, or towed by, the screed portion of the paver, shall not be permitted.

A 3 m straight edge shall be provided on each paver. This straight edge shall be of metal or wood, with a level recessed in its upper surface parallel to the lower edge, and be kept in good condition.

Note: Contractors should note that all electronic equipment and sensors for mat thickness and grade control must be functioning properly and not introduce variability in mat consistency and ride ability.

The Contract Administrator will discontinue the use of any paver that is experiencing difficulty in achieving a consistent, smooth, satisfactory mat in conformance with this specification until the Contractor carries out, and demonstrates, suitable corrective measures.

All pavers shall be equipped with an infra-red joint heater to heat joints. All costs associated with the gas-fired torch, its fuel and its operation shall be borne by the Contractor.

TS 310.06.01.02 *Blade Graders*

Self-propelled blade graders shall have sufficient gross mass, blade length, wheel base, and power to shape a full 3.75 m lane width of hot mix asphalt in one pass. The hot mix so shaped shall yield, after compaction, the final desired elevation of the lift being placed.

TS 310.06.01.03 *Rakes*

Dimensions and tine-configuration of rakes, and the use of rakes, shall be such as to avoid segregation of the hot mix during hand spreading.

TS 310.06.02 *Rollers***TS 310.06.02.01 *Classification of Rollers***

Rollers shall be classified into categories as follows:

- Class S: Self-propelled steel-tired, tandem or three-wheel rollers according to Table 1.
- Class R: Self-propelled pneumatic-tired rollers according to Table 2.

Table 1: Requirements for class “S” rollers

Roller class	Minimum Mass, t	Minimum mass per mm Total roll width, kg
S1	7	3.5
S2	9	4.5

Table 2: Requirements for class “R” rollers

Roller class	Minimum Mass, t	Minimum mass per tire kg
R1	8	900
R2	18	2500
R3	25	3600

Class V: Self-propelled vibratory roller specifically designed for hot mix compaction, having either dual vibratory drums or a combination of vibratory drum and pneumatic tires with a contact area equal to or greater than 70 per cent of the drum width and according to Table 3.

Table 3: Requirements for class “V” rollers

Roller class	Minimum roll diameter m	Minimum roll with m	Minimum static mass per mm total roll/tire with kg
V1	1.0	1.4	2.0
V2	1.2	1.6	2.6
V3	1.4	1.9	2.9

TS 310.06.02.02 *Requirements for All Rollers*

All rollers shall be capable of reversing without backlash.

The mass of all rollers, except for Class V rollers, shall be determined in the presence of the Contract Administrator and they shall be ballasted, if required, immediately before commencing work on the Contract and whenever subsequently required by the Contract Administrator.

TS 310.06.02.03 *Requirements for Steel-Tired Rollers*

Steel-tired rollers shall be according to the following requirements:

- 1) To prevent adhesion of hot mix asphalt to the roller, the rolls shall be kept moist, but excess water shall not be permitted.

Note: Contractors should note that for hot mix incorporating a performance graded asphalt cement, it may be necessary to use a soap/detergent solution on the rolls to prevent adhesion of hot mix asphalt to the rolls.

- 2) The rear rolls of three wheel rollers shall each be not less than 0.45 m in width.
- 3) The rolls of tandem rollers shall each be not less than 1.20 m in width.

TS 310.06.02.04 *Requirements for Pneumatic-Tired Rollers*

Pneumatic-tired rollers shall be constructed such that wheels on either the front or back shall oscillate either independently or in pairs. The wheels shall be mounted with smooth rubber tires. Tire inflation pressure shall be a minimum of 350 kPa when the tires are cold. All tires shall have equal pressure. Skirts or windbreaks shall be provided at all times to protect all tires from the cooling effects of ambient conditions. Each roller shall be equipped with a suitable tire pressure gauge for checking tire inflation pressure.

Note: Contractors should note that for hot mix incorporating a performance graded asphalt cement, it may be necessary to heat the rubber tires or use a soap/detergent solution on the rubber tires to prevent adhesion of hot mix asphalt to the tires.

TS 310.06.02.05 *Requirements for Vibratory Rollers*

Vibratory rollers shall conform to the following requirements:

- 1) To prevent adhesion of hot mix asphalt to the rolls, the rolls shall be kept moist. Excess water will not be permitted.

Note: Contractors should note that for hot mix incorporating a performance graded asphalt cement, it may be necessary to use a soap/detergent solution on the rolls to prevent adhesion of hot mix asphalt to the rolls.

- 2) Frequency of vibrations shall be not less than 2200 vibrations per minute.
- 3) Rollers shall be equipped with provision for automatic shutoff of vibrations before coming to a stop.

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- 4) Not use vibration levels that could potentially damage services and structures, or cause nuisance complaints. If there is any concern with potential vibration problems for the Contract, vibratory rollers shall not be used in such areas.

TS 310.06.03 Truck Scales

Truck scales shall be according to OPSS 102.

TS 310.07 CONSTRUCTION

TS 310.07.01 Superpave and Stone Mastic Asphalt

The work required for the above hot mix items is detailed in this subsection.

The work required for all hot mix items shall include the application of tack coat, where specified in the Contract Documents, except when a tender item 'Tack Coat' is included in the Pricing Form and some or all of the tack coat application is designated in the Contract Documents as being required under the tack coat item.

TS 310.07.01.01 Quality Control

The Contractor shall conduct such quality control (QC) procedures, including sampling and testing, as is necessary to ensure that all hot mix aggregates, all PGAC and all hot mix to be used in the Work is according to the requirements of the Contract. The Contractor shall determine the type and amount of quality control (process control) sampling and testing to be completed. At least 10 Working Days prior to the start of the paving, the Contractor shall provide the Contract Administrator a Quality Control plan which should include the type and amount of testing to be carried out, the methods of testing to be used, the remedies to be implemented if the QC testing results indicate that the project requirements are not being met. The submitted Quality Control Plan is required to be reviewed and approved by the Contract Administrator prior to the start of paving.

The Contractor shall be responsible for the interpretation of the quality control test results and the determination of any action to be taken to ensure that all materials and work conform to the requirements as specified in the Contract Documents.

A laboratory that has current CCIL Type B Certification or AMRL equivalent certification or other equivalent certified laboratory acceptable to the Contract Administrator shall be used. Testing of the samples shall be conducted under the direction and constant supervision of technicians certified to perform the QC tests according to CCIL or equivalent certification

Reclaimed asphalt pavement (RAP) shall be considered as an aggregate for the purposes of quality control.

TS 310.07.01.02 Preparation of Foundation, Existing Pavement and Shouldering

- a) A soil sterilant shall be applied as specified in the Contract Documents. All costs associated with the application of a soil sterilant will be deemed to be included in the unit price for soil sterilant in the Pricing Form in the Contract Documents.

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- b) Prior to placing any course of hot mix asphalt on a granular grade, a conventional steel-tired roller having a minimum mass of 7 tonnes, or an equivalent vibratory roller in terms of compactive effort with a drum width of at least 1.2 m, shall be used to finish roll the grade ahead of the asphalt paver to ensure a compacted smooth and float free surface. This roller shall operate continuously within 300 m of the paver.

The Contractor shall check grades, cross fall, surface tolerance, compaction and moisture content. The Contractor shall correct deficiencies, and check and adjust all frames and appurtenances to grade, including longitudinal and transverse slope. All costs associated with the preparation of granular grade will be deemed to be included in the unit price(s) for hot mix, hot laid asphaltic concrete in the Pricing Form in the Contract Documents. All costs associated with the adjustment of frames and appurtenances will be deemed to be included in the unit prices for frame and appurtenance adjustments in the Pricing Form in the Contract Documents.

- c) Edge ramping and shouldering shall be constructed in accordance with OPSS 314. All costs associated with edge ramping and shouldering will be deemed to be included in the unit prices for edge ramping and shouldering in the Pricing Form in the Contract Documents.
- d) Excavation for pavement widening shall be completed in accordance with TS 206. All costs associated with excavation for pavement widening will be deemed to be included in the unit price for excavation for pavement widening in the Pricing Form in the Contract Documents.
- e) Prior to placing hot mix asphalt on a concrete base, the Contractor shall check grades and cross fall with special attention to intersections and flat sections of profile. The Contractor shall correct deficiencies where directed by the Contract Administrator, with hot mix padding, and check and adjust all frames and appurtenances to grade, including longitudinal and transverse slope. All costs associated with hot mix padding will be deemed to be included in the unit price for hot mix padding in the Pricing Form in the Contract Documents. All costs associated with the adjustment of frames and appurtenances will be deemed to be included in the unit prices for frame and appurtenance adjustments in the Pricing Form in the Contract Documents.
- f) Prior to placing any hot mix padding, patching or asphalt pavement, all existing asphalt and concrete surfaces and previously laid asphalt courses shall be cleaned of all dirt, grime, loose, broken and foreign material, or other contaminants, that might prevent proper bonding of the hot mix asphalt.

The Contractor shall carry out such brooming and flushing as necessary to comply with this requirement. All costs associated with cleaning, brooming and flushing will be deemed to be included in the unit price(s) for hot mixed, hot laid asphaltic concrete in the Pricing Form in the Contract Documents.

TS 310.07.01.03 *Application of Tack Coat*

TS 310.07.01.03.01 *General*

All surfaces that require tack coat shall be uniformly sprayed with SS-1 asphalt emulsion diluted with an equal volume of water. The diluted SS-1 emulsion shall be uniformly applied immediately following any necessary cleaning of the surface, at the rate of 0.5 litre/m², or at a rate as specified by the Contract Administrator.

Hot mix asphalt shall not be placed upon the tack coated surface until the tack coat has dried, and cured to a proper condition of tackiness.

TS 310.07.01.03.02 *Standard Surfaces and Areas to Tack Coat*

Tack coat shall be uniformly applied using suitable spray equipment to all vertical surfaces and an area with 0.3 m width along/or around all existing curbs, appurtenances, service covers and catch basins. Where the hot mix asphalt contacts gutter bricks, granite sets or street car rails, these areas shall have tack coat uniformly applied. At both limits of the area being paved, as well as adjacent to steel bridge joints, a 0.6 m width of surface shall have tack coat uniformly applied. All costs associated with the application of tack coat to these surfaces and areas shall be deemed to be included in the unit price(s) for hot mixed, hot laid asphaltic concrete in the Pricing Form in the Contract Documents.

TS 310.07.01.03.03 *Other Surfaces or Areas*

When and where any other surfaces or areas are to have tack coat applied to them, they shall be given in the Contract Documents by a special provision. All costs associated with the application of tack coat to these other surfaces or areas will be deemed to be included in the unit price for tack coat in the Pricing Form in the Contract Documents.

TS 310.07.01.04 *Transportation of the Hot Mix*

The hot mix shall be transported from the asphalt plant to the work in trucks with smooth metal boxes in good and leak proof condition, previously cleaned of all foreign materials.

Truck boxes shall be lightly coated with a uniform application of a release agent, such as soap/detergent solution, just before loading. If liquid agent is used, the truck boxes must be drained after each application and before loading. Using of kerosene, diesel or other solvent based release agents will not be permitted.

Each truck shall be equipped with a suitable insulated tarpaulin of sufficient size to cover the load. Such insulated tarpaulins shall be on the trucks at all times and will be used to cover the load completely.

Note: Contractors should note the importance of properly insulated tarpaulin use in cold weather to maintain the hot mix at placement temperature.

When insulated tarpaulins are in use, they shall be securely fastened down on all sides of the truck box.

Tarpaulins shall be rolled off the hot mix before the load is dumped into the paver or ShuttleBuggy®.

In no case shall hot mix temperatures be increased at the asphalt plant to offset long distance hauling.

Delivery of hot mix to the site shall be scheduled such that spreading and compaction of the hot mix is completed during daylight, except when night work is permitted by the Contract, or as approved by the Contract Administrator.

Communication between the asphalt paving operation and the asphalt plant shall be the responsibility of the Contractor, and inability to control the delivery of the hot mix, or to make changes in the composition of the hot mix, will not be cause for acceptance of hot mix asphalt which does not conform to the requirements of the Contract, nor will it relieve the Contractor of any responsibility for rejected loads.

TS 310.07.01.05 *Hot Mix Padding*

Hot mix padding shall be carried out to correct geometric deficiencies on the surface of the existing pavement as specified in the Contract Documents. All costs associated with hot mix padding will be deemed to be included in the unit price for hot mix padding in the Pricing Form in Contract Documents.

TS 310.07.01.06 *Hot Mix Patching*

Prior to hot mix patching, any cold mix patching material shall be removed from the locations designated for such removal in the Contract. The resulting holes shall be filled with the specified hot mix asphalt and properly compacted.

Prior to placing hot mix patching material, the areas of the existing pavement designated to be tack coated shall be treated with undiluted SS-1 emulsified asphalt at the rate of 0.35 litre/m². The hot mix patching material shall be machine laid to the required thickness, grade and crossfall.

The ends of the patch, and along the centre line when only one lane is to be patched, shall be feathered down to provide a smooth transition between the existing pavement and the patch.

The transverse joint between the existing pavement and the patch shall be either diagonal or fishtailed as determined by the Contract Administrator at the time of construction.

All costs associated with hot mix patching will be deemed to be included in the unit price(s) for hot mix patching in the Pricing Form in the Contract Documents.

TS 310.07.02 *Sampling*

TS 310.07.02.01 *Asphalt Cement*

When specified in the Contract Documents, the Contractor shall obtain asphalt cement samples according to TS 1101 for quality assurance testing.

TS 310.07.02.02 *Frequency and Location*

The asphalt cement sampling frequencies and locations shall be as specified in the Contract Documents. A minimum of one sample shall be randomly chosen for each asphalt cement used on the Contract.

TS 310.07.02.03 *Labelling*

Asphalt cement samples shall be labelled with the following:

- a) Contract number.
- b) Date (format yyyy-mm-dd) and time of sampling.
- c) Performance grade of the asphalt cement.
- d) Supplier's name.
- e) Refinery name.
- f) Waybill number.
- g) Tanker number.
- h) Whether the sample was taken from a delivery tanker or from a storage tank at the plant.
- i) Name and proportions of additives in the asphalt cement.

TS 310.07.02.04 *Delivery*

Samples for the Owner shall be delivered within 4 hours of sampling to the location specified in the Contract Documents.

TS 310.07.03 *Hot Mix or Warm Mix Asphalt*

The Contractor is responsible for obtaining quality assurance and referee HMA/WMA samples using sample plates or QuarterMaster™ Asphalt Mix Sample Splitter approved by the Contract Administrator for Superpave and SMA mixes. The Contractor may obtain a QC sample at the same location of the QA and referee samples. Samples shall be taken in accordance with the Contract Documents under the direction and in the presence of the Contract Administrator. Samples shall be placed in an appropriate container supplied by the Contractor. The Contract Administrator may apply security seals to the samples prior to transportation.

TS 310.07.03.01 *Frequency and Location*

The minimum frequency for sampling and testing shall be as specified in the Contract Documents.

TS 310.07.03.02 *Labelling*

HMA/WMA samples shall be labelled with the following:

- a) Contract number.
- b) Location of sampling.

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- c) Date (format yyyy-mm-dd) and time of sampling.
 - d) Asphalt type.

TS 310.07.03.03 *Cores*

When a coring and testing program is undertaken to resolve a dispute related to HMA /WMA compaction, the Contractor shall be responsible for all traffic control required to carry out the coring, obtaining and labelling the core samples, delivery of the samples to a mutually agreed upon third part referee laboratory, and repairing core sample holes.

Cores shall be 150 mm in diameter.

The minimum frequency of sampling and testing shall be as determined by the Contract Administrator.

Core samples shall be labelled with the following:

- a) Contract number.
- b) Location of core sample.
- c) Date (format yyyy-mm-dd) and time of sampling.
- d) Asphalt type.

TS 310.07.03.04 *Delivery*

All samples for the Owner shall be delivered within 4 hours of sampling to the location specified in the Contract Documents.

TS 310.07.04 *Repair of Sampling Locations*

HMA/WMA and compaction requirements for filling all sample holes shall be the same as the adjacent undisturbed pavement. All sample holes shall be cleaned, dried, and filled and then compacted using a mechanical, self-powered gas, electric, or air powered compactor immediately after sampling.

TS 310.07.05 *Placing Hot Mix Asphalt*

Asphalt paving shall not be carried out if, in the opinion of the Contract Administrator, the roadbed is frozen. In case of disagreement, the Contractor has the option of demonstrating at the Contractor's own expense and to the satisfaction of the Contract Administrator that the roadbed is frost-free.

Hot mix surface courses shall not be placed unless the air temperature at the surface of the road is at least 7°C and rising except as follows:

- When single course asphalt pavement is laid on granular grade, the air temperature shall be at least 2°C.

All other courses shall not be placed unless the air temperature at the surface of the road is at least 2°C.

When placing the hot mix asphalt on a granular grade, the granular grade shall be free of standing water. Not less than 300 m of prepared grade shall be maintained ahead of the asphalt paver. This requirement shall be waived at the end of the lane, or at the end of the paving operation for that day.

The surface of an existing pavement or previously laid course, upon which hot mix is to be placed, shall be clean and dry at the time of placing the hot mix asphalt. Not less than 30 m of prepared surface shall be maintained ahead of the asphalt paver laying the subsequent course. This requirement will be waived at the end of the lane, or at the end of the paving operation for that day.

A course shall not be placed upon a previously laid course within the 12 hours following final compaction of the latter, or until the temperature of the previous course is 50°C or less, whichever occurs first. For small pavement areas or bridge decks, the Contract Administrator shall issue instructions if any modification to this requirement is to be made.

The temperature of the hot mix asphalt immediately after spreading and prior to initial rolling shall not be less than 120°C.

Immediately after each course is laid and before compaction using rollers is started, deficiencies in the surface geometrics and hot mix asphalt texture shall be corrected. Irregularities in alignment and grade along the outside edge shall be corrected.

A course on the through lane shall be placed beyond the junction where side road tapers, bus bays, acceleration lanes and so on end, before the corresponding course is placed on such adjacent pavements.

For all courses, each adjacent lane shall be completed to approximately the same location at the end of each day's paving.

The temperature of any placed and compacted course shall be less than 60°C before traffic is allowed on it.

Note: Contractors should note that this may require the use of staged paving procedures and/or cooling methods, at no extra cost to the City.

At the end of each completed portion, prior to opening of the lanes to traffic, the completed sections of hot mix asphalt course shall be ramped down to the existing pavement at a slope of 25 mm to 3 m. The hot mix to be used for construction of the ramps shall be determined by the Contractor and approved by the Contract Administrator. In all cases, the ramp shall not form part of the permanent asphalt pavement and shall be removed before the paving of the adjacent section.

For testing purposes, the Contractor shall take for the City small hot mix asphalt samples from the courses. Holes made during such sampling, shall be carefully repaired by the Contractor at no extra cost to the City.

The Contractor shall take care during the transportation, placement and compaction of hot mix to avoid the spillage of any petroleum products such as gasoline, hydraulic oil, oil and diesel on the existing pavement(s) and new pavement(s). Any spill areas will be considered to be defective areas and dealt with in according to clause TS 310.07.05.07, herein.

TS 310.07.05.01.01 *Course Thickness*

The mass of hot mix being placed shall be adjusted as necessary during the asphalt paving operations so that the specified course thickness is uniformly maintained.

TS 310.07.05.02 *Use of Paving Equipment*

Levelling, binder and surface courses shall be laid by means of mechanical self-propelled pavers and a material transfer vehicle such as a ShuttleBuggy®. The hot mix shall be dumped in the centre of the paver hopper or ShuttleBuggy® and care shall be exercised to avoid overloading and spillage of the hot mix and segregation.

The longitudinal alignment of the spreader shall be controlled by following a string line which is set from the curb and gutter or alignment stakes. This means of control shall be placed at each outer edge of the pavement so that the spreader is directed at all times by a string line and not by the edge of the preceding course, except for the trailing paver(s) when pavers are operated in echelon.

The automatic screed controls and all compaction aids on the paver shall be in operation while the hot mix is being placed, except that the automatic screed controls shall not be used when placing a single course on granular grade.

When laying the first course adjacent to concrete gutters and similar structures, a short ski not less than 3 m in length shall be used and shall ride on the structure.

Single pavers, or the lead paver when pavers are operated in echelon, shall be controlled as to longitudinal grade by a 12 m ski or floating beam.

Note: Contractors should note that the City may, when paving major routes in echelon, require all pavers to be controlled by a 12 m ski, floating beam or global positioning system.

The paver(s) shall operate continuously at a uniform speed as necessary to match the output of the plant; however, in no case shall the speed of a paver exceed 18 m/min.

Note: Contractors should note that paving operations will often involve working with traffic.

If the hot mix for surface course paving comes from more than one hot mix plant, the mix from each plant shall be placed by a separate paver. Regardless, all hot mix shall be consistent in materials, gradation and properties.

TS 310.07.05.03 *Widenings and Irregular Sections*

TS 310.07.05.03.01 *Widenings*

When widening existing pavements, hot mix asphalt shall be placed in the widening such that when compacted, the top of the widening portion is flush with the top of the existing pavement. When stepped joints are specified, the courses placed in the widening shall be placed to the top of each step in separate operations.

The hot mix asphalt shall be placed in the widening using special equipment designed or adapted for this purpose.

TS 310.07.05.03.02 *Irregular Sections*

In intersections, turn-outs, driveways, and other irregular sections where it is impractical to spread and finish the binder, levelling or surface hot mix asphalt by paver methods, the Contractor shall use other spreading equipment or shall spread the mixture by hand. Regardless, all through lanes shall be placed by paver.

When laying surface courses, the use of feed augers for placing mix in these areas is permitted only when supplying hot mix to a hydraulic strike-off device.

When it is necessary to hand-spread the hot mix in sections adjacent to paver laid areas, such hand-spreading shall be carried out concurrent with paver-laying.

For any handwork, care shall be taken to avoid hot mix segregation or open hot mix asphalt, and any coarse mix or excess mix from raking shall be removed.

TS 310.07.05.04 *Longitudinal and Transverse Joints*

TS 310.07.05.04.01 *Requirements for all Joints*

All joints shall be made to ensure a thorough and continuous bond between jointed materials and to provide a smooth riding surface.

All dirt or other foreign material and all loose material shall be removed from faces at which a joint is to be made.

When matching existing surfaces, the depth of the uncompacted mat shall be set to allow for compaction and the paver screed should overlap the adjacent surface by no more than 25 mm.

TS 310.07.05.04.02 *Tacking of Joints*

Faces at which joints are made shall be tacked (painted) with a thin uniform and continuous coating of tack coat material, with the exception of joints that are still hot, the joint(s) between pavement lanes laid in echelon. All costs associated with the tacking of joints shall be deemed to be included in the unit price(s) for hot mixed, hot laid asphaltic concrete in the Pricing Form in the Contract Documents.

TS 310.07.05.04.03 *Requirements for Longitudinal Joints*

Longitudinal joints shall be properly "set up" with the back of a rake or lute if necessary, at the proper height and grade prior to rolling. Cold joint is defined as a joint where asphalt mix is placed, compacted and left to cool below 80°C prior to paving of the adjacent lane. Cold joint construction should be avoided by paving in echelon or by providing infrared heaters to heat the cold joint to 135°C prior to paving adjacent lane.

If cold joints cannot be avoided and it is accepted by the Engineer, then overlap adjoining mat (lane) paver by no more than 25 mm. Before rolling, carefully remove and discard coarse aggregate in material overlapping joint with lute or rake. Roll the longitudinal joint directly behind the paving operation. When rolling with static or vibratory rollers, have most of drum width ride on newly placed lane with remaining 150 mm extending onto previously placed and compacted lane.

The width of subsequent courses shall be adjusted to an offset of 150 to 300 mm so that longitudinal joints do not coincide vertically. This shall also apply to the joint between through lanes and speed change lanes and other similar longitudinal joints. The longitudinal joints in the surface course shall correspond to the demarcation between driving lanes, speed change lanes and tapers as specified in the Contract Documents.

For surface courses, the method of making joints shall be such that the excess hot mix is not scattered on the surface of the freshly laid mat. Such excess material shall be removed.

At widenings, longitudinal joints between asphalt pavement laid under this Contract and existing asphalt pavement shall be treated as follows:

- Where a butt joint is to be constructed, the existing asphalt pavement edge shall be trimmed to a straight, clean, vertical face.
- Where a stepped joint is to be constructed, the existing asphalt pavement edge shall be trimmed to a straight, clean, vertical face and the asphalt pavement shall be removed to the depth and width as specified in the Contract Documents to form the stepped joint.

Where a resurfacing course is to be placed flush against a rigid object, for example curb and gutter, a butt joint shall be constructed by removing the existing pavement to provide an exposed face of at least 35 mm at the face of the rigid object and feathered out to zero along a line 1.25 m from and parallel to the exposed face of the rigid object to provide a depth of at least 35 mm of resurfacing hot mix asphalt over the area of removal.

TS 310.07.05.04.04 *Requirements for Transverse Joints*

Except for end joints with hot mix patching, transverse joints between asphalt pavement laid under this Contract and asphalt courses previously laid under this Contract shall be constructed by trimming the end of the previously laid course back to its full depth, to expose a fresh, straight vertical surface.

The asphalt paver shall not move more than 15 m from any transverse joint until that joint has been rolled and checked with a straight edge. If the joint is not satisfactory, it shall be corrected immediately before the paver is allowed to proceed.

Joints between asphalt pavement laid under this Contract and existing asphalt courses not laid under this Contract shall be constructed as follows:

- Where a binder course is placed flush against an existing asphalt pavement and a butt joint is to be made, the existing pavement shall be trimmed back to form a straight vertical face.
- Where a surface course is placed flush against an existing asphalt pavement, the binder course shall be feathered out and a butt joint shall be constructed in the surface course by removing the existing asphalt pavement to a depth of 25 mm and for a longitudinal distance of not less than:
 - i. 3 m where the maximum speed is to be posted at 70 km/h or greater; and
 - ii. 1.25 m where the maximum speed is to be posted at less than 70 km/h.

TS 310.07.05.04.05 *Disposal*

All materials removed for joint construction shall be disposed of away from the Work by the Contractor.

TS 310.07.05.05 ***Compaction***

TS 310.07.05.05.01 *Rolling*

Rolling shall be completed to provide uniform compaction of the hot mix asphalt.

All rolling shall be completed during daylight, except when night work is permitted by the Contract, or as approved by the Contract Administrator.

The Contractor shall supply and use at least the minimum number of roller compaction units in the sequence specified in Table 4.

When vibratory or pneumatic rollers are used, one shall be supplied for each paver.

The operating speed of steel-tired rollers shall not exceed 5 km/h and shall be slow enough to avoid undue displacement of the hot mix asphalt. Rollers shall operate with the drive wheel forward in the direction of paving.

At all places not accessible to rollers, the hot mix asphalt shall be compacted by other suitable means.

Table 4: Maximum rates per paver and roller sequence¹

Maximum production per paver t/s	Minimum roller combinations per paver breakdown + intermediate + finish
120 or less	S2 + R1 + S1 or V1 + R1 + S1
more than 120	S2 + 2xR1 + S1 or S2 + R2 + S1 or V2 + 2xR1 + S1 or V2 + R2 + S1

Note 1: For each pair of rollers used in echelon, only one S1 roller shall be required.

Rolling procedures shall be as follows:

i. Breakdown Rolling

The hot mix asphalt shall be thoroughly and uniformly compacted as soon after placing as it will bear the roller without checking or undue displacement. Rolling shall start longitudinally at the lower edge and proceed towards the higher edge of the course, overlapping on successive trips. Alternate trips of the roller shall be staggered.

ii. Intermediate Rolling

The intermediate roller shall follow the breakdown rolling as closely as possible. Passes shall be so arranged as to ensure overlapping successive tire paths. The rolling operation shall be such as to prevent pick-up of the mixture on the tires.

iii. Finish Rolling

Finish rolling shall be accomplished with the minimum number of passes required to produce a satisfactory surface without any checking of the compacted asphalt concrete. Finish rolling shall start longitudinally at the higher edge and proceed towards the lower edge of the course.

Note: Contractors should note that additional rollers, beyond the combinations given in Table 4, may be required to achieve satisfactory compaction. The influence of lower ambient temperatures/wind on compaction should also be noted by Contractors.

TS 310.07.05.05.02 *Compaction of Irregular Sections and Inaccessible Areas*

All irregular and inaccessible areas that cannot be compacted to the required minimum compaction, given in clause TS 310.07.01.11.01, herein, by the use of the specified rollers, shall be compacted with mechanical tampers. The hot mix asphalt may be heated without "burning" to a temperature of 130°C to facilitate this compaction.

TS 310.07.05.05.03 *Rolling Requirements for Stone Mastic Asphalt*

The compaction of SMA shall be completed using steel-tired (steel-wheel) rollers in the static mode. No pneumatic-tired rollers shall be used on the SMA.

Note: Contractors should note that the proper compaction of SMA requires the breakdown compaction steel-wheel roller(s) to be kept right up to the paver screed. The SMA must be at the proper temperature (typically 145 to 155°C) for compaction. Contractors should also note that SMA is quite resistant to compaction and has only about 30 per cent of the compactibility of conventional mixes. Care must be taken to remove any cold or spilled SMA mix during paving and compaction operations.

TS 310.07.05.06 ***Tolerances***

Each course after final compaction shall be smooth and true to the established crown and grade. The surface of each binder course shall be free from deviations exceeding 5 mm as measured in any direction with a 3 m straight edge. The surface of each surface course shall be free from deviations exceeding 3 mm as measured in any direction with a 3 m straight edge.

TS 310.07.05.07 ***Surface Appearance***

Each course, after final compaction, shall be of uniform texture and shall be free of segregation, fat spots, oil spills, roller marks and any other defects. Areas of medium segregation may be left in place for binder courses, subject to approval of the Contract Administrator, but are considered defective areas for surface course. Areas of severe segregation are considered defective areas for binder and surface courses. Defective areas shall be removed and replaced with acceptable hot mix asphalt of the same type and compacted to the satisfaction of the Contract Administrator.

TS 310.07.06 ***Crack Repair***

All crack repair shall be carried out in advance of paving operations.

Cracks which are to be repaired shall be cleaned and all loose and broken material removed. Hot mix of the type specified in the Contract Documents shall be placed in the crack, feathered to 0.3 m on each side of the crack and rolled with a steel-tired roller having a mass of at least 3 tonnes.

All costs associated with crack repairs will be deemed to be included in the unit price for crack repair in the Pricing Form in the Contract Documents.

TS 310.07.07 ***Depressed Fault Repair***

Depressed fault repair shall be carried out in advance of paving operations as specified in the Contract Documents.

Faults which are to be repaired shall be cleaned, and all loose and broken material shall be removed. Hot mix of the type designated in the Contract shall be placed in the fault and feathered 0.3 m on each side of the fault, and shall be rolled with a steel-tired roller having a mass of at least 3 t.

All costs associated with depressed fault repairs shall be deemed to be included in the Contract Price for depressed fault repair in the Pricing Form.

TS 310.07.08 Milling Existing Asphalt Pavement

The existing asphalt pavement shall be milled off for the area and depth indicated.

All costs associated with milling existing asphalt pavement will be deemed to be included in the Contract Price for milling existing asphalt pavement in the Pricing Form.

TS 310.07.09 Sealing

All joints between frames and appurtenances and the asphalt pavement shall be sealed with a bead of hot-poured rubberized asphalt.

All costs associated with sealing joints between frames and appurtenances and the asphalt pavement will be deemed to be included in the Contract Price for adjustment of frames and appurtenances in the Pricing Form.

TS 310.07.10 Hot-Poured Rubberized Asphalt Joints

All joints and cracks shall be sealed with a 20 mm bead of hot poured rubberized asphalt compound in Portland cement concrete pavements or hot mix asphalt pavements with a small amount of movement.

All costs associated with hot-poured rubberized asphalt joints will be deemed to be included in the Contract Price for hot-poured rubberized asphalt joints in the Pricing Form.

TS 310.08 QUALITY ASSURANCE

TS 310.08.01 General

The Contract Administrator is responsible for conducting QA procedures for all HMA aggregates, asphalt cement, and compaction to meet the requirements of the Contract Documents. QA HMA testing shall be conducted at a frequency specified in Table 5 or as specified in the Contract Documents.

Table 5: Sampling and testing frequency of hot mix asphalt

Quantity per day per HMA type	Minimum frequency of sampling and testing	Minimum Superpave sampling size (Note a) kg
≤ 500 tonnes or per street if quantity is less than 500 tonnes such as for resurfacing contracts (Note c)	One sample	20
> 500 and ≤ 1,500 tonnes	One sample per 500 tonnes or part thereof	20
> 1,500 tonnes	One sample per 500 tonnes (Note b), minimum of 3	20

Note a: One additional 5 kg sample is required for SMA mixes to test for draindown.

Note b: The Contract Administrator may reduce the testing frequency for HMA that is consistently being produced to meet the specification requirements.

Note c: For small quantity paving jobs, typically the first load of the day, every 250 tonnes. Minimum one sample in the morning and one sample in the afternoon.

Acceptance of hot mix aggregates and asphalt cement shall be according to TS 1003 and TS 1101, respectively.

All QA testing shall be completed in a certified laboratory that is CCIL Type B and C, or AMRL accredited, or equivalent. Testing of the samples shall be conducted under the direction and constant supervision of technicians certified to perform the QA tests.

The Contractor may have a qualified representative present during any quality assurance testing. During the quality assurance testing, the qualified representative shall immediately comment on any aspects of the testing which the representative does not consider valid and the Contract Administrator will respond to the comments in order to resolve them. Prior to leaving the quality assurance testing laboratory, any unresolved comments regarding the testing procedures are to be given to the Contract Administrator in writing. Any comments on the testing procedures which are made subsequent to the Contractor's representative leaving the laboratory will not be considered.

The Contract Administrator may reject visually defective HMA areas based on, but not limited to the following defects: flushing, bleeding, segregation, fat spot, surface damage, and surface contamination. Such defective HMA or areas shall be removed from the work and replaced with acceptable HMA.

When the HMA fails to consistently meet the requirements of the Contract Documents, the Contract Administrator may refuse further material until the mix properties are verified for compliance. For Superpave mixes, samples shall be used to determine compliance to asphalt cement content, aggregate gradation, and Superpave mix properties.

TS 310.08.02 Aggregate Gradation and Asphalt Cement Content Acceptance

Aggregate gradation and asphalt cement content test results for HMA samples based on LS-282 and LS-292 shall meet the JMF tolerance requirements as specified in Table 6.

Table 6: Aggregate gradation and asphalt cement content acceptance

Mix Type	Attribute	Acceptance on the Job-Mix Formula		
		Acceptable	Borderline	Rejectable
SMA 9.5, SMA 12.5, SP 9.5 and SP 12.5	DLS, 4.75 mm sieve size	< 5.0	5.0 to 7.5	> 7.5
	0.600 mm sieve size	< 3.5	3.5 to 5.0	> 5.0
	0.075 mm sieve size	< 2.0	2.0 to 3.0	> 3.0
SMA 19.0, SP 19.0 and SP 25.0	DLS, 4.75 mm sieve size	< 7.0	7.0 to 10.0	> 10.0
	0.600 mm sieve size	< 4.5	4.5 to 6.0	> 6.0
	0.075 mm sieve size	< 2.0	2.0 to 3.0	> 3.0
All Mixes	PGAC Content	< 0.3	---	≥ 0.3

If the HMA is deemed borderline for aggregate gradation or asphalt cement content according to Table 6, the Contractor shall be notified in writing by the Contract Administrator and shall take immediate corrective action through process control at the HMA plant. A total of three borderline test results for the same attributes representing up to 1,500 tonnes or up to three individual streets during the paving day of HMA production shall result in the work being deemed rejectable.

If the HMA is deemed rejectable according to Table 6, both the Contract Administrator and the Contractor shall review, agree, and identify the limits of rejected HMA that has been placed. Referee samples within the limits of the affected area shall be delivered by the Contractor to a mutually agreed upon third party referee laboratory to verify aggregate gradation or asphalt cement content or both. When the results from the referee samples are deemed rejectable according to Table 6, the HMA pavement shall be removed and replaced with acceptable HMA pavement.

TS 310.08.03 Hot Mix Asphalt Properties Acceptance

The production air voids for all HMA mixes shall be evaluated according to Table 7.

If the HMA is borderline for air voids as specified in Table 7, the Contractor shall be notified in writing by the Contract Administrator and shall take immediate corrective action through process control at the HMA plant.

Table 7: Air void criteria for hot mix asphalt types

Mix type	Acceptable %	Borderline %	Rejectable %
Superpave Mixes	2.5 to 4.5	2.0 to 2.4 and 4.6 to 5.0	< 2.0 and > 5.0
SMA Mixes	3.0 to 5.0	2.0 to 2.9 and 5.1 to 6.0	< 2.0 and > 6.0

If the HMA is deemed rejectable for air voids according to Table 7, both the Contract Administrator and Contractor shall review, agree, and identify the limits of rejected HMA that has been placed. Referee samples within the limits of the affected area shall be delivered by the Contractor to a mutually agreed upon third party referee laboratory to verify the air void results. When the results from the referee samples are deemed rejectable according to Table 7, the HMA pavement shall be removed and replaced with acceptable HMA pavement.

TS 310.08.04 Compaction Requirements

Compaction testing of the placed HMA shall meet the requirements specified in Table 8.

Nuclear density test gauge results shall be used to assess in-place compaction. When compaction test results do not meet the minimum percent compaction specified in Table 8, the Contractor shall be notified in writing and either the affected area of HMA pavement shall be removed and replaced with acceptable HMA pavement or, in the case of a dispute, the Contractor or the Owner may request that a coring and testing program be undertaken to verify compaction percentage of the mix. The cores shall be provided to the Owner and compaction shall be determined according to the Compaction Determined by Core Density Testing clause using a mutually agreed upon third party referee laboratory. When compaction results from core densities do not meet the minimum percent compaction specified in Table 8, the HMA pavement shall be removed and replaced with acceptable HMA pavement.

Table 8: Compaction requirements¹

Hot mix type	Minimum Pavement Compaction Based on Maximum Relative Density
SP 19.0 and SP 25.0	91.0
All Other Mixes	92.0

Note 1: Determined according to MTO LS-264 and LS-287.

TS 310.08.04.01 *Compaction Determined by Nuclear Density Gauge*

Compaction testing shall be conducted randomly at a minimum frequency of every 100 m per lane or 150 m² area. Compaction testing shall also be conducted randomly at joints.

TS 310.08.04.01.01 *Superpave Hot Mix Asphalt*

Percent compaction shall be determined by comparing the nuclear density in situ BRD to the average plant produced HMA MRD both according to AASHTO T209.

TS 310.08.04.02 ***Compaction Determined by Core Density Testing***

TS 310.08.04.02.01 *Superpave Hot Mix Asphalt*

Density testing of the cores shall be according to AASHTO T166. If the percent water absorbed by the specimen is found to exceed 2% by volume as described in AASHTO T166, then the bulk specific gravity shall be according to AASHTO T275, LS-306, or ASTM D 6752. Percent compaction shall be determined by comparing the core BRD to the average MRD both according to AASHTO T209 of the plant produced HMA.

TS 310.09 **MEASUREMENT FOR PAYMENT**

TS 310.09.01 **Superpave and Stone Mastic Asphalt Mixes**

TS 310.09.01.01 ***Methods of Measurement***

Measurement of hot mixed, hot laid asphaltic concrete shall be by mass in t (megagrams or tonnes) or by area in square metres (m²).

All hot mix that is delivered to the site shall be accompanied by a truck weigh ticket showing the truck number, type of hot mix, contract number, truck time in and out of the hot mix plant, tare mass in kilograms to the nearest 50 kg, gross mass to the nearest 50 kg, net mass in kilograms and driver's signature.

The truck weigh ticket shall be printed by an electronic printer interfaced with the truck scale readout and capable of recording the tare mass, gross mass and net mass. The weigh ticket shall carry a cumulative total for the day. The Contractor shall provide an electronic daily weight ticket summary to the City's representative at the end of each day. The tare mass for the truck shall include the vehicle, operator, fuel, spare tire and so on. The tare mass of the truck shall be taken at least twice per shift.

The Contractor, or Contractor's representative, shall be responsible for ensuring that the truck weigh ticket (delivery ticket) for each load is handed to the City's representative inspecting the asphalt paving operation at the time the delivery truck unloads at the paving site. The Contract Administrator will not accept any responsibility for delivery tickets that are not submitted at the proper time, or are submitted in groups after the delivery trucks have left the paving site.

The Contractor shall permit the Contract Administrator to make random checks of the gross mass and tare mass of trucks hauling hot mix by requiring them to be driven over an independent scale. No additional payment shall be made for any delays or costs attributable to such verification of loads.

TS 310.09.01.02 ***Theoretical Mass***

Where the thickness of a hot mix asphalt course is specified by being given in the Contract Documents, shown on the Contract Drawings, or in written instructions from the Contract Administrator, the theoretical mass shall be determined as follows:

Theoretical Mass = the area of the surface covered x the specified thickness x 91 per cent of the hot mix maximum relative density from the job mix formula for the mix type.

Levelling courses and padding courses, if any, shall not be checked for theoretical mass.

TS 310.09.01.03 *Payment Mass*

When the Pricing Form specifies the thickness of hot mix asphalt course(s) and that the hot mix item(s) shall be measured by mass, the actual mass of hot mix used to produce the course shall not exceed the theoretical mass by more than 15 per cent.

If the mass of hot mix type placed is less than 115 per cent of the theoretical mass for the hot mix type, the payment mass will be the mass of hot mix actually placed as recorded by the weigh tickets, multiplied by the density factor for the hot mix type and composition given in Table 6, as applicable.

If the mass of hot mix type placed exceeds 115 per cent of the theoretical mass for the hot mix type, the payment mass will be based on no more than 115 per cent of the theoretical mass, multiplied by the density factor for the hot mix type and composition given in Table 6, as applicable.

TS 310.09.01.04 *Payment Area*

When the Pricing Form specifies that the hot mix type item(s) is to be measured by area, a check will be carried out for each course laid to confirm the thickness of the course. The actual thickness of the course will be calculated as follows:

$$\text{actual thickness} = \text{specified thickness} \times \frac{\text{actual mass}}{\text{theoretical mass}}$$

When the actual thickness is more than 95 per cent of the specified thickness, the payment area will be the total surface area of the hot mix type laid for the course.

When the actual thickness is less than 95 per cent of the specified thickness, the surface area for payment purposes will be calculated as follows:

$$\text{payment area} = \text{actual area} \times \frac{\text{actual thickness}}{\text{specified thickness}}$$

Table 8: Density factors for SMA ¹

Mix type	Coarse aggregate	Fine aggregate	Density factor
SMA ²	trap rock	trap rock	1.00
	dolomitic sandstone	dolomitic sandstone	1.10
		meta-arkose	1.09
	meta-arkose	diabase	1.03

Note 1: Other approved combinations of SMA aggregates, if any, shall have density factors applied proportional to those given in Table 6.

Note 2: The density factor for SMA is based on a combination of trap rock coarse aggregate and trap rock fine aggregate.

TS 310.09.01.05 *Density Factors*

Density factors for SMA are given in Table 8. The density factor for all other hot mix types is 1.00.

TS 310.09.02 *Hot Poured Rubberized Asphalt Joint Sealing*

Measurement of hot poured rubberized asphalt joint sealing shall be by linear metres (m).

TS 310.10 *BASIS OF PAYMENT*

TS 310.10.01 *Superpave and Stone Mastic Asphalt*

Where there is no separate tender item for tack coat, payment at the Contract Price for the tender item for hot mixed, hot laid asphaltic concrete to be placed on the tack coat shall include full compensation for all labour, Equipment and Material to do the work.

TS 310.10.01.01 *Mass Basis*

When the Pricing Form specifies that the hot mix type item(s) is to be measured by mass, payment will be based on the payment mass.

TS 310.10.01.02 *Area Basis*

When the Pricing Form specifies that the hot mix type item(s) is to be measured by area, payment will be based on the payment area.

TS 310.10.02 *Hot Poured Rubberized Asphalt Joint Sealing – Item*

Payment at the Contract Price shall be full compensation for all labour, Equipment and Material required to the Work.

APPENDIX 310-A,

If the designer wishes to allow the use of warm mix asphalt, Appendix 310-A should be invoked in the Contract Documents. Appendix 310-A contains information that amends TS 310 to include the requirements for using warm mix asphalt on contracts.

Supplementary Requirements for Using Warm Mix Asphalt

TS 310, Hot Mix, Hot Laid Asphaltic Cement, is amended as follows:

310.01 SCOPE

Section 310.01 of TS 310 is amended by the addition of the following:

This specification covers the requirements for the placement and compaction of warm mix asphalt (WMA) designed using Superpave methods.

310.03 DEFINITIONS

Section 310.03 is amended by the addition of the following:

Hot Mix Asphalt (HMA) means hot mixed, hot laid asphaltic concrete and includes mix produced using WMA technologies. The terms are used interchangeably. HMA may include recycled or specialty mixes.

Warm Mix Asphalt (WMA) means warm mixed, warm laid asphaltic concrete produced using technologies that allow for the mixing, handling, and compaction of the asphaltic concrete mixture at a temperature typically 20 to 50 °C lower than conventional hot mix asphalt.

TS 310 is amended by the addition of the following:

310.04 DESIGN AND SUBMISSION REQUIREMENTS

310.04.04 Design Requirements for Warm Mix Asphalt

The Contractor shall be responsible for the following:

- a) Selecting the WMA technology to be used on this Contract from recognized WMA technologies or from the WMA technologies specified in the Contract Documents.
- b) The WMA mix design and the job mix formula at the anticipated WMA production temperature, both of which shall be according to the requirements detailed in the Contract Documents, except as amended by this specification.
- c) Ensuring that, during the development and verification of the WMA mix design, the WMA technology does not adversely affect the asphalt cement performance grade and the WMA mixture performance.

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310.04.05 Submission Requirements for Warm Mix Asphalt

A minimum of 14 Days prior to paving with WMA, the following information shall be submitted to the Contract Administrator in writing:

- a) The name of the WMA technology selected for use on the Contract.
- b) The complete name and address of the WMA technology supplier, if applicable.
- c) Details on how the requirements of this specification shall be met.
- d) If applicable, the type and dosage of WMA additives, how the additives are to be incorporated to produce the WMA, and the WMA technology supplier's established recommendations for usage.

310.05 MATERIALS

Subsection 310.05.01 is deleted in its entirety and replaced with the following:

310.05.01 Warm Mix Asphalt

The materials used in the production of WMA shall be according to TS 1151 for Superpave and SMA mixes.

The Contractor shall be responsible for the following:

- a) Identifying and using a facility capable of producing the WMA according to the WMA technology supplier's instructions for the use of its WMA technology.
- b) Obtaining from the WMA technology supplier all information required for the proper preparation, handling, storage, and use of the WMA materials, including Material Safety Data Sheets.
- c) Obtaining materials; producing mixes; and the transportation, storage, and use of all materials.
- d) Ensuring that the WMA is produced according to the WMA technology supplier's recommendations to prevent any deleterious effects to the finished product.
- e) Using an anti-stripping additive recommended by the WMA technology supplier when an anti-stripping additive is to be incorporated into the WMA.

The WMA shall be produced within the temperature range recommended by the WMA technology supplier to achieve target compaction in the field and to meet the requirements specified in the Contract Documents.

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310.06.02.02 Requirements for Rollers

Clause 310.06.02.02 is amended by the addition of the following:

The rolls or drums shall be operated according to the WMA technology supplier's requirements to avoid mat segregation or roller pickup or both.

Subsection 310.07.01.04 is deleted in its entirety and replaced with the following:

310.07.04 Transportation of Warm Mix Asphalt

The WMA shall be transported from the asphalt plant to the work in leak-proof truck boxes that have been previously cleaned of all foreign materials. If required, truck boxes shall be lightly coated with a uniform application of release agent in accordance with the WMA technology supplier's recommendations. Truck boxes shall be drained after each application and before loading. No release agents shall be used that can adversely affect the quality or performance of the WMA. Release agents shall be used according to the proprietary requirements.

Each truck shall use a tarpaulin of sufficient size to completely cover the load at all times.

310.07.05 Placing Warm Mix Asphalt

310.07.05.01 General

Subsection 310.07.05.01 is deleted in its entirety and replaced with the following:

The Contractor shall provide notice of intent to pave in writing to the Contract Administrator a minimum of 7 Days prior to placing the WMA.

The WMA technology supplier's recommendations for placing the WMA mix shall be followed.

The temperature of the WMA immediately after spreading shall be within the limits identified in Table 9.

Prior to roller compaction, obvious defects in the WMA material placed shall be corrected. Irregularities in the alignment and grade along the outside edges shall be corrected.

A through lane paving course shall be completed prior to the placement of adjacent side roads, speed change lanes, and other paved areas. For all courses, each adjacent lane shall be completed to approximately the same location at the end of each day's paving.

At the end of each completed portion and prior to opening the lanes to traffic, the completed sections of WMA course shall be ramped transversely to the existing pavement to a maximum of 30H:1V. In all cases, the ramps shall not form part of the permanent asphalt pavement and shall be removed prior to continuing paving operations.

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310.08 QUALITY ASSURANCE

310.08.01 General

Clause 310.08.01 of TS 310 is amended by the addition of the following:

When the selected WMA technology requires that additives be added to the asphalt cement, acceptance of the asphalt cement shall be based on the samples that contain the WMA additive. Acceptance of WMA emulsion shall be based on testing the asphalt cement residue obtained from the WMA emulsion.

310.10 BASIS OF PAYMENT

Subsection 310.10.01 is deleted in its entirety and replaced with the following:

310.10.01 Warm Mix Asphalt - Item

Where there is no separate tender item for tack coat, payment at the Contract price for the tender item for warm mix asphalt to be placed on the tack coat shall be full compensation for all labour, Equipment, and Material to do the work.

Removal and replacement of the following shall be at no extra cost to the City:

- a) Defective areas of WMA, including but not limited to those due to flushing, bleeding, segregation, fat spots, surface damage, and surface contamination.
- b) WMA that does not meet the requirements of the Contract Documents.

Referee testing undertaken to resolve a dispute shall be at no extra cost to the Owner if the referee test results confirm that the WMA is deemed borderline or rejectable according to Table 9.

A coring and testing program undertaken to resolve a dispute shall be at no extra cost to the City if the mix compaction is confirmed to be below the minimum specified compaction.

No additional payment shall be made for any delays or costs attributed to verification of the gross mass and tare mass of trucks requested by the Contract Administrator.

Table 9 is added:

Table 9: Allowable Limits for WMA Paving Temperature

Minimum Allowable WMA Paving Temperature	Maximum Allowable WMA Paving Temperature
The higher of 60 °C and the minimum temperature recommended by the WMA technology supplier	The lower of 125 °C and the maximum temperature recommended by the WMA technology supplier.