Construction Specification for Hot Mixed, Hot Laid Asphaltic Concrete Paving

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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 206	Amendment to OPSS 206 – Construction Specification for Grading
TS 1003	Material Specification for Aggregates – Hot Mixed, Hot Laid Asphaltic Concrete
TS 1101	Material Specification for Performance Graded Asphalt Cement and Performance Graded Asphalt Cement with Elastic Recovery
TS 1150	Material Specification for Hot Mixed, Hot Laid Asphaltic Concrete

Ontario Provincial Standard Specifications, General Conditions

OPSS 102	Weighing of Materials

Ontario Provincial Standard Specifications, Construction

OPSS 314	Untreated Granular Sub base, Base, Surface, Shoulder and Stockpiling

Ontario Provincial Standard Specifications, Material

OPSS 1103	Emulsified Asphalt

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)

TS 310.03 DEFINITIONS

For the purpose of this specification, the definitions given in TS 1003, TS 1101 and TS 1150, 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.

HL-8 (HS, 10% RAP) means HL-8 high stability hot mix asphalt incorporating Reclaimed Asphalt Pavement (RAP), with a replacement limit of 10 per cent (recycling 'ratio' limit of 10/90, RAP to new aggregate). HL-8 (HS, 10 per cent RAP), if any is designated in the Contract Documents, will be specified through a special provision.

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

HL, Hot Mix, Mixture, Mix means hot mixed, hot laid asphaltic concrete.

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, rideability or safety.

HL (HS) Types, High Stability Types means the high stability hot mixes.

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.

Large Stone Binder Course (LSBC) means the dense graded, large-size crushed aggregate (minus 37.5 mm), hot mix binder 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 sublot, 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.

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

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 1150.

TS 310.05.02 Tack Coating Material

Tack coating material shall be SS-1 emulsified asphalt and shall be according to OPSS 1103.

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, satisfactory mat in conformance with this specification until the Contractor carries out, and demonstrates, suitable corrective measures.

All pavers shall be equipped with a gas-fired torch 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 width 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 with elastic recovery (PGAC-E), 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 with elastic recover (PGAC-E), 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 with elastic recovery (PGAC-E), 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.

4) Not cause 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 Hot Mix HL-1, 2, 3, 3 HS, 3 Fine, 3 Mod, 8, 8 (HS)
Recycled Hot Mix HL-8 (up to 20% RAP), HL-8 (HS, 10% RAP)
Dense Friction Course Mix (DFC)
Stone Mastic Asphalt (SMA)
Large Stone Binder Course Mix (LSBC)
Specialty Mixes

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 PGAC-E 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.

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.

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.

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 according to 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/m^2.

Hot mix asphalt shall not be placed upon the tack coated surface until the tack coat has dried 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 leakproof 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.

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 shuttle buggy.

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 310.07.01.07 *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.

- When single course asphalt pavement is laid on HL-2 which is laid on a 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 City may take small hot mix asphalt samples or asphalt concrete cores 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 310.07.01.13, herein.

TS 310.07.01.07.01 *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 310.07.01.08 *Use of Paving Equipment*

Levelling, binder and surface courses shall be laid by means of mechanical self-propelled pavers and a load transfer vehicle such as a shuttle buggy. The hot mix shall be dumped in the centre of the paver hopper or shuttle buggy 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 HL-2 or a single course on granular grade.

Except for HL-2, 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 310.07.01.09 *Widenings and Irregular Sections*

TS 310.07.01.09.01 *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 310.07.01.09.02 *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 310.07.01.10 *Longitudinal and Transverse Joints*

TS 310.07.01.10.01 *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 50 mm.

TS 310.07.01.10.02 *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 and joints between adjacent lanes of HL-2. 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 310.07.01.10.03 *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.

With the exception of HL-2 courses, 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 310.07.01.10.04 *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 310.07.01.10.05 *Disposal*

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

TS 310.07.01.11 *Compaction*

TS 310.07.01.11.01 *Compaction Testing Based on Nuclear Density Gauge Testing*

Each completed course of asphalt pavement shall be compacted to at least the minimum percent compaction of the hot mix's theoretical maximum relative density given in Table 4, regardless of the depth of the course being laid. Compaction shall be determined by calibrated nuclear density gauge testing (nuclear density gauge densities calibrated against core densities for each hot mix type for the Contract).

Table 4: Compaction requirements[1]

Hot mix type	Minimum per cent compaction of theoretical maximum relative density
all except HL-3 Fine	92.5
HL-3 Fine	91

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

TS 310.07.01.11.02 *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 5.

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 5: Maximum rates per paver and roller sequence[1]

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 5, may be required to achieve satisfactory compaction. DFC, HL-1 and HS (High Stability) may be difficult to compact and require close attention to roller selection and operation. The influence of lower ambient temperatures/wind on compaction should also be noted by Contractors.

TS 310.07.01.11.03 *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 310.07.01.11.04 *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 310.07.01.12 *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 310.07.01.13 *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 310.07.02 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 310.07.03 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 deemed to be included in the Contract Price for depressed fault repair in the Pricing Form.

TS 310.07.04 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 310.07.05 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 310.07.06 Hot-Poured Rubberized Asphalt Joints

When and where hot-poured rubberized asphalt joints are to be constructed, they shall be given in the Contract by a Special Provision. 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

Quality assurance (QA) acceptance testing of the Work shall be conducted by the City. Compaction acceptance requirements are given in subsection TS 310.08.02. Aggregates acceptance requirements are given in TS 1003. PGAC and PGAC-E acceptance requirements are given in TS 1101. Hot mixed, hot laid asphaltic concrete acceptance requirements are given in TS 1150.

All visually defective hot mix asphalt (clause TS 310.07.01.13) or work will be rejected by the Contract Administrator, irrespective of any quality assurance test results. Such defective hot mix asphalt or work shall not be incorporated into the Work.

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.

TS 310.08.02 Compaction Requirements

Compaction testing of the placed hot mix asphalt course, completed by the City (based on calibrated nuclear density gauge testing), shall be according to clause TS 310.07.01.11.01, herein

TS 310.08.02.01 *Acceptance/Rejection*

If the average compaction of a placed hot mix asphalt course does not meet the requirements of clause TS 310.07.01.11.01, herein, or if the compaction is variable, the Contractor will be warned, and shall take immediate corrective action. The adequacy of any corrective action shall be checked by the Contract Administrator (calibrated nuclear density gauge testing). This may result in delays to the asphalt paving until the necessary corrective compaction measures are proven.

Note: Contractors should note that nuclear density gauge testing compaction process control is of advantage to setting roller patterns and the number of roller passes required to achieve the required compaction.

TS 310.09 MEASUREMENT FOR PAYMENT

TS 310.09.01 Hot Mix HL-1, 2, 3, 3 HS, 3 Fine, 3 Mod, 8, 8 (HS)
Recycled Hot Mix HL-8 (up to 20% RAP), HL-8 (HS, 10% RAP)
Dense Friction Course Mix (DFC)
Stone Mastic Asphalt (SMA)
Large Stone Binder Course Mix (LSBC)
Specialty 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 (m^2).

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 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 97 per cent of the hot mix bulk 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 6: Density factors for DFC, HL-1 and SMA [1, 2]

Mix type	Coarse aggregate	Fine aggregate	Density factor
DFC [3]	trap rock	trap rock	1.00
	dolomitic sandstone	dolomitic sandstone	1.10
	meta-arkose	meta-arkose	1.09
	diabase	diabase	1.03
	gneiss	gneiss	1.10
HL-1 [4]	trap rock	100 % crushed find aggregate asphalt sand	1.00
	dolomitic sandstone	100 % crushed find aggregate asphalt sand	1.06
	meta-arkose	100 % crushed find aggregate asphalt sand	1.06
	diabase	100 % crushed find aggregate asphalt sand	1.02
	andesite	100 % crushed find aggregate asphalt sand	1.05
	gneiss	100 % crushed find aggregate asphalt sand	1.04
SMA [5]	trap rock	trap rock	1.00
	dolomitic sandstone	dolomitic sandstone	1.10
	meta-arkose	meta-arkose	1.09
	diabase	diabase	1.03

Note 1: The density factor for HL-2, HL-3 (HS), HL-3, HL Fine, HL-3 Mod, HL-8 (HS), and HL-8 and LSBC is 1.00.

Note 2: Other approved combinations of DFC, HL-1 or SMA aggregates, if any, shall have density factors applied proportional to those given in Table 6.

Note 3: The density factor for DFC is based on a combination of trap rock coarse aggregate and trap rock fine aggregate.

Note 4: The density factor for HL-1 is based on a combination of trap rock coarse aggregate, 100% crushed fine aggregate asphalt sand.

Note 5: 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 DFC, HL-1 and SMA are given in Table 6. The density factor for all other hot mix types is 1.00.

TS 310.10 BASIS OF PAYMENT

TS 310.10.01 Hot Mix HL-1, 2, 3, 3 HS, 3 Fine, 3 Mod, 8, 8 (HS)
Recycled Hot Mix HL-8 (up to 20% RAP), HL-8 (HS, 10% RAP)
Dense Friction Course Mix (DFC)
Stone Mastic Asphalt (SMA)
Large Stone Binder Course Mix (LSBC)
Specialty Mixes

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 310.10.01.03 *PGAC and PGAC-E*

A measurement of the PGAC or PGAC-E used shall not be made. The cost of asphalt cement shall be included in the respective hot mix type unit price in the Pricing Form.

In the event that the results of extraction tests carried out by the City indicate that the average PGAC or PGAC-E content for a hot mix type lies below the acceptable tolerance shown in subsection 1150.08.02 of TS 1150, and the Contract Administrator elects to allow this hot mix asphalt to remain in the Work, the payment quantity for this hot mix type will be reduced 10 per cent for each 0.1 per cent that the average PGAC or PGAC-E content lies below the tolerance.