CONSTRUCTION SPECIFICATION FOR
HOT IN-PLACE RECYCLING AND HOT IN-PLACE
RECYCLING WITH INTEGRAL OVERLAY

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332.01 SCOPE

This specification covers the requirements for the preparation of the existing pavement surface; heating and scarifying the existing asphaltic concrete; adding and mixing in one or more of fine aggregate, rejuvenating agent and beneficiating hot mix asphalt and redistribution and compaction of the mixture in a single operation.

An asphaltic concrete overlay is placed as part of the integral overlay process.

332.02 REFERENCES

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

**Ontario Provincial Standard Specifications, General:**

OPSS 102 Weighing of Materials
OPSS 180 Management and Disposal of Excess Material
DEFINITIONS

For the purpose of this specification, the following definitions apply:

**Beneficiating Hot Mix:** means an asphaltic concrete designed to assist the final hot in-place recycled mix to conform to specified requirements.

**Heated Scarified Material:** is the material produced during the heating and scarifying of the existing asphaltic concrete.

**Hot In-Place Recycled (HIR) Mix:** means the mixture of heated scarified material containing one or more of the following components: fine aggregate, rejuvenating agent and beneficiating hot mix asphalt.

**Integral Overlay:** means a conventional asphaltic concrete placed concurrently, prior to compaction, over the reprofiled HIR mix.

**Rejuvenating Agent:** means a product designed to be added to the heated scarified material, for the purpose of increasing the penetration of the asphalt cement in the HIR mix.

SUBMISSION AND DESIGN REQUIREMENTS

The mix design for the HIR mix shall be submitted in writing for review by the Contract Administrator a minimum of 10 working days prior to the start of HIR operations. The submission shall include:

a. the amount, name, manufacturer and supplier of the rejuvenating agent, fine aggregate and beneficiating hot mix asphalt to be used;
b. copy of all calculations which were completed to determine the amount of rejuvenating agent and beneficiating hot mix, or both as required, to be used;

c. the air voids laboratory test results and calculations; and

d. a graph of temperature-kinematic viscosity relationship for the combined rejuvenating agent and the recovered asphalt cement present in the existing pavement.

332.05 MATERIALS

Materials for HIR mix shall meet the requirements of OPSS 313 except that the Asphaltic Concrete subsection shall not apply.

332.05.01 Recovered Penetration and Air Voids Requirements

The HIR mix produced shall be according to the recovered penetration requirements of OPSS 1149.

The percent air voids, by volume, of the HIR mix produced shall be within the range of 2.5 percent to 5.5 percent.

332.05.02 Fine Aggregates

The fine aggregates shall be according to the physical requirements for HL4 Fine Aggregates in OPSS 1003.

332.05.03 Beneficiating Hot Mix Asphalt

The asphalt cement contained in the beneficiating hot mix asphalt added to the heated scarified material shall be according to OPSS 1101.

The delivery, handling, and storage of asphalt cement shall be according to OPSS 1149.

The aggregate contained in the beneficiating hot mix asphalt shall be according to the physical requirements for HL4 Aggregates in OPSS 1003. Maximum aggregate size contained in the beneficiating hot mix asphalt shall not exceed the maximum aggregate size of a HL4 mix.

Reclaimed asphalt pavement shall not be used in the composition of the beneficiating hot mix asphalt.

The handling, feeding and drying of aggregates for beneficiating hot mix asphalt shall be according to OPSS 1149.

The beneficiating hot mix asphalt shall be produced using equipment according to OPSS 1149. Preparation of the beneficiating hot mix asphalt shall be according to OPSS 1149.

332.05.04 Integral Overlay

The integral overlay mix shall be according to the hot mix type and layer thickness specified in the contract.

332.06 EQUIPMENT

332.06.01 Spreading Equipment

Requirements for mechanical pavers specified in the subsection titled Spreading Equipment of OPSS 313 shall apply.
Fine aggregates added to the hot in-place recycled material shall be added using equipment which measures the quantity added by means of a metering system.

332.06.02 Heating Unit

The heating units shall apply heat in a uniform manner to the surface of the existing pavement to be scarified. Direct flame shall not contact the asphaltic concrete pavement.

The heaters shall be spaced and operated such that sufficient pavement heat penetration to the specified recycled depth is obtained to achieve the desired HIR mix temperatures. The pavement surface shall not be damaged as a result of overheating the asphalt cement binder and aggregates.

The entire heater assembly shall be designed to be raised or lowered by a single control. The heater assembly shall be adjustable in width from 3.0 to 4.1 m.

332.06.03 Recycling Machine

The recycling machine shall be a self-contained machine specifically designed for HIR asphaltic concrete pavements. Heaters used as part of the recycling machine shall conform to the specified requirements for heating units. The supply of hot mix asphalt to the recycling machine for an integral overlay and any beneficiating hot mix asphalt shall be accomplished without allowing traffic on the uncompacted mat.

The scarifying unit shall be capable of uniformly scarifying the preheated asphaltic concrete to the depth specified and be adjustable in width from 3.0 to 4.1 m.

The scarifier shall have an independent mechanical or hydraulic quick lift device for the purpose of clearing utility maintenance holes and other obstructions in the pavement surface.

The rejuvenating agent storage unit shall be thermostatically controlled and be capable of maintaining the rejuvenating agent at the temperature recommended by the manufacturer.

The spraying unit shall be a system that supplies a uniform spray of rejuvenating agent across the full width of the heated scarified material. The spray bar shall be equipped with drip free nozzles. The system shall incorporate a meter calibrated in ml/m². Delivery of the rejuvenating agent to the spray system shall be by a variable positive displacement pump geared to the speed of the recycling machine or by other means that ensures uniform application regardless of machine speed. The system shall be capable of dispensing the rejuvenating agent by specified volume per m² within a tolerance of ± 5%. The spray shall be protected from the influence of wind by a suitable enclosure.

The blending unit shall be a rotary blending system capable of thoroughly mixing the heater scarified material, fine aggregate, rejuvenating agent and beneficiating hot mix asphalt as required, to obtain a homogeneous mixture.

When an integral overlay process is selected, the HIR mix shall be uniformly distributed to the required profile and crossfall by the use of reversible augers and a strike off. The strike off shall be equipped with an adjustable crown control and each end of the strike off shall have thickness adjusting screws for providing the required profile and crossfall. The strike off shall be adjustable in width from 3.0 to 4.1 m.

The final placement of material by the recycling machine shall be uniformly distributed to the required profile and crossfall by the use of reversible augers and a heated vibratory screed. The screed shall be equipped with an adjustable crown control and each end of the screed shall have thickness adjusting screws for providing the required profile and crossfall. For placement of the integral overlay material, the screed may be controlled to the longitudinal grade by a 12 m ski or floating beam. The screed shall be adjustable in width from 3.0 to 4.1 m.
CONSTRUCTION

332.07.01 Hot In-Place Recycled Mix
Hot In-Place Recycled Mix with Integral Overlay

The work shall meet the requirements of OPSS 313 except that the following subsections shall not apply to the Hot In-Place Recycled Mix when placed alone or with an integral overlay:

- Application of Tack Coat,
- the Method clause in the Sampling of Mix for Acceptance Testing,
- Placing Mixes,
- Use of Paving Equipment,
- Widenings and Irregular Sections, and
- Option to Use Reclaimed Asphalt Pavement in HL4 and HL8 Binder Course Mix

When the Contractor chooses to place the optional overlay, the overlay work shall meet all the requirements of OPSS 313.

332.07.02 Operational Constraints

The hot in-place recycling process shall be carried out between May 15 and October 15 inclusive.

332.07.03 Preparation of Pavement Surface

Materials such as cold mix patching materials, crack sealant and spray patch material shall be removed and disposed of as specified, prior to the heating and scarifying process.

332.07.04 Sampling

Samples shall be obtained by the Contractor using plate samples, or from the screed auger chamber or by coring.

332.07.04.01 Frequency of Sampling

The sampling frequency for the 10 kg samples shall be two random samples per lot. The Contractor shall deliver the samples to the designated CCIL testing laboratory. The laboratory shall determine the penetration of asphalt cement recovered from the mix by using LS-284 and the air void content using LS-265. When either the process of the HIR mix production or the source of material is changed or terminated, the lot shall be considered to be terminated and the Contract Administrator shall be notified in writing. Minor mix adjustments shall not be considered a change in the process.

332.07.05 Placing Mixes - General

The heating and recycling machines shall heat and scarify the asphaltic concrete pavement across the complete lane width to a depth, on average, not less than the specified scarification depth.

Each successive pass of the HIR machine shall overlap the previously scarified adjacent surface by a minimum of 100 mm with the heaters overlapping an additional 100 mm beyond the section that is scarified.

When testing indicates that the required average depth of heating and scarifying has not been attained, the process shall be immediately corrected. Following the scarifying process, the rejuvenating agent or beneficiating hot mix asphalt or both shall be added in the amount specified in the mix design. The fine aggregate, rejuvenating agent and beneficiating hot mix asphalt shall be mixed with the heater scarified material and the resultant mixture shall be homogeneous.
Areas which are not accessible to the heating and scarifying equipment shall have the asphaltic concrete removed to a depth which is equal to the hot recycled depth. These areas shall be paved with the specified integral overlay hot mix asphalt. Where an integral overlay is not a requirement, a hot mix asphalt type shall be specified. The surface of each layer placed and compacted shall be level with the adjacent pavement. The paving of such areas shall be completed prior to the placing of a subsequent course on the HIR mix and as a separate operation from any other paving.

The HIR mix shall be at a minimum temperature of 110°C immediately after screeding and prior to initial rolling.

### 332.07.05.01 Placing HIR Mix Without Integral Overlay

The HIR mix shall be placed using the heated vibratory screed.

### 332.07.05.02 Alternate Overlay

The Contractor has the option of placing a 40 mm thick overlay as a separate surface course in lieu of the integral overlay. This alternate overlay shall consist of the same type of hot mix specified for the integral overlay.

When the equipment is unable to place an integral overlay, or mix design results indicate a beneficiating hot mix asphalt is required and the equipment is unable to add the beneficiating hot mix asphalt in addition to placing the integral overlay, a 40 mm overlay shall be placed as a separate course in lieu of the integral overlay specified.

Additional granular material shall be placed and compacted as required to accommodate the new hot mix asphalt surface.

### 332.07.06 Requirements of Longitudinal Joints

Longitudinal and transverse joints for HIR mix and HIR mix with integral overlay shall meet the requirements of OPSS 313 except that the following clauses do not apply:

- Point b, Painting of Joints,
- the first and second paragraphs in Point c, Requirements for Longitudinal Joints, and
- Point d, Requirements for Transverse Joints.

All longitudinal joints at intersecting roads shall be butt joints.

Where the surface of the integral overlay extends up to 25 mm above adjacent gutter, ramping will be allowed at the gutter. For overlays over 25 mm, the existing pavement shall be milled to provide an exposed gutter face equivalent to the compacted overlay thickness. The pavement removal shall be feathered out to zero thickness along a line a minimum of 1.5 m from and parallel to the exposed face of the gutter to provide for the depth of the overlay material over the area of removal.

### 332.07.07 Compaction

Compaction for HIR mix and HIR mix with integral overlay shall be according to OPSS 313.

### 332.07.07.01 Hot In-Place Recycled Mix with Overlay

The HIR mix and the integral overlay mix shall be compacted as a single operation. The acceptance of the compaction for both mixes will be completed with both mixes being considered as a single layer.
When the Contractor chooses the option to place a 40 mm hot mix overlay as a separate surface course in lieu of the integral overlay, the HIR mix and the overlay mix shall be compacted separately. The acceptance of the compaction for both mixes will be considered as two separate layers.

332.07.02 Rolling

Rolling shall be according to OPSS 313.

332.07.08 Determination of Hot In-Place Recycling Scarification Depth

Random tests shall be carried out at midlane, in the longitudinal direction to determine the depth of scarification:

a. Four tests will be required for hot in-place recycling and hot in-place recycling with integral overlay for the first 4000 m² after each day's start of operation of the hot in-place recycling equipment.

b. Two tests shall be done for each subsequent 4000 m² or portion thereof.

The Contract Administrator will determine the location of each test.

Holes in the hot mix mat which are made during the removal of material for testing shall be filled with appropriate hot mix and mechanically compacted.

Testing for the depth of scarification shall be the responsibility of the Contractor.

332.07.09 Testing to Determine Scarification Depth

Testing to determine scarification depth shall be according to the following:

a. Equipment:

   1. One circular metal ring with a minimum inside area of 0.1 m² and a minimum depth of 100 mm.
   2. One portable balance accurate to 0.1% of the test load and of sufficient capacity to measure the mass of the test sample in one operation.
   3. One 5 kg test mass for scale calibration.
   4. One metal spoon.
   5. One smooth metal container of sufficient capacity to hold the test sample.

b. Procedure:

   1. Set up and level the balance in a firm location protected from the wind.
   2. Check the tolerance of the balance with the 5 kg test mass.
   3. Obtain the tare mass of the metal container.
   4. Prior to rolling of the HIR mix press the circular metal ring manually into the hot in-place recycled mix and integral overlay mix.
   5. Carefully spoon out all the material inside the ring down to the hard unscarified pavement and place the removed material in the metal container.
6. Determine the mass of the removed material.

7. Clean the metal container, spoon and ring.

c. Calculation:

1. The scarification depth shall be determined with the following formula:

\[
\text{Actual depth of scarification in mm} = \frac{1000 \times ((M/A) - V - B - C)}{E}
\]

- \( M \) = mass of material removed from circular ring - kg.
- \( A \) = area of test ring - \( m^2 \).
- \( V \) = mass per \( m^2 \) of integral overlay mix for the thickness specified - kg/m\(^2\). When using actual distribution rate procedure to calculate overlay thickness, a minimum of 60 tonnes shall be used.
- \( E \) = mass per \( m^3 \) of existing asphaltic concrete pavement - kg/m\(^3\).
- \( B \) = mass per \( m^2 \) of beneficiating hot mix asphalt added to the HIR mix - kg/m\(^2\).
- \( C \) = mass per \( m^2 \) of fine aggregates added to the HIR mix - kg/m\(^2\). Mass used is to be for the material in a loose dry state.

2. Test results shall be determined immediately in the field and reported daily, in writing on a Determination of Scarification Depth form to the Contract Administrator and shall include the calculated depth of scarification, contract number, date, and station location and offset from the centreline of the highway for the testing locations.

332.07.10 Management and Disposal of Excess Material

Management and disposal of excess material shall be according to OPSS 180.

332.08 QUALITY ASSURANCE

Quality assurance for HIR mix shall meet the requirements of OPSS 313 except that the following do not apply:

- the Acceptance of Asphalt Cement Content and Aggregate Gradation subsection,
- the first paragraph of the Lot Size clause, and
- the second paragraph of the Requirements, Conformance and Repair clause.

332.08.01 Acceptance of Scarification Depth

The Contract Administrator will determine if the hot in-place recycling scarification depth is acceptable based on determination of hot in-place recycling scarification depth tests. Hot in-place recycling scarification depths will be accepted when the moving average of all groups of four consecutive determination of scarification depth tests are equal to or greater than the depth specified.
332.08.02 Lot Size

The lot size for acceptance of hot in-place recycled mixes shall be based on 2000 m$^2$ lots for the first two lots with the remaining lots based on 4000 m$^2$ lots. Lot size may be reduced at the discretion of the Contract Administrator when it is necessary to reduce the lot size because of the sequence of the paving operations.

332.08.03 Acceptance of Air Voids

When the Contract Administrator performs air void content compliance testing, the testing shall be done in accordance with MTO LS-265 method for briquettes prepared by MTO LS-261 procedures using The Asphalt Institute Manual Series No. 2 (MS-2) Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types, using 75 blows per side of test specimen with a manual compaction hammer, or a mechanical equivalent.

A moving average of four test results shall be maintained provided that the average remains in the range of 2.5 percent to 5.5 percent. All averages shall be reported to one decimal place utilizing the rounding off procedure given in LS-100.

If the moving average of four air void test results is less than or equal to 2.5 percent or greater than or equal to 5.5 percent the Contractor shall take corrective action to ensure that the air voids return to the acceptable range of 2.5 percent to 5.5 percent.

When the moving average of four air void test results is less than 2.0 percent, or greater than 5.5 percent, the next two consecutive test results will be included to determine the average of six results. If the moving average of six test results is less than 2.0 percent or greater than 5.5 percent, the HIR mix is rejectable.

332.08.04 Requirements, Conformance and Repair

When the recovered penetration of a lot does not conform to the requirements specified and the test result is less than 35 penetration units or more than 95 penetration units the HIR mix in the lot will be rejected. Where the test result is between 35 to 50 units or 80 to 95 units, the HIR mix will be considered borderline.

The criteria for air void content acceptance is given in subsection 332.08.03.

For deficiencies in recovered penetration and air voids, the repair options for all layers placed shall include either:

a. processing with hot in-place recycling,
   or
b. partial depth removal and replacement to a recycled depth equal to the base of the rejected mat.

The surface of the repaired area shall consist of the specified surface hot mix.

332.09 MEASUREMENT FOR PAYMENT

332.09.01 Actual Measurement

332.09.01.01 Hot In-Place Recycled Mix

Hot In-Place Recycled Mix with Integral Overlay

Measurement of the existing pavement area to be hot in-place recycled will be made in square metres. There will be no additional payment made for the removal of asphaltic concrete pavement or for hot mix which is required to replace the material removed in areas which are not accessible to the heating and scarifying equipment. These areas will be measured as hot in-place recycled pavement.
There will be no additional payment under this item for hot mix required to retrofit partially paved shoulders or for pavement widening. Payment will be made under the hot mix item for the integral overlay.

332.09.01.02 Hot Mix for Integral Overlay

Measurement of the hot mix overlay placed over the HIR mix to form the integral overlay will be made under the appropriate hot mix item.

332.09.01.02.01 Alternate Overlay

The hot mix overlay placed as a separate surface course in lieu of the integral overlay shall be weighed for acceptance purposes according to OPSS 102.

The payment quantity $Pq$ will be in tonnes according to the formula:

$$Pq = SA - TM$$

$SA$ = Actual weighed quantity incorporated into the separate surface course in tonnes.

$TM$ = theoretical difference in weight in tonnes between the 40 mm separate surface course and the integral overlay depth specified elsewhere in the contract in tonnes.

332.09.02 Plan Quantity Payment

332.09.02.01 Hot In-Place Recycled Mix
Hot In-Place Recycled Mix with Integral Overlay

When measurement is by Plan Quantity, such measurement will be based on the units shown in the clause under Actual Measurement.

332.10 BASIS OF PAYMENT

332.10.01 Hot In-Place Recycled Mix - Item
Hot In-Place Recycled Mix with Integral Overlay - Item

Payment at the contract price for the above tender item shall be full compensation for all labour, equipment, and material to do the work.

No additional payment will be made for the following labour, equipment and materials required:

a. to remove, dispose and replace pavement not accessible to the heating and scarifying equipment.

b. to place and compact the hot mix type specified for the integral overlay.

c. for the Contractor to supply, place and compact the additional alternate overlay hot mix and granular shoulder material in lieu of an integral overlay.

Payment for the hot mix overlay placed as a separate surface course in lieu of the integral overlay will be made at the contract price for the hot mix item designated for the integral overlay.

For purposes of determining lot sizes and the number of lots for acceptance, the quantity of the overlay to be placed in lieu of the integral overlay will be used. For purposes of calculating payment adjustments under end result specifications, the lot size and the contract price for the hot mix item designated for the integral overlay will be used.