CONSTRUCTION SPECIFICATION FOR
COLD RECYCLED MIX

TABLE OF CONTENTS

334.01 SCOPE
334.02 REFERENCES
334.03 DEFINITIONS
334.04 DESIGN AND SUBMISSION REQUIREMENTS
334.05 MATERIALS
334.06 EQUIPMENT
334.07 CONSTRUCTION
334.08 QUALITY ASSURANCE
334.09 MEASUREMENT FOR PAYMENT
334.10 BASIS OF PAYMENT

APPENDICES

D 334-A Commentary

334.01 SCOPE

This specification covers the requirements for a cold mix paving process incorporating reclaimed asphalt pavement (RAP) from stockpiles. The process includes production and processing of RAP, design and testing, placement, and compaction.

334.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.
Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner’s use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

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

**Ontario Provincial Standard Specifications, Construction**

- OPSS 310 Hot Mix Asphalt
- OPSS 313 Hot Mix Asphalt - End Result

**Ontario Provincial Standard Specifications, Material**

- OPSS 1102 Liquid Asphalt
- OPSS 1103 Emulsified Asphalt

**Ministry of Transportation Publications**

- SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats
- Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing

**MTO Laboratory Testing Manual:**

- LS-291 Quantitative Extraction of Asphalt Cement and Mechanical Analysis of Extracted Aggregate from Bituminous Paving Mixtures - Ontario Procedure
- LS-300 Preparation of Marshall Specimens for Cold In-Place Recycled Mixture
- LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

**Ontario Traffic Manual (OTM):**

- Book 7 - Temporary Conditions
334.03 DEFINITIONS

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

CCIL means the Canadian Council of Independent Laboratories

Cold Recycled Mix (CRM) means a mix of processed RAP and asphalt modifier produced through a cold mixing process.

Foreign matter means anything other than hot mix aggregate or granular aggregate.

Hot Mix Asphalt (HMA) means hot mixed, hot laid asphaltic concrete. The terms are used interchangeably. HMA may include recycled or specialty mixes.

Reclaimed Asphalt Pavement (RAP) means the processed HMA material that is recovered by partial or full-depth removal.

334.04 DESIGN AND SUBMISSION REQUIREMENTS

334.04.01 Design Requirements

Prior to commencing the work, for mix design purposes, the Contractor shall obtain RAP samples that are representative of the material to be processed. These samples shall be used to establish the design rate of the asphalt modifier as a percentage by mass of the RAP. The design rate of the asphalt modifier shall be a minimum of 1.2%.

The mix design shall be completed by a laboratory with either CCIL Type A certification or equivalent. Each mix design shall include the following:

a) Information on the type, manufacturer, and supplier of the asphalt modifier.

b) A copy of the mix design and all calculations performed to determine the mix design.

c) All calculations performed to determine the design rate of asphalt modifier.

d) Maximum field rate adjustment allowed to the design rate without adverse affects to mix properties.

334.04.02 Submission Requirements

The mix design shall be submitted to the Contract Administrator a minimum of 7 Days prior to the start of CRM operations.

A new mix design shall be submitted when the asphalt modifier design rate is adjusted by greater than 0.5%. A new mix design shall be submitted if the composition of the existing RAP changes significantly.

334.05 MATERIALS

334.05.01 Reclaimed Asphalt Pavement

The processing operation shall ensure that 100% of the RAP aggregate passes the 26.5 mm sieve. The amount of RAP aggregate passing the 75 µm sieve shall not exceed 15% by mass. Adequate measures shall be taken to manage the RAP source to ensure consistency and prevent contamination.
RAP containing steel slag or asbestos is not permitted. RAP that has become mixed with foreign matter of any description shall not be used.

### 334.05.02 Asphalt Modifier

The asphalt modifier shall be emulsified asphalt or liquid asphalt as specified in the Contract Documents.

Emulsified asphalt shall meet the requirements of OPSS 1103 and be either a mixing grade polymer modified high float emulsified asphalt or a mixing grade high float emulsified asphalt, as specified in the Contract Documents.

Liquid asphalt shall be according to OPSS 1102.

### 334.06 EQUIPMENT

#### 334.06.01 Production and Processing Equipment

Crushing or milling equipment and screening equipment shall be used to generate and process the RAP to the size specified in the mix design. Material shall be handled in such a way as to prevent recompaction of the material before mixing takes place.

#### 334.06.02 Mixing Equipment

The mixing unit shall be capable of producing a uniform thoroughly blended CRM consisting of RAP and asphalt modifier. The RAP feed system to the mixing unit shall be equipped with a means of determining the mass of material being deposited into the mixing unit prior to the addition of the asphalt modifier. The mixing unit shall be capable of continuously maintaining the amount of asphalt modifier added within ± 0.2% by weight of the RAP. All measuring devices shall be calibrated according to the manufacturer's specifications at the start of the Contract and whenever deemed necessary by the Contract Administrator.

The asphalt modifier supply system shall identify and display flow and delivery information.

#### 334.06.03 Placing Equipment

Placing of the CRM shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

#### 334.06.04 Compaction Equipment

The Contractor shall select the appropriate compaction equipment to achieve the required compaction.

#### 334.06.05 Drying Unit

The drying unit shall be specifically designed to provide radiant heat to the CRM mat. Open flame heating shall not be used. The entire heater assembly shall be capable of readily adjusting the intensity of heat on the pavement surface.

#### 334.06.06 Straight Edge

A 3 m commercially made metal straight edge is required. The straight edge shall have a level recessed in its upper surface, parallel to the lower edge.

#### 334.06.07 Pilot Vehicle
The pilot vehicle shall be according to the requirements of the OTM, Book 7.

334.07 CONSTRUCTION

334.07.01 Operational Constraints

The placing of CRM shall not be carried out when the ambient temperature is less than 10 °C or when the overnight low is forecast to be less than 2 °C. After September 1st, written approval must be obtained from the Contract Administrator prior to CRM paving.

The work shall be carried out when the roadway is clean and free of standing water. CRM shall not proceed during periods of rain.

The wearing surface shall not be placed on the CRM mat until the following requirements have been met:

a) The CRM mix has been allowed to cure for a minimum of 14 Days. The curing period may be shortened with the approval of the Contract Administrator.

b) The average in situ moisture content of the CRM is 2% or less with no test value greater than 3% immediately prior to placing the wearing surface.

c) The specified density has been achieved.

d) All defective areas in the CRM mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CRM mat, provided the CRM mix meets the requirements of this specification.

All traffic, including construction traffic, shall be kept off the freshly placed CRM mat until it is able to carry traffic without damage. The Contractor shall be responsible for repair of the damaged CRM mat.

334.07.02 Mixing

The asphalt modifier shall be added at the design rate. The rate of addition of asphalt modifier may be adjusted as required to within 0.5% of the design rate or to the maximum field rate adjustment of the design rate allowed according to the mix design, whichever is less, to produce a uniformly coated CRM mix that can be compacted to the required density.

334.07.03 Compaction

The CRM shall be compacted to a minimum of 96% of the laboratory bulk relative density as determined by the submitted mix design, according to LS-300.

CRM that cannot be compacted to the required density shall be removed and replaced according to Table 1.

334.07.04 Surface Appearance

The compacted CRM surface shall be smooth and conform to the crossfall and grade specified in the Contract Documents. The surface of the CRM mat shall be of uniform texture and free of segregation, longitudinal streaks, fat spots, oil spills, roller marks, and other defects.

334.07.05 Drying
Prior to the placement of the wearing surface, the Contractor may elect to use a drying unit. Overheating or burning of the CRM shall not be allowed.

334.07.06  Sampling

334.07.06.01  General

The Contract Administrator may apply security seals to the samples taken for Quality Assurance (QA) testing.

All samples, including those handled by a commercial carrier, shall be accompanied by a sample data sheet and any additional documents as specified elsewhere in the Contract Documents. When not specified or not included on the sample data sheet, samples shall be delivered with a transmittal form identifying the following information:

a) Contract Number.

b) Name of Contractor, name of contact person and telephone numbers.

c) Name of Contract Administrator, and telephone numbers.

d) Quantity and type of sample. When a sample consists of more than one item, each item shall be individually identified.

e) Date sampled.

f) Date shipped.

g) Sample, lot and sublot number.

h) Sample location.

The Contractor may carry out quality control sampling and testing of the CRM mat.

Holes resulting from the removal of samples shall be repaired according to the sampling provisions of OPSS 310 or OPSS 313, as appropriate to the Contract, using surface course HMA or other material approved by the Contract Administrator.

334.07.06.02  Compaction

After initial compaction, a minimum of three samples of the compacted CRM shall be obtained by the Contractor, at random locations as determined by the Contract Administrator, for each full day or partial day of production. These samples shall be used for compaction testing.

Samples shall be removed intact from the pavement in sufficient quantities to carry out testing according to the MTO Laboratory Testing Manual.

334.07.06.03  Moisture Content

At least 4 Business Days prior to the planned overlay of the CRM mat, the Contractor shall obtain 2 slab samples of the CRM mix for each sublot taken at random locations, as directed by the Contract Administrator.
The moisture content shall be determined in accordance with LS-291. The Contractor shall test one of the duplicate samples and the other shall be delivered to the testing laboratory designated in the Contract Documents.

Each sample shall be dry cut 150 x 150 mm and removed intact from the pavement. It shall be packaged to protect sample integrity, appropriately labelled, sealed in waterproof containers, and delivered by the Contractor in good condition to the designated testing laboratory within 24 hours of sampling.

If a sample condition is found to be unsuitable for testing by the laboratory, the Contractor shall be notified immediately by the Contract Administrator to resample that location.

### 334.07.06.04 Asphalt Modifier

Samples of the asphalt modifier used in the mix, shall be obtained, labelled, properly identified, and delivered within 5 Business Days of sampling to the testing laboratory designated in the Contract Documents. Each sample of material shall be a minimum of 2 full four-litre containers.

Samples shall be taken at the job site from each tanker load of material. Each sample shall be taken after a minimum of 4,000 kg has been drawn from the tanker, from a sampling spigot on the transfer line, if available, or from the end of the transfer line.

The sample containers supplied by the Contractor shall be new triple tight epoxy lined pails or suitable leak-proof plastic containers. The sample labels shall be obtained from the Contract Administrator.

### 334.07.07 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the CRM mat is able to carry traffic without damage.

### 334.07.08 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

### 334.08 QUALITY ASSURANCE

#### 334.08.01 General

The Contract Administrator shall reject all visually defective material, mix, or work according to Table 1. Such defective material, mixture, and work shall not be incorporated into the finished work.

QA testing shall be carried out at a laboratory currently certified by CCIL with Type A or Type B certification or equivalent. Samples shall be used to determine compliance for moisture content and compaction. Acceptance criteria shall be based on the lot mean computed from QA test results for each sublot within the lot.

If a tested sample fails to meet the Contract requirements, the Contractor shall be notified of the failure by the Contract Administrator within 24 hours of the Contract Administrator receiving the information.
334.08.02 Lot Size

A lot shall consist of a single day’s production of CRM processed to a given mix design. Each lot shall be divided into a minimum of 3 equal sublots of 5,000 m² or smaller.

334.08.03 Surface Tolerance

After compaction, the surface of the CRM mat shall be free from deviations exceeding 6 mm, as measured in any direction with a 3 m straight edge.

334.08.04 Acceptance Criteria for Moisture Content

The moisture content shall be determined according to LS-291. The mean moisture content for each lot shall be less than 2.0% with no sublot moisture content exceeding 3.0%.

334.08.05 Acceptance Criteria for Compaction

The compaction of the CRM mix shall be determined according to LS-306. Each lot of CRM mix shall be compacted to a minimum mean of 96.0% of the target density established for the mix with no sublot result falling below 95.0%.

334.08.06 Asphalt Modifier

The supplied emulsified asphalt samples shall be according to OPSS 1103 for the particular type and grade, when tested according to the test methods specified.

The supplied liquid asphalt samples shall meet the requirements of OPSS 1102 for the particular type and grade, when tested according to the test methods specified.

Failure of the sample to conform to any of the material requirements shall be cause for rejection of the material. The CRM that has incorporated asphalt modifier represented by the failed test result shall be unacceptable and remedial measures up to and including removal and replacement of the deficient mix shall be negotiated with the Contract Administrator.

334.08.07 Repair of Unacceptable Cold Recycled Mix Mat

The CRM mat that is unacceptable shall be repaired or removed and replaced as specified in Table 1. Repairs shall be for the full width of recycling to the depth specified in Table 1. Removal shall be for the full depth and lane width of recycling. Reprocessing may be considered as a repair method, upon submission of a proposal by the Contractor and approval by the Contract Administrator.

334.09 MEASUREMENT FOR PAYMENT

334.09.01 Actual Measurement

334.09.01.01 Cold Recycled Mix

Measurement of the CRM placed shall be by area in square metres.

334.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.
334.10 BASIS OF PAYMENT

334.10.01 Cold Recycled Mix - Item

Payment at the Contract price for the above items shall be full compensation for all labour, Equipment, and Material to do the work.

Asphalt modifier is included in the cold recycled mix item.

Samples found to be unsuitable for testing upon delivery to the laboratory shall be resampled at no cost to the Owner.

Repair to or removal and replacement of unacceptable CRM mat shall be carried out at no cost to the Owner.

HMA required to replace unacceptable CRM material shall be at no cost to the Owner.
### TABLE 1
Unacceptable CRM Mix and Required Repairs

<table>
<thead>
<tr>
<th>Deficiency Type</th>
<th>Severity</th>
<th>Required Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ravelling/Coarse Aggregate Loss (Note 1)</td>
<td>Very Slight to Slight</td>
<td>No action required.</td>
</tr>
<tr>
<td></td>
<td>Moderate to Severe</td>
<td>Mill 50 mm and replace with same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.</td>
</tr>
<tr>
<td></td>
<td>Very Severe</td>
<td>Remove all CRM material and replace with same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.</td>
</tr>
<tr>
<td>Segregation (Note 2)</td>
<td>Slight to Medium</td>
<td>No action required.</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td>Mill 50 mm and replace with same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.</td>
</tr>
<tr>
<td>Moisture content could not be achieved as per the Acceptance Criteria for Moisture Content subsection.</td>
<td>N/A</td>
<td>Remove all CRM material in the sublot represented by the test and replace with CRM or the same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.</td>
</tr>
<tr>
<td>Compaction could not be achieved as per the Acceptance Criteria for Compaction subsection.</td>
<td>N/A</td>
<td>Remove all CRM material in the sublot represented by the test and replace with CRM or the same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.</td>
</tr>
</tbody>
</table>

Notes:

1. Deficiency and severity definitions according to SP-027.
2. Deficiency and severity definitions according to Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing.
3. The HMA shall be placed in compacted lift thicknesses between 40 and 75 mm.
Appendix 334-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner’s design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Type of asphalt modifier (i.e., emulsified asphalt or liquid asphalt modifier). (334.05.02)
- Type of wearing surface. (334.07.01)
- Crossfall and grade. (334.07.04)
- Location of testing laboratory. (337.07.06.01, 334.07.06.02, 334.07.06.03, 334.07.06.04)
- Replacement HMA to be used. (334.08.07)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- The emulsified asphalt as either a mixing grade polymer modified high float emulsified asphalt or a mixing grade high float emulsified asphalt. (334.05.02)
- Traffic convoy requirements. (334.07.07)

CRM can be a cost-effective paving material for structural improvement of low volume roads.

CRM is susceptible to moisture intrusion and ravelling, and must be sealed with a wearing surface. Typically, cold recycled mix is overlain with a surface treatment or single lift hot mix overlay. For higher traffic volume application, multiple lifts of hot mix may be considered.

Designer should be aware of when setting up quantities, due to the variability of RAP, field adjustment of the quantity of asphalt modifier may be required.

Currently, there is no standardized mix design methodology for CRM.

Designer should address the issue of RAP ownership and quality of RAP during the preparation of contract specifications. Identify who owns the RAP and who is responsible for RAP quality.

CRM contracts should be tendered to allow for placement in warm summer months to achieve proper curing of the CRM mat.

A single contract incorporating placement of CRM and wearing surface is recommended.

Since payment for the CRM is by the square metre, the designer should ensure that grade preparation is part of the CRM contract.

A tack coat is recommended prior to surfacing CRM with HMA.

When specifying liquid asphalts, the designer should consider the environmental aspects of the product.
Appendix 334-A

Contract scheduling should allow for CRM paving and follow-up wearing surface placement to be completed within the time and temperature operational constraints.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here