CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLED MIX

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333.01 SCOPE

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement; sizing; adding corrective aggregate or active filler or both, if required; adding and mixing of emulsified asphalt; and spreading and compacting the cold in-place recycled (CIR) mix.

333.01.01 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 according to the Contract Documents.

333.01.02 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.

333.02 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

Ontario Provincial Standard Specifications, Material

OPSS 1003 Aggregates - Hot Mix Asphalt
OPSS 1103 Emulsified Asphalt
OPSS 1301 Cementing Materials

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-200 Penetration of Bituminous Materials
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 Mixtures
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
LS-602 Sieve Analysis of Aggregates
LS-625 Sampling of Granular Materials

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

ASTM International

D 6752 / D 6752M -11 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

333.03 DEFINITIONS

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

Active Filler means substances added to the reclaimed existing asphalt pavement that chemically alter the mix properties.

AMRL means as defined in OPSS 310.

CCIL means as defined in OPSS 310.

Cold In-Place Recycled (CIR) Mix means the in-place mixture of existing reclaimed HMA pavement, corrective aggregate or active filler or both if required, emulsified asphalt, and water.

Corrective Aggregate means virgin aggregate or reclaimed asphalt pavement (RAP) or both added to the reclaimed existing asphalt pavement to meet the CIR mix design requirements.

Hot Mix Asphalt (HMA) means as defined in OPSS 310.

Quality Assurance (QA) means as defined in OPSS 310.

Quality Control (QC) means as defined in OPSS 310.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 310.

Segregation means a condition of the pavement characterized by areas with comparatively coarser or finer texture than that of the surrounding pavement. Longitudinal streak is segregation that manifests itself as a longitudinal mark on the pavement mat.:

a) **Slight Segregation** means the pavement matrix is in place between the coarse aggregate particles; however, there are slightly more coarse aggregate particles in comparison with the surrounding acceptable mix.

b) **Medium Segregation** means the pavement has significantly more coarse aggregate particles than the surrounding acceptable mat and usually exhibits some lack of surface matrix. Some coarse aggregate particle to coarse aggregate particle contact may also exist.

c) **Severe Segregation** means the pavement appears very coarse, predominantly with coarse aggregate particle to coarse aggregate particle contact and the pavement has little or no matrix.

Target Density means the average Bulk Relative Density for the lot established according to LS-300, and used to determine the per cent Compaction.

333.04 DESIGN AND SUBMISSION REQUIREMENTS

333.04.01 Design Requirements

For mix design purposes, prior to commencing the work samples representative of the material that is

produced during the milling operation shall be obtained. These samples shall be used to establish the design rate of emulsified asphalt as a percent by mass of the RAP. The design rate of the emulsified asphalt shall be a minimum of 1.2%.

The mix design shall be completed by a laboratory with CCIL Type A certification or equivalent equipped to carry out CIR mix design. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

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

b) The percent by mass of emulsified asphalt in the CIR, referred to as the design rate, and all calculations performed to determine the design rate of the emulsified asphalt.

c) The optimum moisture content and the mix design bulk relative density.

d) The amount of water to be added to the mix.

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

f) Recovered penetration for the binder of the existing pavement according to LS-200.

g) Type, source, gradation, and quantity of corrective aggregate, if required.

h) Type, source, and quantity of active filler, if required.

333.04.02 Submission Requirements

The mix design shall be submitted to the Contract Administrator a minimum of 7 Days prior to the start of CIR operations. When more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

A new mix design shall be submitted when the emulsified asphalt design rate is adjusted by greater than 0.2%. Separate or new mix designs shall be submitted if the composition or layer thicknesses or both of the existing pavement changes significantly.

333.05 MATERIALS

333.05.01 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined by the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. No more than 1% by mass of Portland cement shall be added to the mix.

333.05.02 Corrective Aggregate

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined in the mix design. Corrective aggregate shall meet the physical and consensus property requirements of OPSS 1003 for the coarse and fine aggregates of Superpave 19.0 binder course.

333.05.03 Emulsified Asphalt

Emulsified asphalt shall be mixing grade meeting the requirements of OPSS 1103, and be compatible with the process and materials used. The addition of polymer modification shall be as specified in the Contract Documents.

333.05.04 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve and 95 to 100% passing the 26.5 m sieve after processing, as per LS-602.

333.05.05 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

333.06 EQUIPMENT

333.06.01 Recycling Train

The recycling train shall include the following:

a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.

b) A sizing unit capable of processing the RAP to meet the requirements of this specification.

c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the emulsified asphalt. The scale shall be calibrated to the manufacturer's tolerance at the start of the Contract and when requested by the Contract Administrator.

d) An emulsified asphalt control system equipped with a flow meter calibrated in litres per tonne and a total delivery meter calibrated in litres to continuously maintain the required amount of emulsified asphalt added to within 0.2% by mass of the reclaimed material feed.

e) A means of monitoring and controlling the addition of water.

f) A mixing unit equipped with a device capable of producing a uniform and thoroughly blended CIR mix.

Alternative equipment may be considered subject to approval by the Contract Administrator and demonstration of meeting the requirements of the Cold In-Place Recycling Trial Section subsection.

333.06.02 Placing Equipment

Placing of the CIR mix 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.

333.06.03 Compaction Equipment

Appropriate compaction equipment to achieve the required compaction shall be used.

333.06.04 Drying Unit

A drying unit specifically designed to provide radiant heat to the CIR mat may be used. 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.

333.06.05 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

333.06.06 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

333.07 CONSTRUCTION

333.07.01 General

HMA pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable binder course HMA. The HMA shall be placed to the CIR depth specified in the Contract Documents in compacted lift thicknesses between 40 and 75 mm in depth.

The overlap between successive passes of the recycling train shall be a minimum 100 mm.

333.07.02 Operational Constraints

The work 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. CIR shall not be placed after September 1st without written approval from the Contract Administrator. The work shall be carried out when the roadway is clean and free of standing water. CIR shall not proceed in the rain.

All traffic, including construction traffic, shall be kept off the freshly placed CIR mat until it is able to carry traffic without damage. Damaged CIR mat shall be repaired.

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

a) The CIR mat has been opened to traffic and allowed to cure for a minimum of 14 Days.

b) The specified moisture content has been achieved according to the Acceptance Criteria for Moisture Content subsection.

c) The specified density has been achieved according to the Compaction subsection.

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

The wearing surface shall be placed within 30 Days of placing the CIR mat. The 30 Day requirement may be waived by the Contract Administrator if the CIR mix does not meet the requirements of this specification and is subject to repair.

333.07.03 Cold In-Place Recycling Trial Section

Prior to carrying out CIR on the Contract, the ability to successfully carry out CIR according to this specification shall be demonstrated to the Contract Administrator by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the Contractor has demonstrated the ability to successfully mix, handle, place, and compact CIR with the same equipment, placing crew, and methodology to meet the Contract requirements for placing CIR on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The location of the trial section shall be proposed to the Contract Administrator for approval. The Contract Administrator shall be given a minimum of 48 hours' notice prior to placing the trial section.

The Contract Administrator shall allow the CIR work to continue based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIR is rejected by visual assessment, additional trial sections shall be completed until the CIR meets the requirements of this specification.

Unacceptable trial sections shall be repaired, removed, or replaced, as required.

333.07.04 Surface Preparation

When specified in the Contract Documents, milling prior to CIR work shall be carried out to achieve the specified crossfall and grade.

All deleterious and loose milled material shall be removed from the milled surfaces at longitudinal and transverse joints after reclaiming operations are completed and before placing the CIR mix.

All existing crack sealant shall be removed and disposed of prior to CIR reclaiming operations.

333.07.05 Mixing

The emulsified asphalt shall be added at the design rate. The rate of addition of emulsified asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIR mix that can be compacted to the specified density. The minimum percent of emulsified asphalt added shall be 1.2%

Water may be added in a controlled manner to facilitate uniform mixing.

333.07.06 Compaction

The CIR mix shall be compacted according to the requirements of the Acceptance Criteria for Compaction subsection.

333.07.07 Surface Appearance

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

333.07.08 Drying

Prior to the placement of the wearing surface, a drying unit may be used. Overheating or burning of the CIR shall not be allowed.

333.07.09 Sampling

333.07.09.01 General

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

333.07.09.02 Cold In-Place Recycling Material

At least 4 Business Days prior to the planned overlay of the CIR mat, 2 slab samples of the CIR material shall be obtained for each area taken at random locations, as directed by the Contract Administrator:

One slab sample shall be used to test for moisture content and the other shall be used to test for compaction. Each slab sample shall be dry cut 150 x 150 mm and removed intact from the CIR mat.

The samples shall be packaged in non-absorptive materials to protect sample integrity, sealed in waterproof containers, appropriately labelled, and delivered in good condition within 48 hours of sampling to the designated QA testing laboratory specified in the Contract Documents.

Additional slab samples to test for compaction and moisture content shall only be taken once remedial work has been carried out to improve compaction in the failed areas. The Contractor shall be charged the cost of additional testing.

At the start of production for each location in a Contract, or whenever the existing pavement material significantly changes composition within a location in a Contract, 15 kg of material reclaimed from the roadway after adding emulsion shall be obtained for the purpose of determining target density. Samples shall be taken at random locations as directed by the Contract Administrator.

The Contractor shall be permitted to carry out QC sampling and testing of the CIR mat.

333.07.09.03 Emulsified Asphalt

For information purposes, samples of emulsified asphalt used in the mix shall be taken at the job site from each tanker load of material used on the Contract. Each sample shall be taken either from a sampling spigot on the transfer line, if available, or from the end of the transfer line after a minimum of 4,000 kg has been drawn from the tanker. Each set of samples shall be a minimum of 2 full four-litre containers.

Samples of the emulsified asphalt used in the mix shall be obtained, properly labelled and identified, and delivered to the designated QA testing laboratory.

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.

333.07.09.04 Corrective Aggregate

The Contract Administrator may request samples of the corrective aggregate to demonstrate conformance to the requirements of this specification. When requested, two 25 kg samples shall be taken in the presence of the Contract Administrator.

QA samples shall be taken in accordance with the procedures given in LS-625 and at the time and location determined by the Contract Administrator.

Samples of the corrective aggregate shall be obtained, properly labeled and identified, and delivered within 48 hours of sampling to the designated QA testing laboratory as specified in the Contract Documents.

333.07.09.05 Active Filler

The Contract Administrator may take samples of active filler to demonstrate conformance to the requirements of this specification.

333.07.10 Traffic Convoy

Traffic shall be convoyed 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 CIR mat is able to carry traffic without damage.

333.07.11 Management of Excess Material

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

333.08 QUALITY ASSURANCE

333.08.01 General

Acceptance shall be based on QA testing. QA testing shall be carried out at a laboratory currently certified by CCIL with Type A or Type B certification or AMRL accredited or equivalent laboratory.

The Contract Administrator shall reject all unacceptable material and all visually defective material, mix, or work shown in Table 1. Defective material, mixture, and work shall not be incorporated into the finished work.

If the CIR does not meet the requirements of the specification within 30 Days after placing the CIR mat, it shall be deemed unacceptable.

333.08.02 Surface Tolerance

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

333.08.03 Acceptance Criteria for Moisture Content

Acceptance criteria shall be based on the QA test results for each location in the Contract.

The moisture content shall be determined according to LS-291. The average moisture content for each location in a Contract placed shall be 2.0% or less, with no individual test for the location exceeding 3.0%.

The CIR mix that does not meet moisture content requirements shall be deemed unacceptable.

333.08.04 Acceptance Criteria for Compaction

Acceptance criteria shall be based on the QA test results for each area represented by a set of slab samples and the Target Density established for that area.

The CIR mix shall be compacted to a minimum of 96% of the Target Density.

Compaction shall be calculated for area of CIR represented by a set of slab sample from the bulk relative density determined from slab samples according to LS-306 or ASTM D 6752 and the Target Density as follows:

Compaction = (bulk relative density of slab sample / Target Density) x 100%

The Target Density shall be established according to LS-300.

CIR that is not compacted to the required density shall be deemed unacceptable.

333.08.05 Acceptance of Corrective Aggregate

QA testing shall be carried out to ensure that corrective aggregate to be used in the work is according to the physical and consensus property requirements of OPSS 1003 for the coarse and fine aggregates of Superpave 19.0 binder course.

333.08.06 Repair of Unacceptable Cold In-Place Recycled Mat

The CIR mat that is unacceptable shall be repaired as specified in Table 1.

Repairs shall be for the full lane width and a minimum length of 15 m to the depth shown in Table 1.

The HMA required to repair unacceptable CIR shall be placed in compacted lift thickness between 40 to 75 mm.

The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

333.09 MEASUREMENT FOR PAYMENT

333.09.01 Actual Measurement

333.09.01.01 Cold In-Place Recycled Mix

Measurement of CIR placed shall be by area in square metres.

333.09.02 Plan Quantity Measurement

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

333.10 BASIS OF PAYMENT

333.10.01 Cold In-Place Recycled Mix - 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.
The addition of corrective aggregate or active filler to the mix shall be at no extra cost to the Owner.

HMA required to replace unacceptable CIR material shall be at no extra cost to the Owner.

Emulsified asphalt shall be included in the Cold In-Place Recycled Mix item.

Repair of an unacceptable CIR mat shall be carried out at no extra cost to the Owner.

HMA placed in areas inaccessible to the reclaiming equipment shall be included in the Cold In-Place Recycled Mix item.

Repair of areas of CIR damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

TABLE 1
Unacceptable CIR Mix and Required Repair

Defect Type	Severity	Required Repair
Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	No action required.
	Moderate to Severe	Mill 50 mm and replace with an acceptable binder course HMA (Note 3).
	Very Severe	Remove CIR to full depth and replace with an acceptable binder course HMA (Note 3).
Segregation (Note 2)	Slight to Medium	No action required.
	Severe	Mill 50 mm and replace with an acceptable binder course HMA (Note 3).
Moisture content could not be achieved as per the Acceptance Criteria for Moisture Content subsection.	N/A	Remove CIR material to full depth represented by the test and replace with an acceptable binder course HMA (Note 3).
Compaction could not be achieved as per the Acceptance Criteria for Compaction subsection.	N/A	Remove CIR material to full depth represented by the test and replace with an acceptable binder course HMA (Note 3).

Notes:

1. Defect and severity definitions according to SP-027.
2. Defect and severity definitions according to Definitions section of this specification.
3. Reprocessing may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.

Appendix 333-A, November 2015
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

Cold in-place recycling (CIR) is suitable for treating a wide range of pavement distresses. CIR can repair pavements exhibiting age, thermal, fatigue, or reflective cracking and previously recycled pavements and is beneficial in mitigating reflective cracking. CIR is not suitable for pavements with extensive base or subbase problems, pavements containing steel slag, or pavements of insufficient strength.

The designer should specify the following in the Contract Documents:

- The addition of polymer modified may be considered to enhance additional performance (333.05.03)

- Depth of CIR. (333.07.01)

- Crossfall and grade. (333.07.07)

- Testing laboratory to carry out CIR moisture content and compaction testing. (333.07.09.02)

- Testing laboratory to carry out corrective aggregate testing. (333.07.09.04)

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

- Additional items for milling or padding or both if significant crossfall deficiencies (> 1%) exist in the existing pavement surface. (333.07.04)

It is recommended that adequate pre-engineering be carried out on the project and that existing pavement thicknesses and composition be established. Additional investigation should be carried out where pavement composition changes, such as patched areas. Pre-engineering data should be included in the Contract Documents.

Corrective aggregates are used when existing pavements are experiencing rutting, shoving, or flushing and it is suspected that the existing bituminous material is the cause of these distresses. Corrective aggregate may also be required to achieve mix design properties.

Any full depth repairs required for frost heave and distortion corrections should be repaired prior to CIR.

In urban areas, the designer should be aware of appurtenance adjustment requirements, curb heights, and accessibility concerns to accommodate the CIR equipment train and the requirement for traffic detours.

Contract scheduling should allow for CIR and follow-up paving to be completed within the time, temperature, and operational constraints.

The designer should be aware that severe distresses (e.g., significant alligator cracking, map cracking) may create an abundance of oversize material and remediation (e.g., pre-milling, pre-pulverizing) that may need to be addressed to meet gradation requirements.

Appendix 333-A

The designer should be aware that the length of CIR paving operation may affect traffic management.

CIR treatment depths typically range from 75 to 125 mm. The depth of CIR treatment shall be selected to minimize disturbance of the underlying granular base. It is recommended to have at least 25 mm of remaining HMA pavement below the CIR.

CIR is typically overlaid with HMA wearing course. Surface treatment, slurry surfacing, or microsurfacing may be considered.

A tack coat is recommended prior to paving HMA wearing course.

QC requirements have been removed from this specification, as acceptance is based on QA testing. If an Owner requires Contractor QC to confirm that the work meets the specification requirements, a special provision detailing the required Contractor QC should be included in the Contract Documents.

The payment clause for this specification is all inclusive. Should a municipality desire to pay for corrective aggregate, active filler, or emulsified asphalt separately, separate payment items are required.

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.