



**CONSTRUCTION SPECIFICATION FOR  
COLD IN-PLACE RECYCLING WITH EXPANDED ASPHALT**

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**TABLE OF CONTENTS**

<b>335.01</b>	<b>SCOPE</b>
<b>335.02</b>	<b>REFERENCES</b>
<b>335.03</b>	<b>DEFINITIONS</b>
<b>335.04</b>	<b>DESIGN AND SUBMISSION REQUIREMENTS</b>
<b>335.05</b>	<b>MATERIALS</b>
<b>335.06</b>	<b>EQUIPMENT</b>
<b>335.07</b>	<b>CONSTRUCTION</b>
<b>335.08</b>	<b>QUALITY ASSURANCE</b>
<b>335.09</b>	<b>MEASUREMENT FOR PAYMENT</b>
<b>335.10</b>	<b>BASIS OF PAYMENT</b>

**APPENDICES**

<b>335-A</b>	<b>Commentary</b>
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**335.01 SCOPE**

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement, sizing, adding active filler if required, adding and mixing expanded asphalt, and spreading and compacting the cold in-place recycled expanded asphalt mix (CIREAM).

**335.01.01 Specification Significance and Use**

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

### **335.01.02 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.

### **335.02 REFERENCES**

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

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

#### **Ontario Provincial Standard Specifications, Construction**

OPSS 313 Hot Mix Asphalt - End Result

#### **Ontario Provincial Standard Specifications, Material**

OPSS 1101 Performance Graded Asphalt Cement  
OPSS 1301 Cementing Materials

#### **Ministry of Transportation Publications**

MTO Laboratory Testing Manual:

LS-200 Penetration of Bituminous Materials  
LS-297 Determination of Indirect Tensile Strength of Expanded Asphalt Mixes  
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens  
LS-602 Sieve Analysis of Aggregates

Ontario Traffic Manual (OTM):

OTM Book 7 - Temporary Conditions

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

## **ASTM International**

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

## **American Association of State Highway and Transportation Officials (AASHTO)**

T40-02 Sampling Bituminous Materials

## **Wirtgen GmbH Publication**

Wirtgen Cold Recycling Technology manual, 1st edition, 2012

### **335.03 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.

**Cold In-Place Recycled Expanded Asphalt Mix (CIREAM)** means the in-place mixture of existing reclaimed asphalt pavement (RAP), active filler, and expanded asphalt.

**Cold In-Place Recycled Expanded Asphalt Mix (CIREAM) Mat** means a pavement course which comprises Cold In-Place Recycled Expanded Asphalt Mix

**Expanded Asphalt** means heated asphalt cement expanded from its normal volume by the addition of water.

**Hot Mix Asphalt (HMA)** means as defined in OPSS 313.

**Performance Graded Asphalt Cement (PGAC)** means as defined in OPSS 313.

**Quality Assurance (QA)** means as defined in OPSS 313.

**Reclaimed Asphalt Pavement (RAP)** means as defined in OPSS 313.

**Target Density** means the average bulk relative density for each subplot established according to LS-297, and used to determine the per cent compaction.

### **335.04 DESIGN AND SUBMISSION REQUIREMENTS**

#### **335.04.01 Design Requirements**

For mix design purposes, prior to commencing the work, the Contractor shall obtain samples that are representative of the material that is produced during the milling operation. These samples shall be used to establish the design rate of expanded asphalt as a percent by mass of the RAP. The mix design shall meet the following requirements:

- a) The design rate of the expanded asphalt shall be a minimum of 1.0%.
- b) The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. Mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out expanded asphalt mix designs. 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 grade, manufacturer, and supplier of the PGAC.
- b) The percent by mass of expanded asphalt in the CIREAM, referred to as the design rate, and all calculations performed to determine the design rate of expanded asphalt.
- c) The recommended PGAC temperature for foaming, the half-life, the expansion ratio and the percent of water added for foaming.
- d) The optimum moisture content and the mix design bulk relative density.
- e) The dry tensile strength, the wet tensile strength, and the tensile strength ratio.
- f) The amount of water to be added to the mix.
- g) Maximum field rate adjustment allowed to the design rate without adverse effects to the mix properties.
- h) Recovered penetration for the binder of the existing pavement according to LS-200.
- i) Type, source and quantity of active filler, if required.

#### **335.04.02 Submission Requirements**

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of CIREAM operations. Within 4 Business Days commencing after the day of delivery of all required documents for the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by greater than 0.20%. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

#### **335.05 MATERIALS**

##### **335.05.01 Reclaimed Asphalt Pavement**

RAP material shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve after processing, and shall be measured based on air dried gradation according to the coarse sieving operation of LS-602.

### **335.05.02 Performance Graded Asphalt Cement**

PGAC shall be according to OPSS 1101. The table of Additional Testing Requirements and Acceptance Criteria for PGAC Grades shall not apply. PGAC shall be selected with performance properties meeting the design maximum pavement temperature of 52 °C and the minimum pavement temperature of -28 °C at a minimum, and the selected PGAC shall have suitable expansion characteristics.

### **335.05.03 Water**

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

### **335.05.04 Active Filler**

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

When used as active filler, Portland cement shall be according to OPSS 1301. Not more than 1% by mass of Portland cement shall be added to the mix.

## **335.06 EQUIPMENT**

### **335.06.01 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 screening and sizing unit capable of processing the RAP.
- 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 expanded asphalt. The scale shall be calibrated to the manufacturer's tolerance prior to the start of the work and when requested by the Contract Administrator.
- d) An asphalt cement expansion system capable of producing optimum expansion and an injection system capable of injecting and blending expanded asphalt uniformly throughout the reclaimed material.
- e) A system to control and regulate the application of expanded asphalt in relation to the mass of RAP being processed within a tolerance of  $\pm 3.0\%$  by volume of asphalt cement.
- f) A mixing unit capable of producing a uniform and thoroughly blended CIREAM.

### **335.06.02 Placing Equipment**

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade shall be used to place the CIREAM. 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.

### **335.06.03 Compaction Equipment**

Compaction equipment shall be selected to achieve the required compaction.

**335.06.04                      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.

**335.06.05                      Pilot Vehicle**

Pilot vehicles used to control traffic shall be according to OTM, Book 7.

**335.07                              CONSTRUCTION**

**335.07.01                      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 CIREAM 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.

**335.07.03                      Operational Constraints**

Cold in-place recycled expanded asphalt mix (CIREAM) shall not be placed after September 1st without the written approval from the Contract Administrator.

The work shall be carried out when the roadway is clean and free of standing water. Cold in-place recycled expanded asphalt mix shall not proceed during periods of rain or when the surface is in a saturated condition.

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

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

- a) The CIREAM mat has been opened to traffic and allowed to cure for a minimum of 3 Days.
- b) The specified tensile strength has been achieved according to the Quality Assurance section.
- c) The specified density has been achieved according to the Compaction subsection.
- d) All defective areas in the CIREAM mat have been repaired to the satisfaction of the Contract Administrator.

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

**335.07.03                      Cold In-Place Recycling Expanded Asphalt Trial Section**

Prior to carrying out CIREAM, the ability to successfully carry out CIREAM 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 ability to successfully mix, handle, place, and compact CIREAM with the same equipment, placing crew, and methodology to

meet the Contract requirements for placing CIREAM has been demonstrated 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. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the CIREAM work to continue based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIREAM is rejected by visual assessment, the trial sections shall be repaired or removed and replaced until the CIREAM meets the requirements of the Surface Appearance subsection.

#### **335.07.04                      Surface Preparation**

When specified in the Contract Documents, milling prior to CIREAM 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, and longitudinal and transverse joints after reclaiming operations are completed and before placing CIREAM.

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

#### **335.07.05                      Mixing**

The expanded asphalt shall be added at the design rate. The rate of addition of expanded asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIREAM that can be compacted to the specified density. The expanded asphalt added shall not be less than 1.0%.

#### **335.07.06                      Compaction**

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

#### **335.07.07                      Surface Appearance**

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

#### **335.07.08                      Traffic Control with Moving Vehicles**

Traffic shall be controlled with moving vehicles according to OTM, Book 7.

The moving vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until such time as the CIREAM mat is able to carry traffic without damage.

#### **335.07.09                      Management of Excess Material**

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

**335.08 QUALITY ASSURANCE**

**335.08.01 General**

Acceptance of the CIREAM shall be based on the following criteria:

- a) Surface Appearance
- b) Surface Tolerance
- c) Compaction
- d) Tensile Strength
- e) RAP Gradation

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

**335.08.02 Sampling**

**335.08.02.01 Lot Size**

The Contract Administrator shall determine the size and location of the lots and sublots after discussion with the Contractor and before CIREAM production starts. A lot shall typically represent 25,000 m<sup>2</sup> with 5 equal sublots of 5,000 m<sup>2</sup> in size.

**335.08.02.02 Cold In-Place Recycled Expanded Asphalt Mix Samples**

Samples of CIREAM material shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. Samples shall be transported in a manner that avoids stacking and extreme temperatures.

**335.08.02.02.01 Loose Samples**

After placement and prior to compaction, the Contractor shall obtain one 15 kg sample of the CIREAM from each subplot, taken at random locations as directed by the Contract Administrator. The samples to be tested for acceptance of CIREAM shall be used to test for dry tensile strength and wet tensile strength according to LS-297.

For the purpose of determining the RAP gradation, another 30 kg sample of CIREAM samples shall be taken from each of two randomly selected sublots for every lot.

**335.08.02.02.02 Slabs**

Prior to the planned overlay of the CIREAM mat, two slab samples of the CIREAM material shall be obtained from each subplot. The two slab samples shall be located side-by-side and taken at random locations as directed by the Contract Administrator. Each slab samples shall be dry cut 150 x 150 mm and removed intact from the CIREAM mat.

One slab sample shall be used to test for bulk relative density and the other slab sample shall be used to test for moisture content for the purpose of moisture adjustment according to LS-306.

Additional slab samples for QA acceptance tests shall only be taken after the Contractor has carried out remedial work to improve compaction in the rejected subplot. The Contractor shall be charged the cost of additional tests.



### **335.08.02.03 Performance Graded Asphalt Cement**

Samples of PGAC to be used in the mix shall be taken from the storage tank at the terminal according to the Tank Tap Method specified in AASHTO T40-02 and the terminal's health and safety plan in the presence of the Contract Administrator at a frequency of three sets of samples per Contract for PGAC providing to three different lots. Each set of samples shall be a minimum of 2 full one-litre portions. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

Samples of PGAC used in the mix shall be obtained, properly labelled and identified, and delivered to the designated QA testing laboratory as specified in the Contract Documents.

### **335.08.03 Acceptance Criteria**

#### **335.08.03.01 Surface Appearance**

Surface appearance shall be assessed by the Contract Administrator based on visual surveys after the CIREAM mat has been opened to traffic. The finished CIREAM surface shall have a uniformly smooth texture and shall meet the surface appearance requirements of ravelling, segregation and rutting as specified in Table 1 prior to placement of HMA overlay.

#### **335.08.03.02 Surface Tolerance**

The surface tolerance of any CIREAM surface shall be such that when tested with a 3 m straight edge placed anywhere on the CIREAM surface, except across the crown, and in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the CIREAM greater than 6 mm.

#### **335.08.03.03 Compaction**

The compaction of the CIREAM mix shall be calculated for each subplot 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 the slab sample / target density) x 100%

where the target density to be used for acceptance purposes shall be calculated for each subplot by averaging the densities of the six (6) compacted specimens produced for indirect tensile strength testing according to LS-297.

Each lot of CIREAM shall be compacted to a minimum mean of 96.0% of the target density established for the mix, with no individual subplot bulk relative density result falling below 95.0% of the target density. CIREAM that is not compacted to the required density shall be deemed rejectable.

#### **335.08.03.04 Tensile Strength of Cold In-Place Recycled Expanded Asphalt Mix**

Acceptance of the CIREAM shall be based on dry tensile strength and wet tensile strength.

Samples of CIREAM shall be tested for acceptance purposes according to LS-297.

Dry tensile strength requirements for the lot are met when:

- a) The mean dry tensile strength of the lot is equal to or greater than 225 kPa; and
- b) No individual subplot dry tensile strength is less than 200 kPa.

Wet tensile strength requirements for the lot are met when:

- a) The mean wet tensile strength of the lot is equal to or greater than 100 kPa; and
- b) No individual subplot wet tensile strength is less than 75 kPa.

CIREAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

**335.08.03.05 Reclaimed Asphalt Pavement Gradation**

If the RAP does not meet the gradation requirements, the Contractor shall submit an action plan of remediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

**335.08.04 Repairing and Re-Evaluating**

CIREAM that is rejectable based on the Acceptance Criteria subsection shall be repaired according to the requirements specified in Table 1.

Repairs shall be for the full lane width. For repairs due to the surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the recycling train, or by the paving equipment, whichever is applicable. For other repairs based on the lot and subplot acceptance, the minimum length shall follow the Repairing and Re-Evaluating clause of OPSS 313 and to the depth specified in Table 1.

The HMA required to repair unacceptable CIREAM shall be placed in compacted lift thicknesses between 40 and 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.

All repairs will be re-evaluated and retested according to the Acceptance Criteria subsection.

**335.09 MEASUREMENT FOR PAYMENT**

**335.09.01 Actual Measurement**

**335.09.01.01 Cold In-Place Recycled Expanded Asphalt Mix**

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

**335.09.02 Plan Quantity Measurement**

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

**335.10 BASIS OF PAYMENT**

**335.10.01 Cold In-Place Recycled Expanded Asphalt 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 active filler or other additives to the mix, including any expanded asphalt that is required due to the additives, shall be at no extra cost to the Owner.

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

PGAC shall be included in the CIREAM item.

Repair of an unacceptable CIREAM 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 CIREAM item.

Repair of areas of CIREAM 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  
Acceptance Criteria and Repair Requirements for CIREAM**

Acceptance Criteria	Defect Type	Severity / Criteria	Acceptable / Rejectable	Repair Requirements
Surface Appearance	Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
	Segregation (Note 1)	Slight to Medium	Acceptable	No action required.
		Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
	Rutting (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
	Surface Tolerance	Non-conformance for surface tolerance as per the Surface Tolerance subsection of the Acceptance Criteria.	> 6 mm based on 3 m straightedge measurement	Rejectable
Compaction	Non-conformance for Compaction as per the Compaction subsection of the Acceptance Criteria.	< 96% for Compaction of Lot's Mean; and < 95% for Compaction of Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Recompact the CIREAM mat, if required, with reheating process, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIREAM material to full depth and replace with an acceptable binder course HMA.
Tensile Strength	Non-conformance for Tensile Strength as per the Tensile Strength of Cold In-place Recycled Expanded Asphalt Mix subsection of the Acceptance Criteria.	For Dry Tensile Strength: < 225 KPa for Lot's Mean; and < 200 KPa for Individual Sublot.  For Wet Tensile Strength: < 100 KPa for Lot's Mean; and < 75 KPa for Individual Sublot.	Rejectable	Remove CIREAM to full depth in the lot or sublot represented by the test and replace with an acceptable binder course HMA (Note 2).
Notes: 1) Defect and severity definitions according to SP-027. 2) Reprocessing with a recycling train may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.				

**Appendix 335-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**

No information provided here.

**Related Ontario Provincial Standard Drawings**

No information provided here.

