



**CONSTRUCTION SPECIFICATION FOR
COLD IN-PLACE RECYCLED EXPANDED ASPHALT MIX**

TABLE OF CONTENTS

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

APPENDICES

335-A	Commentary
--------------	-------------------

335.01 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 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 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.

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 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 1101 Performance Graded Asphalt Cement
OPSS 1301 Cementing Materials

Ontario 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-625 Sampling of Granular Materials

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

SP-024 Manual for the Condition Rating of Flexible Pavements

ASTM International

D 6752-09 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 3rd edition, 2010

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.

AMRL means as defined in OPSS 310.

CCIL means as defined in OPSS 310.

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

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

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 310.

Performance Graded Asphalt Cement (PGAC) 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 as defined in OPSS 310 and includes the following severities:

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

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 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 design rate of the expanded asphalt shall be a minimum of 1.0%. The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa. The tensile strength ratio shall be a minimum of 50%.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. Mix design work shall be completed by a laboratory with CCIL Type A certification or equivalent equipped to carry out expanded asphalt 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 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 the 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 affects to the mix properties.
- h) Recovered penetration for the binder of the existing pavement according to LS-200.
- i) Type, source, gradation, and quantity of corrective aggregate, if required.
- j) Type, source, and quantity of active filler, if required.

335.04.02

Submission Requirements

The mix design shall be submitted by the Contractor to the Contract Administrator a minimum of 7 Days prior to the start of CIREAM 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 expanded 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.

335.05 MATERIALS

335.05.01 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 one percent by mass of Portland cement shall be added to the mix.

335.05.02 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, with the exception of the sand equivalent test, for the coarse and fine aggregates of Superpave 19.0 binder course.

335.05.03 Performance Graded Asphalt Cement

The Contractor shall select a PGAC with suitable expansion characteristics. PGAC shall be according to OPSS 1101, excluding PGAC zone requirements.

335.05.04 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.

335.05.05 Water

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

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 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 expanded 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 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 equipped with a device capable of producing a uniform and thoroughly blended CIREAM.

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

335.06.02 Placing Equipment

Placing of the CIREAM 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.

335.06.03 Compaction Equipment

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

335.06.04 Pilot Vehicle

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

335.06.05 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.

335.07 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.

335.07.02 Operational Constraints

CIREAM 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. CIREAM shall not proceed in the rain.

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

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 Recycled Expanded Asphalt Trial Section

Prior to carrying out CIREAM on the Contract, the Contractor shall demonstrate to the Contract Administrator the ability to successfully carry out CIREAM according to this specification 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 CIREAM with the same equipment, placing crew, and methodology to meet the Contract requirements for placing CIREAM on any Contract within the last 12 months.

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

The Contract Administrator shall allow the Contractor to continue the CIREAM work 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 Contractor shall repeat additional trial sections until the CIREAM meets the requirements of this specification.

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section.

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 at 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 minimum percent of expanded asphalt added shall be 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 shall be according to the crossfall and grade specified in the Contract Documents. The surface of the CIREAM mat shall be of uniform texture and shall be free of segregation, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other defects.

335.07.08 Sampling

335.07.08.01 General

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

335.07.08.02 Cold In-Place Recycled Expanded Asphalt Mix

After placement and prior to compaction, the Contractor shall obtain one 15 kg sample of the CIREAM from each 5,000 m² placed, 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, wet tensile strength, and tensile strength ratio according to LS-297.

Prior to the planned overlay of the CIREAM mat, the Contractor shall obtain 2 slab samples of the CIREAM from each 5,000 m² placed, to be 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 CIREAM mat.

The samples shall be packaged in non-absorptive materials to protect sample integrity, sealed in waterproof containers, appropriately labelled, and delivered by the Contractor 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 shall only be taken once the Contractor has carried out remedial work to improve compaction in the failed areas. The Contractor shall be charged the cost of additional testing.

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

335.07.08.03 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 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 labelled and identified, and delivered within 48 hours of sampling to the designated QA testing laboratory as specified in the Contract Documents.

335.07.08.04 Active Filler

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

335.07.09 Traffic Convoy

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 CIREAM mat is able to carry traffic without damage.

335.07.10 Management of Excess Material

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

335.08 QUALITY ASSURANCE

335.08.01 General

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

Acceptance criteria shall be based on the QA test results for each 5,000 m² placed.

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

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

335.08.02 Surface Tolerance

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

335.08.03 Acceptance Criteria for Compaction

The CIREAM shall be compacted to a minimum of 96% of the target density.

Compaction shall be calculated for each 5,000 m² placed 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%

The target density to be used for acceptance purposes shall be calculated for each 5,000 m² placed by averaging the densities of 6 compacted specimens produced for indirect tensile strength testing according to LS-297.

335.08.04 Acceptance Criteria for Cold In-Place Recycled Expanded Asphalt Mix

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

Samples of CIREAM shall be tested for acceptance purposes in accordance with LS-297.

Dry tensile strength requirements for each 5,000 m² placed are met when the dry tensile strength of the sample is equal to or greater than 225 kPa.

Wet tensile strength requirements for each 5,000 m² placed are met when the wet tensile strength of the sample is equal to or greater than 100 kPa.

The tensile strength ratio for the individual samples shall not be less than 50%.

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

335.08.05 Acceptance of Corrective Aggregate

QA testing may 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, with the exception of the sand equivalent test, for the coarse and fine aggregates of Superpave 19.0 binder course.

335.08.06 Repair of Unacceptable CIREAM

CIREAM that is unacceptable shall be repaired as shown in Table 1.

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

The HMA required to repair unacceptable CIREAM 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.

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 corrective aggregate or active filler to the mix 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 unacceptable CIREAM mat shall be carried 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
Unacceptable CIREAM 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 CIREAM to full depth and replace with an acceptable binder course HMA.
Segregation (Note 2)	Slight to Medium	No action required.
	Severe	Mill 50 mm and replace with an acceptable binder course HMA (Note 3).
Compaction is not achieved as per the Acceptance Criteria for Compaction subsection.	N/A	Remove CIREAM, to full depth, represented by the test and replace with an acceptable binder course HMA (Note 3).
Dry tensile strength, wet tensile strength, or tensile strength ratio is not achieved as per the Acceptance Criteria for Cold In-Place Recycled Expanded Asphalt Mix subsection.	N/A	Remove CIREAM, to full depth, represented by the test and replace with an acceptable binder course HMA (Note 3).
<p>Notes:</p> <ol style="list-style-type: none"> 1. Defect and severity definitions according to SP-024. 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 approval by the Contract Administrator. 		

**Appendix 335-A, November 2013
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 with expanded asphalt (CIREAM) is suitable for treating a wide range of pavement distresses. CIREAM can repair pavements exhibiting age; thermal, fatigue, or reflective cracking and previously recycled pavements and is beneficial in mitigating reflective cracking. CIREAM 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:

- Depth of CIREAM. (335.07.01)
- Grade and crossfall. (335.07.07)
- Designated testing laboratory. (335.07.08.02, 335.07.08.03)

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 exist in the existing pavement surface. (335.07.04)

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 when 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 CIREAM.

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

Contract scheduling should allow CIREAM and follow-up pavement to be completed within the time 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) needs to be addressed to meet gradation requirements.

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

Appendix 335-A

It is recommended to have at least 25 mm of remaining HMA pavement below the CIREAM.

CIREAM is typically overlaid with a 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 asphalt cement separately, separate payment items are required.

In times of volatile asphalt cement prices, on multi-year contracts, and on Contracts with greater than 1,000 tonnes of paver laid CIREAM material, designers may consider using the MTO PGAC price index for payment adjustment. The MTO PGAC price index is available on the Ontario Ministry of Transportation website at www.raqs.mto.gov.on.ca, by clicking on Contractor, Contract Bulletin, Asphalt Price Index. The MTO PGAC price index is only a tool for qualifying PGAC prices and is not intended as a standard asphalt cement price to be incorporated into the contract bid. The MTO PGAC price index calculation for a given month takes in the average of the 4 weeks of the month and is published on the last day of the month.

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.