

### 3.56 COLD IN-PLACE RECYCLING

#### 3.56.1 GENERAL

This specification covers the requirements for Cold In-Place Recycling (CIR) which consists of reclaiming the existing asphalt pavement; sizing the reclaimed material; adding corrective aggregate (if required); adding a bituminous stabilizer; adding other additives; mixing of all components and spreading and compacting the cold in-place recycled mix.

##### 3.56.1.1 Test Procedures

ATT 11	Density, In-Place Nuclear Method
ATT 12 & ATT 26	Extraction and Sieve Analysis (25 000 µm minus)
ATT 13	Forming Marshall Specimens, Field Method
ATT 15	Moisture Content, Part II, Oven Method, Emulsified Asphalt Mixtures
ASTM D 1188	Bulk Specific Gravity / Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D6752	Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing
ASTM D 2041	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 3203	Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
ASTM D 4867	Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixes

##### 3.56.1.2 Definitions

**Cold In-Place Recycling (CIR)**, for the purposes of this project, is defined as a pavement rehabilitation technique where the top portion of the asphalt pavement is recycled and stabilized in-place without heat; the construction process is carried out with a train of multi-functional recycling equipment.

**Cold In-Place Recycled (CIR) Mix** means the in-situ mixture of reclaimed existing asphalt pavement, corrective aggregate if used, Portland cement or other approved additive, bituminous stabilizer, and water.

**Bituminous Stabilizer**, unless otherwise specified, an emulsified asphalt or foamed asphalt cement, but not both, may be used.

**Foamed Asphalt** means a process where heated asphalt cement is expanded from its normal volume by the addition of precise amounts of water.

**Visually Failed Area** is an area of CIR mat which fails, loses specified density, becomes too wet, ravel, contains excess bituminous stabilizer or oil spills, becomes rutted, distorted, loose

or rough, or contains any other defect judged by the Consultant to negatively affect the long term performance of the pavement structure.

### 3.56.2 MATERIALS

#### 3.56.2.1 **Reclaimed Asphalt Pavement**

The gradation of the reclaimed asphalt pavement material shall be 100 percent passing the 40 mm sieve size and 90 to 100 percent passing the 25 mm sieve size, after processing.

#### 3.56.2.2 **Bituminous Stabilizer**

Unless otherwise specified, the type of bituminous stabilizer to be used by the Contractor shall be either an emulsified asphalt or an asphalt cement to be used as part of a foaming process.

The Contractor shall select the grade of emulsified asphalt to be used in accordance with the grades listed in Specification 5.7 Supply of Asphalt. Use of alternative grades not listed in Specification 5.7 will be subject to the approval of the Consultant. When proposing to use an alternative grade the Contractor shall provide the appropriate ASTM or AASHTO material specification.

The Contractor shall select the grade of asphalt cement best suited for foaming purposes. Asphalt cement used for foamed asphalt shall meet the requirements of Specification 5.7, Supply of Asphalt, for the grade selected.

Sampling of the bituminous stabilizer shall be as outlined in Specification 5.7 at a frequency of one sample per three Lots.

#### 3.56.2.3 **CIR Additive**

A Portland cement additive shall be incorporated into all CIR mixes at a nominal rate of 1.0 percent by weight of reclaimed pavement material. Other addition rates for Portland cement, to a maximum of 1.5 percent, will be allowed if the material characteristics are demonstrated to have been improved in the mix design process. Portland cement shall be Type GU that meets the requirements of Specification 5.11, Supply of Portland Cement.

Other additives such as lime may be used subject to approval of the Consultant.

#### 3.56.2.4 **Corrective Aggregate**

Corrective aggregate is only to be used if so specified within the contract documents or the mix properties are demonstrated to be improved.

Corrective aggregate, if required by the mix design, shall meet the requirements of a Designation 1 Class 12.5 aggregate as outlined in Specification 3.2 Aggregate Production and Stockpiling unless otherwise approved by the Consultant.

When required, the Contractor shall supply aggregate in accordance with Specification 5.2, Supply of Aggregate and haul materials in accordance with Specification 4.5, Hauling.

3.56.2.5 **Water**

Water shall be clean and free from deleterious concentrations of acids, alkalis, salts or other organic or chemical substances.

3.56.3 MIX DESIGN REQUIREMENTS

Preparation and submission of CIR mix designs for Consultant verification and approval is the responsibility of the Contractor. The design shall be prepared by a laboratory that is pre-qualified by the Department in the category of Mix Design - Marshall, or can provide proof of experience in preparing CIR mix designs. The mix design shall be submitted to the Consultant a minimum of seven days prior to the start of CIR operations. All costs incurred for CIR mix design formulation are the responsibility of the Contractor. The Contractor shall not commence CIR operations on the project prior to receiving the Consultant’s written notice that the CIR mix designs have been approved.

For mix design purposes, prior to commencing the work, the Contractor shall obtain samples that are representative of the material that will be produced during the milling operation. These samples shall be used, along with any corrective aggregate and approved additive (e.g. Portland cement), to establish the design rate of bituminous stabilizer as a percentage by mass of the reclaimed asphalt pavement.

The resulting combination will, when approved by the Consultant, be the CIR Job Mix Formula (JMF). The design rate of bituminous stabilizer shall be a minimum of 1.2 percent emulsified asphalt, or 1.0 percent for foamed asphalt. A new mix design shall be submitted when the bituminous stabilizer design rate is adjusted by 0.3 percent or greater. Separate or new mix designs shall be submitted if the composition of the existing pavement changes significantly.

Each mix design shall include the following.

- a. Information on the type, manufacturer, and supplier of the bituminous stabilizer.
- b. The asphalt content, aggregate gradation and coarse aggregate fracture count of the reclaimed ACP.
- c. The design addition of corrective aggregate and/or additive if used.
- d. The design addition rate of bituminous stabilizer and foaming characteristics if foamed asphalt is used or total asphalt content and residual asphalt content if an emulsified asphalt is used.
- e. All calculations performed to determine the design rate of bituminous stabilizer.
- f. The amount of water to be added to the mix.
- h. Information to satisfy the physical requirements given in Table 1.

**Table 1**  
**CIR Mix Physical Requirements**

<b>Property</b>	<b>Requirement</b>
Air Void Content (%)	Criteria not specified, report only.
ITS <sub>Dry</sub> (kPa) @ 25°C	225 (Note 1)
Wet Tensile Strength Ratio (%)	50 min.

Note 1: Indirect Tensile Strength (Dry).

The mix design shall follow procedures outlined in the Wirtgen Cold Recycling Technology manual (Wirtgen GmbH, Windhagen, Germany, 1st Edition, 2012, Appendix 1 - "Laboratory procedures for stabilised materials (mix designs)" for Class 1 BSM (bitumen stabilised material).

The Maximum Theoretical Density shall be determined on briquettes after testing for indirect tensile strength.

#### 3.56.4 EQUIPMENT

##### 3.56.4.1 **Corrective Aggregate**

Any corrective aggregate shall be distributed directly in front of the recycling train. The methods used to determine the addition rate of corrective aggregate in accordance with the mix design, are subject to the approval of the Consultant.

##### 3.56.4.2 **Recycling Equipment**

Single stage CIR units in which the milling, crushing, screening, mixing and placement of the stabilized pavement material is performed using one machine shall not be used.

The equipment used shall be specifically designed for performing CIR with the ability to:

- a. Cold mill a full lane width and shoulder of asphalt pavement to the depth specified in the Contact Documents.
- b. Size and screen, where necessary, the reclaimed asphalt pavement to meet specified gradation requirements.
- c. Measure and regulate the mass of reclaimed material being processed prior to the addition of the bituminous stabilizer. Scales and other measurement systems shall be calibrated to the manufacturer's tolerance at the start of the Contract and when requested by the Consultant.
- d. For emulsified asphalt stabilization, 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 percent of the reclaimed material feed.
- e. For foamed asphalt stabilization, an asphalt cement expansion system capable of optimum expansion and an injection system capable of injecting and blending foamed asphalt uniformly throughout the reclaimed material in the required amount within 0.2 percent of the reclaimed material feed.
- f. Monitor and accurately control the addition of water.
- g. Produce a uniform and thoroughly blended CIR mix.

##### 3.56.4.3 **Placement 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 cross fall and grade. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed that is not to be heated and is capable of vibrating the full width of mix placed.

A pick-up machine or material transfer unit shall be used to feed the paver hopper. When a pick-up machine is used it shall be so operated that the entire windrow to the underlying surface is picked up.

#### 3.56.4.4 **Compaction Equipment**

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

#### 3.56.4.5 **Straight Edge**

The Contractor shall supply a 3 m metal straight edge for determining conformance to surface tolerance requirements. When requested the Contractor shall provide the Consultant with the use of the straight edge instrument.

### 3.56.5 CONSTRUCTION

#### 3.56.5.1 **Operational Constraints**

When using an emulsion stabilizing agent 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. When using foamed asphalt the work shall not be carried out when the ambient temperature is less than 5°C. The work shall be carried out when the roadway is clean and free of standing water.

When emulsion is used for bituminous stabilization, the wearing surface course shall not be placed until the Contractor has demonstrated that the specification requirements have been met.

When foamed asphalt is used for bituminous stabilization, the wearing surface course shall not be placed until the CIR mix has been allowed to cure for a minimum of 2 days and the Contractor has demonstrated that the specification requirements have been met.

The wearing surface shall be placed no later than 30 days following placement of the CIR mat, provided the CIR mix meets specification requirements. The Contractor shall schedule his operations to ensure that prior to winter shutdown, all accepted CIR is covered with a wearing surface or subsequent lift of ACP. A tack coat shall be applied to the CIR mat prior to paving, in accordance with Specification 3.19, Prime, Tack and Fog Coats.

#### 3.56.5.2 **General**

The CIR mix shall be spread and compacted to the specified width, thickness and cross slope dimensions. The Contractor shall be responsible for managing and disposing of any excess CIR or reclaim pavement material in a manner subject to the approval of the Consultant. Spreading excess material across existing paved shoulders will not be permitted. No separate or additional payment will be provided to the Contractor for the disposal of excess materials unless otherwise provided in the special provisions.

Asphalt pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable ACP using the mix specified for top lift paving. The ACP shall be placed to the specified CIR depth in accordance with Specification 3.50.

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

#### 3.56.5.3 **Preparation of Longitudinal and Transverse Joints**

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.

#### 3.56.5.4 **Mixing**

The bituminous stabilizer shall be added at the design rate. The rate of addition may be adjusted to the allowable field adjustment rate up to a maximum of 0.3 percent from the approved JMF rate to produce a uniformly coated CIR mix that can be compacted to the required density.

The Contractor shall add water, when required, in a controlled manner to facilitate uniform mixing.

#### 3.56.5.5 **Surface Appearance**

The compacted CIR mat shall be smooth and conform to the cross fall and grade specified in the contract documents. The surface of the CIR mat shall be of uniform texture, free of segregation and any visually failed areas.

#### 3.56.5.6 **Interim Lane Markings**

The Contractor shall provide interim lane markings on the newly constructed CIR surface, or tacked CIR surfaces that are to be exposed to traffic overnight.

Interim lane markings shall meet all the requirements of Specification 3.50, Asphalt Concrete Pavement - EPS, Section 3.50.5.8, Interim Lane Markings.

### 3.56.6 QUALITY CONTROL

#### 3.56.6.1 **General**

Quality control activities and testing is the responsibility of the Contractor throughout every stage of the Work. Tests that may be performed by the Consultant to determine compliance with specifications will be quality assurance tests and will not be considered as quality control tests.

The Contractor shall submit all QC test reports and summaries in writing to the Consultant representative prior to 2:00 p.m., on the next working day, except when otherwise indicated by the Consultant.

The Contractor will be responsibility for all costs associated with quality control and for obtaining

quality assurance samples as herein specified.

### 3.56.6.2 Demonstration Section

As part of the quality control process the Contractor shall assemble all items of equipment for the recycling operation on the first day of work. The Contractor shall construct a demonstration section on the project consisting of 300 linear metres of one lane width and shoulder, or as approved by the Consultant. The Contractor shall have on site personnel experienced in CIR work to monitor the demonstration section, advise on suitability of mixed material, bituminous stabilizer dispersion within the mixed material, moisture control within the mixed material, compaction and surface finish. Bulk application rates are to be determined for bituminous stabilizing agent, water and corrective aggregate (if required) and thickness checks completed for processing depths. This information is to be provided to the Consultant.

Prior to continuing with CIR operations the Consultant will review the demonstration section, and subsequent demonstration sections (if required), for visual appearance and the results of the bulk application checks and processing depths. Further CIR operations shall not continue until the Consultant determines the operations to be suitable.

If the Consultant determines the operations to be unsuitable the Contractor shall make necessary adjustments and undertake a second demonstration section with the same monitoring as required for the first section. The demonstration section process shall continue until the Consultant determines that the CIR operations conforms to specification requirements.

The Contractor shall be responsible for the repair, removal, or replacement of any demonstration section material that the Consultant determines to be unacceptable.

### 3.56.6.3 Quality Control Testing

The Contractor shall sample, test, and evaluate the CIR process in accordance with the minimum frequencies provided in Table 2.

**Table 2**  
**Minimum Quality Control Frequencies**

TEST OR ACTION	FREQUENCY	TEST METHOD
Daily Inspection Report	Daily - Provide to the Consultant the following day	<b>Note 1</b>
Density of CIR and % Compaction	1 per 300 lin.m.	ATT 11
Air Temperature	4 per day	-
Road Surface Temperature	1 per day at start of production	-
Processing Depth Checks	1 per 200 m	<b>Note 2</b>
Bulk Application Rates (daily rates and rates since last test)	1 per 500 m	-
Corrective Aggregate Gradation (if applicable)	One per 8 hour shift of crusher operation or a minimum of three test, whichever is greater	ATT 26
Marshall Density (75 Blow)	3 per Lot	ATT 13

TEST OR ACTION	FREQUENCY	TEST METHOD
Obtain CIR slab or core samples for QA testing of moisture and compaction	2 samples per segment (emulsion) 1 sample per segment (foamed)	As outlined in section 3.56.7
Obtain samples of bituminous stabilizer for QA testing.	One sample per three Lots	ATT-42
Tensile Strength Testing	At least once per each Mix Design or minimum three per Project	Note 3

**Note 1** - Daily Inspection Report. The Contractor shall maintain a daily inspection report documenting the following information where applicable.

Date

Highway and direction of travel

Beginning and end stations

Air and road temperatures

Calibration Control Settings

Processing Depth Checks

Total area treated

Water and asphalt counter reading (beginning, end, total)

Bulk application rates for bituminous stabilizer and corrective aggregate

**Note 2** - To check that the automatic sensor system is functioning correctly, the actual depth of cut shall be physically measured by the Contractor at both ends of the milling drum at least once every 200 metres along the cut length.

**Note 3** - Specimens shall be prepared as outlined in section 3.56.3.

### 3.56.7 QUALITY ASSURANCE

#### 3.56.7.1 **General**

Quality assurance (QA) testing shall be carried out by the Consultant. Samples shall be tested to determine compliance for moisture content and compaction. Acceptance criteria shall be based on the Lot mean computed from QA test results for each segment within a Lot.

If a tested sample fails to meet the Contract requirements, the Consultant will notify the Contractor of the failure immediately.

#### 3.56.7.2 **Lot Size**

A Lot shall consist of a single day's production of more than 4 hours of CIR processed to a given mix design. Production from a day of less than 4 hours may be combined with the previous Lot or following Lot as determined by the Consultant.

Each lot shall be divided into a minimum of three equal segments of 7 000 square metres or smaller.

#### 3.56.7.3 **Samples of CIR Mat**

At least four (4) days prior to the planned overlay of the CIR mat, the Contractor shall obtain

either slab or core samples of the CIR mix for each segment taken at random locations, as directed by the Consultant. Slab samples shall measure 150 x 150 mm and core samples shall measure 150 mm in diameter. Each sample shall be dry cut and removed intact from the CIR mat. It shall be packaged in non-absorptive materials to protect sample integrity, sealed in waterproof containers, appropriately labeled, and delivered by the Contractor in good condition to the Consultant laboratory within 24 hours of sampling.

If an emulsion stabilizing agent is used then two samples shall be obtained for each segment. One sample shall be tested for moisture content and the other shall be tested for compaction.

If a foamed asphalt process is used then one sample shall be obtained per segment and tested for compaction.

If a sample condition is found to be unsuitable for testing by the laboratory, the Contractor will be notified immediately by the Consultant to resample that location. The Contractor shall resample that location and resubmit the samples at their own cost.

The Contractor may carry out quality control sampling and testing of the CIR mat at his own cost.

Holes resulting from the removal of samples shall be repaired using surface course ACP mix type or other material approved by the Consultant.

### 3.56.8 ACCEPTANCE CRITERIA

#### 3.56.8.1 **Acceptance Criteria for Moisture Content**

The moisture content shall be determined according to ATT 15. Acceptance will be granted when the mean moisture content for each lot is less than two percent and no individual segment moisture content exceeds three percent. A lot of CIR material with mean moisture content above two percent may be accepted at the discretion of the Consultant.

#### 3.56.8.2 **Acceptance Criteria for Compaction**

The compaction of the CIR mix shall be determined according to ASTM D 1188 or ASTM D6752. Each lot of CIR mix shall be compacted to a minimum mean of 96.0 percent of the Lot mean Marshall Density with no segment result falling below 95.0 percent.

#### 3.56.8.3 **Bituminous Stabilizer**

The supplied emulsified asphalt or asphalt cement samples shall be compliant with the requirements herein when tested according to the test methods designated.

Failure of the sample to conform to any of the material requirements shall be cause for rejection of the material. The CIR that has incorporated bituminous stabilizer represented by the failed test result shall be unacceptable and remedial measures up to and including removal and placement of the deficient mix shall be negotiated with the Consultant.

#### 3.56.8.4 **Surface Tolerance and Appearance**

After compaction the Consultant will inspect the CIR mat for surface tolerances and appearance.

The surface of the CIR mat shall be free from localized deviations exceeding 10 mm, as measured in any direction with a three metre straight edge. The finished CIR mat shall also meet the surface tolerances for base course work as outlined in specification amendment AMC\_S155 Amendment to Specifications 2.3 Grading, 3.1 Subgrade Preparation and all Base Course Specifications Regarding Tolerance for Surface Finish.

The CIR mat shall be free of any visually failed areas and severe segregation in accordance with Specification 3.50.4.7 Pavement Segregation Requirements.

#### **3.56.8.5 Repair of Unacceptable CIR Mat**

Unacceptable CIR material shall be repaired by removal and replacement with Asphalt Concrete Pavement. The depth of removal shall be for the full extent of the deficiency or 50 mm, whichever is greater. Repairs shall extend across the full lane width of recycling. Reprocessing may be considered as a repair method, upon submission of a proposal by the Contractor and approval by the Consultant.

Localized deviations in excess of 10 mm may be patched using asphalt concrete material.

No additional payment will be provided for the repair of unacceptable CIR material or localized surface deviations.

#### **3.56.9 MEASUREMENT AND PAYMENT**

Measurement of the area of accepted cold in-place recycled mix placed shall be made in square metres.

Payment will be provided at the unit price bid per square metre for “Cold In-Place Recycling” and shall be full compensation for all labour, sampling and quality control, equipment and material to do the work, including the supply of bituminous stabilizer, Portland cement or other additive, disposal of excess CIR material and ACP placed in areas inaccessible to the reclaiming equipment.

Payment for the supply and incorporation of corrective aggregate, when required, shall be as “Extra Work”.

No payment will be provided for any materials used for repair.