State of Illinois Department of
Transportation Bureau of Local
Roads and Streets

SPECIAL PROVISION FOR COLD IN-PLACE RECYCLING (CIR) WITH EMULSIFIED ASPHALT

Effective: April 1, 2012
Revised: January 4, 2019

All references to Divisions, Sections, and Articles in this Special Provision shall be construed to mean specific Divisions, Sections, and Articles in the Standard Specifications for Road and Bridge Construction adopted by the Department of Transportation.

Description. This work shall consist of cold milling and pulverizing existing bituminous layers to a specified depth and maximum size; mixing emulsified asphalt, water, and additives with the recycled material; and spreading and compacting the mixture.

Materials. Materials shall be according to the following Articles of Division 1000 – Materials.

Item	Article/Section (Item Article/Section
(a) Portland Cement (Note 1)	1001
(b) Water	1002
(c) Fine Aggregate (Note 2)	1003
(d) Coarse Aggregate (Note 2)	1004
(e) Fly Ash (Note 1)	1010.02
(f) Lime Slurry (Note 1)	1012.04
(g) Reclaimed Asphalt Pavement (Note 3)	1031
(h) Emulsified Asphalt (Note 4)	1032.06
(i) Cold Pulverized Material (Note 5)	
(j) Mix Design (Note 6)	

Note 1. If necessary, the mix design may require additional additives to increase fines in the mix. The type and allowable percentage will be described in the mix design.

Note 2. The mix design will specify gradation and quality of any additional aggregate.

Any additional fine aggregate shall meet Class B quality as a minimum. Any additional coarse aggregate shall meet Class C quality as a minimum.

Note 3. The Engineer may allow reclaimed asphalt pavement (RAP) from Conglomerate "D" Quality or better RAP stockpiles as specified in Article 1031.02 or from millings of the existing highway. The RAP material shall not exceed the maximum size requirement of the cold pulverized material, and when blended with the cold pulverized material shall produce a product which meets the specifications of the mix design.

Note 4. The emulsified asphalt shall be selected for the project by the emulsified asphalt supplier based on the Contractor's mixture design. The penetration of the supplied emulsified asphalt shall be within ± 25 percent of the penetration of the design emulsified asphalt. A representative from the emulsified asphalt supplier shall be on the job site at the beginning of the project to monitor the characteristics and performance of the emulsified asphalt. Throughout the job, the representative shall be available to check on the project and make adjustments to the emulsified asphalt formulation as required. The emulsified asphalt shall be received on the job site at a temperature no greater than 120 ºF (49 ºC).

The emulsified asphalt shall meet the following requirements:

CIR-FDR EMULSIFIED ASPHALT MATERIAL SPECIFICATION			
Test	Procedure	Minimum	Maximum
Viscosity, Saybolt Furol, at 77°F (25°C), SFS	AASHTO T 59	20	100
Sieve Test, No. 20 (850 µm), retained on sieve, %	AASHTO T 59		0.10
Storage Stability Test, 24 hr, %	AASHTO T 59		1.0
Distillation Test, Residue from distillation to 347 ± 9 °F (175 ± 5 °C), %	AASHTO T 59 [1]	64.0	
Oil distillate by volume, %	AASHTO T 59		1.0
Penetration, 77 ° F (25 °C), 100 g, 5 s, dmm	AASHTO T 49	75	200

Note: 1. Modified AASHTO T 59 procedure – distillation temperature of 347 ± 9 °F (175 ± 5 °C) with a 20 minute hold.

Note 5. Prior to the addition of the emulsified asphalt, the gradation of the cold pulverized material shall meet the following:

COLD PULVERIZED MATERIAL GRADATIONS		
Grad No.	Sieve Size and Percent Passing	
	1 1/2 in. (37.5 mm)	1 in. (25 mm)
PM 1	100	
PM 2 [1]		100

PM 2 shall only be used when a finer gradation of RAP is required by the mix design.

Note 6. A mix design for each distinct section shall be submitted to the Department prior to construction using actual materials (in-situ sampled by the Contractor and new materials from the Contractor's material suppliers) proposed for the project. The job mix formula shall meet the following criteria and be approved by the Engineer.

CIR WITH EMULSIFIED ASPHALT MIX DESIGN REQUIREMENTS		
Test Method	CIR	Test Purpose
Gradation for Design Millings, AASHTO T 27	Report	
Design Moisture Content	Report	Dispersion of Emulsion
Superpave Gyratory Compaction, 1.25° angle, 87 psi (600 kPa)	30 gyrations at 4 in. (100 mm) [1]	Laboratory Density Indicator
Bulk Specific Gravity (Density), ASTM D 6752 or ASTM D 2726	Report	Laboratory Density Indicator
Rice (Maximum Theoretical) Specific Gravity, ASTM D 2041	Report	Laboratory Density Indicator
Air Voids	Report	Laboratory Density Indicator
Marshall Stability, ASTM D 1559, lbs (kg)	1250 (567) minimum [1]	Stability Indicator
Retained Stability, %	70 minimum	Moisture Damage Resistance
Raveling Test, 50 ° F (10 °C), %	2 maximum	Raveling Resistance
Additional Additive(s) [2]		
Coarse Aggregate	Report	
Fine Aggregate	Report	
RAP	Report	
Fly Ash	Report	
Cement, %	1.0 maximum	
Emulsified Asphalt [2]		
Distillation Residue, % Residue	Report	
Penetration, dmm Optimum	Report	
Emulsion Content, % Residual	Report	
Asphalt to Cement Content Ratio	3:1 minimum	

Notes: 1. 6 in. (150 mm) samples may be used; however, if 6 in. (150 mm) samples are used, the Marshall Stability is required to be 2,500 lb (1134 kg) minimum.

2. Report shall include type/gradation and producer/supplier.

Equipment. Equipment shall be according to the following Articles of Division 1100 – Equipment.

Item	Article/Section
(a) Self-Propelled Pneumatic-Tired Rollers (Note 1)	1101.01(c)
(b) Steel Wheel Tandem Rollers	1101.01(e)(1)
(c) Vibratory Roller (Note 2)	1101.01(g)
(d) Mechanical Sweeper	1101.03
(e) Self-Propelled Milling Machine	1101.16(a)
(f) Spreading and Finishing Machine	1102.03
(g) Multi-unit Recycling Train (Note 3, 5)	
(h) Single-unit Recycler (Note 4, 5)	
(i) Pick-Up Machine (Note 6)	

Note 1. The self-propelled pneumatic-tired roller shall have a gross weight (mass) of not less than 25 tons (23 metric tons).

Note 2. The double drum vibratory rollers shall have a gross operating weight (mass) of not less than 10 tons (9 metric tons) and a width of 78 in. (1950 mm).

Note 3. The multi-unit recycling train shall contain the following.

a. A self-propelled cold milling machine that is capable of pulverizing the existing bituminous material in a single pass to the depth shown on the plans and to a minimum width of not less than 12.5 ft (3.8 m). The machine shall have automatic depth controls to maintain the cutting depth to within ± 0.25 in. (6 mm) of that shown on the plans, and shall have a positive means for controlling cross slope elevations. The use of a heating device to soften the pavement will not be permitted.

b. A material sizing unit having screening and crushing capabilities to reduce the cold pulverized material to the appropriate size. The screening and crushing unit shall have a closed circuit system capable of continuously returning oversized material to the crusher. All of the pulverized material (100 percent) shall be processed to the maximum size requirements as specified.

c. A mixing unit equipped with a belt scale for the continuous weighing of the pulverized and sized bituminous material and a coupled/interlocked computer controlled liquid metering device. The mixing unit shall be an on-board completely self-contained pugmill. The liquid metering device shall be capable of automatically adjusting the flow of emulsified asphalt to compensate for any variation in the weight of pulverized material coming into the mixer. The metering device shall deliver the amount of emulsified asphalt to within ± 0.2 percent of the required amount by weight of pulverized bituminous material (for example, if the design requires 3.0 percent, the metering device shall maintain between 2.8 percent to 3.2 percent). The emulsified asphalt pump should be of sufficient capacity to allow emulsion contents up to 3.5 percent by weight of pulverized bituminous material. Also, automatic digital readings will be displayed for both the flow rate and total amount of pulverized bituminous material and emulsified asphalt in appropriate units of weight and time.

Note 4. The single-unit recycler shall be a self-propelled cold milling machine/cold recycling machine with a down cutting cutter head capable of pulverizing and recycling the existing hot-mix asphalt pavement to a maximum depth of 5 in. (125 mm), incorporate the emulsified asphalt and water, and mix the materials to produce a homogeneous material. The minimum power of this machine is 900 hp (670 kW). The machine shall be capable of pulverizing and recycling not less than 12.5 ft (3.8 m) wide in each pass. The machine shall have two systems for adding emulsified asphalt and water, with each system having a full-width spray bar with a positive displacement pump interlocked to the machine's ground speed to insure that the amount of emulsified asphalt and water being added is automatically adjusted with changes to the machine's ground speed. Each additive system shall have its own spray bar equipped with 2 nozzles per ft (6 nozzles per m) of spray bar and be capable of incorporating up to 7 gal/sq yd (31.7 L/sq m) of emulsified asphalt and/or water. Individual valves on the spray bar shall be capable of being turned off as necessary to minimize emulsified asphalt and water overlap on subsequent passes.

Note 5. Any additives such as water, lime slurry, etc. added by the recycling equipment at the mill head or mixing unit shall be controlled through liquid metering devices capable of automatically adjusting for the variation in the weight of the pulverized material going into the mixing unit. The metering devices shall be capable of delivering the amount of additive to within ± 0.2 percent of the required amount by weight of the pulverized bituminous material. A capability of adding up to 5% water by weight of the pulverized bituminous material, if necessary based on environmental and material requirements, is mandatory. It will not be required to meter the water added at the milling machine to control dust in the screens, belts, or crusher/material sizing unit.

Note 6. The pick-up machine shall be capable of removing the entire windrow down to the remaining underlying material.

CONSTRUCTION REQUIREMENTS

Weather Limitations. This work shall be performed when the atmospheric temperature in the shade and away from artificial heat is 50 °F (10 °C) and rising. Also, the weather shall not be foggy or rainy. The weather forecast shall not call for freezing temperature within 48 hours after placement of any portion of the project. The Engineer may restrict work when the heat index is greater than 100 °F (38 °C).

Preparation of Existing Pavement. Grass and other vegetation shall be removed from the edge of the existing pavement to prevent contamination of the pulverized bituminous material during the milling operation.

The existing pavement shall be milled to the required depth and width as indicated on the plans. Recycling shall be in a manner that does not disturb the underlying material in the existing roadway. The milling operation shall be conducted so that the amount of fines occurring along the vertical faces of the cut will not prevent bonding of the cold recycled materials. The pulverized bituminous material shall be processed to the required gradation specified. When a paving fabric is encountered during the CIR operation, the Contractor shall make the necessary adjustments in equipment or operations so that at least 90 percent of the shredded fabric in the recycled material is no more that 5 sq in. (3200 sq mm). Additionally, no fabric piece shall have any dimension exceeding a length of 4 in. (100 mm). These changes may include, but not be limited to, adjusting the milling rate or screens in order to obtain a recycled material meeting specification requirements. The Contractor shall be required to waste material containing over-sized pieces of paving fabric as directed by the Engineer. When the Contractor is aware that paving fabric exists, such as indicated on the plans, the Contractor will not receive additional payment. However, if the Contractor is not made aware of the paving fabric, then the Contractor shall receive additional payment for any necessary adjustments in equipment and operations.

Mixing Operation. The pulverized material shall be processed through a mixing unit capable of combining the pulverized material, emulsified asphalt, and any additives to produce a homogeneous recycled mixture. The emulsified asphalt shall be incorporated into the pulverized bituminous material at the initial rate determined by the mix design(s) and approved by the Engineer. Sampling and mix design may determine different levels of emulsified asphalt at various portions of the project.

Spreading and Finishing. The recycled material shall be spread using a self-propelled paver. A pick-up machine shall be used to transfer the windrowed recycled material into the spreading and finishing machine. The pick-up machine must be within 150 ft (45 m) of the mixing unit. The recycled material shall be spread by a spreading and finishing machine in one continuous pass, without segregation, and to the lines and grades established by the Engineer.

Compaction. The compacted recycled material shall be at a thickness of 2.5 to 5.0 in. (63 to 125 mm). The recycled material shall be compacted according to the following.

(a) Growth Curve. Compaction shall be accomplished by performing a growth curve within the first one-half mile of production. If an adjustment is made to the emulsified asphalt application rate or recycled depth, the Engineer reserves the right to request an additional growth curve. The growth curve, consisting of a plot of lb/cu ft (kg/cu m) versus number of passes with the project breakdown roller, shall be developed. Roller speed during the growth curve testing shall be the same as the normal paving operation. This curve shall be established by use of a nuclear gauge. Tests shall be taken after each pass until the highest lb/cu ft (kg/cu m) is obtained. This value shall be the target density.

A new growth curve is required if the rollers used on the growth curve are replaced with a new roller during production. The target density shall apply only to the specific gauge used. If additional gauges are to be used to determine density specification compliance, the Contractor shall establish a unique minimum allowable target density from the growth curve location for each gauge.

(b) Rollers. Immediately after processing and final shaping, the recycled material shall be compacted with equipment meeting the following requirements.

MINIMUM ROLLER REQUIREMENTS FOR CIR			
Breakdown Roller (one of the following)[1]	Intermediate Roller [1]	Final Roller (one or more of the following)[1]	Density Requirement
V_S, V_D	P	V_S, T_F	95 - 102 percent of the target density obtained on the growth curve

Note): 1. Equipment definitions in Table 1 of Article 406.07.

(c) Rolling. Breakdown rolling shall be achieved by using a vibratory roller either operating in a static or vibratory mode. Vibratory mode should only be used if it is shown to not damage the pavement. Intermediate rolling shall be completed by a self-propelled pneumatic-tired roller(s) until no displacement is occurring or until the pneumatic-tired roller(s) is walking out of the mixture. Final rolling to eliminate tire marks and to achieve density shall be done by a separate double drum steel roller(s) operating in static mode.

Rolling shall start no more than 30 minutes behind the paver. Finish rolling shall be completed no more than one hour after milling is completed. When possible, rolling shall not be started or stopped on uncompacted material but with rolling patterns established so that they begin or end on previously compacted material or the existing pavement.

Opening to Traffic. After the completion of compaction of the recycled material, no traffic, including that of the Contractor, shall be permitted on the completed recycled material for at least two hours. After two hours, rolling traffic may be permitted on the recycled material. This time may be adjusted by the Engineer to allow establishment of sufficient cure so traffic will not initiate raveling or permanent deformation. All loose particles that may develop on the pavement surface shall be removed by power brooming.

After opening to traffic, the surface of the recycled pavement shall be maintained in a condition suitable for the safe movement of traffic.

Maintenance. The Contractor shall maintain the recycled pavement in a manner satisfactory to the Engineer until the wearing course has been constructed. Maintenance related to Contractor construction procedures or quality of work, shall not be paid for separately.

Curing. Before placing the specified wearing course, the recycled pavement shall be allowed to cure until the moisture of the material is reduced to 2.0 percent or less, or approval of the Engineer. Unless otherwise directed by the Engineer, the specified wearing course shall be placed within two weeks of the recycled pavement final cure, but no later than November 1.

Surface Tests. The completed recycled pavement will be tested for smoothness in the wheel paths with a 16 ft (5 m) straightedge.

For each variation in the recycled pavement that exceeds 3/8 in. (10 mm), the entire area affected shall be corrected by a self-propelled milling machine. The recycled pavement shall be swept by a mechanical broom to remove all loose material from the recycled pavement before opening to traffic.

The Contractor shall furnish a 16 ft (5 m) straightedge and shall provide for its jobsite transportation at no additional cost to the Department.

Quality Assurance/ Quality Control (QC/QA).

(a) Quality Control by the Contractor. The Contractor shall perform or have performed the inspection and tests required to assure conformance to contract requirements. Control includes the recognition of obvious defects and their immediate correction. This may require increased testing, communication of test results to the job site, modification of operations, suspension of the work, or other actions as appropriate.

The Engineer shall be immediately notified of any failing tests and subsequent remedial action. Passing tests shall be reported to the Engineer no later than the start of the next work day.

(b) Quality Assurance by the Engineer. The Engineer will conduct independent assurance tests on split samples taken by the Contractor for quality control testing. In addition, the Engineer will witness the sampling and splitting of these samples and will immediately retain witnessed split samples for quality assurance testing.

(c) Tests Methods and Frequency.

(1) Depth of Pulverization (Milling). The nominal depth at the centerline shall be required. Anytime depth changes are made or equipment is idle, a depth check shall be taken.

(2) Pulverized Material Sizing and Gradation. A sample shall be obtained before emulsified asphalt addition and screened using a 1.5 in. (37.5 mm) sieve (or smaller sieve if required) to determine if meeting the maximum particle size requirement. Gradations shall be performed each day on the moist millings using the following sieves: 1.5 in., 1.0 in., 3/4 in., 1/2 in., 3/8 in., No. 4, No. 8, No. 16, and No. 30. The resulting gradation shall be compared to the mix design gradations to determine any necessary changes to emulsion content.

Sampling procedures shall generally be in accordance with ASTM D 979 or AASHTO T 168. When the Engineer determines the location for a gradation sample, the Contractor will be notified to turn off the emulsified asphalt and mark the location continuing to pulverize the hot-mix asphalt pavement until the Engineer is satisfied with the length of material pulverized without the addition of the emulsified asphalt. The maximum length of pulverization without the addition of the emulsified asphalt shall not exceed 100 ft (30 m). After the Contractor collects the gradation sample, the machine will be backed up to the location where the emulsified asphalt was turned off, then re-pulverize this material, adding the required amount of emulsified asphalt to the pulverized material.

(3) Emulsified Asphalt Content. The Engineer shall be notified any time emulsified asphalt content is changed. The emulsified asphalt content shall be checked and recorded for each segment in which the percentage is changed. Emulsified asphalt content changes shall be made based upon mix design recommendations, which are based upon different mix designs for road segments of varying construction. The emulsified asphalt content shall be checked from the belt scale totalizer or emulsified asphalt pump totalizer.

(4) Water Content. The Engineer shall be notified any time the water content is changed. Water content at the milling head shall be checked and recorded for each segment in which the percentage is changed. This information shall be gathered from the water metering device, which can be checked from the belt scale totalizer to verify daily quantities used. Water content changes shall be made based on mixture consistency, coating, and dispersion of the recycled materials.

(5) Compacted Density. A wet density shall be determined using a nuclear moisture-density gauge generally following the procedures for ASTM D 2950, backscatter measurement. This measurement shall be compared to the target density obtained by the growth curve.

(6) Frequency. The following table provides the minimum frequency for tests; however, the Engineer may increase the testing frequency if the construction process is experiencing problems or unknown conditions are encountered.

QC/QA TESTING FREQUENCY		
Test	QC Frequency [1]	QA Frequency [1]
Depth of Pulverization	1 per 500 ft (150 m)	1 per 1000 ft (300 m)
Pulverized Material Sizing and Gradation	1 per 0.5 day of production	1 per day of production
Emulsified Asphalt Content	1 per 500 ft (150 m)	1 per 1000 ft (300 m)
Water Content	1 per 500 ft (150 m)	1 per 1000 ft (300 m)
Compacted Density	1 per 0.25 mile (0.4 km)	1 per mile (1.6 km)

Note: 1. The Contractor shall perform all quality control tests within the first 500 ft (150 m) after startup or any change in the mix. The Department will also run the split samples at these locations.

Method of Measurement.

Bituminous materials will be measured for payment as specified in Section 1032.

Coarse aggregate will be measured in square yards (square meters).

The cold in-place recycling will be measured in square yards (square meters) of the recycled pavement.

Basis of Payment.

The bituminous material will be paid for at the contract unit price per ton (metric ton) for CIR-FDR EMULSIFIED ASPHALT.

The coarse aggregate will be paid for at the contract unit price per square yard (square meter) for ADD ROCK.

The cold in-place recycling will be paid for at the contract unit price per square yard (square meter) for COLD IN-PLACE RECYCLING, of the thickness specified.

If provided as a payment item, the additional cement, lime or fly ash required by the mix design will be measure and paid as specified in Section 302. If not provided as a payment item, the cost of additional cement, lime or fly ash required by the mix design will be paid for according to Article 109.04.