SPECIAL SPECIFICATION

3305

Reflective Crack Relief Interlayer (RCRI)

1. **Description.** This Item shall govern for the materials and construction requirements for producing and placing a Reflective Crack Relief bituminous interlayer (RCRI) to be placed in one lift (1 inch in thickness) in conformance with the lines, grades, and typical cross sections shown on the plans, or established by the Engineer. The Reflective Crack Relief Interlayer is a highly elastic, impermeable hot mix interlayer that is designed to delay reflective cracking from Portland Concrete Cement (PCC) pavements. The RCRI is applied with a conventional paver and roller(s) directly on the PCC or leveling course. The RCRI is a volumetrically controlled, performance designed interlayer, used in conjunction with overlays designed for local traffic patterns and loads.

The RCRI is a performance-designed interlayer using the combined effects of fine aggregates and modified binder. Its performance is qualified in the design stage utilizing the Flexural Beam Fatigue device (AASHTO TP-8), and controlled during production through the use of volumetrics, gradation, and binder content as outlined below.

(1) Unless otherwise stated, specification section references are from the 1993 version of the TxDOT Standard Specifications for Construction of Highways, Streets, and Bridges, and its supplements.

(2) The RCRI is a fine-graded, highly elastomeric polymer modified asphalt mixture. The RCRI shall meet all the requirements for asphaltic concrete in Item 340, except as modified herein.

2. **Materials.** All materials shall conform to TxDOT Standard Specifications for Construction of Highways, Streets, and Bridges and its supplements unless otherwise noted.

(1) **Asphalt Binder.** The Hveem Stability and Flexural Beam Fatigue, requirements of Section 3(3)(a) of this specification, determines the final formulation for the asphalt binder used in the RCRI. At a minimum, the asphalt binder shall meet the requirements of Table 1 with a PG high temperature of 76°C or higher and a PG low temperature of −22°C or lower. In addition, the asphalt binder must be smooth and homogeneous, and show no separation when tested in accordance with Test Method Tex-540-C.

Separation testing is not required if:
- a modifier is introduced separately at the mix plant either by injection in the asphalt line or mixer,
- the binder is blended on site in continuously agitated tanks, or
- binder acceptance is based on field samples taken from an in-line sampling port at the hot mix plant after the addition of modifiers.
<table>
<thead>
<tr>
<th>Performance Grade</th>
<th>PG 58</th>
<th>PG 64</th>
<th>PG 70</th>
<th>PG 76</th>
<th>PG 82</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average 7-day Max Pavement Design Temperature, °C</td>
<td>58</td>
<td>64</td>
<td>70</td>
<td>76</td>
<td>82</td>
</tr>
</tbody>
</table>

**ORIGINAL BINDER**

| Flash Point, AASHTO T 48: Min, °C | 230 |
| Viscosity, AASHTO TP 48: 2, 3 Max, 3.0 Pa•s, Test Temperature, °C | 135 |
| Dynamic Shear, AASHTO TP 5: 4 $G'$/$\sin(\delta)$, Min, 1.00 kPa Test Temperature @ 10 rad/sec., °C | 58 | 64 | 70 | 76 | 82 |
| Elastic Recovery, ASTM D 6084, 50°F, % Min | - | - | 30 | - | 30 | 50 | - | 30 | 50 | 60 | 30 | 50 | 60 | 70 | 50 | 60 | 70 |

**ROLLING THIN FILM OVEN (Tex-541-C)**

| Mass Loss, Max, % | 1.0 |
| Dynamic Shear, AASHTO TP 5: $G'$/$\sin(\delta)$, Min, 2.20 kPa Test Temperature @10 rad/sec., °C | 58 | 64 | 70 | 76 | 82 |

**PRESSURE AGING VESSEL (PAV) RESIDUE (AASHTO PP 1)**

| PAV Aging Temperature, °C | 100 |
| Dynamic Shear, AASHTO TP 5: $G'$/$\sin(\delta)$, Max, 5,000 kPa Test Temperature @10 rad/sec., °C | 25 | 22 | 19 | 28 | 25 | 22 | 19 | 28 | 25 | 22 | 19 | 28 | 25 | 22 | 19 | 28 | 25 | 22 |
| Creep Stiffness, AASHTO TP 1: 5, 6 $S^*$, Max, 300 MPa, $\mu$ – value, Min, 0.300 Test Temperature @ 60 sec., °C | -12 | -18 | -24 | -6 | -12 | -18 | -24 | -6 | -12 | -18 | -24 | -6 | -12 | -18 | -24 | -6 | -12 | -18 | -24 |
| Direct Tension, AASHTO TP 3: 5 Failure Strain, Min, 1.0% Test Temperature @ 1.0 mm/min., °C | -12 | -18 | -24 | -6 | -12 | -18 | -24 | -6 | -12 | -18 | -24 | -6 | -12 | -18 | -24 | -6 | -12 | -18 | -24 |

1 Pavement temperatures are estimated from air temperatures using an algorithm contained in a TxDOT supplied computer program, may be provided by the Department or by following the procedures outlined in AASHTO MP 2 and PP 28.

2 This requirement may be waived at the Department’s discretion if the supplier warrants that the asphalt binder can be adequately pumped, mixed, and compacted at temperatures that meet all applicable safety, environmental, and constructability requirements. At test temperatures where the binder is a Newtonian fluid, any suitable standard means of viscosity measurement may be used, including capillary (AASHTO T 201 or T 202) or rotational viscometry (AASHTO TP 48).

3 Viscosity at 135°C is an indicator of mixing and compaction temperatures that can be expected in the lab and field. High values may indicate high mixing and compaction temperatures. Additionally, significant variation can occur from batch to batch. Contractors should be aware that variation could significantly impact their mixing and compaction operations. Contractors are therefore responsible for addressing any constructability issues that may arise.

4 For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be substituted for dynamic shear measurements of $G'$/$\sin(\delta)$ at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary (AASHTO T 201 or T 202) or rotational viscometry (AASHTO TP 48).

5 Silicone beam molds, as described in AASHTO TP 1-93, are acceptable for use.

6 If creep stiffness is below 300 MPa, direct tension test is not required. If creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used instead of the creep stiffness requirement. The $\mu$-value requirement must be satisfied in both cases.

(2) Blended Aggregate.

(a) Description. The blended aggregate may consist of local materials; natural sands (60% maximum), crushed fines, and washed screenings (manufactured sands) that meet the criteria in Article 340.2 of the Standard Specification except as modified herein.

- RAP shall not be used in the RCRI
- Samples of each aggregate shall be submitted for approval in accordance with Item 6, “Control of Materials” of the Standard Specification
Acceptance of the RCRI is based on mixture qualities (performance, volumetrics, and stability) as set forth in this specification.

(b) **Gradation.** The blended aggregates shall meet the requirements shown in Table 2.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent by Weight (Tex-200-F, Part II)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8”</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>80 – 100</td>
</tr>
<tr>
<td>No. 8</td>
<td>60 – 85</td>
</tr>
<tr>
<td>No. 16</td>
<td>40 – 70</td>
</tr>
<tr>
<td>No. 30</td>
<td>25 – 55</td>
</tr>
<tr>
<td>No. 50</td>
<td>15 – 35</td>
</tr>
<tr>
<td>No. 100</td>
<td>8 – 20</td>
</tr>
<tr>
<td>No. 200</td>
<td>6.0 – 14.0</td>
</tr>
</tbody>
</table>

(c) **Sand Equivalent.** The sand equivalent of the total blend shall be a minimum of 45% as determined by Tex-203-F.

(d) **Material Acceptance.** All aggregates shall be sampled, tested, and approved by the Engineer, prior to use.

3. **Sampling and Design.** The Contractor shall provide the Job Mix Formula (JMF), Hveem Stability testing, and Flexural Beam Fatigue testing. The Contractor shall provide quality control in accordance with Item 340 of the Standard Specifications and technical support for production and placement of the RCRI.

(1) **Job Mix Formula.** The Contractor shall obtain, in the presence of the Engineer, representative samples of asphalt binder and mineral aggregates for testing. The samples of materials shall be of the size specified by the Engineer and shall be submitted to the designated laboratory for testing. The Contractor shall also develop and submit the Job Mix Formula, certified test results, and job control specimens for the Engineer's approval.

(a) No mixture will be accepted for use until the Job Mix Formula and job control specimens are approved by the Engineer.

(b) The Job Mix Formula shall be within the master range specified for the RCRI and shall include the type and sources of all materials, the gradations of the aggregates, the relative quantity of each material, and it shall state a definite percentage for each sieve fraction of aggregate and asphalt binder.

(c) The Job Mix Formula approved for the RCRI shall be in effect until modified in writing by the Engineer. The AASHTO TP-8 test results shall be submitted to the Engineer by an accredited laboratory. When unsatisfactory results or other conditions occur, or should a source of material be changed, a new Job Mix Formula may be requested in accordance with the requirements of this Specification.
(2) **Mixture Testing Procedures:** The RCRI shall be tested in accordance with Subarticle 340.3.(1), except as noted herein.

- No RAP shall be used in the RCRI
- Test Method Tex-200-F, Part II “Washed Sieve Analysis” shall be used to develop the JMF
- Moisture susceptibility testing is not required
- Individual aggregate quality limitations shall conform to Sections 2(2)(b) “Gradation” and 2(2)(c), “Sand Equivalent”.

(3) **Job Mix Formula Acceptance Criteria**

(a) Fifty gyrations \(N_{\text{max}} = 50\) shall be required for SuperPave gyratory compaction (150mm molds for volumetric properties). The Job Mix Formula shall meet the following volumetric and performance requirements. The RCRI for beam testing should be aged 4 hours at 135°C in accordance with AASHTO PP2-99 Section 7.2 “mechanical property testing”, prior to compacting the beams.

<table>
<thead>
<tr>
<th>Mixture Property</th>
<th>Test Procedure</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Content, %, min.</td>
<td>Tex-236-F</td>
<td>7.0</td>
</tr>
<tr>
<td>Air Voids (Va), %</td>
<td>Tex-207-F</td>
<td>0.5 - 2.5</td>
</tr>
<tr>
<td>Voids in the Mineral Aggregate (VMA), %, min.</td>
<td>Tex-207-F</td>
<td>16.0</td>
</tr>
<tr>
<td>Hveem Stability*, min.</td>
<td>Tex-208-F</td>
<td>18.0 min.</td>
</tr>
<tr>
<td>Flexural Beam Fatigue**, min., avg. of 2 samples</td>
<td>AASHTO TP-8</td>
<td>100,000 cycles**</td>
</tr>
</tbody>
</table>

* Test performed at 140°F using 100mm molds, 50 gyrations, and the Superpave Gyratory Compactor

** Test parameters: 2000 Microstrain, 10 Hz, 3.0±1.0% air voids*, 20°C

Note: The void requirement for the Flexural Beam Fatigue test specimens differs from the gyratory samples. The 3.0 ± 1.0% air voids represents the in-place construction density.

(b) **Job Control Specimens:** Job control specimens shall be produced using the proposed Job Mix Formula and shall be compacted to \(N_{\text{max}}\) (50 gyrations) using 150 mm SuperPave Gyratory Compactor Molds. The Voids in the Mineral Aggregate (VMA) and Air Voids (Va) shall be determined.

(c) The Contractor shall submit the Voids in the Mineral Aggregate (VMA) and Air Voids (Va) for the job control specimens to the Engineer. No mixture shall be placed on the project until the job control specimens have been verified by the Engineer.

4. **Construction Requirements and Quality Control.**

(1) **Surface and Base Preparation.** Immediately prior to applying the RCRI, the surface shall be thoroughly cleaned of all vegetation, loose materials, dirt, mud, visible moisture, and other objectionable materials. Joints larger than 1/2 inches wide shall be filled as determined by the Engineer. ASTM non-expansive crackfiller or silicone joint material that will not be affected by the heat of the RCRI during placement shall be used.
Any moderately or highly D-Cracked areas, high severity punch-out, blow-ups, and severe
distresses as listed in Distress Identification Manual for the Long-Term Pavement
Performance Project (SHRP-P-338) shall be repaired by a doweled, full-depth patch as
necessary.

Prior to the placement of the RCRI, large surface deformities (greater than 3 inches deep and
4 feet in diameter) shall be filled with approved hot mix. During placement of the RCRI,
smaller pavement deformities such as popouts, corner breaks, and spalls may be filled with
the RCRI mixture.

(2) Weather Limitations. The RCRI shall not be placed when either the air temperature or
the temperature of the surface on which the RCRI is to be placed is below 50°F. To
reduce the occurrence of blisters, the RCRI shall not be placed on a wet surface or
within 24 hours of a rain unless processes, approved by the engineer, have been taken to
dry the pavement.

(3) Application of Tack. Tack shall be applied in accordance with Item 300, “Asphalts,
Oils, and Emulsions”, and the tack shall be undiluted. Typical shot rates shall be 0.02
to 0.04 gallons per square yard (undiluted tack) as determined by the Engineer.
Cutback asphalt tack shall not be used.

A tack coat shall be placed between the hot mix overlay and the RCRI with diluted or
undiluted tack.

(4) Quality Control. The aggregate gradation and the asphalt binder content of the
produced mixture shall not vary from the JMF by more than the tolerances shown in
Table 4, except as approved by the Engineer. Control samples shall be taken every 750
tons based on random numbers supplied by the Engineer. Sampling will take place at
the Hot Mix Plant in accordance with Tex-222-F, “Sampling Bituminous Mixtures”.
Each sample will be tested for the following qualities:

- Tex-200-F, “Washed Sieve Analysis”
- Tex-236-F**, “Determining Asphalt Content from Asphalt Paving Mixtures by the
  Ignition Method”
- Tex-227-F, “Determining Maximum Specific Gravity of Bituminous Mixtures”
- Tex-207-F, Part I, “Bulk Specific Gravity of Bituminous Material”
- Tex-203-F, “Sand Equivalent”, (1 per 3 sublots)

Note: Completion of testing shall be within one working day of the end of the sublot.
** Correction factors for asphalt content and gradation (#200 sieve) shall be performed
prior to the completion of the test strip or first sublot during production. These
samples will be lab blended using the JMF binder content and placed in the ignition
oven. The difference between the oven’s display and the JMF binder content will be
used to correct the binder content during production.
(a) **Gradation Control.** The maximum deviation from the approved JMF shall be as shown in Table 4:

<table>
<thead>
<tr>
<th>Description</th>
<th>Test Method</th>
<th>Allowable Difference from Current JMF Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>% passing the No. 8 sieve</td>
<td>Tex-200-F</td>
<td>±4.0</td>
</tr>
<tr>
<td>% passing the No. 200</td>
<td>Tex-200-F</td>
<td>±1.0</td>
</tr>
<tr>
<td>Air Voids (Va), %</td>
<td>Tex-207-F</td>
<td>±0.5</td>
</tr>
<tr>
<td>VMA, %</td>
<td>Tex-207-F</td>
<td>±1.0</td>
</tr>
<tr>
<td>Asphalt Content, %</td>
<td>Tex-236-F</td>
<td>±0.3</td>
</tr>
</tbody>
</table>

(b) **Gradation Adjustment.** Adjustments to the Natural Sand portion of the gradation are limited to ±5% from the Job Mix Formula and not to exceed the 60% natural sand limit as outlined in Subarticle 2(2), “Blended Aggregate”.

(c) **Mixture Control.** Control specimens from the RCRI produced for the project shall be made in accordance with Item 340.3(2) Tex-207-F, Part I, “Bulk Specific Gravity of Bituminous Material”. The specimens shall be within the following volumetric criteria when compacted to N_max of 50 gyrations using a SuperPave gyratory Compactor.

(d) **Asphalt Content Control.** The asphalt binder content shall be within the tolerances shown in Table 4 above.

Samples of asphalt binder will be taken and sampled in accordance with Section 2(1), “Asphalt Binder” and Special Provision to Item 300, (300---062), Subarticle 300.2(11), “Acceptance of Performance Graded Binder”.

Per Subarticle 340.3(2), if 3 consecutive tests results for the mix, or 2 for the binder content, fall outside the specified range, production shall cease until test results or other information indicate, to the satisfaction of the Engineer, that the next mixture to be produced will be within the specified range.

(5) **Spreading, Compacting, and Finishing.**

(a) The RCRI shall be applied at a thickness of 1 inch with a tolerance of ±1/4 inch. The RCRI shall overlap the PCC longitudinal joints by at least 6 inches to eliminate construction joints over the underlying longitudinal joints.

(b) **Temperatures.** The RCRI should never be mixed hotter than 350°F. The RCRI supplier shall supply specific mixing, laydown, and compaction temperatures.

(c) **Compaction and Density.** Compaction operations shall start promptly after placement of the RCRI. Only steel wheel rollers in the static mode shall be used for compaction of the mixture. Density of the in-place place Reflective Crack Relief Interlayer shall be 96% minimum of the maximum specific gravity as determined by Tex-207-F, Part III, “Determining Density of Compacted
Bituminous Mixtures”. The average of all maximum theoretical specific gravities for the day’s placement will be used to calculate in-place road densities.

The recommended method for taking cores is to place paper in front of the paver at the location where the core will be taken, to prevent adhesion to the PCC.

(d) **Release to Traffic and Overlay Placement.** The place RCRI shall be covered with the binder course within five days after placement. The RCRI may be opened to traffic or covered with the hot mix overlay after cooling to less than 160°F or as determined by the Engineer.

(e) **Appearance.** After final rolling, the place RCRI should be deep black in appearance. The surface texture should be tight. Occasional small flushed areas approximately 1 foot by 1 foot are normal for the crack reducing purpose of the RCRI. More flushing than this may indicate that the mixture is out of specification. The quality control criteria should be verified in areas of concern.

Areas determined unacceptable by the Engineer, in accordance with this specification, shall be removed and replaced at no additional cost to the Department.

(f) **Blisters.** Due to the impermeability of the place RCRI and moisture within the PCC, small blisters may occur in the mat after rolling. If blisters occur and do not disappear by the time of overlay, blisters can be perforated, overlaid, or removed with a roller as determined by the Engineer.

(6) **Test Strip.**

(a) This work shall consist of constructing the RCRI test strips for each mix design to determine the needed adjustments to meet specifications.

(b) Test strips shall be constructed after approval of a Job Mix Formula and calibration of the bituminous hot mix plant. The test trip shall consist of approximately 250 tons or one hour’s production, whichever is less, of approved mix in a single lane within the project limits. The paver and rollers to be used on the project shall be used to place the test strip. Separate test strips shall be provided for each mix design. Acceptable test strips shall meet density and all other requirements for the mixture tested as outlined in Subarticle 4(4).

(c) Density will be determined in accordance with the requirements herein. If necessary, additional test strips shall be constructed until a rolling pattern has been established which would provide the specified density. A new test strip shall also be required whenever a change in the Job Mix Formula occurs, the compaction method or the compaction equipment is changed or unacceptable results occur. Test strips that do not have the specified density shall be removed as directed by the Engineer. No additional mix shall be laid until a rolling pattern, acceptable to the Engineer, has been established on a test strip.

(7) **Damaged Areas.** The Contractor shall replace at no additional charge any traffic-damaged or marred areas.
5. **Measurement.** The Engineer will measure the completed RCRI, including any multiple passes or lifts, to the nearest square yard. An adjusted or additional measurement of the completed surface will not be made except for authorized changes, by the Engineer, during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

6. **Payment.**

(1) **Reflective Crack Relief Interlayer.** The accepted quantity of the RCRI will be paid for at the unit price bid for “Reflective Crack Relief Interlayer.” The RCRI unit price is defined as the cost, per unit, of all materials (all aggregates and binder) used to meet the performance criteria of this specification.

(2) **Test strips.** The materials in test strips approved by the Engineer will be paid for at the unit price bid for those materials as provided in the contract. All materials in unacceptable test strips removed by the Contractor shall become the property of the Contractor and will be disposed of by the Contractor at his expense.