Item 358
Hot In-Place Recycling of Asphalt Concrete Surfaces

1. DESCRIPTION

Use the hot in-place process to recycle the existing pavement in one of the following sub-categories described below.

1.1. Recycling. Recycling is the process in which the existing asphalt pavement is heated, softened and then milled. A recycling agent is added and the material is thoroughly mixed and placed with a standard paving screed.

1.2. Remixing. Remixing is similar to recycling with the addition of virgin aggregate or new hot-mix asphalt (HMA) added to the recycled material. The materials are then thoroughly mixed and placed with a standard paving screed.

1.3. Repaving. Repaving combines either recycling or remixing with an overlay of new HMA placed immediately after the recycled mixture. The new HMA layer is placed directly on the recycled layer, and both are compacted simultaneously.

The Department will provide on the plans all typical sections and any grade change requirements; the depth and width of recycling required; core information from the existing roadway to include pavement layers, lift thicknesses; the asphalt content and penetration value of the existing asphalt to be recycled; and any other data collected from the pavement evaluation.

2. MATERIALS

2.1. Recycling Agent. Furnish a recycling agent in accordance with Section 358.4.2., “Mixture Design,” and meeting the requirements of Section 300.2.6., “Recycling Agent.” Other recycling agents may be allowed when approved or required when directed or shown on the plans.

2.2. Hot-Mix Asphalt. If the process requires additional HMA, furnish new HMA that meets the requirements of Section 358.4.2., “Mixture Design.” Use materials meeting the requirements of Article 340.2., “Materials,” to produce the new HMA. Other HMA mixture types are allowed when shown on the plans.

2.3. Aggregate. If the process requires additional aggregate, furnish aggregates to meet the requirements shown in Section 358.4.2., “Mixture Design.” Use aggregates meeting the requirements of Article 340.2., “Materials.”

3. EQUIPMENT

Provide required or necessary equipment in accordance with Item 320, “Equipment for Asphalt Concrete Pavement.”

3.1. Processing Equipment. Provide equipment that is capable of a continuous single pass, multi-step operation, including heating; milling; introducing recycling agent, virgin materials, or HMA (if determined necessary); mixing the reclaimed material; redistributing the recycled material; placing the mix and leveling it with an asphalt paver or paving screed; and compacting the mixture, that meets the following requirements.

3.1.1. Pavement Pre-Heaters. Supply pavement pre-heaters capable of uniformly heating the existing pavement to a temperature high enough to remove excess moisture and allow dislodging of the material to the specified depth, while minimizing the fracturing of aggregate particles. Equip heaters with an enclosed or shielded
hood to prevent damage to adjacent property or vegetation. Ensure that the heaters overlap the completed adjacent lane by a minimum of 6 in. to create a hot bond at the longitudinal joint.

3.1.2. **Pavement Milling Heads.** Provide milling heads for pavement recycling capable of uniformly loosening the entire pavement lane width to the depth specified on the plans. Accomplish the recycling by using milling heads that have a grade control system for each head. Ensure that the tooth spacing of the milling heads is enough to allow material to pass without excessive retention. Use equipment that is capable of raising and lowering the milling heads to recycle the material around manholes and other obstacles.

Equip the milling heads such that they are capable of gathering the heated and loosened asphalt concrete pavement. Operate the milling heads in such a manner to minimize aggregate degradation. Use milling heads that are capable of creating a windrow of the milled material ahead of the mixing chamber or subsequent milling units.

3.1.3. **Recycling Agent Application System.** Provide a system for adding and uniformly applying a recycling agent at the specified rate to the hot, loosened material. Control the system to within 5.0% of the target application rate. Equip the recycling agent system with positive on/off capabilities to prevent any dripping. Add the recycling agent during or after milling has taken place to provide uniform application of the recycling agent and adequate mixing with the recycled material during the mixing cycle.

3.1.4. **Mixing Unit.** Provide equipment with an on-board mixing chamber that is capable of thoroughly mixing the heated, reworked material with new materials. Enclose and configure the mixing chamber such that no milled material escapes or bypasses the mixer chamber. Ensure that the rotation of the mixer apparatus does not cause segregation during the mixing process.

3.1.5. **Paving Unit.** Furnish a paver or paver screed meeting the requirements of Section 320.2.3.1., “Asphalt Paver.”

3.2. **Rollers.** Provide rollers meeting the requirements of Article 210.2., “Equipment.”

3.3. **Broom.** Furnish rotary self-propelled power brooms. The broom should have positive control on the downward pressure applied to the surface.

3.4. **Field Laboratory.** Unless otherwise shown on the plans, furnish a mobile testing laboratory meeting the requirements of Tex-237-F and a Level 1A certified laboratory technician qualified under the Department’s approved program. If fresh HMA is added, perform the tests necessary to control plant production.

4. **CONSTRUCTION**

Rehabilitate existing asphalt concrete pavement to meet the typical sections shown on the plans and the lines and grades established. The existing pavement should be heated and milled to the required depth of treatment as shown on the plans.

4.1. **Certification.** Personnel certified by a Department-approved hot-mix certification program must conduct all mixture designs, sampling, and testing. Supply a list of certified personnel and copies of their current certificates before beginning production and when personnel changes are made.

4.2. **Mixture Design.** Design a mixture to meet the requirements listed in Table 1 using a Superpave Gyratory Compactor. Compact specimens at the anticipated production temperature between 200°F and 250°F at 50 gyrations in accordance with Tex-241-F. The target number of gyrations may be adjusted when approved. Submit the completed mix design for approval before the start of the project. Perform additional mix designs based on road variability, as directed.

4.2.1. **Sampling.** Before bidding, the Engineer will provide material and pavement information obtained from roadway cores, such as layer thicknesses, gradation, asphalt content and recovered asphalt penetration of the pavement to be recycled using the Construction Division’s protocol and guidelines. Additional cores may be taken by potential Bidders to obtain further information on the material to be recycled when approved.
After the project is awarded, obtain an adequate amount of roadway cores throughout the project to perform the mixture design and to determine the existing condition of the roadway to account for any variability within the project limits. Evaluate the material from the roadway cores and document any existing material that could be detrimental to the process (rubber seal, fabric underseal, etc.). A minimum of 2 in. of the existing pavement structure must remain in place following milling. Document any base or uncoated material within the layer to be recycled. Provide documentation of any of these conditions before proceeding with the mixture design.

4.2.2. **Job-Mix Formula Approval.** The job-mix formula (JMF) is the combined aggregate gradation and target asphalt recycling agent percentage established from the laboratory mixture design.

4.2.3. **Hot-Mix Asphalt.** If the process requires new HMA, use materials meeting the requirements of Section 340.4.3., “Mixture Design,” or as shown on the plans. Document in the JMF the percentage of new HMA used in the laboratory mix design submitted.

4.2.4. **Aggregates.** If necessary, use aggregates meeting the requirements in Table 1 of Article 340.2., “Materials,” or as shown on the plans.

4.2.5. **Additives.** Other additives may be allowed to meet the requirements in Table 1. When other additives are used, document the type and percentage in the mixture design submittal.

### Table 1: Laboratory Mix Design Properties

<table>
<thead>
<tr>
<th>Mixture Property</th>
<th>Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design gyrations (N&lt;sub&gt;design&lt;/sub&gt;)</td>
<td>Tex-241-F</td>
<td>50</td>
</tr>
<tr>
<td>Laboratory-molded density, %</td>
<td>Tex-207-F &amp; Tex-227-F</td>
<td>Note 1</td>
</tr>
<tr>
<td>Indirect tensile strength, psi&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Tex-226-F</td>
<td>75–200</td>
</tr>
<tr>
<td>Hamburg Wheel-tracking Test, minimum number of passes at 12.5 mm rut depth</td>
<td>Tex-242-F</td>
<td>10,000</td>
</tr>
<tr>
<td>Overlay test, minimum number of cycles</td>
<td>Tex-248-F</td>
<td>150&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>Boil Test&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Tex-530-C</td>
<td>-</td>
</tr>
</tbody>
</table>

**Combined Asphalt Property**

<table>
<thead>
<tr>
<th>Mixture Property</th>
<th>Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration, 77°F, 100 g, 5 sec.</td>
<td>T 49</td>
<td>40–80</td>
</tr>
</tbody>
</table>

1. For informational purposes only.
2. Used to establish a baseline for comparison to production test results.
3. May be reduced when approved.

4.3. **Pavement Heating.** Heat the existing pavement without charring the pavement surface and without producing undesirable pollutants. Maintain a minimum temperature of 200°F of the material immediately behind the heater. Uniformly heat the pavement surface across its full lane width such that cold milling of the pavement surface does not occur.

4.4. **Pavement Milling.** Mill the existing pavement to the required depth and width as indicated on the plans. Do not disturb the underlying material in the existing roadway when recycling. Remove grass and other vegetation from the edge of the existing pavement to prevent contamination of the recycled bituminous material during this operation.

Use the milling heads to remove a minimum of 3 in. laterally of the completed adjacent pass and make a square vertical cut in the heated material to achieve a hot bonded longitudinal joint. Ensure all material across the full lane-width is processed between consecutive lane passes to assure any wedges (slivers) of unprocessed materials are not left untouched by the milling heads and covered by the recycled material, unless otherwise approved.

Ensure the temperature of the milled surface directly behind the milling heads is greater than 160°F so cold milling does not occur. Clean all loosened asphalt material away by the milling heads, and a milling tooth pattern must be clearly visible after milling.
Remove all material around manholes and utility structures before paving the recycled mixture to allow for the plan depth of the pavement around these structures.

Cold mill and sweep clean any areas that cannot be heated and milled by the recycling equipment. Properly tack and pave these areas of cold milling in advance of the recycling process.

4.5. **Addition of Recycling Agent.** Incorporate the asphalt recycling agent into the hot recycled bituminous material at the rate determined by the approved mix designs. Sampling and testing during mixture production may result in varying quantities of recycling agent at different portions of the project to meet the requirements in Table 1. Change the recycling agent content only as approved.

4.6. **Placement of Recycled Material.** Spread the material using a paver and screed attached to the mixing/milling unit or a traditional paver in a separate and continuous operation meeting the requirements of Section 320.2.3.1., “Asphalt Paver.” Spread the recycled material to the established lines and grades. Ensure the temperature of the recycled material behind paver is greater than 200°F.

4.7. **Compaction.** Uniformly compact the pavement to contain between 3.8% and 8.5% in-place air voids.

Furnish the type, size, and number of rollers required for compaction as approved and meeting the requirements of Article 210.2., “Equipment.” Use a pneumatic-tire roller to seal the surface unless excessive pickup of fines occurs. Use additional rollers as required to remove any roller marks. Use only water or an approved release agent on rollers, tamps, and other compaction equipment unless otherwise directed.

On the first day of production, use the control strip method given in Tex-207-F, Part IV, to establish the rolling pattern that will produce the desired in-place air voids unless otherwise directed.

Operate rollers in vibratory mode only when doing so does not damage the pavement. Establish a new rolling pattern when changes occur in the recycled mix or placement conditions. Adjust or cease compaction when cracking or displacement occurs. Ensure that pavement is fully compacted before allowing rollers to park on the pavement.

4.8. **Traffic.** Allow the compacted pavement to cool to 160°F or lower before opening to traffic unless otherwise directed. Maintain the surface of the recycled pavement in a condition suitable for the safe movement of traffic. Power broom the pavement surface to remove all loose particles if needed.

4.9. **Irregularities.** Identify and correct irregularities, including but not limited to segregation, rutting, raveling, flushing, fat spots, mat slippage, irregular color, irregular texture, roller marks, tears, gouges, streaks, uncoated aggregate particles, or broken aggregate particles. The Engineer may also identify irregularities, and in such cases, the Engineer will promptly notify the Contractor. If the Engineer determines that the irregularity will adversely affect pavement performance, the Engineer may require the Contractor to remove and replace (at the Contractor’s expense) areas of the pavement that contain irregularities and areas where the mixture does not bond to the existing pavement. If irregularities are detected, the Engineer may require the Contractor to immediately suspend operations or may allow the Contractor to continue operations for no more than one day while the Contractor is taking appropriate corrective action.

4.10. **Curing.** A surface treatment may be allowed as the final riding surface when shown on the plans. Cure the hot in-place recycled bituminous material for a minimum of 7 days, or as directed when HMA or another applicable surface treatment is placed as a surface course.

4.11. **Weather Conditions.** Unless otherwise approved, perform hot in-place recycling operations when the existing pavement surface temperature is 60°F or higher and when weather conditions and moisture conditions of the roadway surface are suitable, in the opinion of the Engineer. Measure the roadway surface temperature with a handheld infrared thermometer. The Engineer may allow mixture placement to begin before the roadway surface reaching the required temperature requirements, if conditions are such that the roadway surface will reach the required temperature within 2 hr. of beginning placement operations.
5. **PRODUCTION ACCEPTANCE**

5.1. **Production Lot.** Each day of production is defined as a production lot. Lots will be sequentially numbered and will correspond to each new day of production. Note that lots are not subdivided into sublots for this specification.

5.2. **Production Sampling.**

5.2.1. **Mixture Sampling.** The Engineer may obtain mixture samples in accordance with Tex-222-F at any time during production.

5.2.2. **Recycling Agent Sampling.** The Engineer may obtain or require the Contractor to obtain 1-qt. samples of the recycling agent at any time during production in accordance with Tex-500-C, Part III. The Engineer may test any of the samples to verify compliance with Item 300, “Asphalts, Oils, and Emulsions.”

5.3. **Production Testing.** The Engineer will test at the frequency listed in Table 2. The Engineer may suspend production if production tests do not meet specifications or are not within operational tolerances listed in Table 2. The Engineer may suspend operations if the Contractor’s corrective actions do not produce acceptable results. The Engineer will allow production to resume when the proposed corrective action is likely to yield acceptable results.

<table>
<thead>
<tr>
<th>Table 2 Operational Tolerance and Minimum Testing Frequency</th>
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<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Asphalt binder content, %</td>
</tr>
<tr>
<td>Theoretical max spec. (Rice) gravity</td>
</tr>
<tr>
<td>Laboratory-molded density, %</td>
</tr>
<tr>
<td>Hamburg Wheel-tracking test, 50°C, mm</td>
</tr>
<tr>
<td>Boil test</td>
</tr>
<tr>
<td>Air voids</td>
</tr>
</tbody>
</table>

4. Hamburg values must not exceed 12.5 mm in 10,000 passes, unless otherwise directed.
5. Compare with sample from mix design to determine amount of stripping.
6. In-place air voids should be between 3.8% and 8.5%.

5.4. **Total Asphalt Binder Content.** Adjust the asphalt recycling content based upon mix design recommendations for varying roadway conditions to meet the requirements in Table 2.

6. **PLACEMENT ACCEPTANCE**

6.1. **Placement Lot.** A placement lot is defined as the area placed during a production lot (one day’s production). Placement lot numbers will correspond with production lot numbers.

6.2. **Placement Sampling.** Provide the equipment and means to obtain and trim roadway cores on-site. On-site is defined as in close proximity to where the cores are taken. Obtain the cores within one working day of the time the placement lot is completed unless otherwise approved. Unless otherwise shown on the plans, obtain two 6-in. diameter cores side-by-side at each location selected by the Engineer for in-place air void determination. Mark the cores for identification, measure and record the untrimmed core height, and provide the information to the Engineer. The Engineer will witness the coring operation and measurement of the core thickness. Visually inspect each core and verify that the current paving layer is bonded to the underlying layer. If an adequate bond does not exist between the current and underlying layer, take corrective action to ensure that an adequate bond will be achieved during subsequent placement operations.

Trim the cores after obtaining the cores from the roadway in accordance with Tex-207-F if the core heights meet the minimum untrimmed shown on the plans. Trim the cores on-site in the presence of the Engineer. Use a permanent marker or paint pen to record the date and lot number on each core as well as the designation as Core A or B. The Engineer may require additional information to be marked on the core and
may choose to sign or initial the core. The Engineer will take custody of the cores immediately after they are
trimmed and will retain custody of the cores until the Department’s testing is completed. Before turning the
trimmed cores over to the Engineer, the Contractor may elect to wrap the trimmed cores or secure them in a
manner that will reduce the risk of possible damage occurring during transport by the Engineer. After testing,
the Engineer will return the cores to the Contractor.

The Engineer may elect to have the cores transported back to the Department’s laboratory at the HMA plant
via the Contractor’s haul truck or other designated vehicle. In such cases where the cores will be out of the
Engineer’s possession during transport, the Engineer will use Department-provided security bags and the
Roadway Core Custody protocol located at http://www.txdot.gov/business/specifications.htm to provide a
secure means and process that protects the integrity of the cores during transport.

Instead of the Contractor trimming the cores on-site immediately after coring, the Engineer and the
Contractor may mutually agree to have the trimming operations performed at an alternate location such as a
field laboratory or other similar location. In such cases, the Engineer will take possession of the cores
immediately after they are obtained from the roadway and will retain custody of the cores until testing is
completed. Either the Department or Contractor representative may perform trimming of the cores. The
Engineer will witness all trimming operations in cases where the Contractor representative performs the
trimming operation.

Dry the core holes and tack the sides and bottom immediately after obtaining the cores. Fill the hole with the
same type of mixture and properly compact the mixture. Repair core holes with other methods when
approved.

6.3. **Placement Testing.** The Engineer may measure in-place air voids at any time during the project to verify
specification compliance.

6.3.1. **In-Place Air Voids.** The Engineer will measure in-place air voids in accordance with **Tex-207-F** and
**Tex-227-F.** Before drying to a constant weight, cores may be pre-dried using a Corelok or similar vacuum
device to remove excess moisture. The Engineer will use the corresponding theoretical maximum specific
gravity to determine the air void content of each core. The Engineer will use the average air void content of
the 2 cores to determine the in-place air voids at the selected location.

The Engineer will use the vacuum method to seal the core if required by **Tex-207-F.** The Engineer will use
the test results from the unsealed core if the sealed core yields a higher specific gravity than the unsealed
core.

When the in-place air voids exceed the range of 3.8% and 8.5%, take immediate corrective action to bring
the operation within these tolerances. The Engineer may suspend operations or require removal and
replacement if the in-place air voids are less than 2.7% or greater than 9.9%. The Engineer will allow paving
to resume when the proposed corrective action is likely to yield between 3.8% and 8.5% in-place air voids.

6.3.2. **New Hot-Mix Asphalt.** If applicable, control the quantity of new HMA added to the recycled mix from haul
tickets to within 5.0% of the target JMF.

6.3.3. **Depth of Recycled Material.** Maintain the required nominal depth on both outside vertical faces and in the
center of the recycled area. Manually measure and report recorded depths each 1/4 mile approximately each
hour of production. Measure from the bottom of the mill pass to the top of the surface placed.

6.4. **Ride Quality.** Use Surface Test Type A to evaluate ride quality in accordance with Item 585, “Ride Quality
for Pavement Surfaces,” unless otherwise shown on the plans.

7. **MEASUREMENT**

Hot in-place recycling of asphalt concrete surface will be measured by the square yard. The dimensions for
determining the surface areas are established by the depths and widths shown on the plans and the lengths
measured at placement.
Recycling agent will be measured at the applied temperature by the gallon from strap depths measured from the calibrated strap stick for each load or other approved automated means.

New HMA will be measured by the ton of composite mix, which includes asphalt, aggregate, and additives. Measure the new HMA on scales in accordance with Item 520, “Weighing and Measuring Equipment.”

8. **PAYMENT**

Hot in-place recycling of asphalt concrete surfaces will be paid for at the unit bid price for “Hot In-Place Recycling of Asphalt Concrete (Surface)” of the depth specified.

Asphalt recycling agent will be paid for separately at the unit bid price for “Hot In-Place Recycling of Asphalt Concrete (Recycling Agent).”

New HMA will be paid for at the unit price bid for “Hot In-Place Recycling of Asphalt Concrete (Mix).”

This price is full compensation for the removal and processing of the existing pavement; for preparing, hauling, and placing materials; for all freight involved; for all manipulations, including rolling and brooming; and for all labor, tools, equipment, and incidentals necessary to complete the work. This price also includes any surface treatment that is allowed on the plans but not required to complete the above work.