The Illinois Experience.

Illinois to be in conformance with the ISTEA mandate, estimates crumb rubber requirements to be 3 million pounds in 1994 with increases of 3 million pounds per year to a maximum requirement of 12 million pounds in 1997. In an effort to determine the most cost effective utilization of crumb rubber, IDOT determined that the dry process (introduction of unreacted crumb rubber directly into HMA) should be investigated. Wet processed crumb rubber is not included in this study. While most conventional wet process crumb rubber mixes use approximately 20 pounds of rubber per ton of mix (one percent by weight of mix), the intent of IDOT was to consider use of small amounts of crumb rubber in every ton of state funded HMA used. Six projects were designed to study effects of relatively low concentrations of rubber as well as the conventional 20 pounds per ton of HMA. Three projects included 0, 1/2, 1, 1 1/2, and 2 pounds per ton “Variable Rate” and three used the ISTEA proposed rubber loading of 20 pounds per ton “Fixed Rate.”

Mix Design.

Mixtures for Variable Rate projects were not specifically designed for crumb rubber since laboratory studies indicated that addition of up to 2 pounds per ton did not affect conventional mix properties.

Mixtures for Fixed Rate projects (20 pounds of crumb rubber per ton of mix) required special mixture designs to accommodate the crumb rubber and provide adequate air voids and stone-on-stone contact. In order to accommodate the 1 percent crumb rubber that is expected to expand by approximately 25 percent in the dry process, natural sand was reduced by 1.25 percent to provide for the voids to accommodate the expanded crumb rubber. Conventional 50 blow Marshall design was used and split tensile strength was measured. Design Marshall stability ranged from 1200 to 1500 pounds.

Production.

Rubber was packaged in preweighed meltaway plastic bags and in conventional 50 and 2000 pound paper bags. Crumb rubber was introduced by several methods including manually throwing preweighed bags into a pugmill, by mineral filler vane feeders, and by a fiber injection system. For pugmill operations, dry mix time was increased by 5 seconds to 15 seconds to insure dispersion of rubber.

Some problems were encountered with vane feeders inasmuch as pressure was lost when recharging with crumb rubber. This problem was overcome with slight modifications of the feeder to hold vacuum during recharging. The fiber injection system presented a problem with line clogging until the unit was moved closer to the mixer to provide a shorter feedline.

Whatever the method of feeding, introduction of the rubber must be made at a point in the drum where the rubber is immediately covered with liquid asphalt to prevent loss of the relatively lightweight rubber through the exhaust system with consequent contamination of the baghouse.

Construction.

Variable Rate projects did not experience general problems with placement although some stickiness was observed during compaction. One Fixed Rate project (20 pounds per ton) observed objectionable fumes at the paver that were attributed to excessively high temperatures of the mix.

Testing.

For both Variable and Fixed Rate projects, nuclear gages for density did not appear to be affected by the addition of rubber. For Variable Rate projects, asphalt content as measured by nuclear gages was not affected by addition of rubber. However, for Fixed Rate projects, nuclear asphalt content gages did appear to be affected by the rubber. Since nuclear gages sense rubber as well as asphalt, fluctuations in rubber content can lead to misinterpretation of asphalt content if rubber content is not well controlled. Nuclear gages used for binder content must be calibrated to account for the actual rubber content used.

Performance.

Friction measurements made at the time of construction do not indicate any differences due to addition of rubber. At this time no differences in performance between crumb rubber and control sections have been noted. However, performance evaluations will continue in order to determine if differences appear with time.

First Costs.

Average first cost increases due to use of crumb rubber were 23 percent for all projects. Variable Rate projects showed an average first cost increase of 18 percent and Fixed Rate projects showed an average first cost increase of 28 percent. Project costs are shown in the following table: (continued on page 3)
<table>
<thead>
<tr>
<th>Project Cost Per Ton</th>
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</thead>
<tbody>
<tr>
<td><strong>Variable Rate Projects</strong></td>
</tr>
<tr>
<td><strong>Project</strong></td>
</tr>
<tr>
<td>District 4</td>
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<tr>
<td>District 6</td>
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<tr>
<td>District 7</td>
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<tr>
<td><strong>Fixed Rate Projects</strong></td>
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<tr>
<td><strong>Project</strong></td>
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<tr>
<td>District 6</td>
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<tr>
<td>District 7</td>
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<tr>
<td>District 4</td>
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</tbody>
</table>

**IDOT Conclusions.**

Variable Rate Projects (less than two pounds of rubber per ton of mix)
- Crumb rubber does not require special mix designs and does not significantly affect Marshall stability, voids, and flow and does not affect split tensile strengths.
- Crumb rubber can be introduced without complex plant modifications.
- Mixes can be tested with conventional nuclear equipment.
- Vane feeders may require some modification for use with crumb rubber.

Fixed Rate Projects (20 pounds of rubber per ton of mix)
- Crumb rubber mixes require special mix designs.
- Crumb rubber can be introduced with conventional vane feeders but minor modifications may be necessary. However, rubber must make immediate contact with asphalt binder in the drum.
- Density can be tested with conventional nuclear equipment.
- Asphalt content cannot be tested effectively with conventional nuclear equipment.

**IDOT Recommendations.**

- For the present, require small amounts of rubber in all mixes to comply with the mandate.
- Continue to monitor performance.
- Construct additional test sections with 4 and 6 pounds of rubber per ton to determine the practical upper limit of inclusion of rubber without modification of existing HMA procedures.
- Continue to design and construct projects with 20 pounds of rubber per ton to gain experience with the technology.

This information came from a report published by the:
Illinois Department of Transportation
Bureau of Materials and Physical Research
Evaluation of Reclaimed Rubber in Bituminous Pavements
Physical Research Report No. 117, June, 1995
James S. Trepasnis, Bituminous Field Engineer

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