HOT IN-PLACE RECYCLING

Where Have We Been? Where Should We Go?

JENNIFER GRESSETT

The most sweeping changes and innovations in asphalt pavement recycling in North America in the past 10 years have occurred in hot in-place recycling (HIPR). Improvements in equipment and techniques since the first asphalt pavement was placed in the United States in 1870 have enabled asphalt pavement recycling to become a common procedure in the transportation industry.

"Productivity has increased to a degree that recycling of asphalt concrete by a variety of procedures is increasingly attractive to the highway engineer," said Texas Transportation Institute Research Engineer Joe Button. "HIPR is especially attractive because the entire process is performed on the construction site; the need to take the material to a processing plant is eliminated."

HIPR Process

HIPR is the process of correcting asphalt pavement surface distress by softening the existing surface with heat; mechanically removing the pavement surface; mixing with a recycling agent; sometimes adding virgin asphalt or aggregate; and replacing it on the pavement while hot without removing the recycled material from the original pavement site. The process may be performed as either a single-pass (one-phase) operation, whereby the restored pavement is combined with virgin material, or as a two-pass procedure, wherein the restored material is recompacted and a new wearing surface is applied after a prescribed interim period.

The Asphalt Recycling and Reclaiming Association was founded primarily on the principle of hot surface recycling and has rapidly expanded to represent nearly every form of pavement recycling. ARRA recognizes three basic HIPR processes, sometimes referred to as surface recycling:

1. Heater scarification: heating, scarifying, rejuvenating, leveling, reprofiling, and compacting;
2. Repaving: heating, scarifying, rejuvenating, leveling, laying new hot mix, reprofiling, and compacting; and
3. Remixing: heating, scarifying, rejuvenating, mixing (or adding new hot mix), mixing, leveling, reprofiling, and compacting (Figure 1).

Heater scarification typically involves removing up to 25 millimeters (1 inch) of the existing road surface, rejuvenating it, and reshaping it in the final operation. Repaving includes recycling to an approximate 25 millimeter depth, adding a recycling modifier to improve asphalt viscosity, and simultaneously covering the recycled layer with a thin overlay. Remixing involves incorporating and blending virgin material with recycled material in a pugmill and then placing the blended material as a wearing course. In some cases, the scarification process is replaced or assisted by milling.

Regardless of the process used, HIPR has many benefits. Most types of surface distress in an asphalt pavement can be corrected by HIPR, provided the pavement has adequate structural integrity. Types of pavement distress that may be addressed include rutting, corrugations, raveling, flushing, loss of surface friction, minor thermal cracking, and load-associated cracking.

The public views HIPR positively because of increased awareness of the need to conserve natural resources, and because motorists can watch old pavement virtually become new. In addition single-pass HIPR has the added benefit of relatively minor disruption of traffic flow compared with other methods of pavement rehabilitation. The time required for lane blockages is less than that for conventional methods, and safety is enhanced because motorists do not have to avoid a pavement-edge drop-off for a long period. The process is cost-effective in urban areas because recycling offers pavement rehabilitation without the expense of repositioning drains, curbs, manholes, overpasses, shoulders, and other height-sensitive structures.

Use of HIPR

In *National Cooperative Highway Research Program Synthesis of Highway Practice 193: Hot In-Place Recycling of Asphalt Concrete,*

Jennifer Gressett is Publications Intern, Texas Transportation Institute, Texas A&M University.

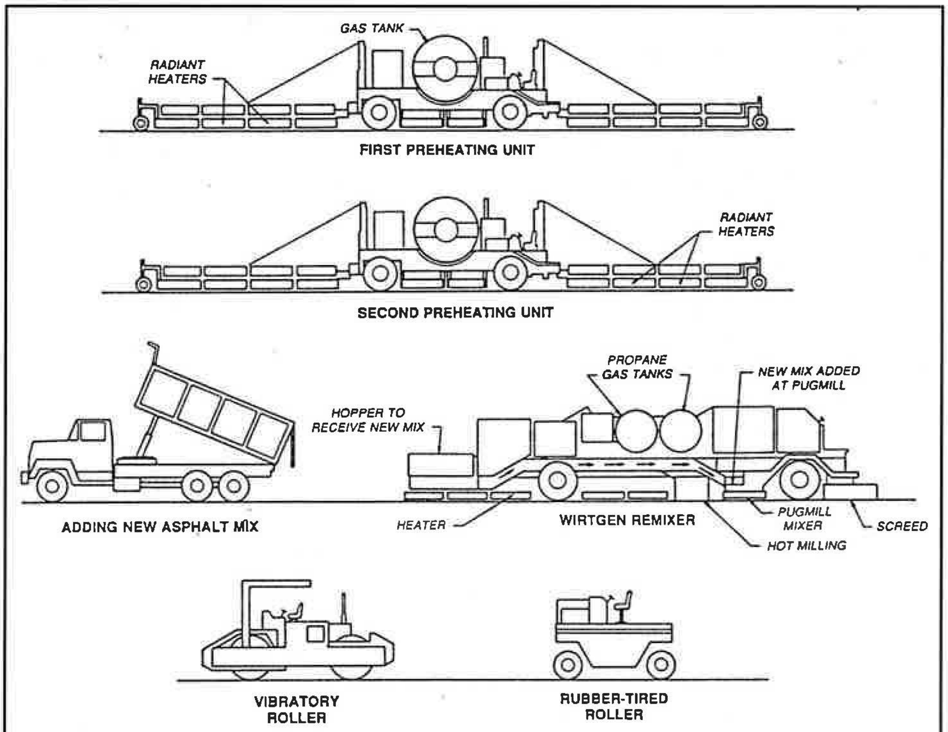

FIGURE 1 Single-pass remixing process (*1*).

Button and coauthors Cindy Estakhri and Dallas N. Little cited two case histories that provided examples of HIPR results. The first was a 1991 project near Beaumont for the Texas Department of Transportation. The pavement tested was rutted severely and exhibited age hardening. Raising pavement elevation by overlaying was impractical, according to the report. Wirtgen remixer and ARA-1 rejuvenating agent were used on the pavement, which had a milling/overlay depth of 25–31 millimeters (1–1¼ inches) and an average temperature of about 115 degrees Celsius (240 degrees Fahrenheit). High traffic volumes limited workers' production to 1400 meters (1,531 yards) per day. The cost for the recycling portion of the job was $2.15 per square meter ($1.80 per square yard). Overall results showed that early performance was satisfactory.

Another example cited by Button was a 1986 Federal Aviation Administration project in Texarkana, Texas, in which a 50 percent savings over cold milling plus a 50-millimeter (2-inch) overlay was reported. The airport pavement was an aged, brittle mix that provided low surface friction. HIPR equipment used was a Cutler repaver. Milling depth was about 25 millimeters, followed by a 25-millimeter overlay. The temperature of the mix was 110 degrees Celsius (230 degrees Fahrenheit). It was noted in the report that the mix disintegrated when "cold" milling was attempted and depth could not be controlled. After six years a few surface cracks appeared in one isolated area, but otherwise performance was reported as excellent.

HIPR is not always the best resurfacing alternative. Old asphalt pavements with obvious base failures and frequent patching and in need of major drainage improvements are not suitable candidates for in-place recycling (Figures 2 and 3). Roads suitable for HIPR should have a minimum of 75 millimeters (3 inches) of hot-mix asphalt in place. Thinner asphalt surfaces may be torn apart and broken loose from the base by the horizontal shear stresses of the banks of scarification teeth.

Gaseous emissions from heating and mixing equipment can also present a problem, causing concern about air pollution, particularly in urban areas. However, major advances in reducing emissions have been made in recent years.

The bottom line, of course, is comparative cost. Published information suggests that when all factors are considered, a savings of up to 35 percent can be achieved when a 25-millimeter HIPR layer is compared with cold milling and replacement with a new 25-millimeter overlay. HIPR eliminates the costs associated with stockpiling, handling, hauling, and inventorying of reclaimed asphalt pavement. Additional cost savings can be realized from reduced interruption to traffic flow.

Extent of HIPR Use

Despite these savings, use of HIPR is still not widespread in the United States. A telephone survey of all 50 state highway agencies was conducted in 1992 to determine the extent of HIPR use and the type of processes being used. The survey revealed that fewer than 10 state agencies routinely use HIPR. Eighteen states have not used the method at all, reporting that equipment and operators were not available in their areas or that most surfaces in the areas were open graded and not therefore suitable for HIPR.

Other reasons given were that pressure from the hot-mix industry to use all new

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FIGURE 2 Old asphalt pavement with surface cracks but with good structural integrity is suitable for hot in-place recycling.

FIGURE 3 Patchwork surface is unsuitable candidate for hot in-place recycling because of difficulty of controlling mixture design.

material was strong and that HIPR would be cost-effective only for use on Interstate highways. In addition some respondents stated that they did not know much about the method or were not impressed because they believed that the procedure burns asphalt.

Twenty-two of the states studied reported using HIPR but only on an experimental basis. Ten additional states use it on a somewhat regular basis but generally constructed fewer than five jobs per year. Collectively these 32 states have used at least one of the three processes—heater scarification. Several others have probably used the process but did not consider it recycling. Fifteen states reported having used the repaving process and 16 reported having used the remixing process.

Conclusions

This study of the state of the art of HIPR has revealed that the process is worthy of further investigation in certain areas. For example, an overall physical characterization of in-place recycled hot mix compared with conventional hot mix is needed. Correct curing techniques and even the importance of proper curing of hot recycled asphalt mixtures are unknown. Users need to know how long rejuvenating agents cause properties of mixtures to change after final compaction and whether the changes are significant, what time period should be required between compaction and testing in the laboratory, and what laboratory curing procedure best simulates field conditions.

Heating and mixing of the existing pavement during HIPR significantly increases the viscosity of the asphalt cement. Therefore further studies should be conducted of field performance compared with laboratory prediction, accurate mixture temperatures, and temperature profiles within the preheated layer to develop guidelines to deal with asphalt hardening directly attributable to the HIPR process.

In addition, mixture design of HIPR surfaces should be based on the most up-to-date and mechanically correct methodology available. Although many HIPR surfaces are too thin for rutting to be a major concern, 50-millimeter (2-inch) to 75-millimeter (3-inch) recycled pavements require such an analysis. The applicability of mixture design procedures developed under the Asphalt-Aggregate Mixture Analysis System and the Strategic Highway Research Program should be determined. Furthermore the influence of stress distribution in the HIPR layer as influenced by the degree of bond developed between the overlay and the base should be evaluated when deciding on the appropriate laboratory test loading conditions to simulate field stress states.

Comprehensive guidelines for the overall HIPR process need to be developed to aid maintenance and design engineers in decision making. Topics that should be addressed include optimum time during a pavement's service life to perform HIPR, preparation of specifications, types of pavements that are viable candidates for HIPR, selection of type and quantity of recycling agent, mixture design and structural design specifically for HIPR, selection of optimum HIPR method, quality control, and quality assurance.

Air pollution associated with HIPR is another growing concern that should be investigated. When compared with conventional processes, the total air pollution generated should be considered to include production and transportation of new materials that would have been used in place of the recycled materials.

Legislation dictates that these environmental concerns must be addressed and that ways must be found to effectively reuse pavement materials. Now that the industry has overcome the early challenges of equipment wear and tear, asphalt recycling and HIPR appear to provide an efficient means of restoring quality pavements.

This article is based on NCHRP Synthesis of Highway Practice 193: Hot In-Place Recycling of Asphalt Concrete *by Joe W. Button, Cindy K. Estakhri, and Dallas N. Little.*

Reference

1. Shoenberger, J. E., and T. W. Voller. *Hot In-Place Recycling of Asphalt Pavements.* Technical Report GL-90-22, U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Miss., Sept. 1990.