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One Chance for Smoothness

Hot In-Place Recycling and Repaving in Colorado Allows Only One Chance to Attain Smoothness Bonus

By Tom Kuennen

A "green" hot in-place recycling (HIR) and repaving project in an environmentally sensitive area of south-central Colorado last year achieved 91 percent of its smoothness bonus for the contractor, even though the in-place process permitted the contractor only one pass to get it right.

In Colorado's Region 5, Cutler Repaving crews repaved 16.5 miles of 12-ft.-wide lanes and 2-ft. shoulders of State Highway 150, right up to the gate of Great Sand Dunes National Park. With a total cost of $2.98 million, using the HIR process, approximately $100,000 per centerline mile was saved compared to conventional overlay.

There was an added "green" benefit of 50 percent reclaimed asphalt pavement utilized in the project, as the existing surface was recycled into a 1-in. leveling course ahead of a 1-in. virgin hot mix asphalt overlay.

Hot in-place recycling (HIR) train on Colorado S.H. 150 included, from left, repaver, preheater, virgin HMA haul unit for surface course, and auxiliary preheater.

The Green Impact

But Cutler's HIR process had a larger green impact than just the complete recycling of the top 1 in. Because the work was done in just one pass, the hot in-place recycling project had a very minimal impact on the local environment.

"Fifty percent of the material was recycled," said Keith Magowan, P.E., design/project engineer, Colorado DOT, Alamosa division. "We only had to haul in half the material, with half the number of haul trucks."

"That's one of the things we liked about it," said Dale Martinez, P.E., Colorado DOT Alamosa division engineer, Region 5. "A standard overlay work zone can be a half-mile in length, while this was very short. And a large number of trucks were eliminated, along with the long queues of traffic, with their exhaust and emissions. Traffic would stop for a few minutes at the repaving train, and then could go on by."

"Moreover, because the process completely reused processed materials resident in the existing surface course, it saved taxpayer money," said Mike Coggins, P.E., Colorado DOT Region 5 materials engineer. "The hot in-place recycling was an efficient process from a cost basis," he said, "as well as an environmentally friendly process reusing the existing investment in roadway surfacing materials, rejuvenating and reviving them to give the motoring public an extended use of those materials for a quality highway, but at a moderate cost."

HIR Not New to Colorado

Hot in-place recycling is not new to Colorado, as the process has been used there before, notably for U.S. 6 from Clifton to Palisade near Grand Junction in 2004.

That project, also involving Cutler Repaving, won *Best in Colorado Smoothest Pavement, Smoothest Paving Crew for a Resurfacing Project,* and *Urban Highway Resurfacing* awards from the Colorado Asphalt Pavement Association.

"The reports from that region were very favorable," Martinez said, "and were among the reasons we chose to use repaving on S.H. 150, with its much higher elevation. As it was, it turned out really well."

Cutler's repaving train includes a self-propelled preheater unit, and self-propelled repaver with scarifier. "The size of the equipment did not come as a surprise. When the operations started, and they got up and going, I was very impressed with what I saw," he said.

"We were tasked with coming up with a quality pavement product that met the budget, knowing that the economic restrictions of a full-blown reconstruction or heavy-duty overlay would not stay within budget," Coggins said. "We needed

to cover the full length of 16.5 centerline miles within the constraints of approximately $3 million. The Cutler process of recycling 1-in., followed by an additional 1-in. of hot mix asphalt, met our needs to provide a quality product in a cost-efficient way.

"A 1-in. leveling course with no milling, and a 2-in. overlay, for a 3-in. total placement, would have been the normal procedure for S.H.150," he said. "However, we didn't have the funds to do 3 inches," Coggins said. "Instead we looked at the Cutler process."

Two self-propelled preheaters were used to initially heat the existing pavement surface.

"The Cutler process saved Colorado DOT a bunch of money," said Lyle Smith, area manager, Cutler Repaving. "The project saved the state over $100,000 per centerline mile, compared to their conventional process. What impressed them was just how smooth we could get that road with that type of equipment, just working with 1 in. of an existing road as a leveling course, and adding an inch of new material on top of that as the wearing course."

"The heating and scarifying associated with the Cutler process accomplishes much the same thing as placement of a leveling course," Colorado DOT's Coggins said. "It takes care of the old, oxidized asphalt that's on the surface, as well as the crack fillers and sealants that tend to complicate a simple overlay," he said. "To get the additional structural integrity of the 1-in. virgin overlay is an added bonus."

Virgin hot mix asphalt for surface course is introduced at front of repaver and is conveyed to screed at rear of unit.

One-Pass Process

The single machine one-pass aspect of the process had appeal to Colorado DOT. "One-pass made it much easier for us to control traffic," Magowan said. "When everything is contained in a single process — with the entire repaving unit being relatively short — versus having a leveling course, then overlay, you avoid having the paving train and traffic control stretched out a half-mile, or even longer.

"While there was not a high traffic count on the highway, minimizing delays still was a priority," Magowan said. "We kept delays to less than 10 to 12 minutes," he said. "Usually there was a maximum of a dozen cars lined up. It really worked out well for us."

The single machine one-pass process was particularly attractive to Martinez. "They did everything in one operation, entirely in one continuous train," he said. "It was a finished product in one pass. And it had the laydown of the surface course right at the end of the repaver. Other hot in-place processes use a separate laydown machine following the heater/scarification process. But Cutler contains it in one unit and is able to eliminate an entire machine."

With single machine repaving, the existing pavement is heated to 300 degrees F. When in the resulting softened, pliant condition, the pavement is scarified to a depth of 1 in., and in the mobile repaving unit, a recycling agent that restores the viscosity of the aged asphalt is mixed into the scarified, reclaimed asphalt.

This reclaimed material then is reapplied and distributed with a screed as a 1-inch leveling course. While that material remains at a minimum 225 degrees F, a virgin hot mix asphalt overlay is placed over the recycled leveling course.

Cutler's single machine repaver scarifies, applies recycling agent, places the leveling course, and applies the new overlay simultaneously in one pass. That benefits road users because there is no delay between the time the pavement is recycled and the time a riding or friction course is placed, resulting in a safer work zone for road users and for contractor personnel.

Thermal Bond Achieved

Because the hot virgin mix is placed over the heated, recycled leveling course, the process achieves a thermal bond between the recycled layer and the new layer.

"From an engineering point of view, there is no delamination between the recycled layer and the new overlay," said Cutler vice president John Rathbun.

Thus the recycled and virgin courses are interlocked to become a monolithic overlay. "If you were to go out and core the pavement, you would not see an inch of virgin mix on top of reclaimed material," Coggins said. "You would see a consistent, 2-in.-thick layer of HMA. It adds to the longevity of the pavement, improves the smoothness of the highway, and saves owner costs, because it is only one process, without the additional traffic control, delays to the public, the overhead of both owner and contractor personnel.

"There's an additional value of saving time that may not be recognized with a HIR recycle

operation followed by an overlay," Coggins added. "Plus, less rock is being mined out of a pit, and less asphalt cement is trucked to the plant from who knows where. This process is a good, economic way of achieving better roads in an environmentally friendly manner, which should serve us for years to come."

"We took a look at it in March and found it holding up really well," Martinez said. "There were a few places where we had a few frost heaves, as there is a big variation between day and night temperatures. The frost heaves relate to the soils in our area, not the hot in-place overlay. But overall it's holding up and we still are impressed with the project."

Smoothness a Major Goal

An improved, smoother pavement on S.H. 150 was a prime goal for the DOT. "The road was in very bad shape, and we were hoping for a big improvement," Martinez said. "Once Cutler was finished with the project we were surprised that they exceeded our expectations by a long shot."

"The consultant for A&S Construction, the prime contractor, went through with a High Speed Inertial Profilograph and measured the existing surface roughness. The project had an average HRI of 80 in/mi before repaving began, but the project's final surface smoothness measured in at an average of 38 in/mi," Magowan said. "There was no difference between the final product and a conventional mill and overlay. The repaving equipment is what gave us the smooth road," he said.

For smoothness measurements, Colorado DOT can choose between the HRI and the percent-improvement method. "The HRI tends to be a stricter process than the percent-improvement," Martinez said. "With this process, everything is contained in one unit, the hot remix operation and the laydown machine. With a stand-alone laydown machine, the paver can 'float' up and down independently, creating bumps in the asphalt, but Cutler's laydown machine is attached to the longer repaver, and that must prevent a lot of fluctuation. Without a doubt this is the smoothest hot-recycle project we've ever done."

"Initially the project started out as a percent-improvement project, where you profile the existing surface, complete the paving, and then profile the final surface," said Craig Young, P.E., principal, CPP Engineering, Inc., a general civil engineering firm which performed the smoothness testing for A&S Construction, Cañon City, Colorado, the prime contractor. "Your incentive/disincentive bonus is based on the percent-improvement in smoothness achieved." To obtain any incentive on the project the contractor would have to have a minimal percent of improvement of 40 percent.

However, the project smoothness category was switched to an HRI Category 1 for evaluation. This gave the contractor a better chance to obtain some incentive on the project based upon the pavements existing surface roughness values.

Smoothness data were collected via an International Cybernetics Corp. (ICC) high-speed profiler data collection system mounted on a Chevy Tahoe.

"The ICC system gives CPP Engineering the ability to collect data on any pavement surface, at speeds of 20 to 70 mph," Young said. "It's a variation of the old profilometer. The ICC system is equipped with two lasers that collect the pavement smoothness data. The lasers are located in each wheel path and can collect the data simultaneously.

"The ability to collect pavement smoothness information from both wheel paths is a big advantage for the contractor," Young said. "We can collect it a lot faster than the old profilometer, so if you have an 18-mile-long project we can have one lane run from one end to the other in 20 minutes," Young said.

The data can be processed right in the field. Based upon a single pass of the project, within a half hour, CPP can determine where the defective segments are, and can be locating them for the Client to be diamond ground. "Our system allows us to be self-sufficient in the field, and help the contractor get his job wrapped up a lot quicker," he said.

"When the project was complete, Cutler had attained an overall average of 38 in/mi over the 18 center line miles for the two lane road, which entitled them to 91 percent of the total maximum incentive for the job," Young said.

"The resulting pavement smoothness is due to the Cutler process," Young said. "Typically smoothness values for asphalt paving below

At rear of HIR train, 1 in. of virgin HMA is placed immediately on top of 1 in. lift of hot in-place recycled asphalt, producing an interlocking bond between the new and recycled layers.

Pneumatic roller executes final compaction, bringing up the rear of HIR repaving train.

40 in/mi are considered smooth, and receive maximum incentive, and values below 30 in/mi are extremely smooth and are only seen when the contractor has two or more chances at improving the pavement smoothness. To obtain smoothness values below 20 in/mi is likely not going to happen with an asphalt pavement, no matter what the contractor does. In the six years our firm has been performing profiling, and in three states, CPP has never had a reading below 20 in./mi."

The smoothness result on S.H. 150 was a real achievement, Young said. "If you compare an apples-to-apples process, that is, a process that puts down a 2 inch overlay, compared to Cutler's process of recycling 1 in. and 1 in. of virgin material, Cutler obtains a smoother pavement surface, based upon our experience. Typically, when processes are compared against each other, Cutler in one pass will obtain as smooth or even smoother pavement surface as compared to other processes which would have two chances at improving the pavement smoothness, such as a leveling course with an overlay, or a mill-and-overlay."

Two factors likely figure into the equation, Young said. "One factor is the repaving train process, and the speed at which it moves; Cutler keeps the machine going at the same rate of speed, and that impacts how the laydown machine performs behind the recycler. Since the paving process is constant, you're going to be eliminating a lot of problems at the paving screed.

"The second factor is the quality that Cutler brings to the job," Young said. "We have observed Cutler over the years, and they've always turned out really high-quality work. Based upon information that CPP has tracked over the years, Cutler has obtained, with one pass, smoothness values that were equal to what other processes were obtaining with two or three different chances for improvement. If I were recommending to an owner the best bang-for-the-buck repaving process, depending on the existing pavement surfaces, the Cutler Repaving process would be at the top of the list."

"Cutler takes pride in its work, and when we have a contractor that takes pride in its work, it puts out a way-better product than contractors who don't take pride in their work," Martinez said. "We're hoping to use this process again."

"One thing that Cutler told me while we were out on the job is that they are only as good as their last project," Magowan said, "and they really meant it. They were a good company to work with."