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# Hot-In-Place Recycling Helps Denver Meet Sustainability Goals



Reduced energy usage and emissions make hot-in-place recycling a key component of the 'Better Denver' program.

**T**he City and County of Denver are both benefiting from a late-November 2007 tax increase which bolstered its streets program. As part of this *Better Denver* program, in addition to named capital projects, a maintenance fund was created to protect street infrastructure with preventive maintenance down the road.

(Above) Hot-in-place recycling is a major part of Denver's sustainable road maintenance program.

But environmentally sustainable construction also is a key component of the Better Denver program, and Denver is increasing its use of hot-in-place recycling. This enhances Denver's sustainability goals, both by increasing the amount of material recycled and by reducing emissions compared to other maintenance methods.

"In November we passed a property tax increase that's dedicated to maintenance of existing infrastructure," said Dan Roberts, P.E., deputy manager for operations, City and County of Denver. "It increased our street resurfacing program budget by about \$6 million in 2008, and that has translated into an increase in our hot-in-place repaving program. It's not just a cost-effective method, but it's a more-sustainable street resurfacing program, environmentally speaking."

In 2008, Denver's hot-in-place program will top \$3.5 million, covering 600,000 square yards, some 40 percent of the total street resurfacing program. "We made the decision to dedicate a big chunk of that tax increase to hot-in-place recycling," Roberts said.

## Denver's sustainability criteria

Along with the November property tax increase for streets, came a \$550 million bond initiative, all under the Better Denver program.

"Sustainability guidelines and targets are part of the construction that will take place under Better Denver, Roberts told *Better Roads*. "The targets were established by the mayor under an executive order. For vertical construction — that is, buildings — the guidelines from LEED are clear. It's not so clear for horizontal construction, like roads, because there is no national standard."

But the criteria are evolving. Denver's evaluation of horizontal projects is based on an adaptation of the *Leadership in Energy and Environmental Design* program of the U.S. Building Council. LEED certification is a new driving force behind value-added private- and public-sector infrastructure design and construction, and the building industry has turned to the LEED Green Building Rating System to evaluate the degree of green design a structure or development incorporates.

The Green Building Rating System is a voluntary third-party rating system in which credits are earned for satisfying specified green building criteria. Projects are evaluated within six environmental categories: *Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, Innovation & Design, and Indoor Air Quality*.

The new LEED-ND (for *Neighborhood Development*) certification category addresses complete multi-unit projects, including pavements, and Denver's scoring of horizontal projects, like roads, is based on the LEED-ND criteria.

Hot-in-place recycling meets Denver's own criteria of sustainable construction based on LEED-ND via use of building materials with recycled content of at least 10 percent (based on cost) of the total value of the materials in the project; recycle and/or salvage with a goal of 50 percent (by weight or volume) of non-hazardous construction and demolition debris; use of regional materials with a minimum of 10 percent (based on cost); and project design or purchase equipment to achieve a 15 percent energy reduction.

## Hot-in-place repaving

For its growing hot-in-place recycling program, Denver uses a process from Cutler Repaving, a recycling contractor based in Lawrence, Kansas. In Cutler's repaving process, the existing pavement is heated to 300 degrees Fahrenheit. This makes the pavement soft and pliant, and the recycling train then scarifies it to a



In Denver, hot-in-place process places HMA over freshly recycled base course.

depth of 1 inch and adds a recycling agent that restores the viscosity of the aged 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 Fahrenheit, a virgin hot-mix asphalt overlay is placed over the recycled leveling course.

Cutler's unique repaving machine 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.

In addition, 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. "That's very important in predicting life-cycle performance. The same heat that's used to take the road apart is used to put it back together, and the two layers are effectively compacted into one lift."

Repaving also reheats the edge of adjacent repaved lanes, resulting in a more durable, higher-density seam between the driving lanes. "I like to see the hot seams, because with this process, you know you will not have a cracking problem on that job down the road," Roberts said.

## Smaller energy, emissions profile

In addition to the benefits of recycled material, hot-in-place recycling, as executed by Cutler, provides a smaller energy-consumption and emissions profile, cumulatively, than nearly every other surface reconstruction method.

Repaving's lower energy consumption is important for cost savings and resource conservation, and it also figures into the LEED-ND evaluation of the process for the Better Denver program.

According to new research, despite the propane-fueled heat used to soften the existing road surface prior to recycling, the repaving process (hot-in-place recycling of 1 inch existing pavement, topped by a 1-inch virgin overlay) uses fewer Btus per square yard (52,487) than two alternatives: a 4-inch cold in-place recycling with a 1.5-inch hot-mix asphalt overlay (90,502), or a 1-inch cold-mill with a 2-inch overlay (83,324).

Only cold in-place recycling with an emulsified asphalt surface treatment used fewer Btus per square yard than the hot in-place repaving — 39,788. But the CIR/fog seal combination lacked the long-term durability and smoothness of the repaving solution.

Denver enhances the sustainability of its repaving program by using up to 40 percent reclaimed asphalt pavement in the hot-mix wearing course.

Hot in-place repaving also features a significantly lower greenhouse gas emissions profile in terms of pounds emitted per square yard repaved. Repaving of 1 inch of existing pavement, topped by a 1-inch asphalt overlay containing 40 percent RAP emits only 7.4 pounds of greenhouse gases per square yard, compared to 12.4 pounds for a 1-inch mill with 2-inch overlay, or 13.4 pounds for a 4-inch cold in-place recycle topped with 1.5-inch asphalt overlay. Only the cold in-place with surface treatment had lower emissions.

The data were compiled by Doug Cutler, executive vice president, Cutler Repaving, using research from COLAS, S.A., the big French road builder and materials supplier. "Our starting point was our work in Denver in 2007," Cutler said. "We took the amount of propane and off-road diesel fuel we consumed on the projects, and extrapolated the figures using an overlay with 40 percent RAP, as we did in Denver." The other data were sourced from COLAS in its publication, *The Environmental Road of the Future*.

"The implications are that hot-in-place recycling is a good way to go if you want to achieve carbon savings," Cutler told *Better Roads*. "A lot of people assume that because we use propane to heat the pavement to rework it, it's not necessarily carbon-efficient. But we achieve our savings by working material in-place on the road, not having to transport it back and forth, with less virgin materials consumed."

## Dedicated to hot in-place

As Denver is located in an environmentally aware region, all this works to Denver's advantage in its growing use of hot-in-place recycling. Roberts has calculated that hot-in-place costs one-third less than a traditional 2-inch mill and overlay, and delivers 80 percent of the

estimated service life of that mill and overlay. It also delivers 67 percent longer life than a chip seal.

Denver is looking at alternatives to make its hot-in-place pavements last longer. It has used both crumb-rubber modified asphalt and stone-matrix asphalt (SMA) mixes as the overlay on hot-recycled surfaces using the Cutler technology. "We are seeing some unanticipated cracking in the crumb rubber overlays, but for the SMA, after a test in 2006 and limited use in 2007, we will be

using SMA on many of our repavings by Cutler this year," Roberts said. "We will be putting down an inch of SMA, but may bump to an inch and a half."

And all of this is unfolding against the backdrop of today's environmentally sustainable pavements. "Denver's Mayor John Hickenlooper has established a climate action plan with a number of sustainability goals," Roberts said. "They include reuse of material, reduction of carbon footprint, and reduction of energy consumption. Hot-in-place recycling helps us achieve those goals as we look program wide across the street resurfacing program." BR

*This article was commissioned by Cutler Repaving.*



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