

Clean. Green. Mainstream

Paving's Soft Footprint

A New surface transportation bill may demand greener highway building. This industry is already doing that.

Whether you believe that anthropogenic (man-made) climate change is taking place or not maintaining a smaller carbon and other emissions “footprint” when building pavements can pay dividends now and in the future.

A smaller emissions footprint will not only make your operation less-obnoxious to residents and businesses adjoining and on the way to a project, but it will prepare you for the “transformational” federal surface transportation bill just around the corner.

And it will save money in both raw materials and fuel for trucks and equipment.

The technology exists today to greatly lower emissions of carbon dioxide (CO₂) and proven air pollutants such as oxides of nitrogen (NO_x) in materials production, hauling and placement.

The next surface transportation reauthorization – whenever it arrives – has every indication of becoming a transformational bill that will drive American transportation policy further toward green highways and transportation modes.

The highway industry must prepare for the next reauthorization's containing very strong green elements that may restrain the ability to use funds for highway construction. There may be a pronounced shift toward funds for pavement preservation, with a strong capital program for alternative modes, and requirements for use of environmentally sustainable design, construction and materials for eligibility of highway projects for funding.

The existing *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy For Users* (SAFETEA-LU) expires at the end of September, and new authorizing legislation must be enacted by then or else the federal surface transportation program will expire.

The House of Representatives took the initiative, reporting a bill in mid-June, which could come to the floor of the House this month.

However, in mid-July, the Senate Environment and Public Works Committee approved an 18-month extension of SAFETEA-LU. The legislation authorizes the program in FY 2010 at



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— U.S. Transportation Secretary
Ray LaHood,
at the National Association of Counties

this year's funding level of \$41 billion and provides \$20.5 billion in authority for the first six months of FY 2011.

The Obama Administration approves of the Senate's SAFETEA-LU extension, as the 18-month timeframe dovetails with the administration's desire to perfect new, "sustainable" surface transportation policy initiatives to include in a long-term reauthorization after March 2011.

"[This] 18-month extension of SAFETEA-LU...will send a message of certainty to all of our states and give us the time to develop a transformational transportation bill with a stable, reliable funding source," said Senate Environment and Public Works Committee chair Barbara Boxer (D-Calif.).

Her term, *transformational*, means more emphasis on an "environmental" highway program. "Most of us believe the next surface transportation bill should and must be transformational, to reflect the need for more sustainable communities, cleaner air, and more transportation options for the American people," Boxer said.

U.S. Transportation Secretary Ray

LaHood at the National Association of Counties (NACO) echoed her words in July. "*The American Recovery and Reinvestment Act* [stimulus funding bill] is essential to bringing our economy back, but it's also a dress rehearsal for an even more ambitious effort," LaHood said. "We want to ensure that transportation plays a major role in our ability to create the kinds of neighborhoods people want to live in; to reduce our dependence on private vehicles and foreign oil; and promote a cleaner, greener environment.

"For too long, federal policy has unfortunately encouraged sprawl and congestion and pollution, rather than quality public transportation and smart, sustainable development. We intend to change that. To do so, we need to re-think our federal spending priorities and focus on transportation investments that more effectively meet the needs of our communities. It's up to Congress to address these issues in the upcoming transportation reauthorization package — and I assure you, getting this done right is a high priority for President Obama."

The seriousness of the challenge is underscored by the July 2009 launch of a Web site that highlights strategies to reduce greenhouse gas emissions from the transportation sector.

The American Association of State Highway & Transportation Officials' (AASHTO) new Web site — *Real Transportation Solutions for Greenhouse Gas Emissions*, available at www.transportation1.org/RealSolutions — includes best practices, state examples, research findings, and links to other climate change information sites. The site is structured to assume that anthropogenic climate change is taking place, and that steps taken by public agencies can reduce the amount of future global warming.

But to a great degree, America's highway construction and reconstruction industry already has been contributing to a greener America.

America's highway construction and reconstruction industry is now by far and away the No. 1 recycler of waste materials in terms of tonnage, saving tax money and reducing demands on landfills and quarries and gravel pits, prolonging those resources. The

intensive degree of waste material recycling is reducing highway construction's carbon footprint, as well as solving landfill disposal problems.

Restoration of pavement surfaces via mill-and-fill operations are very common and conserve unextracted virgin aggregates for future use in more critical mix designs. And use of reclaimed asphalt pavement (RAP) in mixes lowers CO₂ emissions upstream from a project.

Slash emissions, save money

But new options such as in-place cold recycling of existing pavements, utilization of in-plant low-energy mix production technologies, use of portable low-emission cold mix plants near a job site, and use of the new generation of warm-mix asphalts (WMAs) will slash CO₂, NO_x and heat emissions generated from a project, while saving money for the owning agency.

The role of anthropogenic carbon dioxide in climate change has been argued for decades. Yet even as the discussion on anthropogenic climate change rages, the highway industry is coming to realize that there is no reason to continue to emit excess CO₂, NO_x and heat as an adjunct of roadbuilding when other options are available.

With industrial byproducts in concrete, less cement is needed for a given application, so use of these cementitious byproducts in concrete means a reduction in the amount of energy consumed by the cement manufacturing industry, and parallel reductions in CO₂ and water vapor emissions. These admixtures — principally coal fly ash, silica fume and ground, granulated blast furnace slag — add both strength and durability to the concrete, allowing designers to specify fewer elements, all things being equal, with equivalent first — cost savings.

Highway building also excels in creating wetlands. According to an April 2008 report issued by the President's Council on Environmental Quality, the most recent data available, the federal-aid highway program has achieved over 52,000 acres of wetlands mitigation since 1996. This represents

RoadScience

In New Hampshire, full-depth reclamation of existing two-lane blacktop minimizes carbon footprint of project compared to old-school practice.

Photo by Tom Kuemen

almost a 2.75 to 1 ratio of wetlands created versus wetlands impacted by transportation projects, way beyond the mandate.

With highway noise mitigation being a requirement for federal funding, with federal reimbursement of 90 percent of cost, noise barriers – once considered an extravagance for urban highways – now are commonplace, and have added to the steep rise in the overall cost of highway projects.

Warm mix getting hotter

The new warm-mix asphalt (WMA) technologies – created by use of one of a variety of additives – allow production and placement of asphalt pavement material at lower temperatures than conventional technologies. Conventional asphalt pavement material is produced at around 320 degrees Fahrenheit, and warm mix is typically produced at temperatures ranging from 280 down to 212 degrees Fahrenheit.

At these temperatures, WMA releases substantially fewer greenhouse gases and infrared heat to the atmosphere, while providing other substantial benefits in workability and placement, albeit at a higher price.

“Warm mix was originally explored for its environmental benefits, which include reduced fossil fuel consumption and reduced emissions, including greenhouse gas emissions,” said Na-

tional Asphalt Pavement Association president Mike Acott at a House Science and Technology Subcommittee on Technology and Innovation in March.

“Running warm mix can reduce energy consumption during the manufacturing of the asphalt pavement mixture by an average of 20 percent, which decreases total life-cycle greenhouse gas emissions by 5 percent,” Acott said. “This equates to 1 million tons [of CO₂] offset annually.”

Combining warm mix with reuse/recycling yields even greater benefits, he added. “Warm mix with 25 percent reclaimed asphalt pavement could potentially offset asphalt pavement life-cycle greenhouse gas emissions by 15 to 20 percent. The potential for total savings in greenhouse gas emissions using both warm mix and recycling is about 3 million tons per year.”

Far from seeing it as a threat, Acott sees the coming surface transportation reauthorization as a way to increase the use of warm mix and other environmentally friendly pavements.



“By 2014, with assistance in applied research and technology deployment that may be provided through the next highway bill, we can increase use of warm-mix asphalt to represent the majority of all the pavement material produced in the U.S. [and] we can double the reuse/recycling of asphalt pavements,” Acott said.

In California, the difficulty in siting a portable asphalt plant in the foothills of the Sierra Nevada for reconstruction of I-80 there recently led to a low-emission, in-place recycling of the base, followed a year later with a durable, rubberized, open-graded friction course.



▲ **On California's Pacific Coast Highway 1**, warm-mix asphalt is placed with minimal emissions near town of Point Arena.

Photo courtesy of MeadWestvaco Specialty Chemical Division



▲ **In Minnesota**, crushed and screened reclaimed asphalt pavement (RAP) is fed into a plant to provide lower-carbon footprint paving.

Photo by Tom Kuemen

The original design called for cold milling of the top lift of the existing pavement, and replacement with two lifts of hot-mix asphalt, three separate operations on a roadway with a high volume of traffic. But the closest HMA plant was 25 miles away, and Caltrans was concerned of heat loss during the drive, especially at the higher elevations and the time of year at which the work might be done. Furthermore, there were local objections to the siting of an HMA plant near the interstate.

Instead, relying on past experience, Caltrans chose foam asphalt surface recycling via recycling unit for I-80, which would enable it to open a section to traffic, at highway speeds, just four hours after foaming and compaction.

Use of a very short recycling train also meant there was significantly less construction equipment on the roadway. A standard mill-and-fill process – removing RAP and bringing HMA back in – would have required a lot of trucks going in and out of the traffic closures. “Every time that happens

there’s a potential for an accident,” said Joseph Peterson, P.E., Caltrans District 2 materials engineer. “By virtually eliminating the RAP and hot-mix trucks, we had fewer problems.”

Making people happier

Use of the in-place recycling enabled the state to save approximately 112,200 tons of virgin aggregate, 2,860 tons of liquid asphalt, and 9,200 truck trips, with all the CO₂ emissions associated with the trips. “That’s an incredible number of truck trips, and that doesn’t include all the auxiliary equipment that would have been moving in and out of the work zone,” Peterson said.

Conventional air pollutants also were reduced. “Because the project is in an urban environment, the 15,800 pounds of NOx that we did not put in the environment made a lot of the people in the area a lot happier,” Peterson said. “That is because our mountain and valley areas are subject to inversion layers in the atmosphere, which traps all the smog down low. Anything we can do

on a construction project to lessen that impact is a benefit to everyone.”

Higher use of RAP is another way to quell production of greenhouse gases in road construction.

“Consumption of fuels in the process of acquiring and processing raw materials accounts for a significant share of the greenhouse gas emissions associated with producing asphalt pavement material,” Acott told the House. “Therefore, it is possible to reduce greenhouse gas emissions simply by incorporating RAP in new pavement.

“Currently, the average rate of reuse/recycling is 12 percent,” Acott said. “These numbers include both states that routinely use 30 percent RAP and states that permit minimal use. Using 25 percent RAP reduces total life-cycle greenhouse gas emissions by 10 percent, which equates to two million tons [of CO₂] offset annually.

And more should be on the way, he implied. “A singular quality of asphalt cement is that it is rejuvenated when

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California's I-80 driving surface was foam-recycled in-place with minimal construction traffic, work zone tie-ups or carbon or NOx emissions; was later topped with a rubberized open-graded surface treatment.

Photo courtesy of Wirtgen America Inc.

RAP is incorporated into new pavement, becoming an integral part of the binder," Acott said. "In view of the high reuse/recycling rate in lead states, including a preponderance of evidence that the quality of asphalt pavements incorporating RAP is equal to or better than pavements using all virgin materials, there is ample opportunity to double the quantity of RAP used within five years."

Companies get 'greenovative'

In June, Astec Inc. reported that it sold the 200th Double Barrel Green System since it began producing the in-plant, low-emission asphalt system in 2007. The Double Barrel Green System avoids the use of asphalt additives to achieve what Astec calls a warm mix. Instead, water is injected into the mix along with the liquid asphalt cement. The injection of water causes the liquid asphalt to foam and expand in volume. The foaming action helps the liquid asphalt coat the aggregate at a lower temperature. The result is an in-plant



foamed asphalt mix that is odorless, smokeless and longer lasting.

By running the mixing process at less than 280 degrees Fahrenheit blue smoke and pungent smells can be effectively eliminated. It also allows producers to raise percentages of RAP in mixes to higher levels than in the past, further reducing the carbon footprint of road construction.

Gencor also manufactures a full line of green products, including the Ultra-drum A.R.E. with 50 percent recycle ca-

pability, the Equinox burner with lower greenhouse gas emissions, and its Ultrafoam GX product that lowers mix temperatures and can be fitted to any drum-mix plant.

Terex Roadbuilding manufactures a warm-mix asphalt system, which lowers asphalt mix temperatures by 50 to 100 degrees Fahrenheit, saving producers up to 10 to 22 percent in fuel, the company said. The result is fewer emissions, both visible and invisible, improved conditions for workers and lessened environmental impact.

While Astec's Green Machine is used with existing HMA plants, a stand-alone, low-emission portable plant from Wirtgen America Inc. is providing "Green Mix" production throughout the United States.

Wirtgen Green Mix technology incorporates liquid foamed asphalt, in which hot penetration-grade asphalt is foamed with water and air, and is injected into reclaimed materials and aggregate in a mixing chamber. This green mix is placed, graded and compacted, and can accommodate traffic — including heavy trucks — almost immediately. Most often it serves as a durable base to support a thin asphalt wearing course or surface treatment.

For example, a major asphalt contractor in New Mexico is expanding its markets with a foamed asphalt Green Mix product aimed at government agencies as those agencies are focusing on green operations, such as the City of Albuquerque's Albuquerque Green Q initiative, with the Q standing for Quality, but also a play on Q appearing twice in the city's name. And to dovetail with the city's efforts, the foamed asphalt is

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being marketed by Albuquerque Asphalt Inc. with the moniker Q Base.

Even as the asphalt side reduces its emissions in the search for a smaller carbon footprint for roadbuilding, the cement industry is tackling the issue as well.

Cement is vulnerable because the manufacture of cement is a prime generator of CO₂, which is driven off limestone as it is calcined (heated to fusion) with other ingredients in the rotary kiln. And at calcining temperatures of 2,700 degrees Fahrenheit and higher, cement manufacture consumes vast amounts of powdered coal or other fossil fuels – all of which emit CO₂ during combustion – to heat the raw materials for cement. Also, while much of the heat of calcination is captured in the kiln exhaust and raw material preheating process, some waste heat ultimately is vented to the atmosphere.

"Today, the cement industry accounts for less than 1.5 percent of U.S. carbon dioxide emissions," said the Portland Cement Association in a policy statement. "The industry was among the first to tackle the issue of climate change, and it has remained at the forefront of developing policies and improving the manufacturing process."

PCA said the industry plans to reduce carbon dioxide emissions by 10 percent per ton of product below the 1990 baseline.

Use of waste industrial byproducts (described above) as an admixture to cement admixtures reduces the amount of fuel needed and CO₂ generated upstream of the paving project by the percent of cement replaced. Just as significant, the recent approval of a change to ASTM C 150 specs that allow uncalcined, ground limestone – either interground or blended – now allows ground limestone to be added to cement in amounts of up to five percent. The limestone is added in amounts such that the chemical and physical requirements of the C 150 specification would still be met.

This addition also makes it easier to boost the supply of cement in the marketplace, because an addition of five percent limestone in cement, all things being equal, approximates a 5 percent

increase in cement manufacturing capacity, but without the accompanying laborious environmental permitting and paperwork, and costs of construction.

In European countries addition of limestone to cement can go far higher than the five percent permitted in Canada and the United States. Addi-

tions of up to 35 percent by weight in special classes of cement are not uncommon. ❖

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