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Micro surfacing is placed on residential street in environmentally sensitive area

Micro Surfacing Scores High Points in Ecological Sustainability, Efficiency

By Paul Fournier

An independent standards development organization has verified the findings of an eco-efficiency analysis (EEA) of asphalt pavement technologies which shows micro surfacing using a styrene-butadiene-rubber (SBR) latex polymer to be more economical, and to cause less environmental impact, than "mill and fill" utilizing hot mix asphalt.

[Editor's Note: While micro surfacing was determined by the research to be more economical than mill and fill as a surfacing, micro surfacing does not provide the structural enhancement to the pavement than does a mill and fill with HMA overlay.]

NSF International, a not-for-profit, non-governmental organization that develops national standards and provides third-party conformity assessment services, has verified a report submitted by BASF Corporation detailing the methods and findings of its *Micro Surfacing Eco-Efficiency Analysis*. Established in 1944, NSF is accredited by the

With right mix design, micro surfacing will hold up to Interstate-level traffic loads and volumes

Cured and striped, micro surfacing presents a durable, attractive driving surface

American National Standards Institute (ANSI) to develop standards and serves clients in 80 countries from 26 offices and laboratories worldwide.

EXACTING CERTIFICATION

Eco-efficiency is a term first coined by the World Business Council for Sustainable Development in 1992. BASF technical development leader Arlis Kadrmas, a member of the group that prepared the EEA report, explained that eco-efficiency is "a broad measure of sustainability, which calculates the environmental and economic impact of products or processes over their entire life cycle." This approach goes beyond the current International Organization for Standardization (ISO) standard for life cycle assessment, which only considers environmental impacts.

Certification of the Micro Surfacing EEA indicates the NSF has determined the EEA complies with its Protocol P352: Validation and Verification of Eco-Efficiency Analyses. NSF developed this protocol to help provide an independent, third-party guideline for conducting an eco-efficiency analysis as well as provide a framework for verifying the conformity, quality and transparency of completed studies.

Headed by Bruce Uhlman, BASF senior sustainability specialist, a group of BASF and external experts conducted the study over a nine-month period and submitted its final report for verification. The full report is posted online by NSF at *www.nsf.org/business/eco_efficiency*.

The study findings were presented at the March 2010 annual convention of the International Slurry Surfacing Association (ISSA), which was held in conjunction with the annual meetings of the Asphalt Emulsion Manufacturers Association (AEMA) and the Asphalt Recycling & Reclaiming Association (ARRA). The combined event was attended by representatives of 145 companies involved in pavement preservation and rehabilitation. ISSA also planned to present the study findings at its 7th annual congress scheduled for Lyon, France on Oct. 13, 2010.

MILL AND FILL VERSUS MICRO SURFACING

The BASF EEA compares total life cycle environmental impacts and costs of a 2-in. mill and fill asphalt overlay with those of a cold mix, polymer modified asphalt emulsion-based micro surfacing, with a defined customer benefit as a goal. For purposes of establishing a common unit of comparison between the alternatives, the customer benefit is developed and defined as the pavement preservation of a 1-mile stretch of a 12-ft. lane on an urban road using the two technologies to produce similar profiles and performances over a 40-year period.

These two alternatives were chosen because they are among the most common technologies used for extending the service life of existing pavements across the U.S., and constitute a substantial share of the market.

Micro surfacing is a pavement preservation method employing cold mix slurry made on the job site by mixing aggregate, mineral filler such as portland cement, water, and a polymer-modified asphalt emulsion. The polymer used for the analysis is styrene-butadiene-rubber (SBR) latex. Suitable for heavily traveled roads, micro surfacing can accept traffic in an hour, and is used for wearing courses, leveling surfaces and filling wheel ruts. For the analysis, ISSA quantity guidelines, i.e., 20 lbs. of material per square yard for wheel rut filling, and 25 lbs. per square yard for surface treatment, were used. Micro surfacing was assumed to have a durability of six years.

Mill and fill consists of removing existing surface pavement with a milling machine and hauling the filled material to a storage site. New asphalt plant mix, often containing some recycled asphalt pavement (RAP), is installed to replace the milled-out material. The EEA assumed RAP content to be 10 percent for the primary study case, but also examined another scenario where 40 percent RAP was assumed. A 2-in. compacted depth was assumed for the overlay, with a durability of 11 years. At a thickness of two inches, mill and fill is considered a structural pavement fix. The EEA also studied a second scenario, one assuming a durability of 17 years for the same thickness.

LIFE CYCLE COSTS

The life cycle costs analyzed in the EEA were those occurring in manufacture, delivery and installation of each product over the life cycle of the road, together with disposal costs. The study considered the time value of money and calculated the net present value of all future costs.

The research found that, in general, mill and fill uses about 2.5 times as much aggregate, and more than twice as much asphalt binder, than micro surfacing, in order to produce the same customer benefit over a 40-year life cycle. These facts contribute to the finding that micro surfacing has the lowest overall material and labor costs.

Life cycle costs for micro surfacing were more than 25 percent lower than mill and fill, despite the fact micro surfacing lane striping costs were higher due to more frequent applications. Table 1 shows the component costs.

Life Cycle Costs		Micro surfacing	Mill and Fill
Material Cost	$/yd2	$4.00	$9.25
Material and Labor Costs	$/CB	$97,079	$136,037
Disposal Costs	$/CB	$3,650	$7,900
Lane Rental Fees	$/CB	$7,740	$19,505
Striping Fee	$/CB	$15,633	$9,651
Total Cost	$/CB	$124,103	$173,093

Table 1: Cost inputs for life cycle cost analysis of micro surfacing versus mill and fill

THE ENVIRONMENTAL BURDEN

Examination of life cycle environmental impact, or "environmental burden" as sometimes referred to in the analysis, considered six main categories: *primary energy consumption, raw material consumption, emissions* (air, water and solid waste), *land use, toxicity potential* and *risk potential.*

Energy and Resource Consumption. As mill and fill using hot mix asphalt requires hotter production and application rates, and uses more asphalt and aggregate than micro surfacing, micro surfacing consumes about 40 percent less primary energy than mill and fill over the life cycle.

The bulk of raw material consumption — the most relevant environmental impact category for the study — is attributable to the asphalt binder, aggregate, road markings, end-of-life disposal and transportation of products. Even when considering the use of RAP in the asphalt mix overlay, the study found that micro surfacing uses over 50 percent less resources by mass.

Air, Water and Solid Waste Impacts. Air emissions — the most significant emissions category in the study — include greenhouse gases, photochemical ozone creation potential (summer smog), acidification potential, and ozone depletion potential.

Greenhouse gases (GHG), which trap heat in the atmosphere, include carbon dioxide and methane, entering the atmosphere primarily through the combustion of fossil fuels such as oil, natural gas and coal. The highest carbon fingerprint determined in the EEA occurred in the mill and fill alternative, with

micro surfacing GHG emissions lower by almost 45 percent.

Photochemical ozone creation potential caused principally from methane and non-methane volatile organic compounds emitted from combustion of transportation fuels was lowest for micro surfacing. It was higher for mill and fill because that alternative requires over twice the amount of material to be shipped to and from manufacturing and job sites.

Acidification potential resulting primarily from nitrous and sulfur oxides emissions during the burning of fuel oil to heat aggregate and asphalt was greatest for mill and fill, which requires higher manufacturing and application temperatures.

Ozone depletion potential coming predominately from materials used to manufacture thermoplastic striping material used in lane striping was the least relevant air emission for both micro surfacing and mill and fill.

With regards to water emissions, micro surfacing has the highest critical water volume requirement, attributed primarily to the manufacture of lane striping materials. Excluding the impact of road markings, the remaining water emissions for each alternative are about the same.

Solid waste emissions included those from municipal, special, construction and mining wastes. They are principally the result of sending materials to landfills for disposal. Even when considering the perpetual use of RAP content, the study finds that mill and fill still has the highest impact in this category due to the much greater quantity of materials.

Taken together, the analysis showed the cumulative effects of air, water and solid waste emissions on the environment were greatest for mill and fill.

LAND USE, HUMAN HEALTH AND RISK

With respect to the impact caused by the two technologies on the biodiversity of our ecosystems, the EEA found that energy required to produce and apply mill and fill is the largest contributor to land use. Mining wastes as generated from aggregate production as well as solid waste disposal of un-recycled materials also contribute to the impact on land use.

How human health is directly impacted by the toxicity potential of the two technologies is investigated in depth in the EEA, with specific weighting percentages assigned to the production, use and disposal phases of the 40-year life cycle. The use phase has the highest weighting since the applications of the technologies subject people to the greatest exposure to the materials. Since mill and fill requires more than twice the amount of materials, it scores highest in this category.

Risk potential, the last major category of environmental burden examined by the EEA, considers the

number of working accidents, fatalities, illnesses and diseases associated with the production, use and disposal of materials. The risk potential for occupational illnesses and accidents for both technologies is highest for the aggregate materials, and since mill and fill employs much greater amounts of aggregate than micro surfacing, it also scores much higher in risk potential.

In commenting on this section of the EEA report, Tim Harrawood, a member of the study group and current president of ISSA, pointed out there are social benefits of micro surfacing for both construction workers and motorists: "High production rates lead to less time on the project, fewer traffic delays and reduced exposure to construction zone accidents," Harrawood said.

SUMMATION OF EEA FINDINGS

Evaluating the individual environmental impact categories, the EEA finds that mill and fill has the highest environmental impact on a weighted basis in all main categories. Micro surfacing performs best in all main categories on a weighted basis because it requires less than 50 percent of materials than that for mill and fill, while maintaining the desired customer benefit.

Furthermore, although applied more frequently, micro surfacing scores lowest in resource consumption — the most relevant environmental impact for the study — because of its significant reduction in the amount of binder and aggregate used. This materials reduction also benefits micro surfacing in toxicity potential and risk potential.

Micro surfacing also scores lowest in energy requirement — the second most relevant environmental impact — because of its lower overall consumption of asphalt binder, lower manufacturing and application temperatures, and reduced logistical impacts due to shipping less material to and from the job site.

The BASF EEA methodology combines the six individual environmental impact categories into a single relative environmental score, and balances that with the life cycle cost for each alternative in order to determine its relative eco-efficiency. The study findings support that micro surfacing is the more eco-efficient alternative for urban road pavement preservation due to its combination of lower environmental burden and lower life cycle cost.

Edited by Pavement Preservation Journal *from material contributed by the International Slurry Surfacing Association and BASF Corp. The* BASF Corporation Eco-efficiency Analysis *report was prepared by Bruce Uhlman, senior sustainability specialist; Jim Andrews, marketing manager; Pete Montenegro, marketing manager; Arlis Kadrmas, technical development lead; Luke Egan, technical service manager, all of BASF; and Tim Harrawood, manager, Vance Brothers, Inc. Fournier is a freelance writer in the construction industry.*