The Tennessee Department of Transportation (TNDOT) recently corrected severe pavement cracking on nearly 18 miles of State Routes 13 and 100 with the application of cape seal—a combination of two thin preventive maintenance techniques.

Vance Brothers, a Kansas City, Mo.-based company, has a $1.7 million contract with TNDOT to install cape seal on sections of the two-lane highways in Perry and Houston Counties in west-central Tennessee. Traffic counts of roughly 3,500 vehicles per day—including a significant number of trucks—have contributed to a preponderance of cracking. But this has not diminished pavement strength.

“There are a lot of cracks and some pavement aging. However, the cracks are top-down, and haven’t affected the pavement’s structural integrity,” said Jay Norris, TNDOT’s special projects coordinator. “We chose cape seal because we wanted a relatively inexpensive way to seal the cracks and give the people a good surface to ride on,” he added.

Pavement Preservation Techniques

Cape seal comprises a bottom course of chip seal covered with a wearing course of micro surfacing. Both pavement surface treatments are among a number of thin, non-structural preventive maintenance applications that are classified as pavement preservation techniques. Such techniques can extend pavement life and improve safety, but since they don’t increase capacity or strength they must be employed while a pavement has significant remaining service life.

Pavement Preservation Treatment Construction Guide, the Federal Highway Administration’s online guide based on the Caltrans Maintenance Technical Advisory Guide, states that each dollar spent on preventive maintenance for a pavement that is still in good condition eliminates or delays spending $6 to $10 on rehabilitation or reconstruction.

Retarding Cracks, Smoothing the Ride

Chip seal is a thin surface treatment consisting of spraying an asphalt emulsion on an existing pavement, overlaying this with fine aggregate (the “chips”), and rolling the material to embed the aggregate in the emulsion. The technique seals fine cracks in a pavement’s surface, retarding them from reflecting through to the surface. In addition, it prevents water intrusion into the base and subgrade, and provides a skid-resistant surface where applied. It is not recommended for roads experiencing high-speed traffic since its relatively rough surface generates increasingly loud tire noise as vehicle speed increases. Also, its surface hinders such recreational activities as biking, roller-skating and skateboarding.

Micro surfacing is a thin surface treatment used to protect structurally sound pavement from further distress and oxidation. A cold-mix material, it consists of mineral aggregate, mineral fillers such as portland cement, water and a latex polymer-modified asphalt emulsion. The latex polymer helps bind the asphalt, mineral aggregate and fines together. Micro surfacing can also be spread in variable thicknesses, for example to fill wheel ruts and provide leveling. It is a quick-traffic system, ready to accept traffic within an hour. And no rolling is required since vehicle traffic accomplishes that. In most cases a tack coat is unnecessary before micro surfacing, unless the existing pavement is concrete. This technique is suitable for high-traffic-volume roadways, offering a smooth, quiet road surface.
Cape Seal Smoothes Tennessee Highways

Owner: Tennessee Department of Transportation

General Contractor: Vance Brothers
It should be noted that it is always recommended to utilize a crack sealing program prior to any thin surface treatment.

In a cape seal application, covering a single layer of chip seal with micro surfacing combines the best attributes of both. The combination effectively seals cracks and retards them from reflecting through, provides a waterproof, smooth and quiet riding surface; and yet has a total thickness of less than one inch.

**Scrub Seal Brooms**

For Route 13 and Route 100 applications, TNDOT specified a modified chip seal in the cape seal treatment. Referred to as scrub seal, the modified chip seal process involves a Polymer Asphalt Surfacing System (PASS) incorporating a modified asphalt emulsion and an assembly of brushes that are pulled by the liquid asphalt distributor truck. Ergon Asphalt & Emulsions Inc. supplied the emulsion as well as the brush apparatus to the contractor.

According to Tim Harrawood, Vance Brothers’ southern regional general manager, the brushes were very effective. “Those brushes force the emulsion right into the pavement cracks,” he said. He noted that the PASS system employs a cationic medium-setting emulsion containing an asphalt rejuvenator. In addition to his management role at Vance Brothers, Harrawood is active in promoting pavement preservation techniques in the industry and currently serves as president of ISSA, the International Slurry Surfacing Association.

Vance Brothers’ paving crew, supervised by project superintendent Dorman Tompkins, used a BearCat asphalt distributor to spray the heated emulsion (170 degrees Fahrenheit) at the rate of .31 gallons per square yard. Tompkins said the brushes were very effective. “They filled the cracks, most of which were between 3/8- and 1/2-inch wide. Those brooms worked great,” he said.

Immediately following the distributor, a BearCat chip spreader broadcast the 3/8-inch limestone aggregate supplied by Vulcan Materials. The machine spread these chips at the rate of 26 lbs. per sq. yd. Next, the crew used a custom-designed set of rollers to embed the aggregate in the emulsion.

Designed and built by Vance Brothers, the custom rolling rig consists of a CAT PS150C pneumatic roller towing a roller assembly. Tompkins said it does the work of three pneumatic compactors but uses only one engine, thus reducing engine emissions and energy use. The custom-built roller completely covers a 12-ft. lane in one pass. It also carries a reserve of limestone chips to fill in low spots if necessary.

A CAT 926F loads aggregate on a Sterling truck with a Trail King bottom discharge dump body for haul to chip spreader.

Left: Contractor’s BearCat chip spreader broadcasts 3/8-inch limestone at the rate of 26 lbs. per sq. yd.

On the circle: A BearCat distributor sprays modified asphalt emulsion while towing assembly of brushes that forces emulsion into cracks.

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**Fog Seal and Micro Surfacing**

The contractor scrub sealed one lane of road for two miles at a time, employing a pilot car to lead traffic on the one-way open lane. A Superior Broom was used to sweep loose chips from the completed section, then a fog seal was sprayed over the scrub seal. TNDOT requires a fog seal to be sprayed over the completed scrub seal at the rate of 0.1 gallons per sq. yd. Vance Brothers’ Harrawood explained that this is a diluted polymer-modified asphalt emulsion comprised of three-parts water to one-part CSS-1HP emulsion—the same emulsion used in the wearing course of micro surfacing.

Vance Brothers employed a self-propelled Bergkamp Mobile Mix Paver to blend raw materials and apply micro surfacing. The mix paver applied micro surfacing to the 12-ft. lane in a single pass at the rate of 22 lbs. per sq. yd. While it was operating, the Bergkamp machine was fed all necessary raw materials by ‘nurse trucks.’

The latex polymer-modified CSS-1HP asphalt emulsion specified for micro surfacing treatment was provided by the Memphis plant of Ergon Asphalt & Emulsions. Ergon produces the cationic emulsion using Styrene Butadiene Rubber (SBR), a latex polymer manufactured by BASF Corporation that holds the asphalt, mineral aggregate and fines together in the micro surfacing.

**Polymers Boost Benefits**

Asphalt emulsions are key ingredients of pavement preservation processes such as chip sealing and micro surfacing. A study on Polymer Modified Asphalt Emulsions (PME) conducted for FHWA and the Federal Land Highway Division by the National Center for Pavement Preservation states that asphalt emulsions frequently provide a lower cost, more efficient and more environmentally friendly alternative to hot mixes due to their low energy consumption, reduced hydrocarbon emissions, ease of implementation at remote sites, and pavement life-extending benefits. Polymer modification enhances these benefits.

The PME study notes, “Polymer modification of asphalt emulsions offers improvements in performance and durability, mitigation of pavement distress, and reduced life cycle costs when compared to unmodified asphalt emulsions or hot mix asphalt surface dressings…”

Micro surfacing and chip seal applications utilizing emulsified asphalt binders modified with polymers are noted for their low temperature manufacturing and storage, low or ambient temperature applications, and low- or no-VOC (Volatile Organic Compounds) emissions at the job site.
Eco-Efficient Processes

Such qualities meet the definition of "eco-efficiency," a word coined by the World Business Council for Sustainable Development (WBCSD) in its 1992 publication "Changing Course." According to WBCSD, eco-efficiency is achieved through the delivery of "competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing environmental impacts of goods and resource intensity throughout the entire life-cycle."

More specifically, Arlis Kadmas, technical development leader for BASF Corporation, had this to say about pavement-preservation applications such as the TNDOT cape seal project:

"The pavement-preservation techniques used on this project – modified emulsion chip seal and micro-surfacing – are excellent choices based on findings from recent eco-efficiency studies. Eco-efficiency is a measure of sustainability, which calculates the environmental and economic impact of products or processes over their entire life cycle."

In other words, eco-efficiency means producing more with less energy and fewer resources while minimizing environmental impact.