The smart maintenance strategy:

Paving fabric is a long-lasting, economical choice for road repair

Shedding new light on the economic value of incorporating a paving fabric interlayer in pavement in maintenance projects.

This newly released work is a comprehensive study of pavement repair materials and methods. It examines maintenance treatments on 370 roads in Greenville County, S.C., in the 1997-98 maintenance year.

The work is called *The Study of Pavement Maintenance Techniques Used on Greenville County Maintained Roads*. Released in June 2005, it was performed by C. Joel Sprague, Senior Engineer for Texas Research Institute, Austin, Texas. This exhaustive study compares the cost-effectiveness and performance of four maintenance treatments:

- In-place cold mill recycling and an overlay
- Patching followed by paving fabric and an overlay
- Paving fabric and an overlay
- Overlay only

In this study, "in-place cold mill recycling and an overlay" refers to milling the whole asphalt concrete pavement section, then rejuvenating and replacing it. What makes the study especially compelling is its groundbreaking use of road condition rating as a performance monitoring tool. The rating was used as part of a pavement management system to evaluate the effectiveness of different maintenance strategies.

The road condition rating allows the study to take into account the condition of the pavement at the time maintenance work is done. Common sense suggests that different treatments fare best under different conditions, and this study confirms that that is indeed the case.

"Previous studies have shown that nonwoven paving fabrics extend the life of asphalt overlays up to 10 years," explains John Miner, paving products market manager at Mirafi Construction Products, a Ten Cate Nicolon company, Pendergrass, Ga. "This analysis of pavement condition indexes lets us quantify the benefits of paving fabrics [as compared to] four specific pavement strategies. This is extremely helpful to pavement maintenance engineers around the country as they develop the most cost-effective solutions to repair their roadway systems."

The pavement assessments aren't the only thing that's new. The study is also the first to draw broad-ranging conclusions about the economic benefit of paving fabric interlayers. In the past, some DOTs and other local entities have chosen not to utilize paving fabrics, viewing them as an unnecessary extra cost. However, this study shows that incorporating a paving fabric interlayer is always a cost competitive repair strategy. On a road in a typical "needs repair" condition, the paving fabric repair strategy clearly gives the most bang for the construction buck.

A Suitable Location

Greenville County was an ideal place for a study of this breadth because it has more than a decade of records that document its road maintenance techniques. The County currently maintains about 1600 centerline miles of road. More mileage is being added every year because the area's population and businesses are growing quickly.

The improvements included in the study were part of a program called "Prescription for Progress (PFP), Paving County Roads," which Greenville County initiated in 1997.

In 2002, Greenville County's Department of Public Works (GCDPW) called for a periodic evaluation of its current road improvement methods. It contacted Sprague about the possibility of performing an independent study. GCDPW offered its records and information for the project. The only problem was that at the time, there was no budget allocated for it. Because the county has often used paving fabric as part of its road improvement techniques, Sprague approached the Geosynthetic Materials Association (GMA) for funding.

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GMA agreed to fund the study. However, because there was some uncertainty about the quality and quantity of data available, the association split the project and the funding into two phases.

Phase 1: Can it be done?

The first part of the project was intended to test the proverbial waters--to get an idea of whether the available data would support a more complete study of pavement maintenance techniques used in Greenville County. Phase 1 included data from only 34 roads.

The results of the Phase 1 Study suggested that the effectiveness of various road repair treatments is related to the pavement's condition at the time it is treated.

Sprague used a 100-point scale called the pavement condition index (PCI) to rate the surface conditions on the 34 roads before they were repaired. Then he used two measures of performance to rate the success of the maintenance. One measure, the depreciation cost, represented the amount of the maintenance treatment that was "used up" between the repair (in 1997 or 1998) and the assessment of the pavement condition in 2003. The other measure, the degradation ratio, compared the rate of degradation after the maintenance to the rate at which the road had been degrading before treatment.

This preliminary phase of the project suggested that:

- For roads with a PCI of 30 or less, in-place cold mill recycling with an overlay does the best job of slowing the degradation rate.
- For roads with a PCI in approximately the 35 to 65 range, a paving fabric interlayer with a minimum 1 1/2-inch overlay was the most cost-effective maintenance strategy.
- For roads with a PCI above 70, a simple asphalt overlay and a fabric/overlay system are about equal in performance and cost-effectiveness.

With these results in hand, Sprague then set out to validate his findings with a larger data set.

Phase 2: Explaining the Work

Phase 2, the main body of the study, expanded on the work done in the preliminary phase. This time, Sprague included data on all 370 Greenville County roads repaired during the first year of PFP.

The research in Phase 2 was made up of five steps:

1. Compile a list of roads rehabilitated and/or resurfaced in the first year of PFP (1997-1998). Note the cost of the repairs.
2. For all these sites, find the last known record of the pavement condition index (PCI) prior to any subsequent treatment. Take note of the date it was assessed.
3. From this information, estimate the PCI of the road at the time it was repaired.
4. Calculate the cost-effectiveness of the treatment by measuring the amount of degradation between the time it was repaired and a 2003 road evaluation.
5. Identify trends in the data.

Sprague gathered information for the study from several sources. To find pre-maintenance PCI values for the roads, he referred to pavement evaluation reports gathered between 1994 and 1996. Then he used characteristic pavement degradation curves for Greenville County to project what the PCI was at the time the roads were actually repaired.

Sprague then referred to the 1997-1998 PFP database to find out what treatments had been done on the roads and how much the treatments had cost. Finally, he used a database of 2003 road condition ratings to determine how well the roads had held up after treatment.

The most challenging part of the project was making a quantitative assessment of the pavement's condition at the time it was repaired. The only data available were the 1994-1996 ratings the county had originally used to select roads to be repaired as part of the PFP program. Nothing had been done to the roads in the meantime. And in some cases, nearly four years had elapsed between the time the road was assessed and the time it was maintained.

Luckily, in 1991 the county engineering office had developed characteristic pavement degradation curves for an earlier research project. Sprague interpolated these curves to determine the pavement conditions at the time of treatment.

When the averaged curve was applied to the 370 roads in the study, the calculation indicated a large number of roads with a PCI of zero--not terribly surprising, considering that the intent of Prescription for Progress was to deal with the worst roads first. Any road that qualified for PFP was bound to have reached a PCI of less than 50.

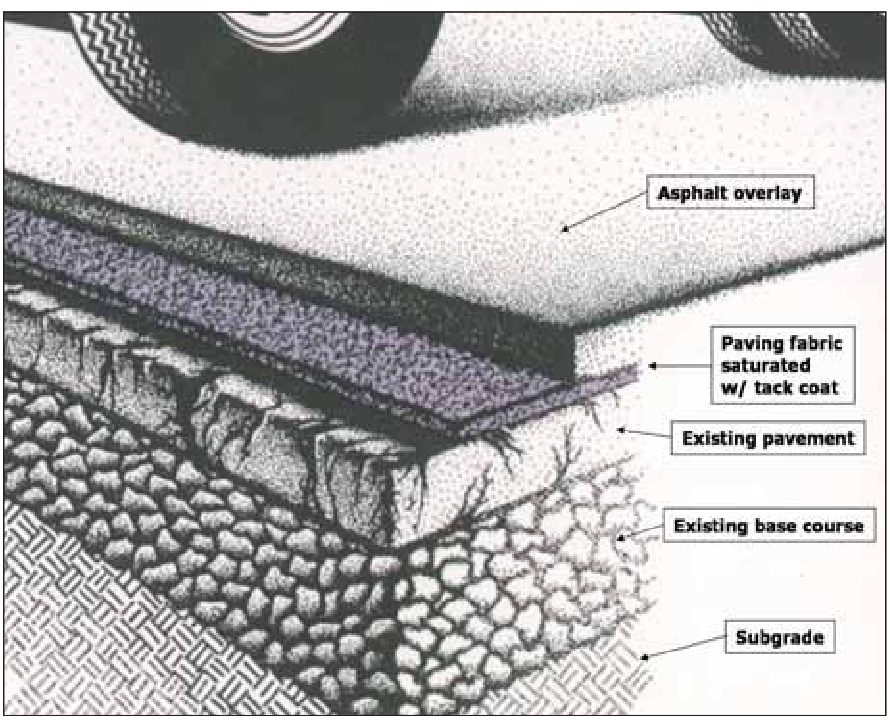
This time around, Sprague decided to use only depreciation cost as a measure of the treatment's success. He dropped the degradation ratio because it was difficult to know exactly how quickly the roads had been degrading before their 1997-1998 treatment.

On the other hand, the depreciation cost for each road was a matter of a simple calculation. The following equation produced a depreciation cost in dollars per square yard per year:

Depreciation cost = Unit Cost of Material X (((100 - Last Rating)/100) / (Last Rating Date - Maintenance Date))

All of the 370 roads were maintained using one of the four methods noted at the beginning of this article: cold mill recycling and an overlay, patching followed by paving fabric and an overlay, paving fabric and an overlay, or an overlay only. In some cases, different sections of the same road received different treatments. In those cases, the roads were divided into subsections for the purpose of the study.

When all was said and done, the team at Texas Research Institute ended up with a large set of data that correlated pre-treatment condition, treatment type, current condition, and depreciation cost. Sprague plotted the data points and fitted a third-order polynomial trendline to them. He chose that type of trendline because it provided the best match to the findings from Phase 1.



Here's what Phase 2 showed:

- For roads with a PCI of 25 or less, in-place cold mill recycling and an overlay is comparable to a patching/fabric/overlay combination in cost-effectiveness. On road surfaces in very bad condition, both of these strategies are a better value for the money than either fabric/overlay or overlay only.
- For roads with a PCI between 25 and 50, paving fabric with a minimum 1 1/2-inch overlay is most cost-effective and appears to do the best job of slowing down degradation.
- For roads with a PCI above 50, a simple asphalt overlay is about equal to a fabric/overlay system in performance and cost-effectiveness. (When the paving fabric interlayer and overlay is as cost-effective as the same thickness overlay with no fabric, it's because the life extension of the pavement is equal to the extra cost up front.) However, more study is needed because very few of the roads included in the study had a condition of 50 or better when they were repaired.

There was quite a bit of scatter in the data, but the scatter is easily explainable. For one thing, the decision of which maintenance treatment to use on each road was left up to the contractor in charge and wasn't made according to any fixed system. And despite a countywide standard stating that overlays should be 2.25 to 2.5 inches thick, the overlay thicknesses were often as thin as 1.9 inches.

Also, despite the use of the characteristic pavement degradation curves, there was still some uncertainty about the exact condition of the roads at the time they were repaired.

In a perfect world, investigators would be able to assess pavement condition immediately before repairing it. Then they would assign treatment according to the PCI and would ascertain that consistent methods were used.

The fact that this study presents such a clear result in an imperfect world adds even more credibility to the author's conclusions. It's also notable that although many of the roads had similarly low pre-treatment ratings, contractors chose a paving fabric interlayer to repair them. Obviously, the roads where fabric treatment was used were in the worst condition beforehand—a condition where a simple overlay would not last long.

Why is a paving fabric interlayer so cost-effective? One reason is the low cost of the installed system. A square yard of paving fabric, installed with the required asphalt cement tack coat, ready to be paved over, typically costs less than half of what milled-in-place asphalt concrete would cost per square yard.

Conclusions

This study is the most comprehensive of its kind. It compares paving fabric interlayers with conventional asphalt overlays and in-place pavement recycling on a large number of roads in relatively poor condition.

Many counties, municipalities, and DOTs have a policy similar to Greenville County's "Worst First" strategy. Their priority is to first repair roads with the worst condition ratings. The results of this study show that including a paving fabric interlayer is always at least cost-competitive with other repair strategies. And in the most common scenario, wherein the road is at or near its terminal serviceability, the use of a paving fabric is clearly the most economical solution.

The study presents clear evidence of what many have known all along: Paving fabric is a smart economic choice.

"While previous studies have shown that nonwoven paving fabrics extend the life of asphalt overlays of up to 10 years, none have quantified that the maximum benefit is achieved within a specific pavement condition type," says Deron Austin, P.E., director of marketing at SI Geosolutions in Chattanooga, Tenn. "This is extremely helpful to pavement maintenance engineers around the country as they develop the most cost-effective solutions to repair their roadway systems."

Indeed, these conclusions will be highly useful to maintenance professionals as they plan their road repair strategies. The study presents clear evidence of what many have known all along: Paving fabric is a smart economic choice.

The full study may be found on the Geosynthetic Materials Association's Web site, www.gmanow.com. It is, simply put, a guide to making better road maintenance decisions.

By Jamie Swedberg

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