Calculation is correct

Simple math can prove its value again and again

Managing one of the nation's largest assets is tough to do, even if you have the most sophisticated software to help predict roadway conditions and recommend what projects this year's budget should be spent on.

By Doug Ford
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A little more than 20 years ago, state, city and municipal departments of transportation (DOTs) were mandated by the Federal Highway Administration (FHWA) to put in place a pavement-management system. Many use various software programs that are capable of predicting how the traffic conditions, climate and construction, and maintenance activities affect the service life of their entire roadway network. These programs have proven extremely beneficial in improving pavement management and helping predict future budgetary requirements. However, these complex programs and their users often overlook one very simple concept—how much each alternative pavement treatment costs on an annual basis. Easy to calculate and utilize, this concept can save agencies substantial amounts of money and can clearly illustrate how cost-effective pavement preservation can help stretch ever-tightening road budgets.

Currently, pavement managers input budget data into these software programs, and the program recommends the type of work and estimated cost for each roadway segment. The project engineer then adjusts those recommendations and cost estimates by examining the roads in person. On the surface, it seems effective enough. However, instead of simply asking what needs to be done to fix this road, the most proactive engineers ask how long this particular treatment will extend the service life of the roadway. Once you know how long the treatment is expected to last, you can then calculate the equivalent annual costs (EACs). These EACs allow agencies to compare different treatment options and their annual costs to help determine a pavement-management program that optimally allocates funds.

Do the math

EACs are calculated using basic math and can provide valuable insight into how effectively DOTs are managing their pavements

and spending their budgets. To make the calculations, simply take each treatment's cost and divide it by the estimated service life for that treatment. That is the treatment's annual cost, or its EAC.

The pavement manager may already know the estimated service life for each treatment or can consult with others in the industry to obtain these estimations. Please keep in mind that the estimated service life of a treatment is very much dependent on whether you apply it on the right road at the right time. Eric Thibodeau, a licensed professional engineer and the chief of pavement management for the New Hampshire Department of Transportation (NHDOT), has been using EACs to help map out his annual resurfacing program for the last four years.

"Equivalent annual costs are not difficult to calculate, can help agencies save substantial amounts of money and really stretch a constantly diminishing budget to help maintain one of our nation's most valuable assets," commented Thibodeau. "The way of thinking has always been centered on the budget and how to stay within it, but with EACs you can use more cost-effective treatments so you can maintain and repair more lane-miles. It's really about doing as much as you can with the little dollars that you may have."

Thibodeau learned about this concept from Dan Patenaude, a licensed professional engineer with Sealcoating Inc. and former director of public works for the town of Wallkill, N.Y. He has been speaking on the critical importance of pavement preservation for more than 10 years and has worked on projects with dozens of agencies up and down the eastern coast of the U.S.

"It's all about doing what is best for your community," stated Patenaude. "Pavement managers need to consider EACs if they want to make the most of taxpayer dollars. We cannot afford to let our roadway network deteriorate to the point of needing expensive repairs and must constantly focus on keeping good roads in good condition. Communicating an agency's EACs to its taxpayers, elected officials and other decision makers can go a long way in building support for proposed projects that will optimize limited funds while also saving money for other pressing community needs."

EACs are unbiased and do not support one treatment over another. One treatment may last longer on lower-volume rural roads but would not be expected to hold up on busier city streets. That is why EACs are unique to each agency and road network. EACs are

FACT FINDER

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constantly evolving as information is gathered over time. Weather conditions, traffic, new technologies and treatment types and ever-changing market cost dynamics all play a role in this evolution.

NHDOT's latest chart of EACs (Figure 1) shows the cost per square yard and the estimated service life for NHDOT's most commonly used treatments. In general, rehabilitation treatments, such as thick pavement overlays or inlays and reconstructive processes such as full-depth reclamations, are more expensive and have longer service lives than maintenance treatments but have the highest EACs. By developing your own EAC chart you can quantify the true difference between annual treatment costs.

Three rights

Many agencies are forced to play catch-up and have to fix the worst roads first because stakeholders and elected officials generally put pressure on DOTs to repair the bad roads, not to maintain the better roads. Why wouldn't they? These roads are in poor shape and need to be repaired. However, placing an emphasis on the utilization of treatments with lower EACs in the pavement-management plan tends to ensure the roads that have just been repaired and are in good shape stay that way. In contrast, an increasing number of cash-strapped agencies are employing some of the less expensive pavement-preservation treatments as a stop-gap measure to hold deteriorating pavements together until sufficient funds are available for more expensive repairs. The growing pavement-preservation industry has provided agencies with a wide variety of tools that can quickly restore a roadway surface to a "like-new" condition, but these treatments may only last two to three years when used on "bad roads" as opposed to six or seven when applied at the appropriate time in the pavement-deterioration process. At this point, the service life of that treatment has been compromised, and the shorter life cycle will increase the EAC of that particular treatment for that particular part of the roadway.

In order to encourage the use of the right treatment on the right road at the right time and optimize EACs, the asphalt deterioration curve (Figure 2) supplied by Patenaude shows the life expectancy of a sample pavement segment and when various treatment options should be used to extend its life. For instance, it would be inadvisable to use fog seal on a road that has not received any treatments for more than 15 years, and a five-year-old road would not typically need a mill-and-overlay treatment. Based on this curve, you can see when various treatments are most appropriate, and the EACs help show how the costs compare.

For example, a network of roads that maintains 650 miles of 26-ft-wide road (on average) has a total pavement area of approximately 9.9 million sq yd. If pavement managers deferred maintenance and were consistently spending the majority of their budgets rehabilitating and reconstructing roadways, it might cost that district approximately $1.10 per sq yd per year for a total cost of $10.9 million per year. If all the roads were in good condition and the pavement manager was focused on keeping them that way, then the same pavement area at $0.50 per sq yd per year would only require a budget of approximately $4.9 million per year. That is a savings of $5.9 million per year.

From ideal to real

Realistically, no agency in the U.S. has all good roads that are just in need of maintenance, and unfortunately, weather conditions and other natural disasters can really wreak havoc on a DOT's road network. But with those kinds of savings, pavement-preservation treatments offer the opportunity to improve the overall condition of an agency's road network, even with limited funds.

Patenaude often speaks on the importance of pavement preservation, and he often uses a graph that illustrates progressive pavement management (Figure 3) and the difference between a preservation strategy and a rehabilitation strategy. The blue curve shows the steps taken to preserve a road over a 50-year cycle. During those 50 years, the road will see some sort of work eight different times for a total cost of $28.65 per sq yd. A road not being maintained and receiving only rehabilitation treatments will need work only three times over that 50-year cycle, but it will have a total

Figure 1. NHDOT's Pavement-Management Section (2011/2012 equivalent annual costs).

Treatment Alternative	2011/2012 Approx. Costs ($/lane-mile)	2011/2012 Approx. Costs ($/SY)	Estimated Service Life (years)	Equivalent Annual Cost ($/SY/year)
Micro or 4.75-mm HMA	$22,810	$3.24	6	$0.54
Double Chip Seal	$28,301	$4.02	7	$0.57
Bonded Wearing Course (Nova Chip)	$41,818	$5.94	10	$0.59
¾-in. Paver Ship	$25,281	$3.59	6	$0.60
1-in. HBP Overlay	$33,708	$4.79	8	$0.60
Chip Seal	$21,120	$3.00	5	$0.60
15% AR Chip Seal	$35,482	$5.04	8	$0.63
1½-in. HBP Overlay	$50,561	$7.18	10	$0.71
1½-in. ARGG Overlay	$70,786	$10.05	13	$0.77
1½-in. HBP Inlay	$67,457	$9.58	10	$0.96
FDR with 4-in. HBP	$147,502	$20.95	15	$1.40
2-in. TW Inlay with 1½-in. FW Overlay	$134,872	$19.16	13	$1.47
4-in. CP with 3-in. HBP Overlay	$156,035	$22.16	15	$1.48

Notes: Cost per lane, lane-mile based on 12-ft lane width.
Costs shown here include a 20% multiplier to account for fixed costs.

cost of approximately $48 per sq yd.

This example encouraged Thibodeau to implement EACs into his pavement-management program. Before 2009, Thibodeau's pavement-management program contained some allocations for preservation, but the efforts were limited and less focused. For example, microsurfacing was only used on shorter lengths of roadway projects and chip-seal work proposed in 2007 only covered 3.5 miles. With funds from the American Recovery and Reinvestment Act (ARRA) of 2009 and the development of his EAC chart, Thibodeau finally had the ability to make some headway on his goal of expanding the pavement-preservation effort and improving New Hampshire roadways.

Before the ARRA funds became available, Thibodeau had proposed projects to cover 250 total lane-miles with preservation treatments, accounting for only about 6% of them. With the ARRA funds, he was able to nearly triple the program to include 706 total miles, and preservation treatments rose to 13% of the overall program, covering 93 miles for 2009. New Hampshire committed a large portion of the ARRA funds to work proposed that year, but in the years following, Thibodeau was able to build on this momentum and use EACs to help show decision makers how they could most effectively use the remaining funds. Pavement-preservation treatments accounted for 81 miles (17%) of the 2010 program, 79 miles (32%) of the 2011 program, 66 miles (19%) of the 2012 program and 106 miles (31%) of the proposed 2013 program.

New Hampshire know-how

Showing that pavement-preservation treatments are being utilized more frequently is positive for the roadways' quality of life, but there is still one question to be answered. How does the amount of roadway being preserved compare to the cost? For 2012, the 66 miles of pavement-preservation projects account for approximately 19% of the total miles resurfaced, but only accounted for 8% of the budget.

Recently, the NHDOT completed two preservation projects: one on S.R. 12 in Troy and Swanzey and one on S.R. 112 in Lincoln. Both sections of road were completely rehabilitated in 2002 or 2003 for approximately $7.7 million combined. Rehabilitation has an estimated service life of 15 years, so if the roadways had been left alone for another five years, a second full rehabilitation may have been required. This would have made the cost of the first rehabilitation a little more than $253,000 a year for S.R. 112 and $260,000 a year for S.R. 12. An asphalt rubber chip seal was applied to S.R. 112 at a cost of $875,000 and has an expected service life of eight years, which equates to approximately $109,000 a year. Microsurfacing was applied to S.R. 12 at a cost of $290,000 and has an expected service life of six years, which equates to approximately $48,000 a year. Combined cost per year for these roadways to be rehabilitated is approximately $513,000, or if you plan wisely with EACs, you can preserve the same sections of road for a combined cost of $157,000 or less annually.

The FHWA may have mandated that DOTs utilize a pavement-management system almost 20 years ago, but until recently, the idea of breaking these costs down annually may have been overlooked. Patenaude has made it his mission to explain the idea of EACs to those pavement managers willing to listen. One of those was Thibodeau and it has paid off tremendously. The pavement-management program in New Hampshire is proving that understanding and applying EACs helps to do more with less. **R&B**

Ford is president of Pavement Coatings Co. and president of the International Slurry Surfacing Association.

For more information about this topic, check out the Maintenance Channel at www.roadsbridges.com.

Figure 2. The asphalt deterioration curve.

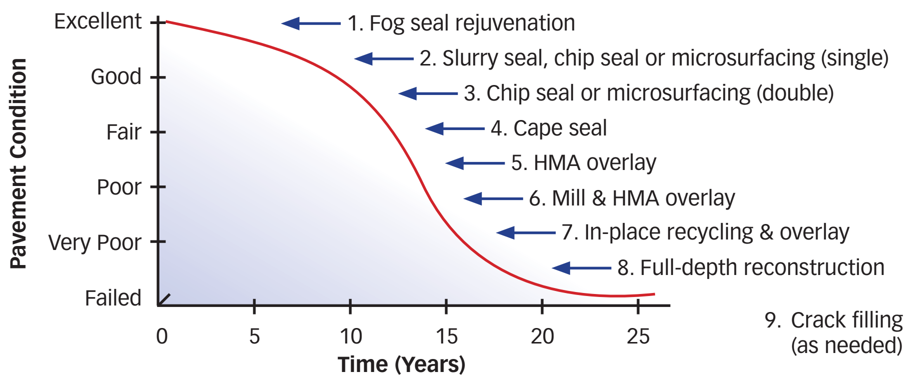
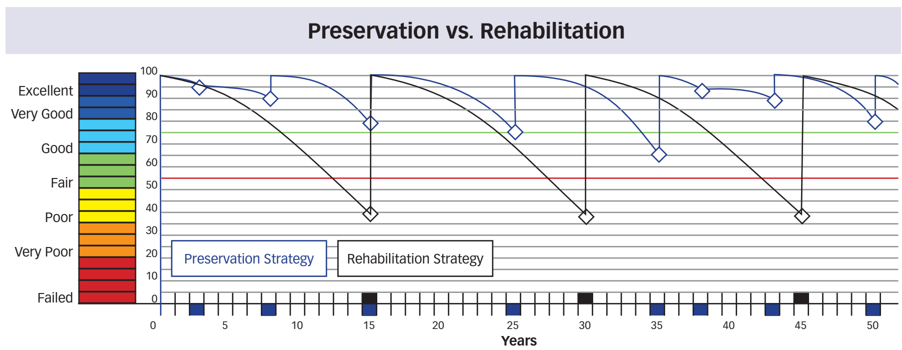


Figure 3. Patenaude's progressive pavement management.



Preservation Strategy

Years 3 & 38: Rejuvenation
Years 8 & 43: Microsurfacing (single)
Years 15 & 50: Microsurfacing (double)
Year 25: Cape seal
Year 35: 1¾-in. hot-mix overlay

Total cost/SY over 50 years = $28.65

Rehabilitation Strategy

Year 15: CIPR with 2-in. HMA overlay
Year 30: CIPR with 2-in. HMA overlay
Year 45: CIPR with 2-in. HMA overlay

Total cost/SY over 50 years = $48.00