*Abridgment*

# Evaluation of Highway Blade-Patching

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A survey of the 50 state highway departments on their use of blade-patching as a maintenance technique is summarized. Blade-patching is defined as cleaning a pavement area, applying tack coat, applying asphalt mix with a motor grader or spreader box, and compacting. On the basis of the information obtained from the survey, a cost analysis comparing blade-patching to a 2-in. overlay was made, illustrating the use of an economic model for decisions between maintenance alternatives. Of the 43 states that responded to the survey, 38 use blade-patching. State highway divisions spend more than $175 million a year on blade-patching, but there is wide disagreement about its usefulness. The best estimate of blade-patch life is 3 years, and economic analysis comparing blade-patching to a 2-in. hot-mix overlay indicates that blade-patching should seldom be used if traffic exceeds 1,500 average daily traffic or if blade-patching required to maintain the pavement exceeds 125 ton/mi/year.

Blade-patching is the application of hot mix, cold mix, or premix to areas of pavement distress, by motor grader or spreader box, without removing existing pavement. Although it is widely used for pavement maintenance, a review of the literature produces little information (*1*). Consequently, a research project was undertaken.

During October 1990, a questionnaire was distributed to the chief maintenance engineer (or similar position) at the highway division of each of the 50 states. The questionnaire requested information about the extent of each state's use of blade-patching as a maintenance technique, appraisals of its usefulness, and suggested alternatives. Forty-three states returned at least partially completed questionnaires.

## SURVEY FINDINGS

Highlights of the survey are presented in this paper. For a more detailed discussion, see Rogge (*2*).

Of the 43 states responding to the survey, 5 indicated that they do not use blade-patching and generally do not consider it cost-effective. Six states indicated that they do use blade-patching but provided no information on tons applied or level of budget allocation for this practice.

Table 1 summarizes use, cost, and service life data. The 27 states responding with budget information reported spending a total of about $180 million a year on blade-patching. The top three users account for 50 percent of the tonnage.

The cost figures presented in Columns 5–7 of Table 1 represent what the states believe to be labor, material, and equipment costs for blade-patching. Cost estimates ranged from $28.70/ton to $85.50/ton, with a median value of $44.00/ton. Twenty-one of twenty-nine respondents cited values between $30.00/ton and $50.00/ton.

It is difficult to determine dollars per square yard of blade-patching, because area and thickness of patches vary widely and records of areas covered are not generally kept. Fourteen states attempted to supply this information, however, providing a low of $0.75/yd$^2$, a high of $11.50/yd$^2$, and a median value of $2.70/yd$^2$.

Thirteen states estimated blade-patching costs per lane-mile improved. Values ranged from $1,300/lane-mi to $28,000/lane-mi, with a median value of $7,099/lane-mi.

Estimates for blade-patching life-expectancy ranged from 6 months to 20 years. Most responses were from 2 to 5 years. The average was 3.6 years, and the median, 3 years. These values are of the same magnitude as the average service life value of 3 years for "premix leveling" determined by a 1986 study at Purdue (*3*).

Respondents were asked to estimate the relative distribution of their blade-patching tonnage to various typical applications. More than half the tonnage was estimated to be used to fill ruts or spot depressions. Other uses included repair of surface cracks, bridge approaches, and sunken grades.

Roadway condition before blade-patching was indicated to be evenly distributed between "fair," "poor," and "very poor" pavements. On average, maintenance engineers thought that blade-patching improved the roadway the equivalent of one rating (e.g., "poor" raised to "fair").

Maintenance engineers were asked to agree or disagree with statements about the effectiveness of blade-patching when used for different types of distress and whether blade-patching is a cost-effective substitute for overlays. Significant differences of opinion were expressed on all of these items with one exception: the statement "blade-patching is a temporary measure to maintain the surface until an overlay may be accomplished" drew agreement and strong agreement from all but one respondent.

The survey specifically requested information about cost-effective alternatives to blade-patching that respondents have discovered. These alternatives were milling, leveling with self-propelled AC pavers, 3/8-in. sand mix laid with a paver, slurry seal, microsurfacing, crack sealing, inlay patching, chip seals, small pavers, and resurfacing. Although it was not mentioned by survey respondents, the author knows through other research that Oregon has successfully used cold in-place recycling with a chip seal in lieu of blade-patching on low-volume roads in the high desert environment of central Oregon (*4*). Hot recycling is another process that shows promise.

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TABLE 1 BLADE-PATCHING VOLUME, COST, AND SERVICE LIFE BY STATE

| | | ANNUAL BLADE-PATCHING | ANNUAL BLADE-PATCHING | ESTIMATED UNIT COST | ESTIMATED UNIT COST | ESTIMATED COST/LANE-MI. | ESTIMATED SERVICE LIFE (YRS) | | |
|---|---|---|---|---|---|---|---|---|---|
| (1) | STATE (2) | (TONS) (3) | ($) (4) | ($/TON) (5) | ($/SY) (6) | ($/LANE-MI) (7) | LOW (8) | AVG (9) | HIGH (10) |
| 1 | AL | 50,976 | $1,244,000 | $37.54 | | | 5 | | 15 |
| 2 | AK | | | | | | | | |
| 3 | AZ | | | | | | | | |
| 4 | AR | 250,000 | $9,750,000 | $39.00 | | | 3 | | 5 |
| 5 | CA | 30,000 | $2,000,000 | $70.00 | $4.00 | $28,000 | | 2 | |
| 6 | CO | 200,000 | $7,100,000 | | | | | 3 | |
| 7 | CT | 50,000 | | | $0.75 | $7,099 | | 3 | |
| 8 | DE | | | | | | | | |
| 9 | FL | | | $54.00 | | | | 4 | |
| 10 | GA | | | | | | | | |
| 11 | HI | | | | | | | | |
| 12 | ID | 157,000 | $4,900,000 | $31.00 | $1.25 | $8,000 | | | |
| 13 | IL | 500 | | | $11.50 | | | 2 | |
| 14 | IN | 13,629 | | $35.69 | | | | 3 | |
| 15 | IA | 35,000 | $1,350,000 | $34.00 | | | 2 | | 10 |
| 16 | KS | 400,000 | $8,800,000 | | | $4,900 | 1 | | 2 |
| 17 | KY | | | | | | | 5 | |
| 18 | LA | 21,000 | $1,200,000 | $57.00 | | | 3 | | 7 |
| 19 | ME | | | | | | | 3 | |
| 20 | MD | 50,834 | $3,002,636 | $59.00 | | | 1 | | 3 |
| 21 | MA | | | | | | | | |
| 22 | MI | 6,400 | | $60.00 | | | 3 | | 5 |
| 23 | MN | 8,000 | | 64.59 | 2.66 | | 1.5 | | 10 |
| 24 | MS | | | | | | | | |
| 25 | MO | 950,000 | $29,000,000 | $30.00 | $1.18 | $1,300 | 3 | | 4 |
| 26 | MT | | | | | | | | |
| 27 | NE | 143,000 | $4,400,000 | $30.64 | | | | 5 | |
| 28 | NV | 22,000 | $3,075,910 | $85.50 | | | | | |
| 29 | NH | 96,000 | $3,557,217 | $37.05 | | $1,872 | 2 | | 3 |
| 30 | NJ | | | | | | | | |
| 31 | NM | 216,000 | $9,500,000 | $44.00 | $2.70 | $19,000 | 1 | | 5 |
| 32 | NY | | | | | | | 0.5 | |
| 33 | NC | 150,000 | $4,500,000 | $30.00 | $2.50 | | | 3 | |
| 34 | ND | 120,000 | $5,500,000 | $45.00 | | | | 20 | |
| 35 | OH | 176,997 | $8,173,263 | $46.18 | | | | 3 | |
| 36 | OK | 130,000 | $4,300,000 | $33.87 | $1.87 | $13,080 | 2 | | 3 |
| 37 | OR | 200,000 | $7,500,000 | $42.50 | | | 3 | | 10 |
| 38 | PA | | | | | | | | |
| 39 | RI | | | | | | | | |
| 40 | SC | 3,760 | $300,000 | $50.00 | $3.75 | | | 2 | |
| 41 | SD | 250,000 | $4,000,000 | $58.00 | $6.00 | $3,000 | 5 | | 10 |
| 42 | TN | | | | | | 1 | | 2 |
| 43 | TX | 1,339,000 | $38,500,000 | $28.70 | $1.50 | | 5 | | 10 |
| 44 | UT | 125,000 | $5,800,000 | $46.40 | $2.20 | | | 3 | |
| 45 | VT | 4,000 | $200,000 | $50.00 | | | 3 | | 5 |
| 46 | VA | | | $50.00 | | | | 8 | |
| 47 | WA | 31,766 | $3,904,951 | | | | | 3 | |
| 48 | WV | 146,000 | $4,600,000 | $31.50 | $2.70 | | | 5 | |
| 49 | WI | | | $34.63 | | | | 4 | |
| 50 | WY | 70,640 | $2,500,000 | | | | | | |
| | TOTAL | 5,447,502 | $178,657,977 | | | | | | |
| | MEAN | 136,933 | $5,598,319 | $44.50 | $2.69 | $8,136 | 2.6 | 3.6 | 6.1 |
| | MEDIAN | 108,000 | $4,400,000 | $44.00 | $2.70 | $7,099 | 3.0 | 3.0 | 5.0 |

NOTE: MEAN VALUES ARE TAKEN AFTER DISREGARDING HIGH AND LOW EXTREME VALUES.

## ECONOMIC MODEL

The survey showed a wide disparity in use and perceived usefulness of blade-patching. To aid maintenance managers in comparing blade-patching and other maintenance techniques, an economic model is offered. The model is best explained graphically. Figure 1 shows a plot of equivalent annual cost (EAC) per mile versus average daily traffic (ADT). The cost values for ADT = 0 represent agency costs only, with no consideration of user costs. Therefore, the intersections of the curves with the y-axis show the effects on agency budgets. The area of the graph corresponding to positive ADT values incorporates user costs. The slopes of the lines represent user costs. The steeper the slope, the greater the cost per mile. For a given ADT, the curve with the lowest EAC represents the preferred economic choice. The intersections of curves show ADT values where the preferred economic choice changes.

The example of Figure 1 shows a comparison of blade-patching with a 2-in. overlay applied to a poor pavement where

- 50 ton/mi/year of blade-patching are required to maintain,
- Blade-patching costs $44/ton (median value in survey),
- Blade-patching reduces variable user costs for "medium" cars from $0.162/mi ("poor") to $0.138/mi ("fair"),
- Overlays cost $30/ton and last 10 years, and
- Overlay reduces variable user costs for "medium" cars to $0.119/mi ("very good").

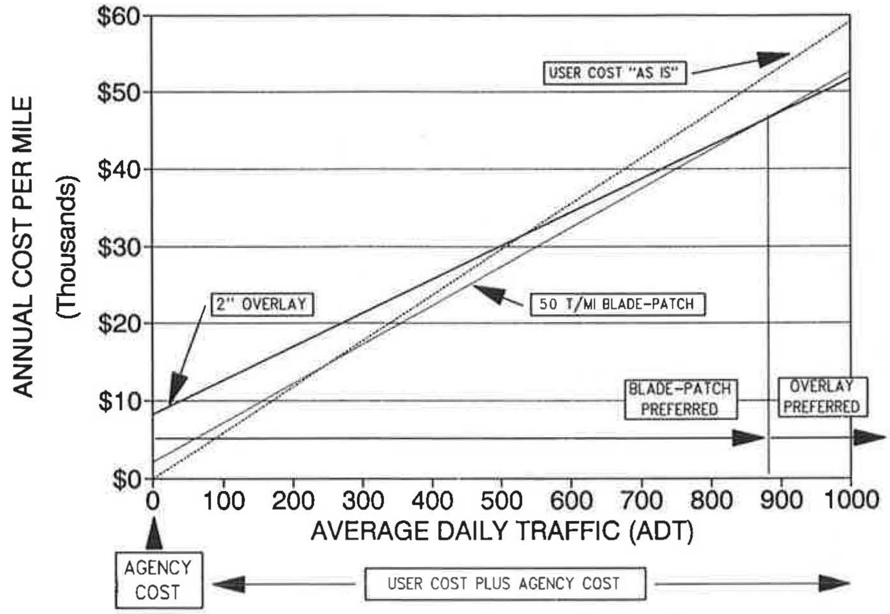


**FIGURE 1 Break-even points of user savings and overlay cost for 2-in. overlay or blade-patching applied to "poor" pavement where 50 ton/mi of blade-patching are required.**

User costs were taken from a study by Zaniewski (*5*). EACs were calculated using traditional methods of engineering economy with an interest rate of 6 percent. A "do nothing" curve is also included for reference. Below 880 ADT, blade-patching is preferred. Above 880 ADT, the overlay is preferred.

A whole family of lines parallel to the 50 ton/mi curve could be plotted on the graph of Figure 1 to represent blade-patching at different ton-per-mile rates. Lower tonnages of blade-patching required per mile would result in preference for blade-patching at higher ADTs. Higher tonnages would shift the break-even point to lower ADTs. In this example, the maximum allowable blade-patching is 190 ton/m with break-even at ADT = 0. In other words, the cost of blade-patching at 190 ton/mi/year is equal to the annualized cost of the overlay, if user costs are neglected.

The above analysis was repeated for application to "fair" pavement and with a range of overlay prices of $25/ton to $30/ton and lives of 10 to 15 years. The conclusion is that blade-patching is seldom preferred over a 2-in. overlay when ADT exceeds 1,500 or when more than 125 ton/mi of blade-patching are required to maintain the road. Maintenance managers are encouraged to substitute their own values and repeat the analysis. See Rogge (*2*) for a more complete discussion.

## CONCLUSIONS

On the basis of the preceding discussions, the following conclusions are warranted:

1. There is a wide divergence of opinion among state highway departments regarding the cost-effectiveness of blade-patching as a maintenance technique. To some it is to be avoided, to some it is a last resort. To others it is a useful technique.
2. The greatest agreement among survey respondents was found to be with the statement "blade-patching is a temporary measure to maintain the surface until an overlay may be accomplished."
3. Costs of blade-patches ranged from $28.70/ton to $85.50/ton with a median value of $44.00/ton.
4. Blade-patches are generally believed to have service lives from 2½ to 6 years; estimates of 3 years were the most common.
5. Respondents collectively estimated that blade-patching raises the condition rating of the pavement approximately one level (e.g., "poor" to "fair").
6. An economic model for comparing blade-patching with other maintenance strategies is presented. When typical values from the survey were incorporated in this model and blade-patching and a 2-in. overlay were compared, blade-patching was seldom preferred if ADT exceeded 1,500 ADT or if more than 125 ton/mi were required to maintain the roadway.
7. Suggested alternatives to blade-patching include milling, leveling with self-propelled AC pavers, 3/8-in. sand mix laid with a paver, slurry seal, microsurfacing, crack sealing, inlay patching, chip seals, small pavers, resurfacing, and recycling.


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