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MaineDOT

Transportation Research Division

Technical Brief (09 – 3)

Evaluation of Alternative Snow Plow Cutting Edges

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Introduction

With approximately 450 snow plow trucks, the Maine Department of Transportation (MaineDOT) uses in excess of 10,000 linear feet of plow cutting edges each winter season. Using the 2008-2009 cost per linear foot of $48.32, the Departments total cost for cutting edges for the winter of 2008-2009 is estimated to exceed $500,000. Considering this significant annual expenditure, MaineDOT is continually looking for alternatives to its existing carbide-insert cutting edges.

During the winter of 2007-2008, MaineDOT's maintenance crew in Baileyville found themselves running low on carbide cutting edges. As an alternative, the crew installed carbide-insert underbody scraper blades. The underbody blade is approximately 1/8 inch thicker than the conventional plow blade (see Photo 1). The crew quickly noticed the underbody blades appeared to last longer than their conventional blades. These promising preliminary results made a more formal evaluation warranted for the winter of 2008-2009.

In addition, MaineDOT has been evaluating a composite plow blade since the winter of 2006-2007. The Tuca SX is manufactured in Bochum, Germany by Kuper GmbH & Co. KG**.** It consists of tungsten-carbide inserts, vulcanized in rubber and laminated between steel. Initial indications from the manufacturer stated the cutting edges would reduce vibration, minimize noise, reduce fuel consumption and provide extended blade life over standard cutting edges.

The surface-contacting edge of the blade is approximately 1.4 inches wide, which is about twice the width of standard plow cutting edges. The blade was originally named the Kombi SX and was evaluated in 2006-2007 and 2007-2008 in the Region 5, Presque Isle area. Preliminary results of that evaluation are available in report 07-2 Evaluation of Kombi SX Snow Plow Cutting Edges, dated October of 2007.

For the 2008-2009 winter season, two sets of the Tuca SX (see Photo 2) blades were installed in the Region 4, Bangor area and the results of that trial are included as part of this report.

Photo 1: Conventional (L) & Underbody Blades

Photo 2: Kuper Tuca SX Cutting Edges

Methodology

The methodology for this evaluation included eight plow vehicles. Two of those vehicles were located at the Baileyville maintenance facility and six were located at the Bangor facility. Actual plow mileage was extracted from the Driver Storm Report. This report is completed by the driver at the end of each storm event.

A total of seven sets of standard carbide-insert edges were worn to termination, while four sets of underbody blades were completely worn. One of the two sets of composite blades was damaged from an impact with a bridge expansion joint and the second set had some wear life remaining at the end of the 2008-2009 winter season.

The results of this evaluation are summarized below.

Results

Standard Carbide-Insert Cutting Edges

MaineDOT's current supplier for their standard carbide-insert cutting edges is Valk Manufacturing Company, New Kingston, Pennsylvania. Of the seven sets of standard blades that were worn to termination, four sets were used on plow routes that were primarily secondary roadways and three sets were used primarily on the Interstate system. Overall, the seven sets lasted an average of 1, 933 miles. For secondary roadway use, the average was 2,124, while the average on the Interstate system segments was 1,711. Plowing habits such as speed, frequency of scraping nearly bare pavement and road surface conditions are believed to be factors in the disparity of averages for Secondary and Interstate plow routes. Anecdotal information indicates that drivers typically plow at a higher rate of speed on the Interstate system, in an effort to maintain speeds similar to the traffic surrounding them. Scraping of nearly bare pavement is also believed to be more prevalent on the Interstate sections. The angle at which the plow is operated can also have an impact on wear life.

Each set of blades consists of two 4 foot sections and one 3 foot section. At $48.32 per foot, this 11 foot total has a cost of $531.52. Overall, the average cost per mile was $0.28. For the Secondary sections, that average dropped to $0.25 per mile and for the Interstate system, the average increased to $0.32 per mile.

This information is summarized in Table I.

Table I: Standard Carbide-Insert Cutting Edges			
Truck Number	**Primary Route**	**Total Miles per Set**	**Cost per Mile**
T11-540	Secondary	2,361	$0.23
	Secondary	1,730	$0.31
	Secondary	2,596	$0.21
T01-838	Secondary	1,810	$0.29
	Average	**2,124**	**$0.25**
T01-139	Interstate	1,329	$0.40
T01-150	Interstate	1,700	$0.31
T01-420	Interstate	2,005	$0.27
	Average	**1,711**	**$0.32**
	Overall Average	**1,933**	**$0.28**

Carbide-Insert Underbody Scraper Cutting Edges

Valk Manufacturing Company also provides MaineDOT with its carbide-insert underbody scraper cutting edges. Two sets of the underbody blades were worn to termination on secondary routes and two on the Interstate system. The four sets lasted for an average of 2,558 miles. On the secondary routes, the underbody blades averaged 3,611. It should be noted that not only is this average derived from only two sample sets, but one of those sets lasted a reported 5,021 miles. The two sets used on the Interstate routes lasted an average of 1,505 miles.

At a cost of $51.73 per foot, an 11 foot set of the underbody blades totals $569.03. The average, overall per mile cost for the underbody blades was $0.22. Secondary routes had a per mile cost of $0.16, while the Interstate routes were significantly higher at $0.38 per mile.

These results are summarized in Table II.

Table II: Carbide-Insert Underbody Scraper Cutting Edges			
Truck Number	**Primary Route**	**Total Miles per Set**	**Cost per Mile**
T11-946	Secondary	5,021	$0.11
T01-838	Secondary	2,201	$0.26
	Average	**3,611**	**$0.16**
T01-139	Interstate	1,177	$0.48
T01-420	Interstate	1,832	$0.31
	Average	**1,505**	**$0.38**
	Overall Average	**2,558**	**$0.22**

Tuca SX Composite Cutting Edges

As stated above, MaineDOT"s experience with the Tuca SX composite blade began during the winter of 2006-2007. During this first evaluation period, the cutting edges failed prematurely (see Photo 3). Pictures

and blade measurements were sent to the manufacturer and it was determined that excessive heat caused the rubber that encases the tungsten-carbide inserts to melt. This problem occurred in approximately 25 percent of the blades used worldwide during the winter of 2006-2007 and was believed to be an improper chemical blending at the manufacturing facility.

For the 2007-2008 winter season, the manufacturer modified the composite blade to include triangular shaped cut-outs (see Photo 4) for the purpose of dissipating the heat generated during higher speed plowing. With this change, results improved dramatically and the blades performed well for the entire season. Although no plow mileage or plowing hours were available because of data recording issues, the set of composite blades lasted as long as three sets of the conventional carbide-insert cutting edges. These results justified a continuation of the evaluation for 2008-2009.

Tuca SX cutting edges were installed January 7th, 2009 on two trucks from the Bangor maintenance facility. One set of cutting edges were provided at no cost by the manufacturer and one set was purchased by MaineDOT at a cost of $1,744.43 The manufacturer has since entered into an agreement with an American company, Kennametal Inc. to distribute their product. Prices for the 2009-2010 season have dropped considerably because of this agreement. Prices released in early May, 2009 indicated that a set of the Tuca SX cutting edges had been reduced to $1,134.00. Per mile cost calculations for 2008-2009 will be based on this price.

Photo 3: 2007 Photo of Failed Cutting Edge

Photo 4: Triangular Cut-Outs for Heat Dissipation

When the winter season ended in early March, 2009 one set of the composite blades had plowed 3,324 miles with some wear life remaining. Using the actual miles plowed, the cost per mile would be $0.34. Actual plow mileage will be reported after the winter season of 2009-2010.

Numerous pictures and measurements were sent to the manufacturer in an effort to quantify the remaining life on the plow cutting edges. Based on this information, the manufacturer indicates that perhaps as much as 50 percent more life remains on the Tuca SX blades.

The second set of blades was removed from the truck because of damage sustained from an impact with a bridge expansion joint. At the point they were removed, the blades had been used for 2,248 miles. Although not representative of blades used to termination, the cost per mile of the damaged blades was $0.50.

The operators in both Presque Isle and Bangor commented on the quietness of the Tuca SX blades. In an effort to validate how much quieter the composite blades might be when compared to standard carbide blades, noise testing was completed inside the cab of the truck using a Dosimeter. Plows were run at 25 miles per hour on bare, dry pavement, in both the up and down position and readings were compared. Decibel levels increased 3.85 percent with the standard carbide blades and only by 0.65 percent with the Tuca SX blades. Results of this testing are presented in Figure 1, below.

Figure 1: Dosimeter Testing

Equipment Used: Quest Electronics – Model 215 Sound Level Meter
Calibrated By: Wilner-Greene Associates Last Calibration Date: January 21, 2009

Truck T01-838 – MaineDOT's Standard Carbide Blade

Plow Up Position – 74 to 75 decibels	Plow Down Position – 77 to 78 Decibels
Increase – 3 Decibels	Percent Difference – 3.85

Truck T01-131 – Tuca SX Composite Blades

Plow Up Position – 76 to 77 Decibels	Plow Down Position– 76.5 to 77.5 Decibels
Increase – 0.5 Decibels	Percent Difference – 0.65

Drivers also indicated that the experimental blades seemed to clear and scrape the road as well as the standard blade. This was raised as a concern during installation, because of the additional thickness of the experimental cutting edges.

Conclusions

With seven sets of the standard carbide-insert cutting edges having worn to termination, the average mileage reported for the winter of 2008-2009 appears to be a good representation of what might be expected from the blades. The lower average on the Interstate system (1,505 miles) was expected because of higher plowing speeds and additional scraping to provide bare pavement faster during a winter event.

Disparity in the mileage reported for the four sets of carbide-insert underbody scraper cutting edges causes concern for the accuracy of this sampling. For three of the sets, the average mileage was approximately the same as reported by drivers using the standard cutting edge. The 5,021 miles reported for the fourth set of underbody cutting edges may have been a result of several factors related to plowing habits and conditions. The supervisor responsible for this truck reported that the pavement surface on this plow route was in very good condition and he considered the driver to be very prudent in his driving habits.

With one of the two sets of Tuca SX cutting edges being damaged during this evaluation, a small sampling size became even smaller. In addition, the remaining set of blades did not wear to termination. Final plowing mileage will be reported after the 2009-2010 winter season. Based on pictures and measurements, the manufacturer estimates the blades have worn about 50 percent.

The evaluation conducted in Presque Isle during the winter of 2007-2008 indicated that the Tuca SX outperformed the standard carbide-insert blade by approximately three to one. This result is consistent with the estimated wear life of the blades evaluated in 2008-2009.

Each of the drivers for this evaluation and the evaluation completed in Presque Isle indicated that all of the blades tested, cleared and scraped the pavement surface equally well.

The Tuca SX was considered quieter by each of the operators that used them. Dosimeter testing also confirmed these opinions.

Unfortunately, the angle of each plow was not checked before this evaluation began. Valk recommends a 60 degree angle be used for its standard carbide-cutting edge to achieve optimum wear life and performance. Kuper GmbH & Company also indicated a 60 degree angle is best for their product.

Using data collected, the underbody scraper blade was less costly to operate than the standard carbide-insert cutting edge. With an overall cost per mile of $0.22, the underbody blade was $0.06 less expensive per mile to operate. This calculation includes the set of underbody blades that totaled 5,021 miles. When using just the three sets of blades whose mileages were similar, the average cost per mile increases $0.11 to $0.33.

Although not included in these calculations, consideration should be given to the cost of replacing additional sets of blades. For example; an estimated cost of replacement of $50.00 would increase the costs of a standard set of carbide-insert blades from $0.28 per mile to $0.30.

Recommendations

Because of the relatively small sample-size for the underbody cutting edge and Tuca SX blade, it is recommended that additional testing be completed before any changes are made to the Departments current practice.

Using the Bureau of Maintenance and Operations standard Driver Storm Report, plow mileage can be collected with little or no additional effort on the part of the drivers. The data collection effort of this evaluation, along with other past evaluations indicates a set of standard carbide-insert plow cutting edges will last approximately 1,500 to 2,000 miles. Because of this repeatability, no additional data is needed for the standard blade.

Data should be collected on a minimum of ten sets of carbide-insert underbody scraper blades and Tuca SX composite blades to determine if the potential savings that appear to be possible, can be substantiated. These blades should be distributed evenly between secondary roadways and interstate highways. Particular attention should be given to plow angles.

Because of the disparity in mileage recorded as part of this research, MaineDOT, Bureau of Maintenance and Operations managers should stress the need to check plow angles before the beginning of the winter season and after each cutting edge change during the season.

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