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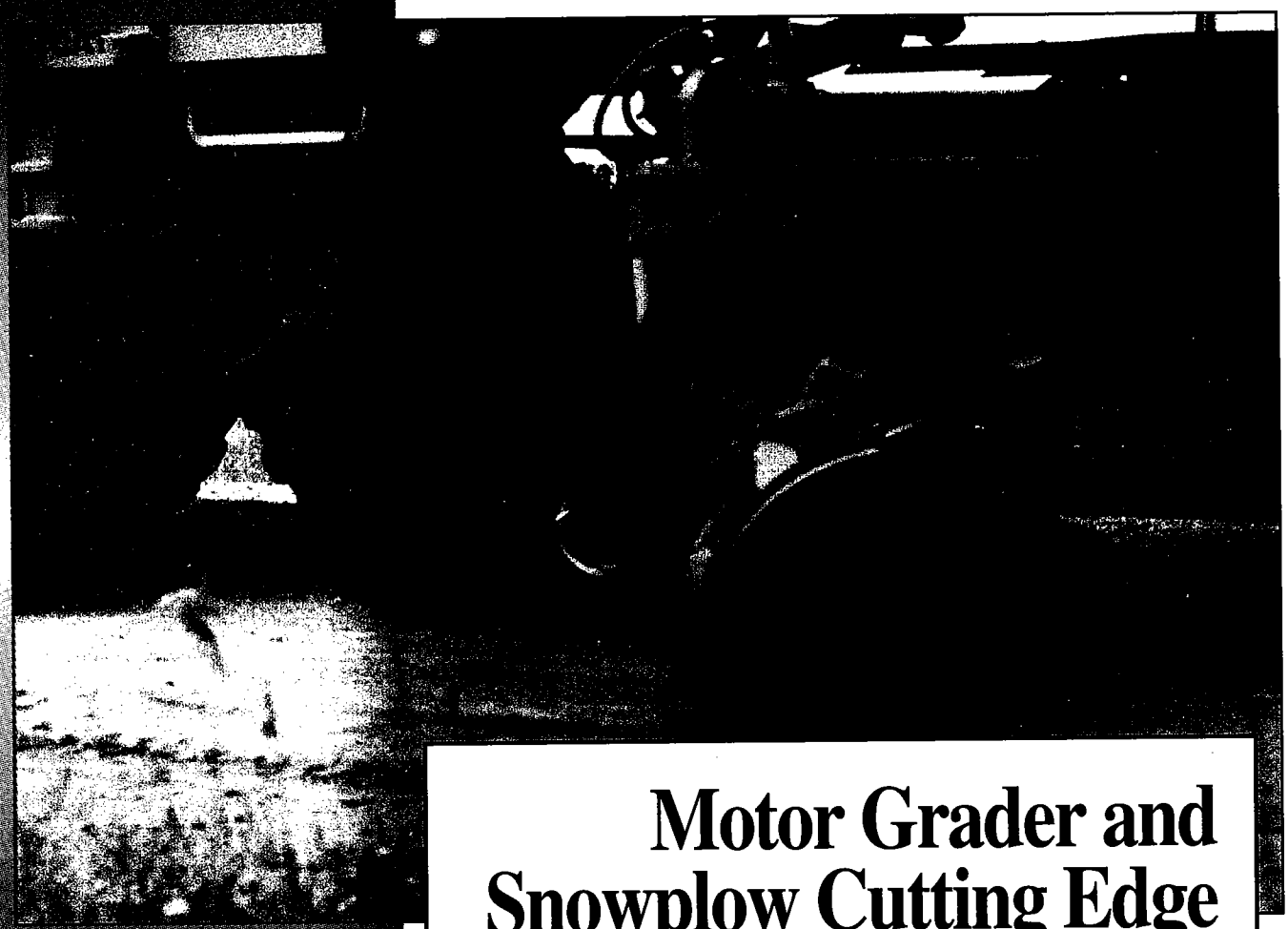
Physical Research



Motor Grader and Snowplow Cutting Edge Durability Study

In cooperation with the
Local Road Research Board
"Sponsoring research for county
and municipal roads and streets"

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The life of the various types of cutting edges for use on Motor Graders and Snowplows varies with the type of steel and its treatment by the manufacturer. This is an evaluation of the wear characteristics of five types of cutting edges, both Motor Patrol and Snowplow, used in the maintenance of gravel roads.

Comparing the two sets of data (gravel and snow) excluding the Carbide edges, the Carbon is best on snowplows and second best but only slightly lower in durability than flame hardened on gravel blading. Gravel blading is about three times more severe than snowplowing on cutting edges other than Carbide Insert.

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MOTOR GRADER AND SNOWPLOW CUTTING EDGE DURABILITY STUDY

Final Report

By Henry Gillis

Minnesota Department of Transportation

January 1993

Prepared for the

MINNESOTA LOCAL ROAD RESEARCH BOARD
OFFICE OF RESEARCH ADMINISTRATION
117 UNIVERSITY 2ND FLOOR
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EXECUTIVE SUMMARY

The life of the various types of cutting edges for use on Motor Graders and Snow Plows varies with the type of steel and its treatment by the manufacturer. At the request of the Minnesota Local Road Research Board and the MN/DOT Maintenance Operations Office this study was initiated to evaluate five (5) types of cutting edges, Carbon, Flame Hardened, Thru Hardened, Carbide Insert and a new treatment (Austempered).

DATA COMPARISON [Gravel vs Snowplow edges]

The data from the snowplow phase of the study is the most accurate available, when the cutting edge touches the pavement surface the wheel measures distance. Comparing the two sets of data, (gravel and snow) excluding the Carbide edges, the Carbon is best on snowplows and second best but only slightly lower in durability than flame hardened on gravel blading. Gravel blading is about 3 times more severe than snowplowing on cutting edges other than Carbide Insert.

CONCLUSIONS

- Carbide Insert Cutting Edges should not be used for blading gravel surfaces.
- Blading gravel is harder on a cutting edge than plowing snow.
- There is very little difference in the durability (miles bladed) of the Flame [370] and Thru [330] Hardened, and Carbon blades [360] when blading gravel.
- There is a significant difference in durability (miles bladed) of the Flame [750] and Thru [990] Hardened, Austempered [750] and Carbon Blades [1200] when used for snow plowing.
- Carbide Insert blades are 3 times more expensive than the other types of cutting edges.
- Carbide Insert blades are over twice as durable as carbon blades and 2 1/2 to 3 times more durable as the other three types when used for snowplowing.

RECOMMENDATIONS

- Before choosing a blade type determine the type of work to be done.
- Do not consider Carbide Insert for gravel blading.
- Analyze your labor costs prior to choosing the type of blade and factor that into the cost equation.

MOTOR GRADER AND SNOWPLOW CUTTING EDGE DURABILITY STUDY

INTRODUCTION

This study was initiated by the Minnesota Local Road Research Board to evaluate the wear characteristics of the various types of Motor Patrol cutting edges used in the maintenance of gravel roads. The initial phase of the study was to conduct a survey of the Counties in Minnesota and compile the results by types of cutting edges used, material prices and labor costs. Because of the variability in the survey results the study was expanded to include a second phase, field testing.

Five types of cutting edges were chosen for evaluation:

1. Carbon Steel
2. Flame Hardened
3. Thru Hardened
4. Austempered
5. Tungsten Carbide

At the request of the Mn/DOT Maintenance Section of the Operations Division, a third phase, evaluating the same types of cutting edges for snow plowing was added.

BACKGROUND

The initial intent of the study was to conduct a survey of the Counties in Minnesota and compile the results by types of cutting edges used, material prices and labor costs.

The results were so widely spread (from 300 to 1500 miles of use for the same type of cutting edge) that it was decided to construct a device that would mount on the motorgrader and actually measure the miles the cutting edge was in contact with the gravel surface.

This second phase of the study was conducted in Morrison County thru the cooperation of the Morrison County Engineer.

The third phase, evaluation of snowplow cutting edges was conducted in Mn/DOT District 1, Duluth.

COUNTY SURVEY ANALYSIS

The data from the first phase (survey) of the study proved to be difficult to analyze with any degree of accuracy, however, figures 1 & 2 show the results of the survey data. Figure 1 shows the Flame Hardened blade with a slight advantage over the carbon giving the most miles (370 vs 355). Figure 2 shows the Flame Hardened with an advantage over the Carbon steel for lowest cost per mile ($0.325 vs $0.35).

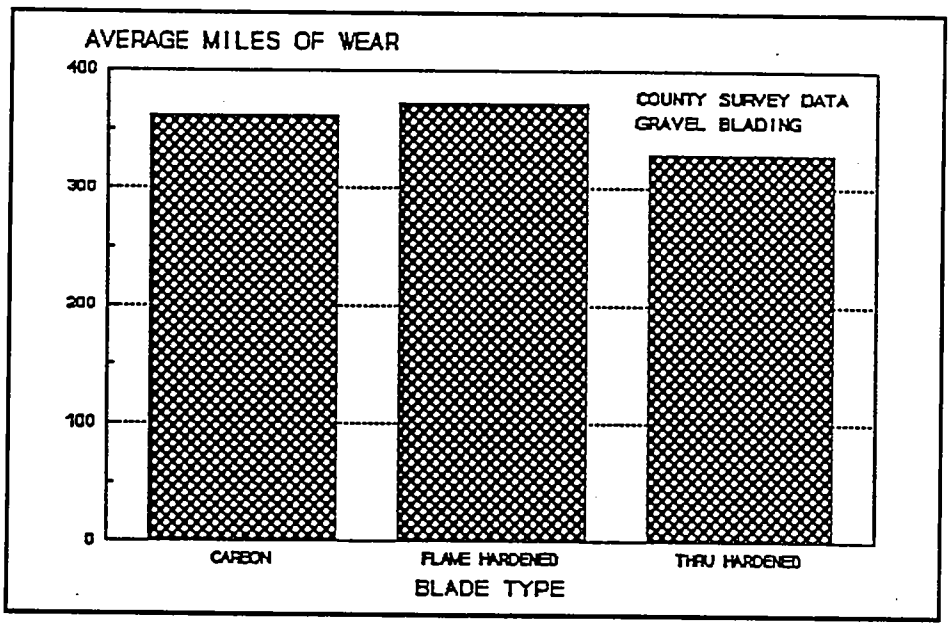

Figure 1 Average Miles To Blade Failure

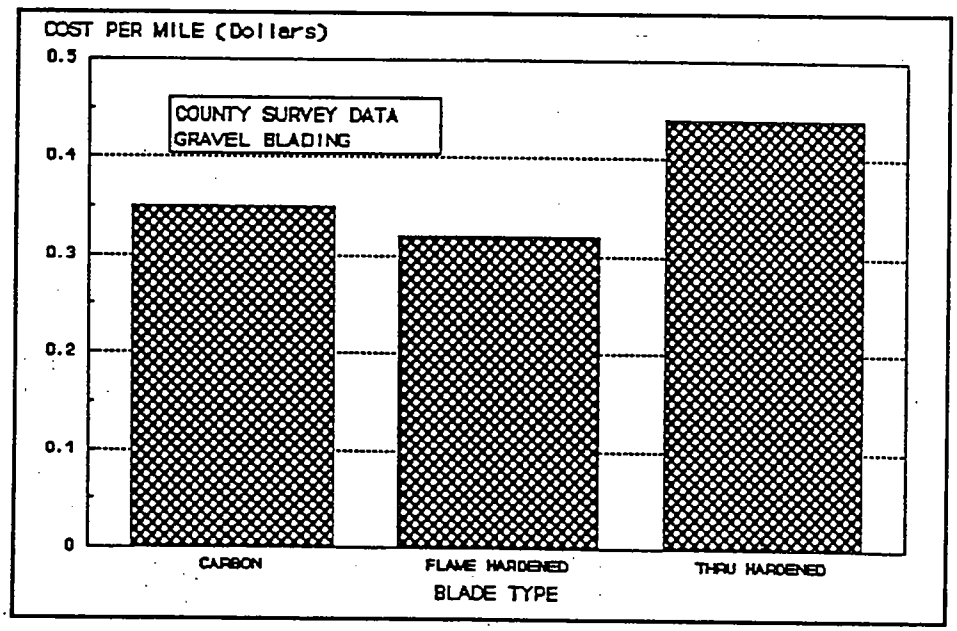

Figure 2 Average Cost Per Mile Bladed

COUNTY FIELD STUDY ANALYSIS [Gravel blading]

Analysis of the data from the cutting edge survey conducted among the counties showed a difference in durability (miles or hours per cutting edge unit) that was so severe that it cast some doubt on the methods of record keeping.

At this point the second phase of the study (field testing) was initiated. Five sets of the five types of cutting edges selected were purchased from Paper, Calmenson & Company, and shipped to Morrison County for testing. An additional five sets were purchased by the MN/DOT Maintenance Operations Office and shipped to Duluth for use on snowplows in the third phase.

The design and construction of the measuring wheels for the motor graders was started, (see Figure 3). The measuring apparatus consisted of a small wheel with a hubmeter mounted on the axle. The wheel was mounted in a frame that allowed both vertical and horizontal movement so that it would be free to move with the moldboard and contact the gravel surface only when the cutting edge was actually blading the gravel surface. The frame was designed to be chained up by the operator when backing or

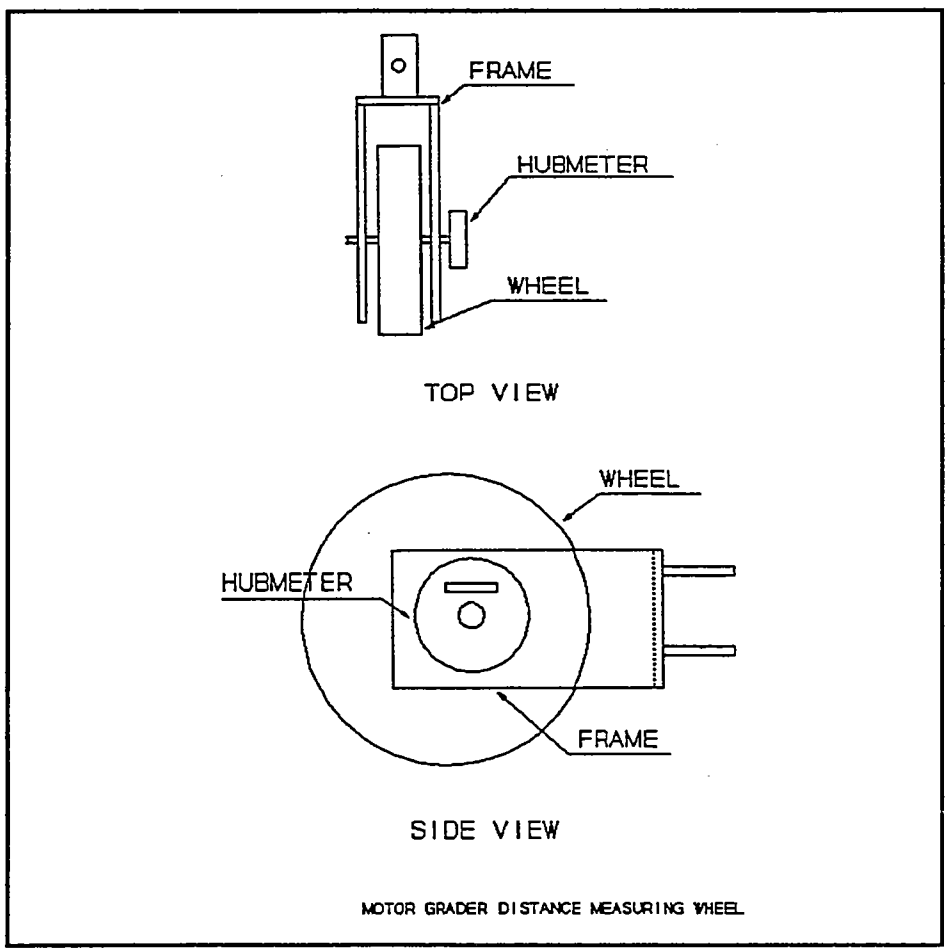

Figure 3 Grader Measuring Wheel

digging out frost boils. In retrospect this should have been automated in some manner (power lift either automatic or manually from the cab of the motor grader), to eliminate any chance of damaging the wheels.

To encourage the cooperation of the operators, the hubmeter was purchased for a larger wheel and a correction factor developed to convert the data to accurate values.

Initially the measuring wheels on the motor graders (Figure 4) operated and collected data as intended. However, within a short time the hubmeters fell off and the wheels were damaged due to backing operations and digging out frost boils.

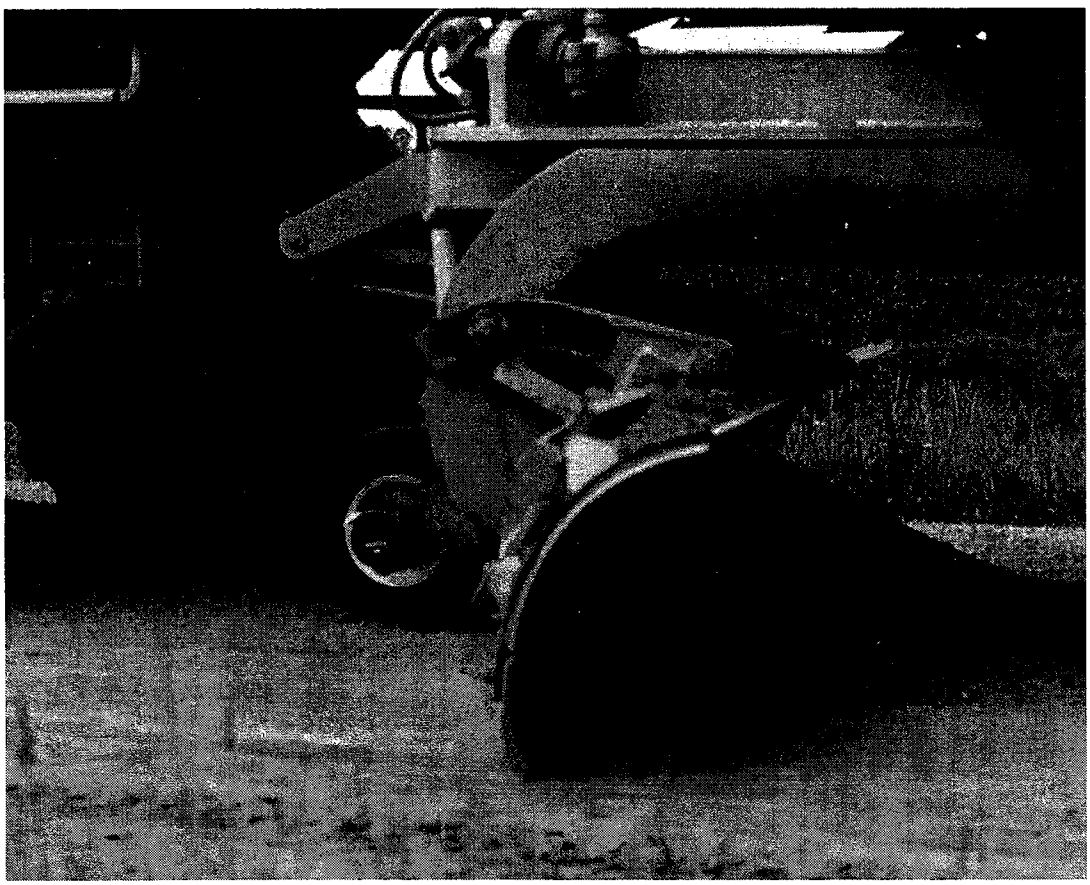

Figure 4 Motor Grader Measuring Wheel

Tungsten Carbide blades are designed with inserts of tungsten carbide brazed into the supporting steel matrix of the the cutting edge to absorb the wear inherent in cutting edge use. The gravel being lifted by the carbide inserts is carried up on the steel matrix of the supporting blade and wears the matrix away weakening the matrix as shown in Figure 5.

After the wear weakens the matrix above the Carbide insert, the cutting edge folds back under pressure and is no longer useable. A second reason is that in order for the carbide insert to be used properly (so that the carbide takes a majority of the wear of blading), the cutting edge must be laid back very close to horizontal. Using the blade in this position makes it impossible for the operator to create a flat surface (the surface ends up like a washboard) creating a rough riding surface.

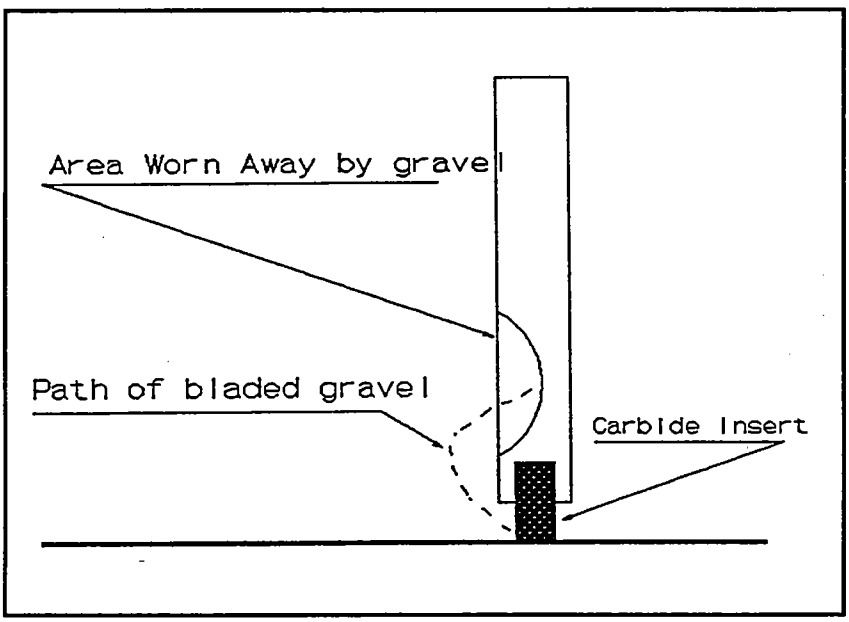

Figure 5 Carbide Blade Wear Pattern

SNOWPLOW DATA ANALYSIS

The five sets of cutting edges were distributed to five different locations for use in snowplowing on both Portland Cement Concrete and Bituminous pavements.

The snow plow measuring system consists of a wheel with hubmeter mounted in the plow frame. When the plow contacts the pavement surface the wheel is lifted off a pad and is free to rotate counting actual miles plowed. When the plow is raised the wheel contacts the pad and stops rotating (Figure 6).

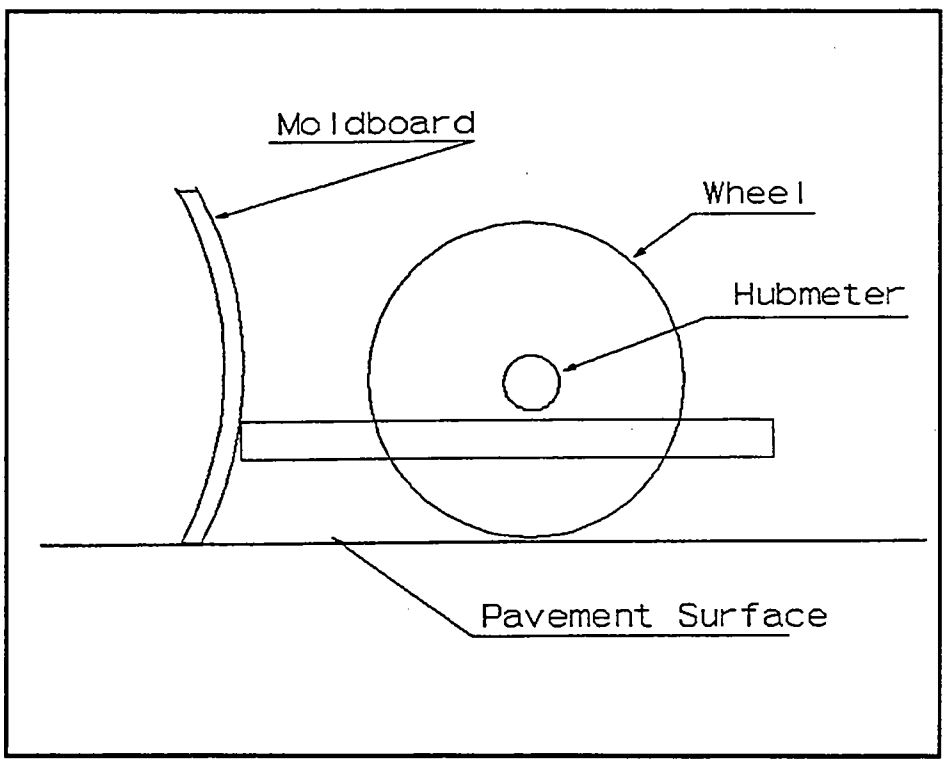

Figure 6 Snowplow Wheel Mount

Figure 7 shows the average miles of wear for the five types of cutting edges used in snow and ice removal. The data is based on sets 5 of cutting edges except for the Flame hardened being on 3, because two were damaged shortly after being installed.

Analyzing the data in Figure 7, the Tungsten Carbide Insert Blade is the most durable type of cutting edge (2100 miles) with plain Carbon steel as second best at (1200 miles) for snow plowing.

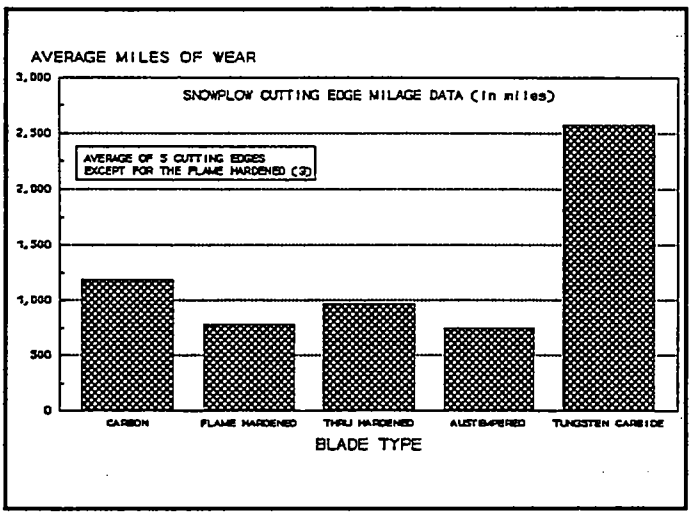

Figure 7
Average Miles
To Blade Failure

Figure 8 shows the cost analysis for the five types of cutting edges when used for snow plowing.

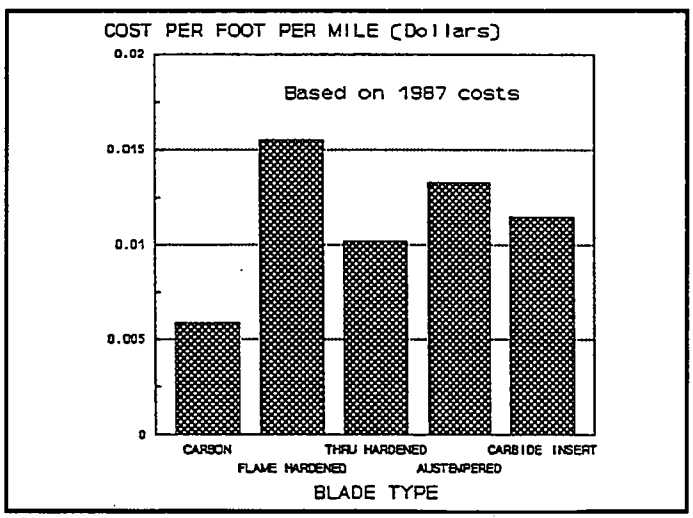

Figure 8
Average Cost
Per Mile Bladed

The data in Figure 8 shows the carbon blade as the lowest purchase cost, the Thru Hardened is second lowest and the Carbide Insert the third lowest in cost per mile. Considering only the material purchase cost, one would choose the carbon blade. However, when down time and labor are considered, the fact that the carbide insert blade has a life six times longer than the carbon blade this may indicate that the carbide blade is a better choice. Down time to change cutting edges in a storm increases the time needed to clear pavements which causes increased costs to the public as well as increased safety problems.

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4. There is a significant difference in durability (miles bladed) of the Flame [750] and Thru [990] Hardened, Austempered [750] and Carbon Blades [1200] when used for snow plowing.

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