# RUBBER SNOWPLOW BLADES AND LIGHTWEIGHT SNOWPLOWS USED FOR THE PROTECTION OF RAISED LANE MARKERS

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The Washington Department of Highways has adopted a policy of installing raised lane markers on all multilane freeways and interchange roadways in western Washington. Because the lane marker is expensive and easily damaged by standard snowplowing operations, a method had to be devised to plow snow and yet protect the raised markers. This paper reports the results of a 2-year study to expand the experience gained by earlier experiments with the rubber snowplow blade. The study was made to document the rubber blade's performance under typical winter road conditions and to evaluate the results of introducing the rubber snowplow blade and lightweight moldboard to the state's snowplow fleet. The lightweight snowplow was specifically designed for use with the rubber cutting edge. It eliminated one of the major causes of excessive wear, namely, the heavy weight of the standard moldboard. Before the lightweight plow was introduced, this problem had been partially overcome by installing a system of restrainer chains and turnbuckles to help support the standard plow's weight and reduce the down-pressure on the cutting edge. The rubber cutting edge was shown to be suitable for snowplowing except when temperatures are consistently below freezing and a slush or semithawing condition does not exist or could not be induced by chemicals. In spite of their higher initial cost, the rubber snowplow blades wear less per mile of plowing than medium steel plow blades and have shown a remarkable service life between blade changes.

•BARRIER or lane stripe effectiveness has been a matter of concern to highway engineers for some time. Until recently, a reflectorized pavement stripe has been the principal means used to delineate traffic lanes on multilane highways or to separate opposing lanes on two-lane roadways. The driver's inability to see readily the reflectorized painted traffic stripe during periods of rainfall or hours of darkness at normal speeds has long been recognized. It also has been established that wear or a moisture film covering the painted stripe on the pavement reduces the reflective ability of the small glass beads imbedded in the paint matrix (1).

It is the general policy of the Washington Department of Highways to paint the centerline or lane lines at least once every year and to paint the edge stripe every 2 years. Striping usually begins in the early spring and continues until inclement weather in the late fall or early winter stops the operation.

In the summer of 1961 research was started to develop a method of traffic line marking that would overcome the problems inherent in the use of painted stripes. Vendors of several types of pavement markings were invited to lay test sections of their product in a test area. These products included (a) hot-applied beaded thermoplastic material, (b) pre-formed, cold-applied, self-adhering plastic, (c) beaded thermoplastic dome-shaped markers, and (d) conventional, beaded white paint stripe.

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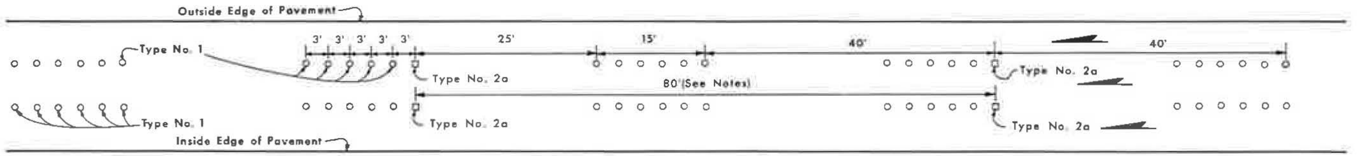
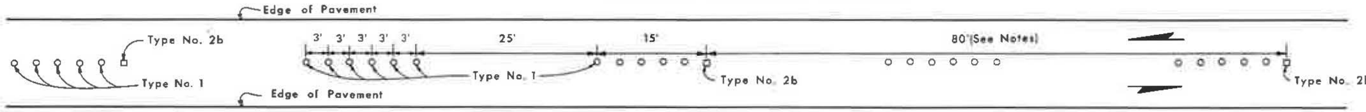
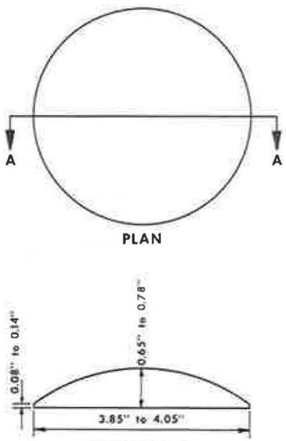



SPACING FOR MULTILANE ONE WAY TRAFFIC

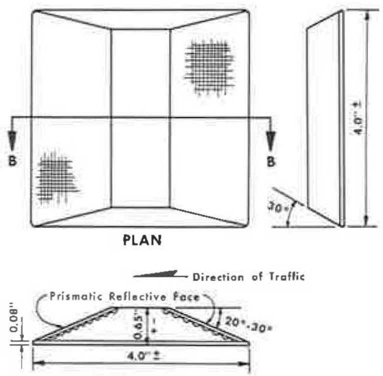



SPACING FOR TWO LANE TWO WAY TRAFFIC




SECTION A-A

TYPE NO. 1




SECTION B-B

TYPE NO. 2

See Table

| PRISMATIC REFLECTIVE FACE COLORS | |
|---|---|
| Type No. 2a | White and Red |
| Type No. 2b | White and White |
| Type No. 2c | Yellow and Red |
| Type No. 2d | Yellow and Yellow |

NOTES:

Throughout the length of horizontal curves with radii less than 5,000 feet, Type No. 2 markers shall be placed at 40 foot intervals. Each series of lane markers through the length of the curve will consist of one Type No. 2 marker and five Type No. 1 markers.

See the standard specifications and special provisions for further requirements.

Figure 1. Standard lane markers.

The first two materials were laid in 15-ft lengths at intervals of 25ft. The stripe was 4 in. wide and approximately ⅛ in. thick.

The dome-shaped traffic markers were installed in a series of six markers spaced 3 ft apart for a total distance of 15 ft in a skip stripe pattern. They were cemented to the pavement by a two-component epoxy resin adhesive. The markers were 4 in. in diameter, flat on the bottom, rounded on the top, and protruded approximately ¾ in. above the pavement.

At the end of the first 30 months of the research project, the reflective value of the marker system became so obvious that the Highway Department adopted the raised traffic marker system for lane markings on all new construction of Interstate highways west of the Cascade Mountains. The raised traffic marker soon thereafter became a standard installation on all multilane highways west of the Cascade Mountains.

The Washington state standard for lane markers requires a set of six buttons placed 3 ft apart with 25 ft between sets. The first button in alternate sets, every 80 ft, is a prismatic reflective marker intended to enhance the night visibility of the system (Fig. 1).

In congested areas, the replacement of lane markers increases the maintenance man's exposure to the hazard of traffic. This problem can be alleviated somewhat by replacing the markers during the hours of lower traffic volumes.

Preliminary cost estimates of the system indicated that the cost of the marker system would be high initially, but when amortized over an expected 10-year period, it was estimated to be the same as the painted stripe system. The annual maintenance cost of the marker system, once installed, was said to be about one-quarter that of a painted stripe (1).

Because of the high cost of installation, it was obvious that measures had to be taken to protect the raised marker from possible damage during snowplowing operations. From 1962 until 1965, the maintenance division searched for possible methods of plowing snow without damaging the raised marker. The search proved to be discouraging because use of the raised marker had been very limited at the time, and the states that had used the markers had given them up because of snow removal problems. Our investigations revealed that a rubber bit had been used successfully in certain areas on small tractor-type units. Reports from England indicated that these units could plow snow without damage to the plow or to roadway appurtenances, such as curbs and manholes. Further investigations revealed that the rubber plow blade had been used in many municipalities on streets and airport runways.

In the spring of 1966, the Goodyear Rubber Company, through one of its local outlets, supplied the department with one hard-rubber snowplow blade. It measured 10 ft in length and was approximately 1½ in. thick and slightly over 10 in. wide (Fig. 2).

The blade was mounted on a standard Washington state snowplow in September, and a trial run was made over a short test section. Water was applied to the roadway ahead of the snowplow to lubricate the plow and to simulate a slush snow condition. The results of this test indicated that the rubber blade would pass over the plastic markers without damage to them and would squeegee the water (simulated slush) off the pavement surface. No appreciable wear of the rubber was noted after the short trial run (2).

Figure 2. Washington standard power reversible moldboard with rubber snowplow blade.

The successful completion of the trial run provided the department with the needed incentive to order 24 blades for use during the following water in areas where the raised traffic markers had been installed. The blades were received late in January 1967. Consequently, they were not available for evaluation during the storms that occurred in late December 1966 and early January 1967.

The rubber snowplow blade was used marginally in the winter of 1967. The Seattle Division was able to use a plow 13 hours in the vicinity of Bellingham and about 12 hours north of Seattle. The Tacoma Division used the plow for approximately 20 hours in the vicinity of North Fort Lewis and Tacoma. Because of this limited use, a definite comparison in the economy of rubber versus steel bits could not be made; however, it was shown that rubber blades could outwear the steel type. The limited use also substantiated the findings of the earlier experiment; i.e., rubber blades will do a satisfactory job of removing slushy snow from pavement surfaces and will ride over the raised traffic markers without damaging them. During this short period of time, it became apparent that it was important that the plow be adjusted properly to bear evenly upon the pavement surface in order to minimize the amount of wear and tear on the blade itself. One of the first approaches in solving the problem was to install side shoes on the standard plow to carry the weight of the plow and to equalize the pressure on the rubber blade. This approach was soon abandoned because the shoe damaged the raised button to the same degree as would a steel blade whenever the plow edge crossed the lane markers. To replace the shoe, a chain and turnbuckle assembly was installed between the truck and the standard plow to help carry the weight of the plow (Fig. 3). When properly adjusted, this system proved to be quite successful and is used with many of our standard plows today.

The idea of reducing the weight of the plow first developed in the fall of 1967. Our equipment personnel discussed the possibility of developing a lightweight plow with a local manufacturer, who had developed a prototype lightweight plow (Fig. 4). This design was modified to meet the requirements of the equipment engineer and one was ordered. It was received in early January 1968 for use in the Seattle area as part of this test.

## PROCEDURES

Our maintenance division, like those in many other states, does not have a surplus of equipment for use for experimental purposes during a snowstorm. It taxes our forces just to keep all available equipment working during a storm. Consequently, we determined that all equipment used during the study would remain in general use and would operate in a normal manner. The only change to the normal routine would be that each operator would report his daily activities on a special form developed for the study. Automatic recording devices were developed and used in the final phases of the test to ease the reporting burden and to remove as much of the "human element" as possible. A Hobbs hour meter (Fig. 5) was used to record the blade contact hours and an Engler electric speedometer/odometer (Fig. 6) recorded the blade contact mileage. Each of these devices was activated only when the moldboard was in a down position and plowing.

Figure 3. Washington standard moldboard with chain and turnbuckle assembly.

Figure 4. End view of rubber snowplow blade attached to moldboard.

Figure 5. Hobbs hour meter mounting.

Figure 6. Engler electric speedometer/odometer.

These procedures resulted in a collection of empirical data that were more representative of what could be expected in the field than might be obtained from a laboratory approach to testing.

Because the main objective of the study was to determine the feasibility of using nondestructive type blades with lightweight moldboards, the data appeared to be decisive enough to justify practical conclusions.

One lightweight moldboard was available in the Seattle area for the study (Figs. 7, 8). Others used the regulation steel plow or steel plow coupled with a rubber-tipped snowplow. The regulation steel plow was used for comparative purposes.

Performance of each type of plow and blade was observed during actual operations under many different conditions that occurred during the storms of 1967 to 1969. Dimensions and weights were recorded after each storm to determine the rate of wear and the plow blade's resistance to damage under normal use.

## PROJECT SCOPE

The project was designed to extend through a maximum of two winter seasons to ensure that enough plowing was done with a lightweight plow and rubber blade to obtain enough data to evaluate properly the moldboard and the nondestructive blade.

Three separate test sections were established for the study. Two of these sections were located north of Seattle and the third was established south of Olympia. Because

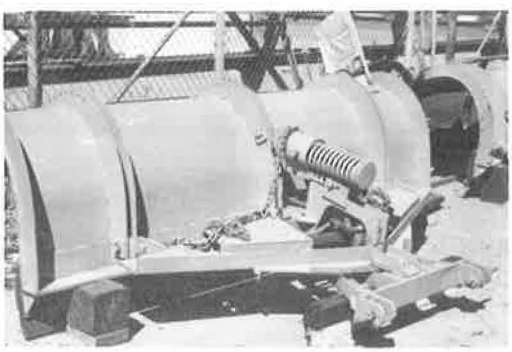


Figure 7. View of the 10-ft lightweight moldboard showing the spring shock absorber on circle. Plow exerts approximately 700 lb on cutting edge.

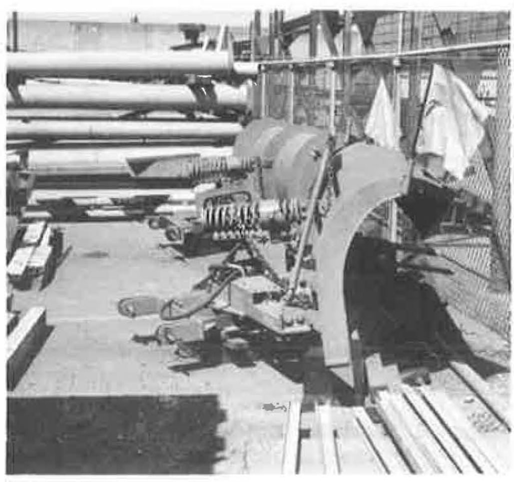


Figure 8. Side view of lightweight moldboard.

the test section established in the Olympia area involved different administrative and operational personnel, we felt that the data collected there could be used to validate results obtained in the Seattle area.

The test data in Table 1 recorded by Vehicle No. 6A5-4 are typical of the records received from all of the vehicles involved in the study. The rubber cutting edge used on Vehicle No. 6A5-4 weighed 85½ lb when it was installed at the beginning of the season and 74 lb on January 31, 1969, at the end of the season. This weight loss represented an average loss in depth of 1⅝ in. Data from the test vehicles are summarized in Tables 2 and 3.

## PERFORMANCE OF STEEL CUTTING EDGE

For years, the department has used a medium steel cutting edge in its snowplowing operations. The medium-grade steel included 0.65 to 0.80 percent carbon, 0.20 to 0.40 percent manganese, and a maximum of 0.04 percent phosphorus and 0.05 percent sulfur.

Standard practice in most divisions on the west side of the Cascade Mountains, where a constant snow bottom is not normally encountered, is to change the cutting edge at least once every shift. Generally, the change is made between shifts so that the operator

TABLE 1

RECORD OF RUBBER SNOWPLOW BLADE TEST (VEHICLE NO. 6A5-4)

| Date | Surface Condition | Total Plow Time (hours) | Total Plow Miles | General Performance |
|---|---|---|---|---|
| 12/19/68 | Slush | 0.5 | 3 | Bladed clean |
| 12/21/68 | Slush | 2.0 | 34 | Bladed clean |
| 12/22/68 | Slush | 0.7 | 11 | Bladed clean |
| 12/31/68 | Compact snow | 3.5 | 50 | Partially |
| 12/31/68 | Compact snow | 4.5 | 87 | Partially |
| 1/1/69 | Compact snow | 3.5 | 53 | Partially |
| 1/2/69 | Compact snow and slush | 6.0 | 53 | Bladed clean |
| 1/2/69 | Slush | 3.0 | 38 | Bladed clean |
| 1/11/69 | Slush | 5.0 | 61 | Clean |
| 1/14/69 | Slush | 2.0 | 50 | Clean |
| 1/15/69 | Slush | 3.0 | 35 | Clean |
| 1/19/69 | Slush | 1.5 | 15 | Clean |
| 1/20/69 | Fresh snow and compact | 4.0 | 42 | Partially |
| 1/26/69 | Fresh snow and compact | 6.3 | 131 | Partially |
| 1/26/69 | Fresn snow and compact | 9.3 | 201 | Partially |
| 1/27/69 | Fresh snow and compact | 10.0 | 210 | Partially |
| 1/28/69 | Fresh snow and compact | 14.7 | 287 | Partially |
| 1/29/69 | Fresh snow and compact | 8.8 | 142 | Partially |
| 1/30/69 | Snow and compact ice | 8.7 | 146 | Partially |
| 1/31/69 | Snow and slush | 3.3 | 50 | Partially |
| Total | | 100.3 | 1,699 | |

Notes: All plowing was on portland cement concrete pavement. Engler Electric Speedometer/Odometer was added 1/26/69 to record automatically the time and distance the plow was in contact with the roadway surface.

TABLE 2

RUBBER SNOWPLOW BLADE USE, WINTER SEASON, 1967-1968

| Vehicle No. | Total Plow Time (hours) | Total Plow Miles | Total Blade Wear | General Performance |
|---|---|---|---|---|
| 6A2-12 | 13.0 | 144 | 8 oz | Bladed clean to partially clean |
| 6A2-25 | 12.5 | 135 | 6 oz | Bladed clean |
| 6A5-2 | 15.4 | 194 | 8 oz | Bladed clean |
| 6A3-46 | 3.8 | 76 | Not available | Bladed clean |
| 6A3-38 | 1.1 | 33 | Not available | Bladed clean |
| 6C2-56 | 36.5 | 455 | 1.35 lb | Worked well |
| 6C2-56 | 29.0 | 884 | 2.70 lb | Worked well |

TABLE 3

RUBBER SNOWPLOW BLADE USE, WINTER SEASON, 1968-1969

| Vehicle No. | Total Plow Time (hours) | Total Plow Miles | Total Blade Wear | General Performance |
|---|---|---|---|---|
| 6A5-4 | 100.3 | 1,699 | 11.5 lb | Clean to partially clean |
| 6A3-38 | 175.3 | 3,118 | 19 lb[a] | Clean to partially clean (would not remove compact snow and ice) |
| 6C2-56 | 51.3 | 1,189 | Not available[b] | Clean to partially clean |

[a]A 3-lb piece was torn and lost from the rubber bit.
[b]Weights were not available but measurements indicated a loss of $1\frac{1}{8}$ in. at one end, $\frac{1}{8}$ in. in the center, and $\frac{1}{8}$ in. on the other end. The uneven wear was attributed to poor weight distribution of the plow.

TABLE 4

STEEL PLOW BLADE RECORD
(VEHICLE NO. 7C12-1, PLOW NO. 23C4-98)

| Date | Hours | Miles | Remarks |
|---|---|---|---|
| 12/18/68 | 2.5 | 81 | New blade |
| 12/22/68 | 3.0 | 63 | |
| 12/22/68 | 4.0 | 85 | New blade |
| 12/28/68 | 6.5 | 114 | New blade |
| 12/29/68 | 1.5 | 35 | New blade |
| 12/30/68 | 5.5 | 137.5 | |
| 12/31/68 | 13.0 | 95.0 | |
| 12/31/68 | 7.0 | 140.0 | New blade |
| Total | 43 | 750.5 | |

can be assured of an adequate depth of steel on the moldboard for cutting purposes during his shift. This practice often results in a waste of steel because frequently the cutting edge is not completely worn out. Because of the emergency nature of the work, these partially worn bits were considered expendable.

The final analysis of the data collected during the two winter seasons indicated that the formal data being collected were not as complete as expected; however, a partial record illustrates the fact that steel blades required constant changing (Table 4). This record indicates at least five new blades were requi during the time interval. These five blades logged only a total of 750.5 miles, or an average of 150.1 miles per blade. A longer life for steel blades is experienced in areas where a compact snow bottom is commonplace, as in certain areas in eastern Washington; however, where bare pavements are encountered, the medium steel blade will be completely worn away within a very few hours.

## ANALYSIS OF WEAR AND COST DATA

No attempt was made to determine a parameter for measuring when a rubber blade was worn to failure and needed to be replaced. However, Table 5 indicates that at least 19 lb of wear on one side could be expected from an $85\frac{1}{2}$-lb blade. An additional 19 lb could be expected to be available for wear if the blade were inverted and used until totally destroyed.

TABLE 5

RUBBER SNOWPLOW WEAR

| Vehicle No. | Total Plow Miles | Total Blade Wear (lb) | Wear Ratio | Wear Cost ($) | Cost per Plow Mile ($) |
|---|---|---|---|---|---|
| Winter Season, 1967-1968 | | | | | |
| 6A2-12 | 144 | 0.5 | 0.025 | 2.66 | 0.018 |
| 6A2-25 | 135 | 0.375 | 0.01875 | 1.99 | 0.015 |
| 6A5-2 | 194 | 0.5 | 0.025 | 2.66 | 0.014 |
| 6C2-56 | 455 | 1.35 | 0.0675 | 7.17 | 0.016 |
| 6C5-56 | 884 | 2.70 | 0.135 | 14.35 | 0.016 |
| Winter Season, 1968-1969 | | | | | |
| 6A5-4 | 1,699 | 11.5 | 0.575 | 61.10 | 0.036 |
| 6A3-38 | 3,118 | 19.0 | 0.95 | 100.95 | 0.032 |

For purposes of our analysis, we have assumed that an average rubber snowplow blade should lose 20 lb by wear before being discarded. Theoretically, over half of the blade's volume, or 43.75 lb, is available for plowing purposes. However, it is expected that many blades will tear or suffer irregular breakage that will reduce the actual amount of blade volume available for abrasive wear, and hence the lower conservative figure for expected weight loss is used.

To compare the cost per plow mile for rubber snowplow blades to medium steel, we made these additional assumptions:

1. Total cost of the rubber blade is chargeable after 20 lb of wear is experienced.
2. One hour of labor, Maintenance Man II class, at the weighted wage of \$4.48 per hour (raised to \$5.14 in fiscal year 1970) is required to change a snowplow blade.
3. A new medium steel cutting edge is required every 150 miles of plowing. It is recognized that additional mileage can be obtained during heavy snowstorms when plowing snow bottom. This is offset, however, by the fact that our practice to replace partially worn blades at the end of a shift reduces the amount of mileage obtained from a blade.

A cost per plow mile was calculated for each vehicle and rubber and steel blade tested as shown by the following example for Vehicle No. 6A2-12:

Given

1. Total plow miles = 144
2. Total blade wear = 0.5 lb
3. Average blade cost = \$101.78

Then

$$\text{Wear ratio} = \frac{\text{Total Wear}}{\text{Maximum Wear Possible}} = \frac{0.5\text{ lb}}{20\text{ lb}} = 0.025$$

$$\text{Wear cost} = \text{Wear Ratio} \times (\text{Blade Cost} + \text{Cost of Installation})$$

$$= 0.025 \times (\$101.78 + \$4.48) = \$2.66$$

$$\text{Cost per plow mile} = \frac{\text{Wear Cost}}{\text{Miles Plowed}} = \frac{\$2.66}{144} = \$0.018/\text{mile}$$

Table 5 summarizes the results of these calculations.

Calculations for steel plow cost per mile as follows, using Vehicle No. 7C12-1 as an example:

1. Total plow miles = 750.5
2. Total blade wear = Total wear on 5 blades (The report began with a new blade and ended with the last blade completely worn.)
3. Average blade cost = \$9.45
4. Wear Ratio = $\frac{5}{1.0}$ = 5.0
5. Wear cost = 5.00 × \$9.45 = \$47.25 plus cost to change 5 blades (Cost to change 5 blades = 5 × 1 man-hour × \$4.48/hour = \$22.40)

Therefore, total cost equals

$$\$47.25 + \$22.40 = \frac{\$69.65}{750.5} = \$0.093$$

(This cost does not take into account the rental of small tools or cost of materials that might be required to make the steel blade changes.)

From the calculations it can be seen that, in spite of the higher initial cost, the rubber snowplow blade is more economical than the medium steel blade in areas where bare pavement is encountered. The recent wage increase widens the difference of wear costs. These figures closely agree with other cost data developed in other areas.

## RAISED TRAFFIC MARKER PROTECTION

The prime purpose of this study was to determine the effectiveness of the rubber snowplow blade in protecting the raised traffic marker. Although it is important to know that the rubber snowplow blade will outwear a medium steel blade and can effectively remove slushy or freshly fallen snow, it is probably more important to know that snow can be plowed from roadways with raised markers without damage to the markers.

To make this determination, we established a typical 1-mile control section within the limits of the two Seattle sections studied. The raised traffic markers were counted before the test began and periodic counts were taken thereafter. The markers were originally installed on the two sections by construction contracts in 1965.

To determine the number of markers missing since their initial installation, the raised traffic lane markers were counted shortly before the first snowfall in 1967. Counts were then made periodically during each winter before and after each snow period. Individual counts were made on sample sections in both the northbound and southbound lanes.

Test section 1, located immediately north of Seattle, is constructed of portland cement concrete and has three lanes in each direction. Data obtained from an analysis of the counts taken on the 1-mile sample section on the northbound and southbound lanes are given in Table 6. The higher losses in the 1968-1969 season were undoubtedly due to the severity of that winter. The Pacific Northwest suffered an extended winter season that year and snowfalls in the lower elevations were much greater than normal.

It should be further noted that part of the marker loss attributed to snow-removal equipment was possibly due to breakage caused by tire chains. We did not attempt to determine the number that were broken by chains because of the difficulties involved. We know that actual losses directly attributed to snow-removal equipment would be somewhat less than noted, but by considering all losses as caused by snow-removal equipment, we felt that we would be giving the rubber blades the most difficult test.

Test section 2, south of Everett, has two lanes in each direction and is constructed of asphalt concrete. A loss analysis of the counts taken on this section revealed the data given in Table 7.

A formal record of button loss was not kept in test section 3; however, the project supervisor in that district reported in his diary that counts before and after the snow season indicated that no loss due to snow removal was evident in the 1967-1968 season. Inspections in the 1968-1969 season found that an area on the south end of the district's

TABLE 6

TEST SECTION 1 DATA

| Time or Cause of Loss | Northbound (percent) | | Southbound (percent) | |
|---|---|---|---|---|
| | 1967-1968 | 1968-1969 | 1967-1968 | 1968-1969 |
| During the season | 1.81 | 1.37 | 2.08 | 2.56 |
| Attributed to snow-removal equipment | 1.43 | 1.07 | 1.90 | 1.94 |
| Caused by normal traffic | 0.38 | 0.30 | 0.18 | 0.62 |

TABLE 7

TEST SECTION 2 DATA

| Time or Cause of Loss | Northbound (percent) | | Southbound (percent) | |
|---|---|---|---|---|
| | 1967-1968 | 1968-1969 | 1967-1968 | 1968-1969 |
| During the season | 6.82 | 3.34 | 4.10 | 4.55 |
| Attributed to snow-removal equipment | 5.36 | 3.09 | 4.10 | 4.42 |
| Caused by normal traffic | 1.46 | 0.25 | 0 | 0.13 |

boundaries showed signs of some marker loss. This occurred, however, only in areas where steel plows from the adjoining district, which had no raised buttons, plowed snow while turning around to return their own district.

The initial count in 1967 indicated that only 158 markers were lost in the southbound lanes and 126 markers in the northbound lanes. This represented the loss since early 1965 when the traffic markers were first installed.

## CONCLUSIONS

From our experience we have concluded that the rubber snowplow blade is an effective and economical tool to use during snowplowing operations, both for removing freshly fallen or slushy snows and for the protection of raised traffic markers or other raised appurtenances on the roadbed. The rubber snowplow blade is most effective when ambient temperatures are near or slightly above freezing. The use of calcium chloride or sodium chloride induces a slushy or thawing condition at a lower temperature range so that the rubber blade can be used more effectively.

Loss of raised traffic markers is not increased significantly when snow is removed with a rubber plow blade. Some of the minor amount of loss noted during the snow season can be attributed to damage from tire chains, studded tires, or other factors.

The rubber blade mounted on a lightweight moldboard is adequate for the job for which it was designed. The standard weight plow mounted with a rubber blade, properly supported, will also plow snow effectively without excessive wear of the blade. The weight on both types of plows must be evenly distributed and controlled to produce the most effective operation and to control blade wear.

A 2- to 2½-in. exposure of the rubber blade provides the best cutting edge. Less exposure slightly increases the blade's ability to cut compact snow but substantially increases the wear on the rubber blade. More exposure causes the blade to tend to roll under and slide over the snow instead of removing it. The blade can be inverted on the moldboard when one side wears out, thereby doubling the life of the blade.

Generally, snowplowing with a rubber blade, properly adjusted, is best done at speeds between 25 and 30 mph. Lower speeds are necessary if blade exposure is greater than the optimum because the blade tends to fold back and plow over the snow bottom instead of cutting at high speeds.

The State of Washington enjoyed an open winter during the 1969-1970 season, particularly in the lower elevations where the rubber snowplow blade is most generally used; consequently, that winter added nothing to our experience of the previous season. One district reported that not one blade was worn out during the season. Personnel from another district reported that after wrecking two steel plows on high monuments, they found that the rubber blades would ride over a monument, railroad crossing, broken pavement, and other obstructions. Most of the eastern Washington districts report limited use of the rubber blade with varying degrees of success, depending on the snow and temperature conditions at the time of plowing.

Our experience with the lightweight plow and rubber blade has convinced us that the combination is suitable for general use in western Washington and limited use in eastern Washington. We are planning to expand the use of the plow in all areas. As of May 1, 1970, we have added a total of 56 lightweight snowplows to our snowplowing fleet. We believe that more will be added once our personnel become acquainted with the new plow and accept the fact that it can do a good job in wet snows and yet is easier to carry and less hazardous to use than the older, heavier Washington standard reversible plow.

## REFERENCES

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