

INVESTIGATION OF SRPM REFLECTOR DAMAGE
CAUSED BY SNOWPLOW CASTER WHEELS IN NEW JERSEY

BY

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SUMMARY AND CONCLUSIONS

Approximately 2600 SRPM's out of a total of more than 86,000 in the state of New Jersey were inspected for damage to the reflectors after a winter of exposure. These markers were at six locations around New Jersey, three at which the snowplows had caster wheels and three at which the snowplows had shoes. The results indicate that at the sites with wheels, the reflectors suffered a higher rate of breakage (32% vs. 25%) when compared to the sites with shoes. However, when considering cracking and breaking together, no difference between the two snowplow conditions existed (48% for wheels vs. 46% for shoes). Using 50% or more damage to the reflector surface as the cutoff, the data showed that snowplow wheels caused more reflectors to need replacement (8.1%) than when shoes were used (4.6%). These replacement rates are considerably lower than information supplied by the Bureau of Maintenance based on their investigations in the fall of 1985. Maintenance measured replacement rates between 39% and 50%.

The yearly cost in damaged reflectors to the state of New Jersey which can be attributed to snowplow wheels is estimated at \$21,000. This is probably an overestimate but will increase as the number of SRPM's increases. This estimate is based on data collected after one winter season. Damage may occur during the other seasons, but not due to the action of snowplow wheels. The capital cost in converting all snowplows in New Jersey to shoes instead of wheels is believed to be in the area of several hundred thousand dollars. This does not include increased snowplow maintenance costs which the Bureau of Equipment believes will occur with shoes.

Finally, information on SRPM damage experience in other states was reanalyzed. This analysis suggests that, while the belief that New Jersey was suffering higher damage rates than New York and Ohio was accepted as fact by

many, the rates of damage may be comparable and perhaps higher in New York. Since Ohio supplied no data, no comparison to New Jersey could be made.

RECOMMENDATION

The results of this study do not support a recommendation for conversion of caster wheels to shoes. The cost of damage attributable to the wheels is small compared to the expected cost of the conversion. This recommendation is based on the assumption that the results of the study represent the total New Jersey experience. Data collected by the Bureau of Maintenance indicates a much higher replacement rate after one winter than generated by this study. This recommendation may change in the future if continued surveillance of SRPM installations shows that the results of this study are an unusually low estimate. The recommendation may also be modified if the increasing use of SRPM's in New Jersey results in sufficient markers being installed to warrant the change to shoes.

INTRODUCTION

In the fall of 1985, inspections of SRPM installations by Research, Traffic Engineering and Maintenance personnel found what was considered an abnormally high rate of damage to the reflectors. It was suggested that the damage might be caused by the snowplow caster wheels. Nearby states (Ohio, New York) reported lower damage rates to their reflectors and the fact that they used shoes in place of the wheels on snowplows supported the hypothesis of the wheels being a major cause of the problem. More will be said about the New York and Ohio experiences later in this report.

Pilot studies conducted by the Division of Research resulted in the reflectors cracking or breaking when they were hit by the snowplow wheels. At the request of the Division of Construction and Maintenance, Research conducted an experiment to determine how much damage could be attributed to the snowplow wheels and to estimate the yearly cost to the state of New Jersey. This figure could be compared to the capital costs and any additional maintenance costs which would result if the wheels were changed to shoes for all plows used by state forces and contractors.

STUDY DESIGN

A total of eight sites were originally selected for study. They consisted of four pairs of sites, each pair having traffic and physical characteristics matched as closely as possible. One pair, the only multi-lane divided sites, had to be dropped from the study due to insufficient time being available to replace the damaged reflectors before the 1985-86 winter. Information on the six remaining sites can be found in Table 1. At the other three pairs of sites, only the cracked and broken reflectors were replaced with the exception of Route 46 (M.P. 6.4-10) at which all reflectors were replaced by contract. For the design, it was necessary to start with undamaged reflectors at all of the sites. At one site out of each pair, the snowplow wheels were changed to shoes. At the other site, the wheels were left alone. This change was made for all plows, both state and contractor owned, which would be used on a particular road section.

After the 1985-86 winter, the SRPM's were inspected and evaluated for the following types of damage:

1. Chipping of the reflector surface.
2. Delamination.
3. Cracking.
4. Breaking, defined as a reflector with a piece missing.
5. Percent damage to the reflective surface.

Information on the amount of snowfall and the approximate number of snowplow passes over the road sections under study was collected from the local maintenance yards. Additional information on snowfall was collected from the Trenton Office of the Bureau of Maintenance.

Research personnel also measured several road and traffic characteristics at each site. These included:

1. Lane width

2. Shoulder width
3. AADT
4. Percent trucks

The results of these measurements are also in Table 1.

TABLE 1
SRPM MAINTENANCE PROJECT

ROUTE	MP	# LANES	MEDIAN	PAVEMENT TYPE	CONDITION	AVG. ROAD WIDTH, FT.	AADT	% TRUCKS	MAINTENANCE YARD	WHEELS OR SHOES
94	1.0-8.0	2	Undivided	P.C.C.	Fair	34.5	4,100	3.6	Yellow Frame	Shoes
46	10.0-17.0	2	Undivided	Bituminous	Good	40.3	3,200	2.9	Port Colden	Wheels
46	6.4-10.0	2/3	Undivided	Bit/PCC	Good	39.0	7,800	13.0	Columbia	Wheels
23	27.9-34.3	2/3	Undivided	Bit/PCC	Good	32.7	10,700	4.0	Sussex	Shoes
206	0.0-6.3	2	Undivided	Bituminous	Good	40.1	8,200	7.5	Folsom	Wheels
206	14.8-20.8	2/3	Undivided	Bituminous	Good	46.9	11,300	6.2	Red Lion	Shoes

RESULTS

A summary of the results of the reflector damage is given in Table 2. Using the Test of Proportions the following statements can be supported:

1. More SRPM's were broken at sites where the snowplows had wheels (32% vs. 25%). The difference is significant at a level of confidence 99%.
2. There is no difference in the number of SRPM's which were cracked or broken (48% vs. 47%) when comparing the sites with wheels to the sites with shoes.
3. More SRPM's were in need of replacement (8.1% vs. 4.6%) at sites with wheels using the criterion of 50% damage to the reflective surface as the cutoff. The difference is significant at a level of confidence 99%.
4. There is no difference between the "old" and "new" SRPM's when considering the percent needing replacement. This suggests that replacing only the damaged reflectors did not have any bearing on the results of the study.

It should be noted that the snowfall during the 1985-86 winter was slightly less than the average over the last seven years (25" vs. 28"). However, it was slightly higher than the previous winter (22") when high damage rates were noticed by the DOT Maintenance personnel. These damage rates (see attached memo from John Semler) are considerably higher than the rates measured in this experiment (39-50% vs. 0-12%). However, it is not certain whether Maintenance and Research used the same criterion for replacement, i.e., 50% of the reflective surface being damaged. The level of damage measured by Maintenance does compare favorably with the percent cracked and/or broken measurements collected in this study.

TABLE 2

RESULTS

SNOWPLOW CONDITION	#SRPM's TOTAL	% BROKEN(1)	RANGE(2)	% CRACKED OR BROKEN	RANGE(2)	% NEEDING REPLACEMENT(3)	RANGE(2)	AVERAGE DAMAGE(4) %	RANGE(2)
WHEELS (3 sites)	1319	32.4	6.0- 54.4	48.4	24.4- 71.9	8.1	1.4- 12.4	14.2	5.5- 21.3
SHOES (3 sites)	1274	24.8	0.9- 38.7	46.5	2.7- 73.2	4.6	0.0- 10.0	11.1	1.8- 16.8

(1) SRPM considered broken if a piece of the reflector was missing.

(2) The range is for the three sites.

(3) The criterion for replacement is when 50% or more of the reflector is damaged or missing.

(4) To the surface of the reflector

The reflectors were replaced if damaged (new) or checked and left in if not damaged (old) during December, 1985. Data collected in April and May, 1986

	<u>New</u>	<u>Old</u>
% Needing replacement	6.6	6.3

NEW JERSEY DEPARTMENT OF TRANSPORTATION

MEMORANDUM

TO: Record

FROM: John Semler

SUBJECT 1985 RPM Lens Replacement
By State Forces

DATE 9/17/85

TELEPHONE NO. _____

Maintenance Forces replaced reflectors on four routes that had RPM's installed under HES-000S(009) in 1984. Lens replacement was based on 50 percent or more of the lens either broken or missing. The crew chief or assistant foreman made the determination of which markers should be replaced.

The following breakdown will indicate the extent of lens damage possibly caused by the wheels on state snowplows.

<u>Route</u>	<u>M.P.</u>	<u>No. of Lenses Installed in 1984</u>	<u>No. of Lenses Replaced in 1985</u>	<u>Percent</u>	<u>Replacement Cost</u>
9	20.34 to 30.64	601 Bi-yellow	267	44.4	\$2,923.65
31	12.35 to 16.30	271 Bi-yellow 130 Mono-white	129 51	47.6 39.2	\$808.83 \$319.77
31	25.5 to 31.8	351 Bi-yellow 141 Mono-yellow	248	50.4	\$1,554.96
179	0.5 to 1.50	104 Mono-white 53	48 25	46.1 47.2	\$300.96 \$156.75

Cost per lens installed, range from \$6.27 per marker for Route 31 to \$10.95 per marker for Route 9 in Cape May County.

The above information was supplied to Traffic Engineering and Safety Programs by Mr. R. Tomlinson, Supervisor, Signs and Lines.

Additional locations will be added to this report when information is provided by Mr. R. Tomlinson.

John J. Semler

JJS:jl

COST ESTIMATE

At present, the number of SRPM's on New Jersey highways is 86,000. This number was supplied by Traffic Engineering.

The data analysis identifies snowplow wheels as one agent of damage to the reflectors, certainly not the only one since sites without the wheels experienced similar types and levels of damage. Therefore, the difference in the number of SRPM's in need of replacement probably cannot be assigned entirely to the effects of wheels. However, for the purpose of this analysis, we will assume that the difference is entirely the fault of snowplow wheels. Using a replacement cost of \$7.00/SRPM, the cost/year can be estimated as follows:

$$86,000 \text{ SRPM's} \times (8.1\% - 4.6\%) \times \$7 = \$21,000/\text{year}$$

As previously stated, this is probably a high estimate but will increase as the number of SRPM's on New Jersey roads goes up. This cost needs to be compared to the capital and maintenance costs of converting snowplow wheels to shoes before a decision on this matter can be reached.

It should be noted at this time that the cost potentially attributable to snowplow wheels assumes all damaged reflectors need to be and will be replaced each year. It has yet to be determined whether the damage rate experienced in this study seriously erodes the delineation capability of a particular location. In the 32 miles of road investigated, there were 16 instances of two reflectors in a row needing replacement and three occurrences where 3+ in a row needed replacement.

ANALYSIS OF NEW YORK AND OHIO EXPERIENCE

Much of the justification for the need to perform this work hinged on the comparative experience of New Jersey to two nearby states, New York and Ohio. During discussions on the SRPM problem in the fall of 1985, it was accepted as a "given" that New Jersey was suffering higher rates of damage to the reflectors when compared to these states. This may have been a premature and erroneous assumption.

Considering the Ohio data is easy because there isn't any data, just an "expectation" that the damage rate is less than 10%. Until the term "damage rate" is defined and data is available, New Jersey should not be compared to Ohio.

Data was received from New York and is given in Table 3. Since the SRPM's at the sites under study were all Stimsonite 96's, only those New York sites where these same SRPM's were installed will be used in this analysis.

Certain similarities exist between the data from the two states. The damage to the reflectors is highly varied from site to site in New Jersey and New York. Also, there does not appear to be a strong correlation between snowfall or AADT and the damage rate. It should be noted at this time that we must assume that New York's "severe damage" is comparable to New Jersey's replacement criterion of 50 percent surface damage. Without this assumption, no comparison is possible. Since the New York data is a five year total, some method of estimating the first year damage rate is needed to allow comparison to the New Jersey data. The model of choice is a negative exponential decay which assumes a constant damage rate over time. The last column in Table 3 is the author's estimation of the first year damage using this model. Another possible model is an accelerated damage rate over time. Since it is unclear what

TABLE 3
STATE OF NEW YORK
SUMMARY OF SRPM PERFORMANCE - FALL 1984

<u>Location</u>	<u>Route</u>	<u>No.</u>	<u>Date Inst.</u>	<u>Model</u>	<u>AADT</u>	<u>Accum. Snow, in.</u>	<u>Percent Damaged - 1984</u>		<u>1st Year Damage(1)</u>
							<u>Casting-%</u>	<u>Reflector-%</u>	
Binghamton	17	197	10/79	96	43,700	284.1	30	57	16%
Binghamton	434	263	10/79	96	16,400	284.1	26	39	9%
Fulton	3	337	10/79	96	10,300	627.6	8	27	6%
Syracuse	57	446	10/79	96	17,600	489.1	21	36	9%
Watertown	11	376	10/79	96	6,700	469.5	27	43	11%
Stony Brook	25A	101	10/79	96	15,000	78.7	45	15	3%
Utica	12	175	10/81	96LP	25,900	237.6	1	19	
Cresent	87-1	125	10/81	96LP	23,150	237.3	25	61	
Port Jefferson	347	708	9/82	96LP	33,000	39	0.3	1.3	
Claverack	9H	25	9/80	Dura.	2,900	173.5	100	68	
Fulton	3	25	9/80	Dura.	5,400	519.7	100	67	
Sag Harbor	114	399	10/81	Dura.	1,200	70.9	96	10	
Port Jefferon	347	713	10/81	Dura.	33,000	57.7	48	17	

No. - Number of markers included in evaluation. Some installations included additional markers that were not evaluated.

% Damaged - Percent of markers exhibiting severe casting or reflector damage as of Fall 1984.

Model - Stimsonite Model 96, Stimsonite Model 96LP and Dura-Brite.

(1) Using a negative exponential decay as the model for estimating the damage per year.

physical mechanism would cause the rate of decay or damage to increase with time, this model should not be used until empirical data provides support for it.

Using this model, the estimate of the first year damage to the New York sites range from 3 percent to 16 percent. This would appear to be comparable and perhaps a little higher than the first year damage in New Jersey measured in this project (0% - 12.4%).

Based on this information and the lack of data from Ohio, it is difficult to support the idea that New Jersey is experiencing more damage than other states.