EVALUATION OF RAISED
AND RECESSED
PAVEMENT MARKERS

Final Report
State Funded Project

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16. Abstract Oregon has been using raised markers for approximately 10 years on all types of roads, west of the Cascades mountain. The raised markers are protected from snow plowing operations and may last longer than raised markers, however, their life expectancy or effectiveness has never been evaluated. Standing water and/or debris has been observed in the recessed grooves which reduces the reflectivity of the markers. In addition, the effect of milled tire wear, abrasion from sanding materials, and traffic on markers has never been fully evaluated.

Paint striping and raised markers are still good alternatives for marking state highways. Paint has a minimal life cycle cost with minimal traffic impacts during replacement. Skip lines enhanced by raised markers provide excellent lane delineation both visually and audibly. However, the reflectivity of the markers may drop as much as 70% in the first year. Because the costs of raised markers are around $250 more per year per mile than paint, they should only be used when it is cost effective or when needed to improve traffic safety.

Skip lines enhanced by recessed markers cost approximately $100 per year per mile more than skip lines enhanced by raised markers. This cost is based on a five-year life for recessed markers, 12-year analysis period and a discount rate of 4%. Recessed markers also do not perform as well as raised markers. The initial performance is reduced strictly because they are recessed. The slots collect debris, rain and snow and when covered are ineffective. Indications are that a maintenance program to remove the debris would not be viable.

We recommend:

1) Because of the expense and poor performance, recessed markers should not be used by ODOT. Paint striping and raised markers are the best alternatives for marking state highways. Consideration should be given to the selection of a marker or paint based on MDT and roadway alignment.
2) Durable markers should be considered for special applications.

17. Key Words

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21. No. of Pages

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22. Price

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* Si is the symbol for the International System of Measurement

(4-7-94 Bpl)
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Evaluation of Raised and Recessed Pavement Markers

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1.0 INTRODUCTION

Oregon has been using recessed markers for approximately 10 years on all types of roads, west of the Cascade mountains. The recessed markers are protected from snow plowing operations and may stay in place longer than raised markers, however, their life expectancy or effectiveness has never been evaluated. Standing water and/or debris has been observed in the recessed grooves which reduces the reflectivity of the markers. In addition, the effect of studded tire wear, abrasion from sanding materials, and traffic on markers has never been fully evaluated.

A research study was initiated in July 1994 to evaluate marker use in Oregon. The study included a literature review, a survey of marker users in Oregon and adjacent states, a cost analysis, and conclusions and recommendations.

1.1 OBJECTIVES

The original objectives of the study included evaluating alternative slot designs to increase the reflectivity and the effectiveness of recessed pavement markers; and determining why water is often found standing in the recessed grooves of open-graded mixes. However, through the course of the study, it was determined that current pavement designs do not permit suitable drainage of the grooves. The original objectives were revised and additional research into recessed marker use was dropped.

The revised objectives of the project were to:

1) Determine the reflective life of pavement markers,

2) Determine the life cycle costs of alternative marker treatments,

3) Recommend applications of markers based on traffic volume and road alignment.
2.0 LITERATURE SEARCH

New York and Texas among other states have conducted research evaluating pavement markers. New York, for example, has conducted a test of recessed reflector delineation and Texas was studying the reflective life of raised pavement markers.

New York's research which has been documented in a report entitled Grooved Stripes for Flow-Resistant Wet-Night Lane Delineation Phase II (1), studied recessed markers in a variety of situations. The variables included in the installation were pavement type, roadway geometry, and reflector and recess depth and configuration. The final report indicates that sight distances under wet-night conditions range from 480 ft (146 m) to less than 40 ft (12 m) and are influenced by roadway geometry, reflector and recess depth, dirt accumulation, and drainage. Delineation varies from excellent to poor.

The Texas Department of Transportation has sponsored a number of studies to assess how quickly reflective markers lose their reflectivity, and to identify what factors influence the rate of reflectivity loss. They have determined that most reflective markers experience significant losses in reflectivity over very short periods of time. Initial losses in reflectivity were due primarily to dirt accumulation on the reflective lenses. Over time, abrasions and weathering caused reflectivity losses to become permanent. Reflectivity loss rates appeared to depend mostly upon the total traffic volume. (2)
3.0 SURVEY RESULTS

A survey was conducted of all region traffic engineers and maintenance districts within the Oregon Department of Transportation (ODOT) and selected state departments of transportation. The survey data collected included the estimated length of service for different types of markers, the most common mode of failure, and any ideas on improving the slot design for recessed markers to reduce the amount of collected standing water.

3.1 ODOT RESPONSES

Based on the information received from eight offices (see Appendix A), it appears that recessed markers last, on the average, 9 to 18 months longer than raised markers. The average life of a raised marker being 24 months, the average useful life of a recessed marker is approximately 36 months. The anticipated useful life of the markers is a direct correlation between average daily traffic (ADT), the number of times the roadway is sanded and plowed and the number of studded tire passes.

The regions east of the Cascades do not use raised or recessed markers. In eastern Oregon, traditional striping is more cost effective given the amount of plowing and sanding that occurs in the winter months.

Some proposed alternatives for removing standing water in the slots included:

1) Using a thicker open-graded mix overlay to allow better drainage;
2) Using longer slots;
3) Angling the slot so at least half the button is elevated; and
4) Filling the slots completely with a hot thermoplastic material with reflective beads.

Since recessed markers were determined to be more expensive and less effective than raised markers, an alternative slot design was not investigated further.

3.2 OTHER STATE'S RESPONSES

Of the four states that responded to the survey (see Appendix A), only California uses recessed pavement markers. Generally, recessed markers are allowed for locations between elevations 1000 and 3000 feet (300 - 900 m) above sea level. The Idaho Transportation Department has very limited experience with raised or recessed markers. Markers in Idaho have been replaced with paint successfully. Both Nevada and Washington do not have any recessed pavement markers.
4.0 OBSERVATIONS

Observations about the effectiveness of pavement markers have been made in various locations around the state and in other states with similar climatic conditions. Generally, both raised and recessed pavement markers provide better lane delineation than traditional striping in adverse weather conditions.

Recessed markers, though, have displayed several operational problems, as shown in Appendix B, figures B.1 and B.2. Problems include collecting water, snow, sand, ice and debris in the grooves. Since they are recessed, they also do not provide the same delineation in wet conditions as the raised markers as shown in Appendix B, figures B.3 and B.4.

In Oregon, a significant contribution to failure of reflective markers is studded tire wear. Recessed markers have been thought to last longer because of the additional protection the groove provides. In actuality this is not the case. Recessed markers were placed in the Bend area, and within three months had lost all relectivity due to damage caused by studded tires. The markers were removed and replaced with another brand of reflective marker and within six months the new markers needed to be replaced. At this time these markers have been completely removed.
5.0 COST ANALYSIS

A cost analysis was performed to determine the equivalent uniform annual cost (EUAC) of applying each of the different pavement marking materials.

The life-cycle cost analyses of the marking materials have several assumptions in common. They are:

1) The evaluation section is a one mile skip line.
2) It is assumed that the pavement section will be overlaid at 12 years. This is the analysis period.
3) Although paint striping typically lasts 8 months, because of the added delineation of the markers, paint was assumed to be replaced every year and a half.
4) The discount rate is 4%.

Delay costs should be considered when comparing the materials, since the traffic delays or user costs vary significantly by alternative. However, these costs were not included in the analyses. The cost differences in plowing with steel blades vs. rubber blades were also not included in this analysis.

5.1 MATERIAL COSTS

5.1.1 Solvent Based Paint

The bid costs for solvent borne paint are approximately $0.11/ft ($0.36/m). The cost for a one mile skip line is $145.00 ($90/km). Actual annual maintenance costs average $106.00/mile ($66/km).

Bid Costs:
Cost = $0.11/ft
Amount of paint/mile = 5280 * .25
Cost of paint/mile = $0.11 * 5280 * .25 = $145.00 ($90/km)

The striping is replaced three times every two years. The EUAC for solvent base paint is $176.00/mile ($110/km). The cost analysis diagram and EUAC calculations are shown below.
\[
PW = \$145 + \sum \$106(P/F, 4\%, n) + \$145(P/F, 4\%, 12)
\quad \text{where } n=\{0.66, 1.34, ..., 11.24\} \text{ years}
\]

\[
= \$1671
\]

\[
EUAC = \frac{\$1671(A/P, 4\%, 12)}{1.066} = \$176/\text{mile} \left[\$110/\text{km}\right]
\]

### 5.1.2 Raised Pavement Markers

There are 132 raised pavement markers per one mile of skip line (the markers enhance a painted skip line). Therefore, the cost to initially place the skip line is \$541.00/mile \left[\$336/\text{km}\right].

**Initial Costs:**

- Cost/marker = \$3
- Cost of paint/mile = \$145
- Cost of marker enhanced skip line = \$3(132) + \$145 = \$541.00/\left[\$336/\text{km}\right]

The service life of raised pavement markers is typically 2 years. As shown below, the actual replacement costs for the markers at \$5.00 each equals \$660.00/mile \left[\$410/\text{km}\right] and the costs for replacing the paint striping is \$106.00/mile \left[\$66/\text{km}\right] every one and a half years. The EUAC for a skip line enhanced by raised pavement markers is \$456.00/mile \left[\$271/\text{km}\right].

![Diagram showing cost breakdown and EUAC calculation for raised pavement markers](Image)

\[
PW = \$541 + \sum \$106(P/F, 4\%, n_1) + \sum \$660(P/F, 4\%, n_2) + \$541(P/F, 4\%, 12)
\quad \text{where } n_1 = \{1.5, 3, ..., 10.5\} \text{ and } n_2 = \{2, 4, ..., 10\} \text{ years}
\]

\[
= \$4092
\]

\[
EUAC = \frac{\$4092(A/P, 4\%, 12)}{1.066} = \$436/\text{mile} \left[\$271/\text{km}\right]
\]
5.1.4 Recessed Pavement Markers

The unit cost of recessed pavement markers is approximately $8.00. The total cost for a one mile skip line enhanced by recessed pavement markers is $1162.00 /$722/km.

Total Costs:
- Cost/mile for markers = $8(132) = $1056
- Cost of paint/mile = $145
- Total cost for paint enhanced by recessed markers = $1162 /$722/km

The service life for the markers is typically three years. The paint skip line is replaced once every year and a half. The replacement costs for the markers are equal to the initial installation costs because of the additional work involved in removing the epoxy from the grooves or having to reuse the grooves. Therefore, the EUAC per mile for a skip line enhanced by recessed pavement markers is $532.00 /$331/km. The cost analysis diagram for recessed pavement markers is shown below.

\[
PW = \frac{1201 + \sum_{i=1}^{n} 106(P/F, 4\%, 1.5, 3, \ldots, 10.5) + \sum_{j=1}^{n} 106(P/F, 4\%, 3, \ldots, 9, 12)}{1056}
\]
where \( n_i = \{1.5, 3, \ldots, 10.5\} \) and \( n_j = \{3, 6, \ldots, 9, 12\} \) years
\[
EUAC = \frac{5056(A/P, 4\%, 12)}{5056(1.066)}
\]
= $539/mile /$335/km
5.2 SUMMARY OF COSTS

Table 5.1 shows a summary of the equivalent uniform annual costs for each of the three alternatives discussed previously.

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<th>ALTERNATIVE</th>
<th>LIFE</th>
<th>EUAC/mile</th>
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<td>8 months</td>
<td>$176</td>
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<tr>
<td>Raised Markers</td>
<td>2 years</td>
<td>$436</td>
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<tr>
<td>Recessed Markers</td>
<td>3 years</td>
<td>$539</td>
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6.0 DURABLE MARKING MATERIALS

Durable marking materials are products that are thicker, harder, more expensive, and generally more difficult to install than traditional pavement marking materials. Installation of these materials usually requires special equipment.

Generally, thicker is better with durable marking materials. Anything thinner than 40 mils or 0.040 inches [1.0 mm] should actually be considered semi-durable. A material of 120 mils [3.0 mm] is not recommended in snow removal areas, because of the possible removal by snow plows. For those areas, a thicker product inlaid should be considered. At lower elevations, profiled markings, which give a rumble effect similar to raised pavement markers, are an excellent way to delineate lane lines and edge lines.

The use of durable marking materials will reduce the number of times the roadway will need to be re-decked because of the significant increase in the life of the markings. Due to the added cost, it is especially important to conduct a value engineering study before specifying these products. Table 6.1 compares the durability, thickness, no-track time, and the cost for different marking materials.

Durable marking materials are an excellent alternative to recessed markers in areas of poor roadway alignment and areas of limited snow removal operations.

<table>
<thead>
<tr>
<th>Material</th>
<th>Durability (years)</th>
<th>Wet Mil Thickness*</th>
<th>No-Track Time (minutes)</th>
<th>Cost/ft. (installed)**</th>
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<td>Alkyd Thermoplastic**</td>
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<td></td>
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<tr>
<td>Waterborne Paint</td>
<td>6-8</td>
<td>15</td>
<td>15</td>
<td>$0.07-$0.11</td>
</tr>
<tr>
<td>Preformed Tape</td>
<td>11-4</td>
<td>15</td>
<td>15</td>
<td>$0.08-$0.11</td>
</tr>
<tr>
<td>(1/2)</td>
<td>60-90</td>
<td>N/A</td>
<td></td>
<td>$1.50-$1.75</td>
</tr>
<tr>
<td>Epoxy**</td>
<td>3-6</td>
<td>15-40</td>
<td>5-20</td>
<td>$0.35-$0.50</td>
</tr>
<tr>
<td>Methacrylate</td>
<td>3-10</td>
<td>Spray: 50-60</td>
<td>18-30</td>
<td>$0.40-$0.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extruded: 90-120</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Profiled: 905000x4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflect. Markers</td>
<td>2-6</td>
<td>750</td>
<td>2-5</td>
<td>$0.50-$0.45</td>
</tr>
<tr>
<td>w/Button**</td>
<td></td>
<td></td>
<td>Epoxy: 20-60</td>
<td></td>
</tr>
</tbody>
</table>

*May require substantial surface preparation.

**Estimates only. Cost varies, depending on location and quantifies.

To convert from cost/ft to cost/m multiply by 3.28.

13
7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

Paint striping and raised markers are good alternatives for marking state highways. Paint has a minimal life cycle cost with minimal traffic impact during replacement. Skip lines enhanced by raised markers provide excellent lane delineation both visually and audibly. However, because the costs of raised markers are around $250 more per year per mile than paint, they should only be used when it is cost effective or when needed to improve traffic safety. Also, the reflectivity of the markers may drop as much as 70% in the first year.

Skip lines enhanced by recessed markers cost approximately $100 per year per mile more than skip lines enhanced by raised markers. This cost is based on a three-year life for recessed markers, 12-year analysis period and a discount rate of 4%. Recessed markers also do not perform as well as raised markers. The initial performance is reduced strictly because they are recessed. The slots collect debris, rain and snow and when covered are ineffective. Indications are that a maintenance program to remove the debris would not be viable.

7.2 RECOMMENDATIONS

We recommend that:

1) Table 7.1 be used for the selection of pavement marking materials. Because of the expense and poor performance, recessed markers should not be used by ODOT. Paint striping and raised markers are the best alternatives for marking our state highways. Consideration should be given to the selection of a marker or paint based on ADT, roadway alignment and adverse weather conditions.

2) Durable markers be considered for special applications.

Table 7.1 Recommendation Matrix

<table>
<thead>
<tr>
<th></th>
<th>SNOW ZONE (elev. &gt;2,500')</th>
<th></th>
<th>NON-SNOW ZONE</th>
<th></th>
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<tr>
<td></td>
<td>&lt;10,000 ADTV</td>
<td>10,000 - 30,000 ADT</td>
<td>&gt;30,000 ADT</td>
<td></td>
</tr>
<tr>
<td>GOOD ALIGNMENT</td>
<td>PAINT</td>
<td>PAINT</td>
<td>RAISED/PAIN</td>
<td>RAISED</td>
</tr>
<tr>
<td>POOR ALIGNMENT2</td>
<td>PAINT</td>
<td>RAISED/PAIN</td>
<td>RAISED/PAIN</td>
<td>RAISED</td>
</tr>
</tbody>
</table>

1 Raised markers should be considered for high seasonal traffic volumes and for heavy rain and fog zones.
2 Consider durable markings for special applications.
8.0 REFERENCES


APPENDIX A
OREGON DEPARTMENT OF TRANSPORTATION
RAISED AND RECESSED
PAVEMENT MARKER
SURVEY

1. What kind of reflective pavement markers are you using? How long do they last?
   Raised:
   - Standard □ ____________ months
   - Abrasive Resistant □ ____________ months
   - Slotted (Recessed) □ ____________ months
   - Snow Pleasable Castings □ ____________ months
   - Other □ ____________ ____________ months
   identify

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity)

3. If you use abrasive resistant reflective pavement markers, please send us a copy of your requirements?

4. Please describe any problems you have with standing water in the slots of the recessed markers?

5. Please enclose a copy of your slot design.

6. Do you have any additional comments?

If you have any questions please contact Kaarea Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to:
Kaarea Hofmann
Research Unit
Oregon Department of Transportation
2950 State Street
Salem, OR 97310
OREGON DEPARTMENT OF TRANSPORTATION
RAISED AND RECESSED
PAVEMENT MARKER SURVEY

1. What kind of reflective pavement markers are you using? **Simsonite - TYPE**
   How long do they last?
   - Raised:
     - Standard: ___ months
     - Abrasive Resistant (glass face or?): ___ months
     - Slotted (Recessed): ___ months
     - Snow Plowable Castings: ___ months
     - Other: ___ months

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity) **Loss of Reflectivity**

3. Do you have any suggestions on altering the slot design to improve the drainage of standing water when recessed markers are used? Please enclose any suggestions or alternatives. **No**

4. Any other comments?

If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann
Research Unit
Oregon Department of Transportation
2940 State Street
Salem, OR 97310

ODOT Personnel

**PAT MASON**
Region 1 Striping Supervisor
1. What kind of reflective pavement markers are you using? Glass Face
How long do they last?
- Raised: 18 months
- Abrasive Resistant (glass face or ?): 18 months
- Slotted (Recessed): 24-36 months
- Snow Plowable Castings: N/A months
- Other: _ months

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity)
- Erosion

3. Do you have any suggestions on altering the slot design to improve the drainage of standing water when recessed markers are used?
Please enclose any suggestions or alternatives.
"P" mix pavement design.

4. Any other comments?
- Use plastic product such as "Durastripe" instead of opaque button when opaque is replacing painted strip line.
- Recess opaque buttons or use recessed "Durastripe" mini strips when delineating double rum locations.

If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann
Research Unit
Oregon Department of Transportation
2950 State Street
Salem, OR 97310

ODOT Personnel
OREGON DEPARTMENT OF TRANSPORTATION
RAISED AND RECESSED
PAVEMENT MARKER
SURVEY

1. What kind of reflective pavement markers are you using? _______________
   How long do they last?
   Raised:
   Standard ☐ __________ months
   Abrasive Resistant (glass face or ?) ☐ _______________ months
   Slotted (Recessed) ☐ ______________ months
   Snow Plowable Castings ☐ ______________ months
   Other ☐ ______________ months

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity)
   Loss of reflectivity

3. Do you have any suggestions on altering the slot design to improve the drainage of standing water when recessed markers are used?
   Please enclose any suggestions or alternatives.
   Wider. Mix overlay to drain underneath

4. Any other comments?

If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann
Research Unit
Oregon Department of Transportation
2950 State Street
Salem, OR 97310

ODOT Personnel
Region 3
OREGON DEPARTMENT OF TRANSPORTATION
RAISED AND RECESSED
PAVEMENT MARKER
SURVEY

1. What kind of reflective pavement markers are you using? 
   _None_.
   How long do they last?
   Raised:
   - Standard - _______ months
   - Abrasive Resistant (glass face or ?) - _______ months
   - Slotted (Recessed) - _______ months
   - Snow Plowable Castings- _______ months
   - Other - _______ _______ months

2. What is the most common form of failure? (e.g. loss from snow plows,
   broken, loss of reflectivity)

3. Do you have any suggestions on altering the slot design to improve the
   drainage of standing water when recessed markers are used?
   Please enclose any suggestions or alternatives.

4. Any other comments? We tried recessed pavement markers on
   Laura Buse. By the end of winter they had lost all
   reflectivity - primarily the face of the reflector was
   eroded and pitted by snows. We elected to __________
   replace them and do not use recessed markers.
   If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or
   Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann
Research Unit
Oregon Department of Transportation
2950 State Street
Salem, OR 97310

ODOT Personnel
1. What kind of reflective pavement markers are you using?  
   Standard - 26 months at best (reflectivity is down)
   Abrasive Resistant (glass face or ?) - 96 months
   Slotted (Recessed) - 96 months
   Snow Plowable Castings - months
   Other - months

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity)
   Loss of reflectivity, some were 2 or up - study seen to be the biggest problem

3. Do you have any suggestions on altering the slot design to improve the drainage of standing water when recessed markers are used?
   Please enclose any suggestions or alternatives.

4. Any other comments?
   Markers in Portland just don't seem to last, with our heat and water, these are a waste of money.

If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann
             Research Unit
             Oregon Department of Transportation
             2956 State Street
             Salem, OR 9730

ODOT Personnel

\[\text{(we need to look at other ways to work our travel lanes)}\]

\[\text{A.D.M. 26} \quad 3-29-95\]
1. What kind of reflective pavement markers are you using? Raised and Recessed
   How long do they last?
   Raised: Depending on winter if there is snow
           Standard—______ months Average 3-5 years
           Ablative Resistant (glass face or ?) — _______ months
   Slotted (Recessed) — ____-60 months
   Snow Plowable Castings—_________ months
   Other —_________—_________ months

2. What is the most common form of failure? (e.g., loss from snow plows,
   broken, loss of reflectivity) Raised- Snow plows
   Recessed- Loss of reflectivity

3. Do you have any suggestions on altering the slot design to improve the
   drainage of standing water when recessed markers are used? No
   Please enclose any suggestions or alternatives.

4. Any other comments? The recessed markers do not show up
   at a distance as good as the raised but last longer

If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or
Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann
Research Unit
Oregon Department of Transportation
2950 State Street
Salem, OR 97310

ODOT Personnel

Albany, Maine.
1. What kind of reflective pavement markers are you using? 
   Lay on Life
   How long do they last?
   Raised:
   Standard - 36 months
   Abrasive Resistant (glass face or ?) - 36 to 48 months
   Slotted (Recessed) - 36 months
   Snow Plowable Castings- _______ months
   Other - _______ months
   Identify

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity)
   1. Loss of reflectivity due to sanding
   2. Loss from Traffic in Curves
   3. Snow PLOw

3. Do you have any suggestions on altering the slot design to improve the drainage of standing water when recessed markers are used?
   Please enclose any suggestions or alternatives.
   One suggestion is to fill the slot with a hot thermoplastic product with reflector bands. That would eliminate the standing water problem.

4. Any other comments?

If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann
Research Unit
Oregon Department of Transportation
2950 State Street
Salem, OR 97310

ODOT Personnel
1. What kind of reflective pavement markers are you using? [Striping]
   How long do they last?
   Raised:
   Standard - ______ months
   Abrasive Resistant (glass face or ?) - ______ months
   Slotted (Recessed) - ______ months
   Snow Plowable Casings - ______ months
   Other - ______ months

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity)

3. Do you have any suggestions on altering the slot design to improve the drainage of standing water when recessed markers are used? Please enclose any suggestions or alternatives.

4. Any other comments? In Dist. 9, we have no raised or recessed pavement markers.

   [Signature]
   [Name]

If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann
Research Unit
Oregon Department of Transportation
2950 State Street
Salem, OR 97310

ODOT Personnel
1. What kind of reflective pavement markers are you using? **None**
   How long do they last?
   Raised:
   Standard —— months
   Abrasive Resistant (glass face or ?) ———— months
   Slotted (Recessed) ———— months
   Snow Plowable Castings ———— months
   Other ———— months

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity)

3. Do you have any suggestions on altering the slot design to improve the drainage of standing water when recessed markers are used? Please enclose any suggestions or alternatives.

4. Any other comments?

If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann
           Research Unit
           Oregon Department of Transportation
           2350 State Street
           Salem, OR 97310

ODOT Personnel

District 1
DATE: March 30, 1995

TO: Kaaren Hofmann
    Research Specialist

FROM: Terry Sladky
      Acting Assistant/District Manager

SUBJECT: Raised and Recessed Pavement Markers

Thanks for the opportunity to respond to the questionnaire. I met with Shane Ottosen from District 2B and Mike Dunning from our Materials Unit along with a representative from Stimsonite to discuss the pavement markers we had installed last fall. They were interested in our concerns about the lack of reflectivity we felt was a problem. They are currently looking into this problem and will write Shane a letter on their findings. I have filled out the questionnaire and it is attached for you review.

TS:/p/pavemark.doc
Attachment
1. What kind of reflective pavement markers are you using? **RECESSED**
   How long do they last?
   Raised:
   Standard - _______ months
   Abrasive Resistant (glass face or ?) - _______ months
   Slotted (Recessed) - _______ & _______ months (as all they have been installed)
   Snow Plowable Castings- _______ _______ months
   Other - _______ _______ months

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity) We have only one town in June last October and most of our failure has been due to snowplows and/or studded tires.

3. Do you have any suggestions on altering the slot design to improve the drainage of standing water when recessed markers are used?
   Please enclose any suggestions or alternatives.
   I feel that a longer slot in and out of the pavement would help with drainage. At the same time longer slots would improve the distance that the reflector could be seen from.

4. Any other comments?

If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann
Research Unit
Oregon Department of Transportation
2950 State Street
Salem, OR 97310

ODOT Personnel
INTEROFFICE MEMO
District 5 Office

To: Kaaren Hofmann
    Research Unit

From: Terry R. Thomas
    Asst. Manager

Date: March 30, 1995

Subject: Pavement Marker Survey

Enclosed is the Pavement Marker Survey for District 5.

Enc: (1)
OREGON DEPARTMENT OF TRANSPORTATION
RAISED AND RECESSED
PAVEMENT MARKER
SURVEY

1. What kind of reflective pavement markers are you using? **installed by contractor**
   (By Stimeute Corp.)
   How long do they last?
   Raised:
   Standard - _18_ months
   Abrasive Resistant (glass face or ?) - __________ months
   Slotted (Recessed) - _36_ months
   Snow Plowable Castings- __________ months
   Other - ___________ ___________ months

   Identify

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity)
   **Snowplows, Stud Tires**

3. Do you have any suggestions on altering the slot design to improve the drainage of standing water when recessed markers are used?
   Please enclose any suggestions or alternatives.
   **No**

4. Any other comments?

If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann
Research Unit
Oregon Department of Transportation
2950 State Street
Salem, OR 97310

ORN Personnel

Debbie S
OREGON DEPARTMENT OF TRANSPORTATION
RAISED AND RECESSED
PAVEMENT MARKER
SURVEY

1. What kind of reflective pavement markers are you using? How long do they last?
   Raised:
   - Standard - 12-24 months
   - Abrasive Resistant (glass face or ?) - 12+ months
   - Slotted (Recessed) - 24+ months
   - Snow Plowable Castings - 24+ months
   - Other - 4” Dia. Reflective - 12+ months
   Identify

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity)
   Studs or bars are the most common. They make the face dull, loss of reflectivity. Also they break the face, then water gets inside which results in failure.

3. Do you have any suggestions on altering the slot design to improve the drainage of standing water when recessed markers are used?
   Please enclose any suggestions or alternatives.

4. Any other comments?

If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann
Research Unit
Oregon Department of Transportation
2950 State Street
Salem, OR 97310

ODOT Personnel
My suggestion is that someone design a durable tape that will work in any water. I've been trying a lot of new work in Anne and I have noticed that the non-degradable temporary tape last about three hours. I think a happy medium, problem would be solved. Suggestion: 1/4 Duratape

Is there a better way to reflect for one-way systems?

Any Questions

Call

David Stearns

Shipping Crew

2026

931-7705

Cell Phone

931-9873

* Hard Plastic with reflective tape all the way through. So if it were broken, it will be there all the way to collect.
Ms. Kaaren Hofmann
Research Unit
Oregon Department of Transportation
2950 State Street
Salem, OR 97310

Dear Ms. Hofmann:

This is in response to your request for information related to the use of raised and recessed reflective pavement markers on California State highways. (See Enclosures).

Recessed reflective pavement markers have been used as a means of providing delineation for highways in light to moderate snow areas since 1979. The recessed groove is tapered down from the plane of pavement to a depth of 9/16 inch in a distance of two feet with the 9/16 inch depth continuing for one foot. The one foot flat bottom provides ample room for two or three replacement markers prior to requiring removal of the expended units. The width of the groove is 5-3/16 inch which will accommodate both the Stimsonite Model 948 and Ray-O-Lite Model 2002.

Only reflective markers passing the Steel Wool Abrasion Procedure, Federal Specification FF-W-1825 are approved for placement in recessed installations. In addition to the steel wool abrasion procedure, a one year field test is required prior to approval.

Generally recessed marker installations are considered only for those locations between elevations of 1,000 and 3,000 feet above sea level. The anticipated useful life of recessed markers is a direct correlation of the traffic volumes and the number of times the roadway is sanded during low ambient temperatures.

For additional information, please contact Mr. Bill Lane at (916) 654-5369.

Sincerely,

ALEX KENNEDY, Chief
Office of Signs, Delineation and Technical Support

Enclosures
1. What kind of reflective pavement markers are you using? How long do they last?

<table>
<thead>
<tr>
<th>Raised:</th>
<th>Standard</th>
<th>36-60 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abraive Resistant</td>
<td>36-60 months</td>
<td></td>
</tr>
<tr>
<td>Slotted (Recessed)</td>
<td>12-36 months</td>
<td></td>
</tr>
<tr>
<td>Snow Plowable Castings</td>
<td>Not used months</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>None months</td>
<td></td>
</tr>
</tbody>
</table>

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity)

Loss of reflectivity

3. If you use abrasive resistant reflective pavement markers, please send us a copy of your requirements?

Enclosed. In addition to laboratory testing, a field test is conducted using the steel tined gutter broom of a mechanical sweeper. Please contact Mr. Richard Hickman, New Technology & Research for additional details (916) 227-7252.

4. Please describe any problems you have with standing water in the slots of the recessed markers?

Although standing water may occur in absolute level areas, the sists can be tapered on both sides of the marker to improve drainage from turbulence created by passing vehicles. The cost of tapering both ends of the set as opposed to only one end is very minimal in comparison to the overall cost of the recessed slots.

5. Please enclose a copy of your slot design. Enclosed.

6. Do you have any additional comments. The useful life of any pavement marker is a direct correlation of its functional environment. In very high volume metropolitan regions a reflective marker on the outside lane may only perform adequately for a period of 12 to 24 months. The same product in a lesser abrasive environment may perform adequately for a number of years.

If you have any questions, please contact Kaaren Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann  
Research Unit  
Oregon Department of Transportation  
2950 State Street  
Salem, OR 97310
OREGON DEPARTMENT OF TRANSPORTATION
RAISED AND RECESSED
PAVEMENT MARKER
SURVEY

1. What kind of reflective pavement markers are you using? How long do they last?
   Raised:
   Abrasive Resistant □ months
   Slotted (Recessed) □ __________ months
   Snow Plowable Castings □ __________ months
   Other □ __________ months

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity)

3. If you use abrasive resistant reflective pavement markers, please send us a copy of your requirements.

4. Please describe any problems you have with standing water in the slots of the recessed markers?

5. Please enclose a copy of your slot design.

6. Do you have any additional comments? Stimacite RRM's have lasted longer than any others, but we are still not totally satisfied with their performance in urban freeways.

If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to:
Kaaren Hofmann
Research Unit
Oregon Department of Transportation
2950 State Street
Salem, OR 97310
1. What kind of reflective pavement markers are you using? How long do they last?
   Raised: Stimsonite Model 948
   Standard □ 12 – months
   Abrasive Resistant □ ___________ months
   Slotted (Recessed) □ ___________ months
   Snow Plowable Castings □ ___________ months
   Other □ ___________ ___________ months

2. What is the most common form of failure? (e.g. loss from snow plows, broken, loss of reflectivity)

3. If you use abrasive resistant reflective pavement markers, please send us a copy of your requirements.

4. Please describe any problems you have with standing water in the slots of the recessed markers?
   We have no recessed at this time.

5. Please enclose a copy of your slot design.

6. Do you have any additional comments?
   We are experimenting more with MIMA profile, thermo-plastic overlay.

If you have any questions please contact Kaaren Hofmann at (503) 986-2851 or Chris Carman at (503) 986-3606.

Return to: Kaaren Hofmann
Research Unit
Oregon Department of Transportation
2950 State Street
Salem, OR 97310

Jon H. Carlson
Pavement Markings and Signing Supervisor
Washington State Department of Transportation
District 1 - Traffic Operations
6431 Canon Avenue South
MS 86
Seattle, WA 98108
(206) 768-5680 / (800) 455-6580
Fax (206) 768-5691 / Home (206) 631-3791
April 4, 1995

Karen Enslow
Research Unit
Oregon Department of Transportation
2050 State Street
Salem, Oregon 97310

RH: RAISED AND RECESSED PAVEMENT MARKERS

Due to the retirement of Max Jensen your letter and request for information has been forwarded to me for action.

The Idaho Transportation Department has very limited experience with raised or recessed pavement marking. These have never been popular because of snow conditions that prevail here in the winter and since they have never proven to be cost effective here.

Most of the pavement markers devices have been used in urban situations and have been raised, ceramic "button" type that afford some degree of channelization. I can find no record of ITS using "abrasive resistant" markers.

Life of the markers appear to be no more than 2 to 3 years with snow plows being the major source of mortality.

The few markers that have been used have not been maintained well and maintenance costs cannot be isolated as they are included with other activities. Recessed markers have displayed problems with standing water, ice, snow and debris and are usually replaced with paint with no apparent problems.

I am enclosing a copy of the ITE Traffic Manual section that addresses these types of markers for your information.

If you need any additional information, please feel free to contact me at (208) 334-8557 any time. Also please inform us of your survey results.

Sincerely,

RONALD B. RICKER
ASSISTANT TRAFFIC ENGINEER

Enclosure

CC: OCHU TRAF

- An Equal Opportunity Employer -
APPENDIX B
Figure B.1 Recessed Slots Filled with Water and Grass.

Figure B.2 Recessed Slot Filled with Water

B-1
Figure B.3  Raised Markers on Rainy Day

Figure B.4  Recessed Markers on Rainy Day

B-3