Pavement Marking Life Cycle Cost Analysis

Kevin Lacy, PE
Overview

• NC pavement markings include paint, thermoplastic, cold applied plastic, and polyurea. Cold applied plastic is only used in select locations.

• This cost analysis was coordinated by the NCDOT Signing & Delineation Unit using NCSU research.

• NCDOT maintains approximately 79,000 miles of roadway with almost 70% of that being two-lane two-way routes. These routes are usually painted.

• These results can be used to assist in the selection of pavement marking materials for roadways based on AADT and needed service life.

• The basis for this pavement marking life cycle analysis is the retroreflectivity of the material which is measured in mcd/lux/m².
Data Acquisition

• Retroreflectivity readings were taken on 350 route segments. Of these segments 21 were striped with paint, 197 with polyurea, and 132 with extruded thermoplastic.

• These readings were taken annually from the initial installation of the markings until the markings were replaced or otherwise removed.

• NCSU used this data in its Pavement Marking Performance Analysis research to provide degradation models for paint and thermoplastic.

• Data for spray thermoplastic was gathered by taking handheld retroreflectometer readings on 17 routes in Wake, Forsyth, and Davidson Counties.

• Polyurea life was derived based on the above readings and historical performance.
Assumptions

• The replacement retroreflectivity value used was 100 mcd/lux/m².

• This value is based on information from AASHTO, MUTCD subcommittee, and a Paul Carlson (TTI) study.

• In moderate to heavily snowplowed areas it was assumed that paint would last 1 year and polyurea life would be reduced by 3 years.

• Yellow center and white skip lines wear quickest due to color and location in roadway.
Chart Explanation

• Charts 1-4 show cost per mile on a 2 lane road for five different materials at four different AADT ranges based on time.

• Charts 5 shows cost per mile on a 2 lane road with moderate to heavy snowplowing for two different materials at an AADT range from 0-10000 based on time. Paint and Polyurea lives are 1 and 7 years respectively in these conditions.

• Materials shown:
  • Paint with Standard Beads
  • Extruded Thermoplastic with Standard Beads
  • Extruded Thermoplastic with Highly Reflective Elements
  • Polyurea with Highly Reflective Elements
  • Hot Spray Thermoplastic with Standard Beads
Results

Cost per Mile vs. Time
ADT: 1300  ADT Range: 0-1300
Min. Retro.: 100

Savings at 12 years:
$16,264 per mile
($1,355 /yr/mile)
Results

Savings at 12 years: $21,333 per mile ($1,777 /yr/mile)
Results

Savings at 12 years: $26,402 per mile ($2,200 /yr/mile)
Results

Cost per Mile vs. Time
ADT: 10000    ADT Range: 5001-10000
Min. Retro.: 100

Savings at 12 years:
$46,678 per mile
($3,890/yr/mile)
Results

Cost per Mile vs. Time
ADT Range: 0-10000
Min. Retro.: 100   Snowplowed

Savings at 12 years: $33,372 per mile ($2,781/yr/mile)
Pavement Marking Material Selection

Notes:
- All bike lane markings should be heated-in-place thermoplastic
Summary of Analysis

### Savings per Year Using Long-Life Markings

<table>
<thead>
<tr>
<th>ADT Range</th>
<th>Division 1</th>
<th>Division 2</th>
<th>Division 3</th>
<th>Division 4</th>
<th>Division 5</th>
<th>Division 6</th>
<th>Division 7</th>
<th>Division 8</th>
<th>Division 9</th>
<th>Division 10</th>
<th>Division 11</th>
<th>Division 12</th>
<th>Division 13</th>
<th>Division 14</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1300</td>
<td>$476,000</td>
<td>$122,000</td>
<td>$508,000</td>
<td>$89,000</td>
<td>$256,000</td>
<td>$474,000</td>
<td>$423,000</td>
<td>$778,000</td>
<td>$65,000</td>
<td>$211,000</td>
<td>$1,071,000</td>
<td>$684,000</td>
<td>$1,021,000</td>
<td>$954,000</td>
<td>$7,132,000</td>
</tr>
<tr>
<td>1301-3000</td>
<td>$176,000</td>
<td>$50,000</td>
<td>$243,000</td>
<td>$44,000</td>
<td>$140,000</td>
<td>$233,000</td>
<td>$309,000</td>
<td>$313,000</td>
<td>$44,000</td>
<td>$87,000</td>
<td>$467,000</td>
<td>$339,000</td>
<td>$417,000</td>
<td>$264,000</td>
<td>$3,126,000</td>
</tr>
<tr>
<td>3001-5000</td>
<td>$139,000</td>
<td>$42,000</td>
<td>$174,000</td>
<td>$31,000</td>
<td>$123,000</td>
<td>$174,000</td>
<td>$251,000</td>
<td>$196,000</td>
<td>$35,000</td>
<td>$64,000</td>
<td>$259,000</td>
<td>$253,000</td>
<td>$192,000</td>
<td>$189,000</td>
<td>$2,122,000</td>
</tr>
<tr>
<td>5001-10000</td>
<td>$183,000</td>
<td>$78,000</td>
<td>$331,000</td>
<td>$43,000</td>
<td>$276,000</td>
<td>$292,000</td>
<td>$486,000</td>
<td>$408,000</td>
<td>$70,000</td>
<td>$202,000</td>
<td>$295,000</td>
<td>$303,000</td>
<td>$261,000</td>
<td>$222,000</td>
<td>$3,450,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$974,000</strong></td>
<td><strong>$292,000</strong></td>
<td><strong>$1,256,000</strong></td>
<td><strong>$207,000</strong></td>
<td><strong>$795,000</strong></td>
<td><strong>$1,173,000</strong></td>
<td><strong>$1,469,000</strong></td>
<td><strong>$1,695,000</strong></td>
<td><strong>$214,000</strong></td>
<td><strong>$564,000</strong></td>
<td><strong>$2,092,000</strong></td>
<td><strong>$1,579,000</strong></td>
<td><strong>$1,891,000</strong></td>
<td><strong>$1,629,000</strong></td>
<td><strong>$15,830,000</strong></td>
</tr>
</tbody>
</table>

**Notes:**
- Total mileage marked from statewide 2014 data.
- Estimated mileage marked in each Division is based on average percent of 4” paint marking from the past 5 years.
- Estimated mileage marked in each ADT range is a weighted percentage of each Division’s total mileage in that range.
- Division 11 – 14 have moderate to heavy snowplowing.
Requirements & Options

Anticipated Federal Requirements

• The next version of the MUTCD will likely have minimum retroreflectivity values for pavement markings.
• Our current practices will not meet these requirements as a whole on our roadway system.

Options

• Spend more money marking roadways or,
• Become more efficient with the money we have by using long-life pavement markings.
Recommendations

The second option proves to be the most cost effective.

Immediate Actions

- Use long-life final markings on all TIP and Resurfacing projects, and in all cases where it is cost effective.

Future Solutions

- Use long-life markings on all final applications.
- This would also lessen worker exposure.
Requirements & Options

Expected Results

• Systematically meet minimum retroreflectivity requirements.
• Save an estimated $15,800,000 a year statewide.

State Forces

• Eventually minimize or phase out utilization of state forces for pavement marking operations.
Questions / Comments