Pavement Marking Materials

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INDOT Materials Management
Overview

- INDOT maintains over 11,000 centerline miles of roadway.
- 1687 people died on Indiana roadways in 2010 (NHTSA FARS data).
- According to FHWA 2008 “value of life” memo, the cost is $6 million per death. Saving lives more than pays for better markings.
Overview

- Pavement Marking Types
  - Paint
  - Thermoplastic
  - Multi-Component (AKA Epoxy)
  - Preformed Plastic
Pavement Marking Materials

- Paint
  - Typically water based
  - Cheapest
  - Most versatile
  - Least durable
  - Typical thickness 15 mils
  - Glass beads sprayed on top of wet paint
Waterborne Traffic Paint

- Standard waterborne traffic paint (50F min)
  - UV resistant and non-coning in most cases
  - $11/ gal, 15 wet mils, 4” width = $0.0344 / LF

- High build waterborne traffic paint (50F min)
  - More is usually better and ability to hold big beads
  - UV resistant and coning may be required
  - $12/ gal, 25 wet mils, 4” width = $0.0632 / LF
  - $12/ gal, 30 wet mils, 4” width = $0.075 / LF

- Cold weather waterborne traffic paint (35F min)
  - UV resistant and coning required below 50F
  - $12/ gal, 15 wet mils, 4” width = $0.0375 / LF
Durable Markings

- Term used for:
  - Thermoplastic
  - Multi-component
  - Preformed Plastic
Pavement Marking Materials

- Thermoplastic
  - Melted plastic
  - Typically used only on HMA
  - More expensive
  - Requires more specialized equipment
  - More durable under higher traffic
  - Typical thickness = 90-125 mils
  - Glass beads mixed in, as well as sprayed on top while still molten
Thermoplastic

- Alkyd thermoplastic is by far the most widely used durable road marking
  - Can be sprayed between 40-125 mils
  - Can be extruded between 60-125 mils
  - Can be inlaid for enhanced durability
  - Minimum application temperature is 50F
  - Can be used with big beads
  - Non-coning
  - Can be profiled
  - Brittle with age

$1600/ton, 90 mils, 4” width = $0.267 / LF
Pavement Marking Materials

- **Multi-Component (AKA Epoxy)**
  - 2 components mixed just prior to application
  - Can be used on any pavement type, but typically only longitudinal lines
  - Better durability and reflectivity than paint
  - Typical thickness = 20 mils
  - 2 types of glass beads typically applied (double drop)
Epoxy Road Markings

- Second most widely used durable (CO, MT, NJ, NY, OH, QB & WI to name a few)
- Epoxy comes in two variations
  - Slow dry - between 15-45 minutes (HPS 2)
  - Fast dry - less than 10 minutes (HPS 3)
  - Minimum temperature for application is 40F
  - Coning required on slow dry, variable on fast dry
- Both are 2:1 ratio products, may “yellow” a bit from UV degradation and are brittle
- May be inlaid and will hold big beads
- $23/ gal, 20 mils, 4” width = $0.096 / LF
Polyurea Road Markings (HPS 5)

- Fast dry - less than 2 minutes, no coning
- Resistant to UV degradation
- Flexible film
- Minimum application temperature is 40F
- 2:1 ratio - works in existing epoxy vehicles with slight modifications
- Can be inlaid
- Will hold big beads
- Largely used in MI, IL, NC and GA
- $50/ gal, 20 mils, 4” width = $0.208 / LF
Modified Urethane Road Markings (HPS 4)

- Fast dry - less than 2 minutes, no coning
- Resists UV degradation
- Flexible film
- 2:1 ratio - works in existing epoxy vehicles with no modifications
- Handles the same as epoxy
- Can be inlaid
- Will hold big beads
- 40F minimum application temperature
- Bridges the cost and performance gap between fast dry epoxy and polyurea - major use in MN & IL

$33/ gal, 20 mils, 4” width = $0.1375 / LF
MMA Road Markings

- Very versatile in application modes, either by hand or mechanical equipment
  - HPS 6 Extrude at 60-120 mils
  - HPS 6 Spray at 40-120 mils (with and without intermix beads)
  - HPS 6 Profile up to $\frac{1}{2}''$ high for enhanced audible and wet/dry retro
  - HPS 7 patterned for enhanced wet/dry retro
  - (pattern usage is equivalent to 100 mils)
MMA Road Markings

- Various ratios available depending on available equipment - 4:1 or 1:1 by volume, 98:2 by weight
- Resistant to UV degradation
- Resistant to snow plow damage even at thicker films
- Can be inlaid
- Some of the variants will hold big beads
- Can be applied below 32F in some instances while normal minimum is 35F
- Major use in AK, ID, OR, WA & Canada. OR has 4 yr warranty w=150 and y=125.
- Does require coning in most cases
- $40/ gal, 40 mils, 4” width = $0.333 / LF
  $40/ gal, 100 mils, 4” width = $0.833 / LF
Pavement Marking Materials

- **Preformed Plastic**
  - Applied as a tape
  - Can be used for permanent or temporary applications (different types)
  - Permanent type can have the highest durability and reflectivity (even under wet conditions)
  - 60F minimum application temperature
  - Highest cost: $1.50/ LF
  - Glass beads are manufactured into the material
## Pavement Marking Materials

<table>
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<tr>
<th>Pavement Marking Materials</th>
<th>Thickness (mil)</th>
<th>Min Temperature (F)</th>
<th>Cost / LF (4&quot;)</th>
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INDOT Specification 808
Pavement Markings

- 808 has been re-written as a performance based specification
- Took effect for contracts let after 9/1/10.
- Performance based specifications have much fewer details/requirements as to materials and application methods
  - INDOT specifies what we want, contractor figures out how to do it
  - Performance requirements have to be specific and measurable
New 808 Requirements

- Performance Requirements:
  - Color
    - ASTM D 6628, ASTM E 811 and ASTM E 1349
  - Durability
    - ASTM D 913
  - Retro-reflectivity
    - ITM 931 - millicandelas per m² per lux
- Quality Adjustments ONLY apply to retro-reflectivity
Retroreflection

Light Comes Back Towards The Source

Mirror reflection

Retro reflection
Measuring Retroreflectivity with 30 Meter Geometry

**Observation Angle**: $1.05^\circ$

**Entrance Angle**: $88.76^\circ$

30-meter viewing distance
<table>
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<tr>
<th>Material (retained time)</th>
<th>Initial White</th>
<th>Initial Yellow</th>
<th>Retained White</th>
<th>Retained Yellow</th>
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<td>Paint (90 days)</td>
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<td>Multi-Component (180 days)</td>
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<td>Preformed Plastic (180 days)</td>
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<td>150</td>
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<td>Extended Preformed Plastic (inlaid) (1 yr/2yr)</td>
<td>650</td>
<td>450</td>
<td>400/300</td>
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FACTORS THAT EFFECT RETROREFLECTIVITY AND DURABILITY

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<tr>
<th>Coatings</th>
<th>Roundness of Bead</th>
<th>Bead Size</th>
<th>Application Temperature</th>
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<tr>
<td>Bead Coverage</td>
<td>Binder Quality</td>
<td>Refractive Index</td>
<td>Application Speed</td>
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<td>Gradation</td>
<td>Bead Embedment</td>
<td>Road Surface</td>
<td>Weather</td>
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<tr>
<td>Color and Clarity of Bead</td>
<td>Binder Viscosity</td>
<td>Bead Rate</td>
<td>Binder Temperature</td>
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Beading and Retro
Glass Beads - Embedment

- High Embedment (<40%), Poor
- Low Embedment (>60%), Poor
- 60% Embedment, Good
National Transportation Product Evaluation Program (NTPEP) is a major resource for comprehensive pavement marking evaluations performed at the national level.

The lead agency collects lab and field performance data for products included in the evaluation and compiles them into a report.

Data are furnished within the report, no approval, disapproval, or endorsements of products are made per NTPEP/ AASHTO policy.
Traffic is moderate (minimum AADT 5,000)

No intersections or access points (excessive braking or turning movements) with full exposure to the sun throughout daylight hours

Good drainage

On both Portland cement concrete and bituminous concrete surfaces

Open to traffic at least one (1) year

Minimal cracking and/or pavement deterioration
THERMOPLASTICS
PREFORMED TAPES
## Reflectivity & Durability

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<th>Interval (months)</th>
<th>Date</th>
<th>Retroreflectivity</th>
<th>Durability</th>
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# Reflectivity & Durability

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NTPEP RETROREFLECTIVITY:

WHITE
(ASPHALT - WHEEL PATH)

Paint
Thermo
Epoxy
MMA
Tape
NTPEP RETROREFLECTIVITY:

WHITE
(ASPHALT - SKI P LINE)

Paint
Thermo
Epoxy
MMA
Tape
NTPEP RETROREFLECTIVITY:

WHITE
(CONCRETE - WHEEL PATH)
NTPEP RETROREFLECTIVITY:

WHITE
(CONCRETE - SKIP LINE)

- Paint
- Thermo
- Epoxy
- MMA
- Tape

Graph showing the retroreflectivity over time for different materials on concrete.
NTPEP DURABILITY - ASPHALT:

- Paint
- Thermo
- Epoxy
- MMA
- Tape

Graph showing durability data for different materials over various dates.
NTPEP DURABILITY - CONCRETE:

[Graph showing durability test results for different materials over time.
Legend: PAINT, THERMO, EPOXY, MMA, TAPE.
# AVERAGE BID UNIT PRICE

(4" Solid Line)

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Installation Methods

- Surface Apply (all materials)
- Inlay (Durable Markings)
Installation Methods

- Surface Apply
Installation Methods

**Inlay-rolling in**

- For preformed tape only, material is placed on the hot asphalt surface, prior to the last roller pass. This causes the material to be slightly depressed, shielding it from snowplow damage.
Installation Methods

- **Grooved - in**
  
a slight depression is ground into the finished pavement surface
INDOT Evaluations (Preformed Tape)

- Dual-lane divided highway
- Should not have extensive crack sealing or patching during the evaluation period
- Average traffic over 17,500 in the two lanes
- Generally free of horizontal and vertical curves
- Speed limit generally 40 mph or higher. (65km/ hr)
- Easy access for traffic control (lane closure)
Surface Applied Preformed Tape
Surface Applied Preformed Tape
Surface Applied Preformed Tape
INDOT RETROREFLECTIVITY:

3M Stamark 380 White Tape
Retroreflectivity one year test on the asphalt surface at U.S. 31 & SR 32

Retroreflectivity mcd/ftcd/sq ft
0 200 400 600 800 1000 1200 1400
Jul-09 Sep-09 Nov-09 Jan-10 Mar-10 May-10 Jul-10

- White E.L.
- White C.L.
- White W.P.
- White Avg
INDOT RETROREFLECTIVITY:

3M Stamark 380 White Tape
Retroreflectivity one year test on the concrete surface at U.S. 31 & SR 32
Grooved-in Installation
Grooved-in Installation
Grooved-in Thermo
Grooved-in Epoxy
Grooved-in Preformed Tape
INDOT Durable Marking Retroreflectivity

Retroreflectivity - White

Retroreflectivity

Thermoplastic
Epoxy
Preformed Tape

1 2 3 4 5 6 7 8 9 10
INDOT Durable Marking Retroreflectivity

Retroreflectivity-Yellow

- Thermoplastic
- Epoxy
- Preformed Tape
Questions???

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