



## Use of Cold-Applied Adhesive for Raised Pavement Marker Applications

*Requested by*  
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# Executive Summary

## **Background**

The Caltrans Division of Maintenance is responsible for the preservation, upkeep and restoration of roadways, bridges and other facilities and structures associated with the state highway system. This includes pavement markings and markers, as well as the methods used to apply them to the pavement.

Caltrans uses raised pavement markers (RPMs), which are permanent or temporary devices mounted on a road surface, as a positioning guide or to supplement pavement markings. The agency currently uses hot-applied bituminous adhesive to attach RPMs to highway pavement. Caltrans would like to improve its RPM installation process and is interested in learning about other state transportation agencies' experiences using cold-applied adhesive for RPMs. Issues of particular concern or interest include:

- Employee safety: Hot-applied bituminous adhesive can emit fumes and require a high operating temperature.
- Equipment maintenance: The shaft of the kettle that holds the adhesive easily becomes clogged, requiring frequent cleaning and maintenance that are time-consuming and costly.
- Daily wait time: Warming hot-applied bituminous adhesive to a usable temperature can exceed two hours.
- Equipment size and space requirement: The 3-by-3-foot kettle that holds the hot-bituminous adhesive occupies significant space on the truck.
- Overall difficulty in use.

To assist with this effort, CTC & Associates conducted a survey of state departments of transportation (DOTs) to gather information about agency use of cold-applied adhesive. CTC also surveyed RPM vendors to learn their opinions on cold-applied adhesive products. The survey findings are supplemented by guidance provided by the survey respondents and by the results of a limited literature search.

## **Summary of Findings**

### **Survey of State and Vendor Practice**

An online survey was distributed to members of the AASHTO Subcommittee on Maintenance and vendors of pavement marking products to gather information about the use of cold-applied adhesive with RPMs. Nineteen states and two vendors responded to the survey.

#### **Cold-Applied Adhesive Used for Raised Pavement Markers**

Seven states reported using cold-applied adhesive for at least some RPM installations. Contractors frequently install RPMs in these states and are permitted to choose hot- or cold-applied adhesive based on manufacturer recommendations.

Three states—Illinois, Maryland and Virginia—use cold-applied adhesive for all RPM installations. Virginia has used cold-applied adhesive for many years with satisfactory results. Illinois DOT generally uses an epoxy with its snowplowable RPMs. The epoxy must be rapid-setting and hard-cured in 30 to 45 minutes, and must meet AASHTO M 237 specifications.

*Note:* A February 2016 Massachusetts DOT publication provides this description of a snowplowable RPM (see page 12 of this Preliminary Investigation for this publication):

A raised snowplowable marker system usually consists of a reflective marker glued into a protective steel or cast-iron casting. This casting is applied with epoxy into a groove that is cut in the pavement surface. The system is designed to enable a snowplow blade to ride up and over the reflective marker, leaving it undamaged. The reflective lens can be replaced in the casting using approved adhesive.

Indiana uses cold-applied adhesive for 85 percent of its installations. Each contractor determines whether cold-applied adhesive is used; the state specifies only that the adhesive conform to AASHTO M 237, Type IV specifications. The equipment used to install RPMs varies by product and contractor.

New Mexico, Texas and Wisconsin use cold-applied adhesive for only selected installations. Texas uses an epoxy-based cold-applied adhesive on all concrete roadways (approximately 10 percent of the agency's overall RPM program). Wisconsin makes little use of permanent RPMs but uses a butyl adhesive to install all temporary RPMs (tRPMs) on construction projects. The agency typically uses the floppy "stick-and-stomp" style of tRPM.

Both vendors recommend using cold-applied adhesive for selected applications: Apex Universal, Inc. for 5 percent of all RPM installations and Pexco LLC for 75 percent of installations.

Twelve states responding to the survey do not use cold-applied adhesive. Snowplowing that is required in some of these states can remove RPMs regardless of installation method. Only Georgia DOT is considering the use of cold-applied adhesive if it were the best product for a specific operation. Nevada DOT discontinued using cold-applied adhesive because it was ineffective for long-term marker retention.

#### Use of Lane Closures for Installation

None of the respondents reporting on the use of lane closures to install RPMs reported traffic issues associated with their practices, although one state schedules RPM installations at night to limit traffic impacts. All of these respondents use contractors to install RPMs.

Two states—Maryland and Wisconsin—use moving lane closures for most or all RPM installations; Texas uses this type of closure on low-volume roads. Static lane closures, with flaggers, are used in Maryland on two-lane roadways; Texas DOT's use of static lane closure is limited to high-volume roads. Virginia DOT uses static lane closures for most RPM installations to provide sufficient time for the adhesive to cure. The agency schedules RPM installations on primary and Interstate roadways primarily at night to reduce or eliminate traffic impacts.

#### Removal of Raised Pavement Markers

Five states have experience removing RPMs, with most reporting that removing these markers results in minimal damage to pavement surfaces. Most states use hand tools to remove RPMs, which isn't difficult but is time-consuming and requires traffic control. Maryland reported that the

grooving process used to remove snowplowable RPMs can cause significant damage to road surfaces. In Wisconsin, any tRPMs that were not removed by snowplowing operations or cannot be removed by hand are removed with a small pavement grinder, which causes some minor damage to the road surface.

### Environmental, Health or Safety Concerns

Only one state—Wisconsin—cited specific environmental, health or safety concerns associated with handling, installing or removing RPMs applied with cold-applied adhesive. The respondent noted that the crew member installing tRPMs on the centerline of a road is close to moving traffic. Also, the plastic tabs used with the agency's tRPMs could end up in ditches or storm sewers after the winter season.

### Benefits and Drawbacks of Using Cold-Applied Adhesives

The benefit most often associated with using cold-applied adhesive for RPMs was the durability of the installation, although at least one state (Nevada) found that cold-applied adhesive was not effective for the long-term retention of the markers. Other benefits include time and cost savings. Wisconsin noted that the rapid installation of RPMs using cold-applied adhesive can make a construction zone safer for the traveling public.

Respondents' concerns about using cold-applied adhesive were minimal. Illinois and Wisconsin cited the additional time required to allow epoxy to cure before the roadway can be used. Wisconsin also noted that while each RPM is quick and easy to install, the quantity required can make it a time-consuming task.

## **Gaps in Findings**

Only seven states that responded to the survey currently use RPMs with cold-applied adhesive. Many of the states responding to the survey don't use cold-applied adhesive, and many more do not install RPMs because of snowy climates.

The literature search produced a limited amount of recent or relevant information about the use of cold-applied adhesive with RPMs. Guidance documents provided by survey respondents supplement the literature search findings.

## **Next Steps**

Going forward, Caltrans could consider:

- Consulting with Illinois, Maryland and Virginia DOTs about their experiences with cold-applied adhesive since these states use cold-applied adhesive for all RPM installations.
- Installing tRPMs in construction zones using pressure-sensitive butyl adhesive pads.
- Using snowplowable RPMs in areas of the state that require plowing, and consult with Illinois, Indiana, Maryland and Virginia about their experiences with this type of RPM and the methods used to install them.
- Consulting with Nevada DOT to learn more about the agency's decision to stop using cold-applied adhesive after concluding that it was ineffective for long-term marker retention.

## Detailed Findings

### Survey of State and Vendor Practice

#### Survey Approach

We distributed an online survey to members of the AASHTO Subcommittee on Maintenance to gather information about the use of cold-applied adhesive with raised pavement markers (RPMs). Nineteen states responded to the survey:

- Alabama.
- Georgia.
- Illinois.
- Indiana.
- Kansas.
- Louisiana.
- Maryland.
- Michigan.
- Minnesota.
- Mississippi.
- Montana.
- Nevada.
- New Mexico.
- Ohio.
- Rhode Island.
- Texas.
- Virginia.
- Washington.
- Wisconsin.

A modified version of this survey was distributed to vendors of RPM products. Two vendors responded to the survey:

- Apex Universal, Inc.
- Pexco LLC.

[Appendix A](#) provides the full text of the survey questions.

#### Summary of Survey Results

Of the 19 states surveyed, seven states reported using cold-applied adhesive for at least some of their RPM installations. Three states—Illinois, Maryland and Virginia—use cold-applied adhesive for all RPM installations. Indiana uses the adhesive for most installations. New Mexico, Texas and Wisconsin use it for selected installations. Both vendors recommend using cold-applied adhesive for selected applications.

The following table summarizes survey responses.

Respondents' Use of Cold-Applied Adhesive to Install Raised Pavement Markers		
Extent of Use	State/Vendor	Comment
Used for All Installations	Illinois, Maryland, Virginia	<i>Virginia.</i> The agency's contractors have used cold-applied adhesive for several years; the respondent noted that the product "seems to work well."
Used for Most Installations	Indiana	The respondent estimates that 85% of the agency's RPMs are installed with cold-applied adhesive.
Used for Selected Installations	New Mexico, Texas, Wisconsin, Apex Universal, Inc., Pexco LLC	<p><i>Texas.</i> The agency uses an epoxy-based cold-applied adhesive on all concrete roadways (approximately 10% of the agency's overall RPM program).</p> <p><i>Wisconsin.</i> The agency uses a butyl adhesive to install all temporary RPMs used on construction projects. The agency makes little use of permanent RPMs.</p> <p><i>Apex Universal, Inc.</i> The vendor recommends cold-applied adhesive for approximately 5% of all RPM installations.</p> <p><i>Pexco LLC.</i> The vendor recommends cold-applied adhesive for approximately 75% of all RPM installations.</p>

The following sections summarize survey results in these topic areas:

- Cold-applied adhesive used for all RPM installations.
- Cold-applied adhesive used for most RPM installations.
- Cold-applied adhesive used for selected RPM installations.
- Nonusers of cold-applied adhesive for RPM installations.
- Vendor recommendations.
- Use of lane closures for installation.
- Removal of RPMs.
- Environmental, health or safety concerns.
- Benefits of using cold-applied adhesive.
- Drawbacks of using cold-applied adhesive.

**Cold-Applied Adhesive Used for All RPM Installations**

Three survey respondents—Illinois, Maryland and Virginia—reported that their state uses cold-applied adhesive for all RPM installations. Contractors install the RPMs in all of these states.

Illinois Department of Transportation (DOT) uses snowplowable RPMs. The adhesive is generally an unspecified epoxy product. The epoxy must be rapid-setting and hard-cured in 30

to 45 minutes, and must meet AASHTO M 237 specifications. The pavement is cut to match the shape of the RPM housing; then the cut is filled with epoxy by hand. Illinois finds that RPM castings are more durable when applied with epoxy, and that equipment is generally not needed when using epoxy. However, additional installation time is required for the epoxy to cure.

*Note:* A February 2016 Massachusetts DOT publication provides this description of a snowplowable RPM (see page 12 of this Preliminary Investigation for this publication):

A raised snowplowable marker system usually consists of a reflective marker glued into a protective steel or cast-iron casting. This casting is applied with epoxy into a groove that is cut in the pavement surface. The system is designed to enable a snowplow blade to ride up and over the reflective marker, leaving it undamaged. The reflective lens can be replaced in the casting using approved adhesive.

In Maryland, contractors choose a hot- or cold-applied adhesive based on the manufacturer recommendations. But the product generally used is Epoplex MA50 Poly-Carb Mark-29.9.

Virginia DOT contractors have used cold-applied adhesive on Interstate and primary state roads for several years. Products used include Epoplex MA50, Epoplex MA52, Thermoset EP-87, Lumiline SMA and Slocum Type M-397. The only equipment needed for these epoxies is a two-part epoxy gun.

### **Cold-Applied Adhesive Used for Most RPM Installations**

In Indiana, cold-applied adhesive is used in approximately 85 percent of all RPM installations. All RPMs are installed and maintained by contractors selected from Indiana DOT's list of prequalified contractors. Each contractor determines the locations or situations where cold-applied adhesive is used; the state specifies only that the adhesive must conform to AASHTO M 237, Type IV specifications. The equipment used to install RPMs varies by product and contractor.

### **Cold-Applied Adhesive Used for Selected RPM Installations**

New Mexico and Texas use cold-applied adhesive for selected RPM installations. In Texas, epoxy works better than hot-applied bituminous adhesive on concrete roadways, which make up about 10 percent of roadways receiving RPMs. Cold-applied adhesive is used to install RPMs on all concrete roadways, and the work is done by contractors. Cold-applied adhesive is not used on asphaltic roadways in Texas.

Most of Wisconsin DOT's RPM use is associated with the floppy "stick-and-stomp" style of temporary RPMs (tRPMs) installed during construction. The agency makes little use of permanent RPMs because of the degradation expected by snowplowing. Contractors install tRPMs ahead of a construction project, generally with a butyl adhesive (most products have a self-adhesive that is not heated before installation). The crew member removes the wax-paper cover from the strip and steps on the RPM to apply it to the pavement. Wisconsin DOT directs its contractors to remove surface dust and dirt by brushing or blowing air at the pavement prior to RPM installation. Equipment selection is up to the contractor.

### **Nonusers of Cold-Applied Adhesive for RPM Installations**

Among the 12 respondents not currently using cold-applied adhesive to install RPMs, only Georgia DOT is considering use of the product. The respondent noted that Georgia DOT "would use it if it were the best option for specific operations." In Nevada, the DOT no longer uses cold-

applied adhesive after determining that the adhesive was “not effective for long-term retention of markers.”

The 10 remaining states do not use cold-applied adhesive and have no plans to use it to install RPMs. Some respondents reported concerns about the use of cold-applied adhesive or offered information about their use of hot-applied adhesive. The table below summarizes survey responses.

<b>Nonusers of Cold-Applied Adhesive to Install Raised Pavement Markers</b>		
<b>Reason for Nonuse</b>	<b>State</b>	<b>Comment</b>
<b>Unspecified Reason</b>	Alabama, Montana, Washington	N/A
<b>Concern About Removal by Snowplows</b>	Kansas, Michigan, Minnesota, Rhode Island	<i>Minnesota.</i> The DOT uses tRPMs for construction. The respondent noted that “[p]ermanent installations do not hold up to snowplows.” The agency does not specify hot- or cold-applied adhesive for tRPMs, instead requiring installation according to manufacturer recommendations.
<b>Use of Hot-Applied Adhesive</b>	Louisiana, Mississippi, Ohio	<i>Louisiana.</i> The agency uses Types II and III hot-applied flexible adhesive.  <i>Mississippi.</i> RPMs are installed by contractors with hot-applied adhesive on a district-by-district basis.  <i>Ohio.</i> The agency uses epoxy heated to 100°C (212°F) to install RPMs.

### **Vendor Recommendations**

Both vendor respondents recommend cold-applied adhesive for selected RPM installations. Apex Universal, Inc. recommends it in approximately 5 percent of installations, while Pexco recommends it for approximately 75 percent of installations.

Apex uses a two-part epoxy that is hand-mixed by the installer in small amounts just before use. According to the survey respondent, the adhesive selected would have to meet Caltrans’ standards.

Pexco uses pressure-sensitive butyl adhesive (offered only for factory-installed RPMs) and a “stick-and-stomp” procedure to install RPMs. The company uses a Marker Applicator TPM 2100 from Epic Solutions to install tRPMs (<http://epicsolutions.us/stripping-roadway-solutions/ram/marker-applicator-tpm-2100/>).



## **Use of Lane Closures for Installation**

None of the respondents reporting on the use of lane closures to install RPMs reported traffic issues associated with their practices, although one state schedules RPM installations at night to limit traffic impacts. All of these respondents use contractors to install RPMs.

Three states—Maryland, Texas and Wisconsin—use moving lane closures to install RPMs. Wisconsin is the only state among the three to use moving lane closures for all RPM installations. Maryland uses a moving closure for most installations, while moving lane closures are used in Texas only on low-volume roads.

Static lane closures with flaggers are used on two-lane roadways in Maryland; Texas DOT uses static lane closures to install RPMs on most high-volume roads. In Virginia, static lane closures are used for most installations to provide sufficient time for the adhesive to cure. The agency schedules RPM installations on primary and Interstate roadways primarily at night to reduce or eliminate the impact to traffic.

## **Removal of RPMs**

Five states—Illinois, Maryland, Texas, Virginia and Wisconsin—commented on the removal of RPMs. All five states have experience removing RPMs. The respondents reported that while removing RPMs does damage pavement, it is typically minimal and limited to the pavement surface. The Maryland respondent said that removing snowplowable RPMs can cause significant damage to the roadway surface due to the grooving process required for installation.

Illinois and Texas use hand tools to remove RPMs. Illinois pries its snowplowable RPMs out of the pavement, and Texas uses an axe or a hammer and chisel to remove them. While the process is not difficult, according to the respondents, it is slow and requires traffic control.

Wisconsin uses a small pavement grinder to remove any tRPMs that were not removed by snowplowing operations the previous winter or cannot be removed by hand. tRPMs can be difficult to remove, and grinding causes some minor damage to the road surface. The respondent also noted that if markers are removed by a process other than grinding, a portion of the adhesive or plastic tab can often remain on the pavement.

## **Environmental, Health or Safety Concerns**

Only the Wisconsin DOT respondent cited specific concerns when asked about the environmental, health or safety concerns associated with handling, installing or removing RPMs applied with cold-applied adhesive. The respondent noted that the crew member installing tRPMs on the centerline of the road is close to moving traffic, and the plastic tabs used with the agency's tRPMs could end up in ditches or storm sewers after the winter season.

## **Benefits of Using Cold-Applied Adhesive**

Survey respondents were asked to indicate the benefits they have experienced with using cold-applied adhesive in RPM installations. The most commonly cited benefits were:

- Durability.
- More effective use of equipment.
- Cost savings.

The most noteworthy benefit associated with the use of cold-applied adhesive was the durability of the installation. According to the Illinois DOT respondent, RPM castings are more durable when applied with epoxy, and the Virginia DOT respondent said the state's RPM installations are very durable and have needed very few repairs. Texas finds that epoxy works better on concrete roadways, so the state uses it on its entire inventory of concrete roadways (approximately 10 percent of installations). Wisconsin uses only tRPMs, installed with cold-applied self-adhesive. Although they are intended to be temporary, the markers are quite durable, according to the Wisconsin DOT respondent, and some actually survive winter snowplowing.

Other benefits mentioned by respondents include equipment, which is not needed for Illinois and Wisconsin installations. If used at all for Virginia installations, equipment does not require additional maintenance. The Wisconsin DOT respondent noted that while equipment is available that can remove tRPMs, the agency has found that the equipment can get clogged with seal coat material and has opted not to use it. Wisconsin DOT does not remove most of the tRPMs it installs, which also reduces the need for equipment.

The Wisconsin DOT respondent also noted that contractors might see a cost savings since they can choose whether to use tRPMs or "same-day pavement marking," a striping treatment that covers much more surface area and requires a great deal of preparation.

### **Drawbacks of Using Cold-Applied Adhesive**

In general, respondents' concerns about using cold-applied adhesive were minimal, but Illinois and Wisconsin mentioned a time cost in using epoxy. The Illinois DOT respondent noted that additional time is needed for the epoxy to cure. The Wisconsin DOT respondent said that while an individual tRPM is easy to install, the quantity required for the average construction project can make it a time-consuming task for the contractor as the project begins.

## Related Research

The citations below are organized in three categories:

- National guidance.
- State guidance and related resources.
- Vendor guidance.

### National Guidance

**Section 3B.11: Raised Pavement Markers—General**, Manual on Uniform Traffic Control Devices, 2009 Edition, Federal Highway Administration, November 2009.

<https://mutcd.fhwa.dot.gov/htm/2009/part3/part3b.htm#section3B11>

This section of the Manual on Uniform Traffic Control Devices describes the general specifications for RPM use.

**Standard Specification for Epoxy Resin Adhesives for Bonding Traffic Markers to Hardened Portland Cement and Asphalt Concrete**, AASHTO M 237-96, AASHTO, 1996.

Citation at [https://bookstore.transportation.org/item\\_details.aspx?ID=515](https://bookstore.transportation.org/item_details.aspx?ID=515)

Several survey respondents reported that the hot- or cold-applied adhesive used in their state must conform to AASHTO M 237 specifications, which describes epoxy resin adhesives for bonding traffic markers to pavement surfaces.

### State Guidance and Related Resources

Below are guidance documents provided by survey respondents. To supplement these documents, we have included a publication from Massachusetts related to pavement markers.

#### **Illinois**

**Division 700: Work Zone Traffic Control and Protection, Signing and Pavement Marking**, Standard Specifications for Road and Bridge Construction, Illinois Department of Transportation, April 2016.

<http://www.idot.illinois.gov/Assets/uploads/files/Doing-Business/Manuals-Guides-&-Handbooks/Highways/Construction/Standard-Specifications/Standard%20Specifications%20for%20Road%20and%20Bridge%20Construction%202016.pdf>

Section 781, Raised Reflective Pavement Markers (page 643 of the report, page 659 of the PDF), and Section 783, Pavement Marking and Marker Removal (page 647 of the report, page 663 of the PDF), provide RPM installation and removal guidelines. Illinois does not specify adhesive type, stating only that the adhesive must meet the manufacturer's specifications; however, for permanent installations, rapid-setting epoxies meeting AASHTO M 237 should be used.

## Indiana

**Section 808.11: Snowplowable Raised Pavement Markers**, 2018 Standard Specifications, Indiana Department of Transportation, 2017 (effective for lettings on or after September 1, 2017).

<http://www.in.gov/dot/div/contracts/standards/book/sep17/2018Master.pdf>

This section of the Standard Specifications discusses snowplowable RPMs only. Indiana DOT requires that any epoxy adhesive used must conform to AASHTO M 237, Type IV (see page 841 of the report, page 923 of the PDF). The roadway surface must be clean and dry, and marker locations must be approved before they are installed by the contractor.

### *Related Resources:*

**Contract Letting Documents**, Indiana Department of Transportation, undated.

<http://erms.indot.in.gov/viewdocs/> (Scroll down to “Enter a Contract Number,” and enter the five-digit contract number: 37939, 39146, 35123 or 35107.)

This web site provides sample contract documents for Indiana DOT transportation construction projects. Contracts T-37939, T-39146, T-35123 and T-35107 address RPM-related projects in four Indiana DOT districts.

**Prequalified Contractors**, Indiana Department of Transportation, August 14, 2017.

<http://www.in.gov/dot/div/contracts/letting/general/pqcontr.pdf>.

The Indiana respondent provided a list of contractors prequalified to install RPMs in the state.

## Maryland

**Section 104.03: Temporary Raised Pavement Markers (RPMs)**, Standard and Supplemental Specifications for Construction and Materials, Maryland Department of Transportation, State Highway Administration, 2017.

[https://policymanual.mdot.maryland.gov/mediawiki/index.php?title=104\\_MAINTENANCE\\_OF\\_TRAFFIC#104.03\\_TEMPORARY\\_RAISED\\_PAVEMENT\\_MARKERS\\_28RPMs.29](https://policymanual.mdot.maryland.gov/mediawiki/index.php?title=104_MAINTENANCE_OF_TRAFFIC#104.03_TEMPORARY_RAISED_PAVEMENT_MARKERS_28RPMs.29).

This section briefly addresses tRPM use. Maryland uses Epoplex MA50 Poly-Carb Mark-29.9 adhesive; however, contract language permits hot- or cold-applied adhesive based on manufacturer recommendations.

## Massachusetts

**Improved Highway Lane Reflectorized Markers**, Nathan H. Gartner, Chronis Stamatiadis and Sushma Srinivas, Massachusetts Department of Transportation, February 2016.

<http://www.umasstransportationcenter.org/Document.asp?DocID=16>

This report provides the results of an 18-question survey that “focused on obtaining answers to questions such as type of pavement markers being used, model numbers, adhesion methods, installation procedure, maintenance, cost, and overall satisfaction of different pavement markers that were being used.” Respondents from 21 DOTs and one Canadian province participated in the survey.

## Texas

**Item 672: Raised Pavement Markers**, Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, Texas Department of Transportation, November 2014.

<ftp://ftp.dot.state.tx.us/pub/txdot-info/des/spec-book-1114.pdf>

RPM installation guidelines and contract specifications are presented on page 829 of the report (page 839 of the PDF). This section also refers to the adhesive selection criteria detailed in DMS-6100 (see Related Resource below).

### *Related Resource:*

**DMS-6100: Epoxies and Adhesives**, Departmental Materials Specification, Texas Department of Transportation, June 2014.

[http://ftp.dot.state.tx.us/pub/txdot-info/cst/DMS/6000\\_series/pdfs/6100.pdf](http://ftp.dot.state.tx.us/pub/txdot-info/cst/DMS/6000_series/pdfs/6100.pdf)

This portion of the specification provides the selection criteria for various epoxies and adhesive materials used in highway applications. Section 6100.1 describes Type III, Classes D, E and F epoxies to be used as anchoring adhesives.

## Virginia

**Approved Lists**, Manual of Instructions, Materials Division, Virginia Department of Transportation, August 2017.

[http://www.virginiadot.org/business/resources/Materials/ApprovedLists/Materials\\_Approved\\_Lists.pdf](http://www.virginiadot.org/business/resources/Materials/ApprovedLists/Materials_Approved_Lists.pdf)

This manual provides a list of approved products for use in the construction or maintenance of highways, bridges and other structures. Section (22) Pavement Markers (Chemistry Lab), Snow Plowable Raised Pavement Markers, on page 80 of the PDF describes the approved brands of adhesive for snowplowable RPMs: Epoplex MA50, Epoplex MA52, Thermoset EP-87, Lumiline SMA and Slocum Type M-397. tRPMs are installed with bitumen adhesive.

**“Factors Affecting Snowplowable Raised Pavement Marker Failures in Virginia,”** Michael D. Fontaine and Brian Diefenderfer, *TRB 90th Annual Meeting Compendium of Papers DVD*, Paper #11-0410, 2011.

<http://docs.trb.org/prp/11-0410.pdf>

*From the abstract:* Snowplowable raised pavement markers (SRPMs) are commonly used in Virginia to supplement lane lines on the interstate and portions of the primary system. While the SRPMs improve lane delineation at night and during inclement weather, the SRPMs can become damaged or detached from the pavement after prolonged exposure to traffic and snowplows. Prior to 2009, Virginia had no formal method or schedule for routinely inspecting these markers following initial installation.

In April 2006, a fragment of an SRPM metal casting became dislodged and injured a motorist. In response to this incident, a statewide study was initiated to determine if there were systemic problems with SRPMs becoming damaged or detached on Virginia’s interstates. Casting condition, reflector condition, epoxy condition, and installation adequacy were inspected on 78 1-mile segments of interstate pavement containing SRPMs. The study found that nearly 8 percent of all SRPM castings inspected were either missing or damaged. Approximately 35 percent of reflectors inspected were either missing or damaged. An analysis of risk factors showed that total traffic since installation and initial installation adequacy were most strongly correlated with casting failures. These data were used to develop an SRPM casting inspection

program and schedule that has been adopted by the Virginia Department of Transportation. The study also recommends increased training for installers and inspectors.

## **Vendor Guidance**

### **Ennis-Flint**

**Raised Pavement Markers: Installation Instructions**, Ennis-Flint, June 2008.

[http://www.ennisflintamericas.com/downloads/dl/file/id/547/product/0/application\\_instructions\\_rpmms\\_epoxy.pdf](http://www.ennisflintamericas.com/downloads/dl/file/id/547/product/0/application_instructions_rpmms_epoxy.pdf)

The manufacturer of RPMs outlines a detailed procedure to install its RPMs with epoxy. *From the installation instructions:*

#### Mixing the epoxy

Combine and mix Stimsonite or other epoxy (meeting AASHTO Designation M 237, Type IV) just prior to anchoring the markers. Automatic dispensing equipment is recommended.

Typical cure times for Stimsonite supplier epoxy are 7 minutes at 85°F and 60 minutes at 50°F.

Caution: Epoxy adhesive cures best at temperatures above 60° F (15.5° C) and low relative humidity. Do not install markers at temperatures lower than 50° F (10° C) or when relative humidity is above 80%.

#### Determine where to locate the marker

When using raised pavement markers to supplement a solid pavement stripe, offset the markers a minimum of 2" from the edge of the stripe. When using raised pavement markers to supplement a dashed stripe, locate the marker in the gap in line with the stripe. This permits repainting without affecting the raised pavement markers' reflectivity.

NOTE: Do not locate markers over joints or cracks in the pavement surface; do not place over existing paint, epoxy or thermoplastic. Marker location must be flat.

#### Prepare the pavement surface

The pavement surface must be clean and dry, at least 24 hours since any significant rainfall. Use a wire brush, if necessary, to loosen and remove dirt. Brush or blow clean.

#### Apply adhesive to pavement

Position melter-applicator\* over desired marker location and dispense a puddle of adhesive approximately 6" in diameter.

#### Place the raised pavement marker

IMPORTANT: Marker must be placed onto the adhesive as quickly as possible, preferably within five seconds of adhesive placement.

NOTE: Adhesive will set up in approximately two minutes and typically requires no protection from traffic.

\* According to Ennis-Flint, these instructions are the same for hot-applied and cold-applied adhesive, except when using a melter (for hot-applied adhesive) or applicator (for cold-applied adhesive).

## **Pexco LLC**

**RPM & Halftrack Durable Raised Pavement Markers Installation Procedures**, Pexco LLC, 2007.

<http://www.pexco.com/media/2007/rpm-halftrack-installation-procedure.pdf>.

Pexco's adhesive selection criteria are proprietary. The company uses pressure-sensitive butyl adhesive pads but also gives basic instructions for using hot melt bituminous adhesive and cold-applied two-part epoxy. tRPMs are installed with the Epic Solutions Marker Applicator TPM 2100 (<http://epicsolutions.us/stripping-roadway-solutions/ram/marker-applicator-tpm-2100/>).

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# Appendix A

## Use of Cold-Applied Adhesive for Raised Pavement Marker Applications: Survey Questions

The following survey was presented to selected state departments of transportation expected to have experience using cold-applied adhesive to apply raised pavement markers (RPMs) to road surfaces. A modified version of this survey was distributed to vendors of RPM products.

### Use of Cold-Applied Adhesive to Install RPMs

1. What is your agency's experience with the use of cold-applied adhesive to install raised pavement markers (RPMs)?
  - We use it now for *all* RPM installations.
  - We use it now for *most* RPM installations.
  - We use it now for *selected* RPM installations.
  - We have used it in the past.
  - We have never used it and don't plan to.
  - We are considering its use.

### RPM Installation Program and Products

1. If your agency uses both hot- and cold-applied adhesives, please estimate the percentage of your overall RPM installation and maintenance program that is associated with each type of adhesive.
2. What cold-applied adhesive product(s) has your agency used?
3. Has your agency established criteria for selecting cold-applied adhesive products? (If yes, please describe your selection criteria.)
4. If your agency has worked with private contractors that have chosen cold-applied adhesive in their bidding submittal process for a large capital roadway project, please provide company contacts.
5. If available, please provide links below to documentation such as contract specifications or installation guidelines relating to your agency's use of cold-applied adhesive to install RPMs. Send any files not available online to Anne Ellis at [anne.ellis@ctcandassociates.com](mailto:anne.ellis@ctcandassociates.com).

### Equipment Used for Cold-Applied Adhesive

1. Please describe the equipment used for application of the cold-applied adhesive, including its general weight and dimensions.
2. Are modifications required for your agency's trucks or the truck beds to accommodate the equipment used to dispense the cold-applied adhesive? (If yes, please describe these modifications.)
3. If your agency uses both hot- and cold-applied adhesives, is a single truck used for both types of RPM installations? (If yes, please describe how a single truck accommodates both installation practices.)

## Applying Cold-Applied Adhesive

1. Please describe how your agency's maintenance crews install RPMs using cold-applied adhesive.
2. Please describe the locations or situations where cold-applied adhesive is used. For example, does your agency consider traffic volume, environmental conditions such as temperature and moisture, or other factors?
3. Are there locations where cold-applied adhesive *will not be used* to install RPMs? (If yes, please describe these locations.)
4. Has your agency had to remove RPMs installed with cold-applied adhesive?
  - No.
  - Yes:
    - Please describe how crews remove RPMs installed with cold-applied adhesive.
    - Please describe the level of difficulty associated with removal of these RPMs.
    - Please describe the level of damage to the roadway incurred by removal.
5. Has your agency identified any environmental concerns related to handling, installing or removing RPMs installed with cold-applied adhesive? (If yes, please describe these environmental concerns.)
6. Has your agency identified any health concerns related to handling, installing or removing RPMs installed with cold-applied adhesive? (If yes, please describe these health concerns.)
7. Has your agency identified any safety concerns related to handling, installing or removing RPMs installed with cold-applied adhesive? (If yes, please describe these safety concerns.)

## Assessing the Use of Cold-Applied Adhesive

1. Listed below are possible benefits associated with the use of cold-applied adhesive to install RPMs. Please provide a brief description for each benefit that applies to your agency's experience and quantify your results, if possible.
  - Time savings.
  - Cost savings.
  - Durability of the RPM installation.
  - More effective use of equipment.
  - Reduction in equipment maintenance.
  - Reduction or elimination of environmental concerns.
  - Reduction or elimination of health concerns.
  - Improved safety.
  - Other (please describe).
2. Listed below are possible drawbacks associated with the use of cold-applied adhesive to install RPMs. Please provide a brief description for each drawback that applies to your agency's experience and quantify your results, if possible.

- Additional time.
  - Additional costs.
  - Diminished durability of the RPM installation.
  - Challenges with equipment use.
  - More frequent equipment maintenance.
  - Environmental concerns.
  - Health concerns.
  - Safety concerns.
  - Other (please describe).
3. Please describe your agency's overall opinion of cold-applied versus hot-applied adhesives.

### **Wrap-Up**

1. *For previous users of cold-applied adhesive only:* You indicated that your agency has used cold-applied adhesive in the past but is not using it now to install RPMs. Why did you stop using cold-applied adhesive?
2. *For agencies considering the use of cold-applied adhesive only:* Please describe why your agency is considering the use of cold-applied adhesive to install RPMs and when you might begin using it.
3. Please use this space to provide any comments or additional information about your answers above.