Optimal Application of Preformed Thermoplastic Pavement Marking Materials

Preheat vs. No Preheat Categories Explained
Preformed Thermoplastic Pavement Markings

Preformed thermoplastic pavement markings are applied using a propane heat torch and are used primarily because of their durability and cost-effective service life. Pre-cut and ready to position onto an asphalt or concrete pavement surface, the most common applications of preformed thermoplastic pavement markings are found at intersections as transverse markings such as stop lines, legends, crosswalks, arrows, bike lane symbols and accessibility symbols.

Misconceptions and Misinformation Exists About Types of Material and Manufacturer’s Proper Application Methods

Some users of preformed thermoplastic pavement markings generally make the assumption that these materials, even from different manufacturers, behave similarly because they look similar. Quite the opposite is true. In fact, applying material based on this assumption can result in unsatisfactory product performance. It is imperative to understand that the manufacturer’s application instructions directly relate to the specific type of material used.

The purpose of this paper is to present the two distinct types of preformed thermoplastic pavement markings and their required, mutually exclusive application methods. Further, it will substantiate the fact that a single product cannot be both a “preheat” and “no-preheat” product.
Recognized Types of Preformed Thermoplastic Pavement Marking Materials

Section 9.3.7 of the Institute of Transportation Engineers (ITE) *Traffic Control Devices Handbook* recognizes two types of preformed thermoplastic pavement marking materials:

1. No preheating of the road surface to a given temperature is required
2. Preheating of the road surface to a certain temperature is required

This recognition of multiple types within the preformed thermoplastic product category is standard practice in the industry, just as the ITE handbook recognizes at least six types of paint, two types of (hot-applied) thermoplastic and four types of raised pavement markers (RPM’s). Similarly, every State DOT recognizes different types of traffic control products within a category.

The Purpose for the Distinction

For preformed thermoplastic, this distinction has been found necessary in order to ensure the applicator can achieve sufficient bond while optimizing retroreflectivity and skid resistance without the hand tossing of glass beads and skid-resistant material, and without scorching the product due to excessive heating. This document defines the differences between these two types of preformed thermoplastic materials and illustrates why one particular product cannot be both types.

*The applicator should be concerned with achieving three primary results:*

1. **Sufficient bond**
2. **Optimized retroreflectivity**
3. **Maximized skid resistance**

How Preformed Thermoplastic Really Works

In order to have good long term performance, a road marking must be well bonded with the pavement. For a preformed thermoplastic pavement marking material, this means that enough heat needs to be applied to the marking in order to develop a low viscosity melt phase at the interface between the road marking material and the pavement. Once this low viscosity melt phase is achieved, the marking “wets” the pavement surface and then cools, achieving an adhesive bond. One may compare this

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* Wet (wetting) is the ability of a liquid (not water) to maintain contact with a solid surface, resulting from intermolecular interactions when the two are brought together.
method of application with hot-applied thermoplastic, which is typically sprayed or extruded in this low viscosity melt phase or with paint that contains solvent in order to achieve a low viscosity and bond with the road. Most road marking materials can only achieve bond if the viscosity of the material is low enough to “wet” the pavement surface.

While drop-on elements (glass beads and/or anti-skid materials) need to be applied to paint or hot applied thermoplastic during field application as a separate process, preformed thermoplastic pavement marking materials typically have glass beads and/or anti-skid materials that are partially embedded during the manufacturing process. This process makes these materials convenient to use because during application these factory-applied surface elements become optimally embedded into the thermoplastic in order to maximize anti-skid and/or retroreflective properties.

Provided the applicator properly follows the manufacturer’s application instructions for the marking, both the process of bonding to the road and achieving optimal retroreflective and/or anti-skid properties are achieved at the same time. As illustrated below in Figure 1, it is not possible to achieve these properties without preheating of the pavement if a preheat type preformed thermoplastic material is used. The same is the case if a “no preheat” type of material is applied to a preheated pavement.

“Preheat”

For a preformed thermoplastic product that requires preheating of the road surface, heating to the point of bonding to the road and proper embedding of factory-installed surface elements (glass beads and/or skid resistant material) occurs in a controlled manner only when the pavement surface has been pre-heated to a temperature of approximately 300°F. Additives are used in the product formulation that impede the sinking of the factory-installed surface elements during application and also act as an insulator that inhibits heat transfer when the surface of the material is heated. For this type of material, if the pavement surface is at ambient temperature (i.e. not preheated) either:

a) sufficient bond will not be achieved with optimal embedment of factory-installed surface elements; or

b) although unlikely, sufficient bond could potentially be achieved by severe overheating of the material surface resulting in heavy charring/damage and less than optimal anti-skid and retroreflective properties

In other words, unless the road surface is preheated to a certain temperature the result is certain to be either a poor bond between the material and the road surface or less than optimal retroreflectivity and skid resistance.
“No-Preheat”

For a preformed thermoplastic product that does not require preheating, heating to the point of bonding to the road and proper embedding of factory-installed surface elements occurs in a controlled manner only when the pavement surface is at ambient temperature when the product is placed on the pavement. Preheating the pavement for a preformed thermoplastic pavement marking that does not require preheating does not offer the applicator an advantage. In fact, it creates an unnecessarily difficult situation for the applicator, as there is a good chance the factory-installed surface elements will be over-embedded resulting in poor anti-skid and/or retroreflective properties.

Bond Strength Data Supports Distinction

As presented clearly in Figure 1 below, a pavement marking that requires preheating cannot achieve bond to the pavement without holding the substrate at elevated temperature, typically 300°F. Shown below is bond strength data for three different pavement marking materials. 180 psi is generally considered acceptable bond strength for thermoplastic materials as referenced in AASHTO T 250. It should be noted that if enough heat and time are given to the application of both HotTape™ and the competitor’s “preheat” product without preheating of the road surface, they could potentially, although unlikely, achieve sufficient bond with the pavement surface. Typically, this requires overheating to the point where the factory-installed surface elements (glass beads and anti-skid materials) sink into the material and/or the marking surface itself is significantly overheated and discolored to the point of affecting daytime visibility as well.

![Figure 1.](image)

A pavement marking that requires preheating cannot achieve bond to the pavement without holding the substrate at an elevated temperature, typically 300°F.

No-preheat means just that; the pavement surface does not require heat to a given temperature prior to positioning the material. The pavement surface should be at ambient temperature.
Conclusions and Considerations

• Dividing preformed thermoplastic pavement marking materials into two types as defined in the Institute of Transportation Engineers (ITE) Traffic Control Devices Handbook is well justified and supported by data.

• While all correctly formulated preformed thermoplastic pavement marking materials can eventually be heated until bonded, good bond is only one part of the installation of these materials. Equally important is the optimal performance of factory-installed surface elements that provide nighttime visibility (retroreflection) and traction (skid resistance).

• A modification to the product formulation would be required for a product that was previously bonded successfully through a pre-heat application process to now be bonded successfully through a no pre-heat application process. Product formulation modifications generally result in a change in the status of the product on most State’s qualified or approved products list (QPL/APL) and related testing requirements.
Ennis-Flint is the manufacturer and supplier of the world-leading “no preheat” product, PreMark® as well as the world-leading “preheat” product, HotTape™. While customers have the option to choose from both types of preformed thermoplastic materials, Ennis-Flint employees have always and will continue to explain beforehand the application differences between the two products. Optimal performance can be achieved using either product provided the applicator follows the specific application instructions provided with each product.

Ennis-Flint places a significant amount of time and effort in the value of training applicators on the specific application methods so they fully understand the behavior of the material and the proper way to use the recommended tools for application. Knowing that customers’ product performance expectations can be met through proper explanation and training is key to the tradition of success for Ennis-Flint. Applicators who do not follow the proper application instructions or who are not adequately trained more often than not experience application failures.

**PreMark®**: Application Features of this “No-Preheat” Product

- Simple 3-step application method: prepare, position, and heat
- No preheating of the road surface to a specific temperature is required
- No minimum air temperature requirements
- Pavement marking season can be extended into colder months when other products cannot be used due to climate restrictions.
- Indents (or heat indicators) in the surface of the material provide a visual cue during application that the material has reached a molten state and proper bond and bead embedment has occurred.
- The recommended Flint 2000 EX® Heat Torch was designed with PreMark® applications in mind for concentrated heat distribution from the fan-shaped nozzle.

**FAQ: Is removing moisture the same as preheating?**

* A: No. Unremoved moisture will block the bond. When PreMark® is heated, the heat penetrates into the road surface. If moisture is present in the road surface it will turn to steam and can only escape by essentially lifting the material. The solution is simple: always remove surface moisture. This is not the same as reaching and holding a required surface temperature prior to positioning material.

**FAQ: Is it necessary to use a thermometer when preheating the surface?**

* A: Yes. The 300°F reading on a thermometer is an accurate indicator that the surface has reached the adequate temperature for proper application. It is important to stay very close to this temperature as being too hot or too cool prior to positioning material can have an adverse effect.

**HotTape™**: Application Features of this “Preheat” Product

- Simple 3-step application method: prepare, position, and heat
- Preheating of the road surface to a certain temperature is required
- The Magnum™ Heat Torch is recommended for HotTape applications because of the broadcast heat distribution to adequately preheat the surface and the material.

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About Ennis-Flint

With corporate headquarters in Thomasville, North Carolina and manufacturing, distribution, and sales locations occupying strategic points around the globe, Ennis-Flint manufactures and distributes a complete line of pavement marking and traffic safety products. From traditional paints and thermoplastics to high-performance formulas and plural components for roadway striping and preferential lane treatments as well as preformed thermoplastic for transverse markings, heavy-duty intersections, and custom horizontal surface signage, you can find Ennis-Flint products on roads and highways, taxiways, runways, parking lots and in all kinds of commercial, contractor, governmental, industrial, airport and architectural settings. Ennis-Flint products help all shared roadway users move in the right direction...safely.

For more information, visit www.ennisflint.com