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MICHIGAN
STATE HIGHWAY DEPARTMENT
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INVESTIGATION OF

PERMA-LINE THERMOPLASTIC PAVEMENT MARKING MATERIAL

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SYNOPSIS

This report covers a laboratory investigation of a thermoplastic type pavement lane marker manufactured for hot-extrusion into an undercut groove in concrete roadways, at sufficient thickness to make the striping permanent.

The study indicates that the striping is apparently in an early stage of development since it has a number of shortcomings. The material does not retain its overlay glass bead complement well, softens excessively and deforms under standard summer pavement temperatures of 120 to 140 F., is subject to surface deterioration under outdoor exposure, has poor resistance to gasoline type solvents, and the white sample had substandard whiteness and reflectivity.

There are also certain disadvantages inherent in using pavement striping in undercut grooves; worn striping presents a recess for collection of dirt and water, provides an unfavorable position for light reflection and creates a shoulder within the road surface.

INVESTIGATION OF
PERMA-LINE THERMOPLASTIC PAVEMENT MARKING MATERIAL

In October, 1955, the Planning and Traffic Division submitted two small samples of Perma-Line thermoplastic pavement marking material for laboratory analysis and evaluation. Figure 1 shows the two 2.5 by 4.5 in. samples (one white and one yellow), prepared by the manufacturer according to his method of pouring the material into a pavement groove at a temperature high enough to liquefy the plastic. The groove in the submitted samples was 0.5 in. deep.

Laboratory Evaluation

The samples were insufficient for field evaluation of serviceability. However laboratory observations included:

1. Bead Retention. The yellow sample specimen had an overlay of glass beads, many of which were dislodged by rubbing a finger briskly across the surface.

Figure 1. Traffic line test samples.

Figure 2. Surface cracking in Perma-Line exposed outdoors for 3-1/2 months.

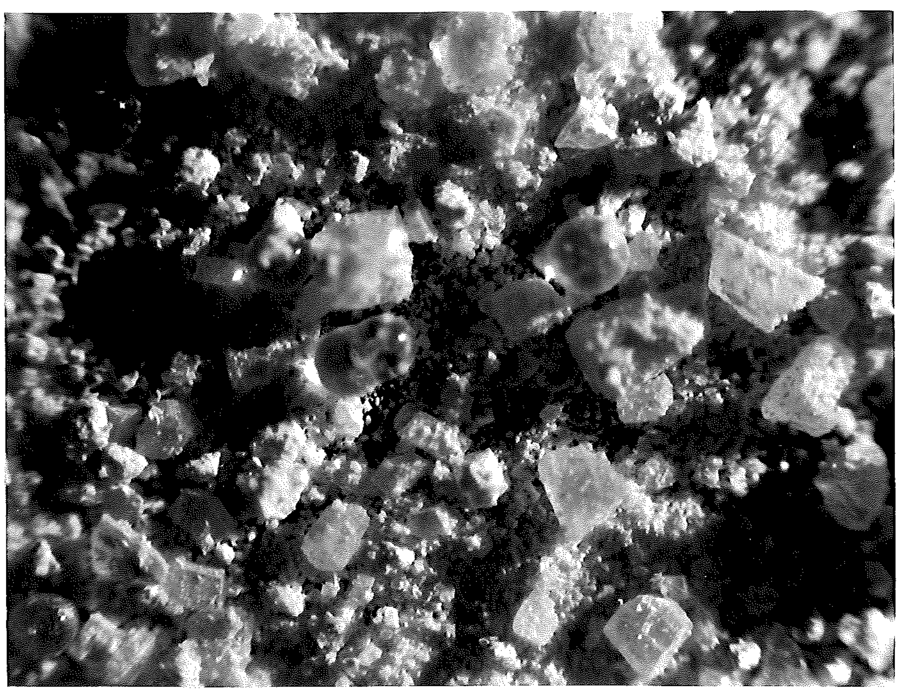

Figure 3. Micrograph of pigment portion of Perma-Line striping. Glass spheres about 250 μ in diameter.

2. Softening Point Temperature. A half-inch thick piece of the plastic striping was placed in an oven at ascending temperatures, to note when the material first began to soften sufficiently to slump, or exhibit flow under its own weight. The Perma-Line striping began to flow noticeably in the range 120 to 140 F.

3. Outdoor Exposure. On August 7, 1956, the white Perma-Line sample was placed on an outdoor exposure rack, facing south, at 45 deg. to the horizontal. Three and one-half months later, surface cracking was in evidence (Figure 2). During exposure, the plastic striping had fused with the black-painted wood block on which it was mounted, suggesting that the striping would bond well with pavement, at least in warm weather.

4. Chemical Resistance. Small pieces of the plastic striping were immersed in various organic solvents to note their resistance to such agents. Perma-Line striping was dissolved by trichloroethylene, dioxane, methyl ethyl ketone, and butyl acetate. Gasoline type solvents disintegrated Perma-Line during an immersion test; Prismo "Plastix" reflective marker softened and swelled in the test. Perma-Line striping was not softened during water immersion.

5. Composition. Physical analysis showed that white Perma-Line had the following proximate composition:

77 percent by weight of pigment and beads
23 percent by weight of plastic binder.

Figure 3 is a micrograph of the pigment portion showing a high proportion of dolomitic type limestone or large particles, and smaller amounts of titanium oxide or small particles, plus glass beads of about 250 microns diameter, about median size for MSHD Type III Glass Beads.

An infrared spectrograph of the plastic binder indicates the presence of an ester constituent either as a resin or plasticizer. However, a vinyl constituent would also be expected in a thermoplastic binder.

6. Color. The following colorimetric data were obtained on the white Perma-Line sample:

Chromaticity coordinate x	=	0.323
Chromaticity coordinate y	=	0.334
Dominant wavelength, $m\mu$	=	573.2
Excitation purity, percent	=	8.2

Luminous directional reflectivity, percent = 65.0, which is 15 percent below the minimum allowable value in the present MSHD specifications.

SUMMARY

Laboratory tests on Perma-Line thermoplastic striping material show that this highly-filled plastic pavement marker, containing some premixed glass beads, fails to retain its overlay bead complement well, softens excessively and deforms under standard summer pavement temperatures of 120 to 140 F., is subject to surface deterioration under outdoor exposure, has poor resistance to gasoline type solvents, and that the white type has substandard whiteness and reflectivity.

In applying a thermoplastic beaded mastic to pavement, the softening point is extremely important. The plastic must have a softening point sufficiently high to resist flattening under traffic and summer heat, yet low enough to permit use of moderate melting temperatures during application. The freshly-applied stripe must also be liquid enough to wet the drop-on glass beads to insure their retention.

Traffic line markers deposited in undercut grooves in pavement, invite stripe obliteration because dirt and water collect atop the worn stripe. The groove also presents an unfavorable position for retroreflection of light. An undercut stripe, when worn, would be a driving hazard, forming a longitudinal crack or shoulder in the pavement.