THE HOT-MELT PLASTIC STRIPE AS A PAVEMENT MARKING MATERIAL

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FOREWORD

Paint is the striping material for thousands of miles of streets and highways. However, its resistance to wear and weathering is so poor, that frequent maintenance of stripes is necessary. Such maintenance is costly.

Recent experimentation has produced an easily applied plastic road marking material of good durability. It is rosin-alkyd resin which can be compounded in either white or yellow color and applied to pavement in hot-melt form. Preliminary tests have indicated a service life of several times that of standard paints on both asphalt and concrete pavements.

Highway technologists have expressed such keen interest in the material that specifications are being made available in this publication. Trade names are mentioned only as necessary to identify ingredients.

It is hoped such information shall be useful in providing greater serviceability from our streets and highways while at the same time reducing striping maintenance costs.

ACKNOWLEDGMENT

Appreciation is expressed to the many companies and individuals who generously gave information and materials for the experiments. Special mention is due Dr. A. R. Lee, Road Research Laboratory, Department of Scientific and Industrial Research, Harmondsworth, Middlesex, England; and Fred J. Benson, research engineer, Texas Engineering Experiment Station. The laboratory and field assistance of Colen Magouirk is also gratefully acknowledged.

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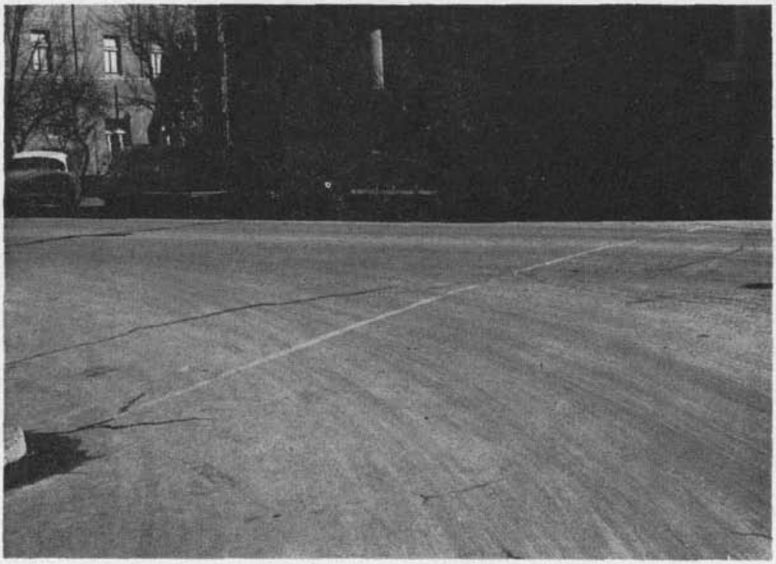
THE HOT-MELT PLASTIC STRIPE AS A PAVEMENT MARKING MATERIAL

Rosin-alkyd resin applied to pavements in hot-melt form immediately dries into long enduring markings. It is suitable for striping either asphalt or concrete pavements in the colors of white and yellow.

INTRODUCTION

The hot-melt plastic stripe is composed of a resinous binder, pigments, fillers, and sand. It is compounded by melting in an oil bath kettle and applied at a temperature of 276° F. to a thickness of 1/16 to 1/8 inch on pavements. The temperature of application results in a fusion with asphaltic pavements. It will harden sufficiently to accommodate traffic in a period of less than five minutes after application. By varying the types and proportions of pigments, a stripe of almost any desired color can be produced making the hot-melt plastic material particularly recommendable for center lines, lane lines, and barrier lines. It is also suitable for parking lines, stop lines, pedestrian crossing lines, and other markings.

A yellow hot-melt plastic stripe across a busy street intersection in the city of Bryan, Texas, after 18 months of service. A parallel paint stripe was repainted 5 times within the first year.



A yellow hot-melt plastic barrier stripe after 6 months of service on asphaltic concrete pavement. The barrier stripes in the background are standard paint stripes.

The British have been using a "plastic white line"[1] material for several years. Road service tests on this material indicated good durability but a need for modification so that it could withstand the temperature range of this section of Texas. The temperature susceptibility of the British "plastic white line" is such that the material softens under Texas summer heat and becomes severely discolored by the adhesion of road dust and tire film to the surface of the stripe. The softened stripes are also deformed under traffic. Material produced by reducing the plasticizer proved to be too brittle and cracked during the cold winter months.

The hot-melt plastic stripe, a modification of the British "plastic white line," is the result of research conducted by the Texas Engineering Experiment Station to develop a durable traffic striping material.

The formulation used in producing the hot-melt plastic stripe has better temperature susceptibility characteristics, although it

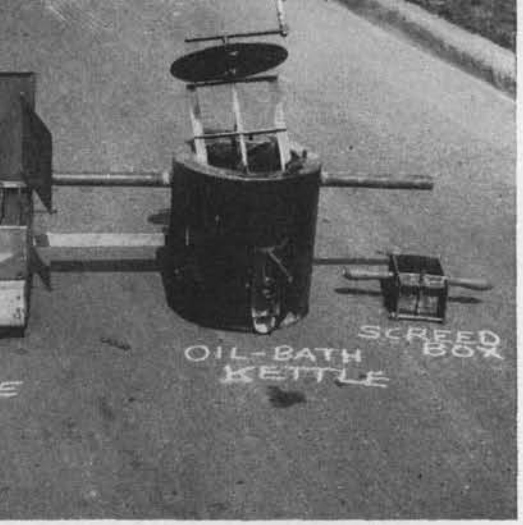
[1]Superior numbers refer to the Bibliography at the end of this bulletin.

The hot-melt plastic stripe used for a white center line on an asphaltic concrete pavement. The horizontal chalk line shows the end of a 3-month-old paint stripe in the foreground with the hot-melt plastic stripe in the background.

does not completely eliminate the objectionable characteristics of the "plastic white line." The hot-melt plastic stripe is susceptible to discoloration for the first few months of service. Rainfall will wash the surfaces of the stripes and restore them to their original color. After a few months of service, the stripes do not discolor severely under traffic.

USES

The tests conducted to date indicate very good durability on asphalt pavements and fair durability on concrete pavements. The ultimate durability is difficult to estimate from the limited tests conducted, but a service life of from three to five years should be expected of stripes receiving relatively light traffic wear, such as center lines, lane lines, and barrier stripes on rural asphalt highways. The service life of stripes on city streets will depend upon the amount and type of traffic wear. The hot-melt plastic stripe should give a longer service life on any asphalt pavement than the standard traffic paints. Lane lines and



parking lines should have an extremely long service life. Stop lines and pedestrian walk lines will have shorter service life.

The service life on portland cement concrete has been variable. Some of the test stripes on concrete pavements have remained in satisfactory condition for more than eighteen months. Others have failed during the first winter of service. A tack coat of asphalt cement applied to the pavement before placing the stripe has increased the service life considerably.

One detrimental characteristic that has been observed is that stripes on portland cement concrete pavements "blister" severely during hot weather. In such blistering the stripe surface puffs up considerably above the rest of the stripe. The weight of traffic causes these blisters to break. Often the softened material will settle back into place, leaving only slight surface deformation. When the blisters are broken during periods in which the stripe is cool and somewhat more brittle, the surface of the blisters is flaked away, leaving cone-shaped depressions in the stripe. It is supposed that these blisters are caused by moisture from the concrete becoming trapped under the stripe. Close examination of these blisters has not revealed the exact cause. These examinations have not disclosed pigment lumps or rosin lumps. An asphalt seal under the stripe lessens the extent of the blistering and the size of the individual blisters.

←UPPER LEFT—Necessary equipment for laying the hot-melt plastic stripe by hand. The hot oil bath kettle shown has a capacity of approximately 5 gallons. The hand screed box is 4 inches wide, 6 inches long, and 4 inches high. CENTER LEFT—Demonstrating application of the hot-melt plastic stripe with a hand screed. LOWER LEFT—Handpowered machine for laying the hot-melt plastic stripe, consisting of a tricycle cart, gasoline heating unit, oil bath kettle, metal screed box (held firmly to the pavement by springs), and a wooden attachment for applying reflectorizing beads.

→ UPPER RIGHT—Two yellow hot-melt plastic barrier stripes on a heavily-traveled concrete highway. The stripes had been in service for 7 months. The stripe on the right was applied over an asphalt film. The stripe on the left was applied over a normal concrete surface. Holes resulted from the stripe blistering during the hot summer months. CENTER RIGHT—Hot-melt plastic stop line (8 inches wide) at the intersection of two highways. The stripes had been in service 7 months on concrete pavement. (Note the extremely dirty pavement creating a great deal of abrasion.) LOWER RIGHT—Photograph showing the adhesion of the hot-melt plastic stripe to asphalt pavements. An extremely hot truck tire parked on the parking lane stripe for a period of time sufficient for the tire to cool. The adhesion to the tire was sufficient to remove a portion of the stripe, tearing away a portion of the pavement as shown.

MATERIALS

Binder—The binder, which comprises approximately one-fourth of the total mix, is composed of wood rosin, alkyd resin, and a plasticizing oil. A light grade of wood rosin (grade WW) is recommended. The alkyd resin should be equal to No. 31 Solid Beckosol (Reichhold Chemicals Company). The plasticizing oil should be a nondrying oil of a high viscosity. Paraplex G-60 (Rohm and Haas Company) or equal is recommended.

The substitution of pentaerythitol ester of rosin for a fraction of the rosin content has been found beneficial in providing a higher melting point mixture and producing a harder stripe. There has been some tendency for these stripes to become too brittle and crack during cold weather. The length of service of these materials has not been sufficiently long to furnish conclusive data.

The substitution of certain resins of rosin ester for the rosin will raise the melting point of the mixture producing stripes which have lesser susceptibility to discoloration. They have a tendency to become brittle, and crack during cold weather but not to a detrimental degree.

Pigments and Fillers—Pigments and fillers comprise 20 per cent of the total mixture. They should be highly stable. Titanium pigment (rutile calcium) (trade RCHT) and resin-treated calcium carbonate (trade name Surfex) make up the pigment and filler combination for the white compound. They are used with equal parts of light or medium chrome yellow and calcium chromate for the yellow compound. Variations in pigmentation does not affect the service characteristics of the material. Basic pigments such as zinc oxide **should not be used.**

Sand—Sand comprises 60 per cent of the mixture. Any good light-colored sand of the proper grading may be used. Limestone sand, readily available in Texas, and processed sands used in portland cement concrete mixtures are desirable. The gradation of the sand depends upon the desired thickness of the stripe. Gradations are shown below for stripes of 1/16- and 1/8-inch thickness. The sand should be thoroughly dry before it is incorporated into the mixture.

Sieve Number	Per Cent of Sand Passing	
	1/8" stripe	1/16" stripe
10	100	100
16		70-90
40	60-80	70-90
100	20-30	20-30
200	0-10	0-10

Metal Driers—Metallic driers are added to the mixture to speed up surface oxidation reducing adhesion of foreign material to the surface of the stripe. Cobalt is used to caseharden the stripe. This is desired because the body of the stripe should remain ductile for better adhesion and flexibility while the surface of the stripe should be hard and dry to prevent discoloration. The value of this metal drier is questionable. (That is, service test stripes have not indicated any appreciable benefit.) Cobalt, if used, should be added in the range of 0.05 to 0.10 per cent metal.

RECOMMENDED FORMULATION

The hot-melt plastic stripe consists of:

Binder	24 per cent
Pigments and filler	20 per cent
Sand	56 per cent

BINDER (24 Per Cent of Total Mix)

The following binder variations have been successfully used. The temperature ranges shown are the recommended application temperatures.

Application Temperature 275° F. ± 5° F.

Binder No. 1	Per Cent by Weight
Rosin, wood (grade WW)	82-81
Plasticizing oil, Paraplex G-60	3-4
Alkyd resin (Solid Beckosol, No. 31)	15
	100

Application Temperature 300° F. ± 10° F.

Binder No. 2	Per Cent by Weight
Rosin (WW)	61-60
Modified pentaerythritol ester of rosin	20
Plasticizing oil	4-5
Alkyd resin (Solid Beckosol, No. 31)	15
	100

Binder No. 3	Per Cent by Weight
Resin (ester of polymerized rosin)	82-80
Plasticizing oil	4-5
Alkyd resin (Solid Beckosol, No. 31)	15
	100

Metal Driers—Cobalt in the range of 0.05 to 0.10 per cent metal based on the weight of binder.

PIGMENT, FILLER, AND SAND (76 Per Cent of Total Mix)

White

	Per Cent by Weight
Titanium pigment (rutile calcium)	13.2
Calcium carbonate (resin treated)	13.2
Sand (limestone or concrete)	73.6
	100.0

Yellow

	Per Cent by Weight
Calcium chromate	6.6
Chrome yellow (medium)	6.6
Titanium pigment (rutile calcium)	6.6
Calcium carbonate (resin treated)	6.6
Sand (limestone or concrete)—No. 16 sieve	73.6
	100.0

The above formulations are based on the results of service tests conducted in Brazos County in Central Texas. Maximum pavement temperatures of slightly above 140° F. have been experienced. Minimum temperatures of 10 to 20° F. have been experienced. In areas where different temperature variations are to be expected, the amount of plasticizing oil should be adjusted to provide the desired ductility and flexibility.

BASIC FORMULATION

Rosin-Alkyd Resin

	Per Cent by Weight WHITE	Per Cent by Weight YELLOW
Gum rosin	19.4	19.4
Alkyd resin (solid)	3.6	3.6
Plasticizing oil	1.0	1.0
Titanium pigment (rutile calcium)	10.0	5.0
Calcium carbonate	10.0	5.0
Chrome yellow (medium)		5.0
Calcium chromate		5.0
Aggregate (concrete sand)	56.0	56.0

MIXING

The ingredients used in preparing the hot-melt plastic material may be weighed separately on any type of scale (or balances) weighing to the nearest 0.1 per cent of total mix.

The mixture should be heated in an oil bath kettle or similar device to insure that no part of the mixture is exposed to a heat greater than the range indicated for the formulation. Standard automotive lubricating oil is satisfactory for use as an oil bath.

It is recommended that the binder be preheated to the recommended temperature in order to expedite the mixing process. The binder must be stirred until it has reached a uniform temperature and is thoroughly blended.

After the binder reaches the consistency of a thick paint mixture, the pigments should be added and well mixed. Care should be taken to break up lumps from the pigment which might fail to incorporate with the mixture. This can be made easier by screening the pigments before adding them to the mixture. Lumps of pigments will cause weak spots in the finished stripe and may cause the stripe to blister during hot weather. When the binder and pigments have been thoroughly mixed, the required amount of preheated sand should be added. Preheating the sand to the desired temperature insures that the sand is absolutely dry before it is added to the mixture. This is highly important to the success of the stripe. Preheating also makes the formulation easier to mix.

Great care should be exercised to prevent the incorporation of even the slightest amount of oil from the oil bath kettle into the mixture, since oil acts as a plasticizer which will soften the material and prevent hardening.

All ingredients must be **thoroughly dry** in order to produce the best results.

LAYING

The pavement surface should be cleaned by brooming, prewashing, or by the use of pressurized air to remove surplus dust and other loose material. The pavement must be reasonably dry, as moisture will chill the material and prevent adhesion with the pavement. Stripes should not be applied for several days following a rain.

The air and pavement temperatures should be above 60° F. at the time of laying a stripe to insure adhesion of the material to the pavement before hardening. If it is convenient, preheating the pavement surface will be beneficial under any conditions.

Care should be exercised to insure the heated material is applied to the pavement as near to the required application temperature as possible. If the laying operation is disrupted at any time, the screed should be removed and cleaned. The material from the screed should be returned to the heating tank. A flat metal plate should be placed at the termination of the stripe so that the screed box can be pulled upon it to form a straight edge. The excess material can then be removed from the plate and placed back into the heating tank.

The material can be mixed in quantity and stored in light metal containers which are easily cut away. By removing the containers, placing the material into the heating tank, and bringing it up to the required heat, the mixture can be made ready for application to the pavement.

EQUIPMENT

A bottomless screed box of desired width should have one end beveled and raised 1/16 to 1/8 inch above the pavement. The box may be constructed of wood or metal; however, metal is preferable for cleaning purposes.

The box is placed on the pavement and the material placed directly into the box. The box is then drawn along a straight-edge or chalk line leaving a stripe of desired width and thickness on the pavement.

For a continuous laying device the following materials are needed:

1. Gas heating unit.
2. Metal oil bath heating kettle.
3. Detachable screed box.
4. Suitable mobile cart.

BEADING

Glass reflecting beads may be applied to the surface of the stripe directly behind the screed box. Any delay in application of the beads will result in very poor bead retention, since the material chills very rapidly. A system of beading short, alternate sections throughout the length of the stripe is recommended—that is, bead 6 inches and leave 6 inches unbeaded.

OPENING TO TRAFFIC

It is not necessary to protect the freshly-laid stripe from traffic, as the stripe should harden sufficiently to accommodate traffic within a period of considerably less than five minutes. A slight surface stickiness will cause some surface discoloration by the adhesion of road dust and tire film. This will clean off as soon as the surface of the stripe has oxidized and the stripe is cleaned by rainfall.

ASPHALT BINDER ON PORTLAND CEMENT CONCRETE

In order to obtain maximum adhesion and service life from stripes applied to concrete pavements, it is recommended that the stripes be laid over an asphalt binder-coat. The binder can be produced by applying a low penetration asphalt cement at a rate of .05 to .10 gallons per square yard. The asphalt should be cut with enough white gasoline or other petroleum solvent to produce an even residual asphalt film. The binder should be sprayed or painted onto a clean concrete surface and allowed to dry sufficiently before applying the hot-melt material. The same application procedure is used for laying the hot-melt material on the binder-coat as is used on asphaltic pavements.

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