COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

May 15, 1964

HENRY WARD
COMMISSIONER OF HIGHWAYS

ADDRESS REPLY TO
DEPARTMENT OF HIGHWAYS
MATERIALS RESEARCH LABORATORY
132 GRAHAM AVENUE
LEXINGTON 29, KENTUCKY

H. 1. 64. 18

MEMORANDUM

TO: W. B. Drake, Assistant State Highway Engineer; Chairman, Research Committee

SUBJECT: Final Construction and Interim Performance Report; Experimental Use of Thermoplastic, Pavement-Striping Material (Experimental Construction and Research, Report No. 3); KYHPR-64-18, HPS-HPR-1(25)

The report submitted herewith succeeds and supplements Report No. 2 which was submitted April 8, 1963. Report No. 1 was in the nature of a pre-construction report and was dated September 19, 1962. These reports have been prepared in accordance with the BPR's PPM 60-2 and PPM 60-2(1). The inspection and reporting phase of this work was authorized under HPS-HPR-1(25), July 1, 1963.

The installations have been in service through two winters; the attrition rate at Test Site 3 (PCC pavement) has been somewhat alarming; however, costs of repair and renewal of the experimental lines cannot be evaluated realistically at this time inasmuch as the repairs made thus far have been covered by certain warranty provisions or have otherwise been made voluntarily by the respective contractors. Attachment 14, in the report, summarizes the total attrition to date.

The losses in footage may be considered, on the one-hand, to be valued at the contract cost per foot without regard to the subsequent cost of repairs borne by the contractor or otherwise accounted for in contractor's bid price; whereas, on the other hand, repairs in like kind and at the contractor's bid price would compound the investment - with no further assurance of extended life. This differs, in concept, from the year-to-year renewal cost of traffic paint--which is accumulative on a pay-as-you-go basis.

The Cataphote Corporation is obligated at this time, under our interpretation of their guarantee, to replace 3,831 feet of line on Test Site 3 and 170 feet on Test Site 4 - or to otherwise make restitution to the Department for this loss. Cataphote will be duly notified so that the work may be done during the forthcoming summer season.

Perma-Line's warranty obligates them only for losses exceeding 50 percent of the footage within 4 years (centerlines) or 3 years (edgelines).

Our surveillance of the performance of the experimental installations will be continued, and additional analyses of actual costs will be forthcoming.

Copies of this report will be forwarded to the Bureau of Public Roads in accordance with PPM's 50-1.1 and 60-2.

Respectfully submitted,

Jas. H. Havens

Jas. H. Havens
Director of Research
Secretary, Research Committee

JHH:afj

Attachment

cc: W. B. Drake
Research Committee
R. O. Beauchamp
R. L. Campbell
T. J. Hopgood
A. O. Neiser
D. V. Terrell
File D.1.7

# FINAL CONSTRUCTION AND INTERIM PERFORMANCE REPORT
# EXPERIMENTAL USE OF THERMOPLASTIC PAVEMENT-STRIPING MATERIALS

Report No. 3

KYHPR-64-18; HPS-HPR-1(25)

May 15, 1964

by

Jas. H. Havens, Director of Research
and
John W. Scott, Research Engineer
Kentucky Department of Highways

Project Numbers, Termini, Station Numbers and Mileages:

Jefferson County; I 264-1(24)16, SP 56-898; Watterson Expressway, 1.231 miles (net); BC pavement.

Section A - East end of Bardstown Road Interchange, extending eastwardly, Sta. 515+00 to Sta. 547+00, 0.606 miles; BC pavement.

* Subsection 1; Sta. 515+00 to Sta. 525+67; 0.202 mi.
** Subsection 2; Sta. 525+67 to Sta. 536+34; 0.202 mi.
*** Subsection 3; Sta. 536+34 to Sta. 547+00; 0.202 mi.

(Subsections 1 & 2, 1067 ft. ea.; Subsection 3, 1066 ft.)

Section B - East end of Taylorsville Road Interchange, extending eastwardly, Sta. 585+00 to Sta. 603+00, 0.341 miles; BC pavement.

* Subsection 4; Sta. 585+00 to Sta. 591+00; 0.1137 mi.
** Subsection 5; Sta. 591+00 to Sta. 597+00; 0.1137 mi.
*** Subsection 6; Sta. 597+00 to Sta. 603+00; 0.1137 mi.

(Subsections 4, 5, & 6, 600 ft. ea.)

Section C - East end of Breckenridge Lane Interchange, extending eastwardly, Sta. 633+00 to Sta. 648+00, 0.284 miles; BC pavement.

* Subsection 7; Sta. 633+00 to Sta. 638+00; 0.0947 mi.
** Subsection 8; Sta. 638+00 to Sta. 643+00; 0.0947 mi.
*** Subsection 9; Sta. 643+00 to Sta. 648+00; 0.0947 mi.

(Subsections 7, 8, & 9, 500 ft. ea.)

Jefferson County; I 264-1(25)20, SP 56-898; Watterson Expressway; north end of US 60 Interchange, extending northwardly, Sta. 28+00 to Sta. 105+00, 1.458 miles; PCC pavement.

** Subsection 1; Sta. 28+00 to Sta. 53+67; 0.486 mi.
*** Subsection 2; Sta. 53+67 to Sta. 79+33; 0.486 mi.
* Subsection 3; Sta. 79+33 to Sta. 105+00; 0.486 mi.

Franklin-Shelby Counties; I 64-3(14)34, SP 37-905, SP 106-806; Louisville-Lexington Road; east end of Ky. 53 Interchange, extending eastwardly, Sta. 1418+00 to Sta. 2081+00; 11.965 miles (net); PCC pavement.

*** Subsection 1; Sta. 1418+00 to Sta. 1628+63; 3.99 mi.
* Subsection 2; Sta. 1628+63 to Sta. 1839+36; 3.99 mi.
** Subsection 3; Sta. 1839+36 to Sta. 2081+00; 3.99 mi.

(Sta. 1983+04 BK, EB = Sta. 1988+40 BK, WB = Sta. 2020+00 AH)

Clark-Montgomery Counties; I 64-5(16)93, SP 25-422, SP 87-557; Lexington-Catlettsburg Road; EKTP Interchange, extending eastwardly, Sta. 430+00 to Sta. 1053+00; 11.80 miles; BC pavement.

* Subsection 1; Sta. 430+00 to Sta. 637+67; 3.933 mi.
** Subsection 2; Sta. 637+67 to Sta. 845+34; 3.933 mi.
*** Subsection 3; Sta. 845+34 to Sta. 1053+00; 3.933 mi.

Allocation of Subsections

* Control - Kentucky Paint
** Catatherm
*** Perma-Line

## A. NATURE AND OBJECTIVES OF EXPERIMENT

The purposes and objectives of this study are: 1) to evaluate the application and performance characteristics of hot-melt plastic, pavement-striping materials which are presently prominent and know commercially as "Catatherm" and "Perma-Line"; 2) to compare the performance of these materials with the performance of painted stripes applied and re-newed according to the current practices of the Kentucky Department of Highways; and 3) to evaluate the economics of these striping materials in terms of cost-per-mile per-day-of-useful-life. The project is described more fully in the "Proposal..." (approved by Division Engineer, September 7, 1962) and in Report No. 1 (Pre-Construction Report) submitted September 19, 1962. Attachment No. 1 shows the location of the test sites.

B. FINAL CONSTRUCTION, INSPECTION, OBSERVATIONS, REPAIRS

TEST SITE 1
I 264-1(25)20; PCC Pavement

Transverse Lines

These lines were applied November 2, 1962. The Kentucky paint lines in this project were repainted the first time on April 15, 1963 (see Attachment 2 for re-painting costs). These lines were inspected on March 25, 1964 (see Figure 1, Attachment 3), and notations of the condition of each line follows:

Line 1: White, Kentucky Paint (3 applications of paint at 3-day intervals, and drop-on beads). The over-all condition of this line was good, although some spalling had occurred along the edges of the line -- this being more pronounced in the right wheel track of the outer lane. This line does not need repainting.

Line 2: White, Kentucky Paint (2 applications of paint at 3-day intervals, drop-on beads). The over-all condition of this line was fair. There was edge-spalling over the entire length of the line; and, in some places, the line was only 2-1/2 inches wide. A 5-inch portion of this line was missing in the right wheel track of the outer lane. The existing portions of line were discernible but the line needs repainting.

Line 3: White , Kentucky Paint (1 application of paint and no drop-on beads). The general condition of this line was poor. This line needs repainting because most of the line was either missing or not discernible.

Line 4: Yellow, Kentucky Paint (3 applications of paint at 3-day intervals, drop-on beads). The over-all appearance of this line was good. There was edge-spalling along 50% of the line-length, and the line was only 2 inches wide in the right wheel track of

the outer lane and was 2-1/2 inches wide at the center of the pavement. There were no portions of the line that was entirely missing. It is recommended that this line be repainted.

Line 5: Yellow, Kentucky Paint (2 applications of paint at 3-day intervals, and drop-on beads). The over-all condition of this line was poor. A 2-foot portion was missing in the right wheel track of the right lane, and an 8-foot portion was missing at the center of the pavement. Over-all spalling had occurred, and the line needs repainting.

Line 6: Yellow, Kentucky Paint (1 application of paint and no drop-on beads). The appearance of this line was poor. A total of 15 feet of this line was missing -- the majority occurring in the left lane. This line needs repainting.

Line 7: White, Perma-Line Thermoplastic. The condition of this line was good. A few, small, bubble-craters were present. Bonding was excellent and there was no visible wear or damage.

Line 8: Yellow, Perma-Line Thermoplastic. The condition of this line was good although some large bubble-craters were present. Bonding was good, and no spalling or chipping had occurred.

Line 9: White, Catatherm Thermoplastic. The appearance of this line was good. A large number of small bubble-craters was present, and alligator cracking had occurred in the center of the right lane. Bonding was excellent, and no spalled portions were present.

Line 10: Yellow, Catatherm Thermoplastic. The appearance of this line was fair. A large number of large bubble-craters was present. This line had an extreme number of transverse and alligator cracks over the entire length. There were no missing portions, and the bond was good.

Subsection 1, Catatherm Thermoplastic

These lines were applied November 1, 1962. On April 9, 1963, there were small areas of spalling at expansion joints where missing portions of the line measured up to 4 square inches. The bonding quality varied from fair to good; and, using a knife edge, it was possible to pry up pieces as large as 1 square inch. A total of 65 feet or 0.53% of the line in this subsection was either missing or badly spalled and considered to be unsatisfactory at that time.

On July 17, 1963, Cataphote, in connection with their warranty provisions, repaired or replaced all lines in this subsection that did not appear to be performing satisfactorily. Approximately 1,259 feet or 10.33% of line were reworked. This included the 65 feet listed as being unacceptable in the Final Construction Inspection Report or noted as being unsatisfactory when earlier performance inspections were conducted.

The following is a brief description of Cataphote's equipment and procedures used in the repair work. A scraping tool was used to remove existing stripes that were poorly bonded to the pavement. For the application of the thermoplastic, Cataphote used one crew operating an automatic, truck-mounted applicator. In front of and attached to this unit was a spray nozzle which was used to apply a bonding primer to the pavement. When re-striping over an existing line, the bonding primer was not applied because the internal heat of the thermoplastic was sufficient to insure bonding with the original stripe. In all other respects, the striping operation was very similar to the original

procedure used by Cataphote in the fall of 1962.

On March 25, 1964, this subsection was inspected and the appearance was good; however, a large number of bubble-craters was present. Portions ranging from 1 to 6 inches were missing at expansion joints. No edge spalling or cracking was noted, and the over-all bond was good. On the concrete bridges, the bond was very poor, and extreme cracking of the line was noted. A total of 119 feet or 0.98% of the line in this subsection was adjudged to be unsatisfactory -- this being damage which incurred during the winter of 1963-64.

In review of the warranty provisions, the Cataphote Corporation guaranteed 80% of a unit for 2 years and 60% of a unit for 3 years -- a unit being defined as "any length of highway having installed thereon 2,000 lineal feet of line of specified width in any combination or pattern." Calculations indicate that a roadway 841.7 feet in length and having a dashed center-line and two edge-lines has 2,000 lineal feet of line. Due to the small amount of footage that was considered to be unsatisfactory, Cataphote's warranty does not apply in this particular instance; and any repairs on this section would be, of course, voluntary on the part of Cataphote or otherwise at the Department's expense. It is felt, however, that no repairs of any kind should be made in this subsection at the Department's expense because the missing footage of line does not give a disordered appearance.

Subsection 2, Perma-Line Thermoplastic

These lines were applied November 1, 1962. On April 9, 1963, this subsection presented a satisfactory appearance,

although there was some slight spalling along the edges of the lines. The bonding of all portions was very good. A total of 117 feet or 0.96% of the line was considered unsatisfactory, and this was primarily due to one area which had been scraped with snow plows.

On May 6, 1963, Perma-Line repaired or replaced all lines that did not appear to be performing satisfactorily. The 117 feet of line that were listed as being unacceptable in the Final Construction Inspection Report or noted as being unsatisfactory during intermediate inspections were replaced.

Perma-Line's repairs were accomplished by one crew operating a hand-liner which was preceded by a truck-mounted kettle. The lines were applied using the same general procedure and materials as used in their original operation. During repair work, bonding primer was applied except where new material was overlaid over existing line. Scraping tools were used to remove extremely loose and spalled line.

On March 25, 1964, this subsection was inspected again, and the appearance was excellent. The over-all bond was good; however, some portions on the bridges had very poor bonding. There was some spalling along the edges, and portions up to 6 inches in length were missing at joints. Small craters were present, but no alligator or transverse cracking was noted. A total of 13 feet or 0.11% of the line in this subsection was considered to be unsatisfactory -- this reflects the damage incurred during the winter of 1963-64.

The Perma-Line Corporation guaranteed at least 50% of the line at each location to remain in place at least 4 years for center-lines and 3 years for edge-lines. The thermoplastic

stripes applied by Perma-Line in this subsection have satisfied, to date, the requirements of the guarantee. It is recommended that no repairs be made to 13 feet of unsatisfactory line because the warranty does not apply, and inasmuch as the over-all appearance of the lines is satisfactory.

Subsection 3, Kentucky Paint

These lines were applied by the Traffic Division of the Kentucky Department of Highways on October 24, 1962. On April 9, 1963, this control subsection of paint was badly spalled and faded. All the line remained discernible even though it was badly faded.

During the Summer of 1963, the center-lines were repainted (see Attachment 2 for costs). The edge-lines were not repainted at this time because they were still discernible.

On March 25, 1964, the over-all appearance of this subsection ranged from fair to good. The center-line was discernible and does not need repainting. The edge-lines were very dim in some instances and portions were missing on the north end of the south-bound roadway. The edge-lines will definitely need repainting this year.

TEST SITE 2

I 264 - 1(24)16; BC Pavement

Transverse Lines

The transverse lines in this project were applied November 2, 1962. These lines are shown in a photograph taken during April of 1963 (Figure 2, Attachment 4), and for comparative purposes, the same lines are shown in a photograph taken during April of 1964 (Figure 3, Attachment 4). The transverse lines of Kentucky Paint have not been repainted. These lines were inspected March 25, 1964, and notations of the condition of each line follows:

Line 1: White, Kentucky Paint (1 application of paint and drop-on beads). This line was dim in the left lane and completely devoid of paint in the wheel tracks of the right lane. Repainting is recommended for this line.

Line 2: White, Kentucky Paint (2 applications of paint at 3-day intervals, and drop-on beads). The left lane portion of this line was in good condition but the right lane was badly spalled. Although the remaining protions were discernible, repainting is recommended for this line.

Line 3: White, Kentucky Paint (3 applications of paint at 3-day intervals, and drop-on beads). The left lane portion of this line was in good condition and the right lane portion was spalled in the wheel tracks. This line should be repainted.

Line 4: Yellow, Kentucky Paint (1 application of paint and drop-on beads). This line was almost absent of paint in the right lane and was dim in the left lane. Line needs repainting.

Line 5: Yellow, Kentucky Paint (2 applications of paint at 3-day intervals, and drop-on beads). The left-lane portion of this line was in good condition; but due to the portions missing in the right lane, this line will have to be repainted.

Line 6: Yellow, Kentucky Paint (3 applications of paint at 3-day intervals, and drop-on beads). This line was in good condition in the left lane, but it was badly spalled in the right lane, and repainting is recommended.

Line 7: White, Perma-Line Thermoplastic. This line was in an excellent condition. The bond was good and no spalling or cracking had occurred.

Line 8: Yellow, Perma-Line Thermoplastic. This line had an excellent over-all appearance. The bond was good and no spalling or cracking was present.

Line 9: White, Catatherm Thermoplastic. This line was in an excellent condition although one small alligator crack was present. A small amount of spalling had occurred, but the over-all bond was good.

Line 10: Yellow, Catatherm Thermoplastic. This line was in good condition, although some transverse cracking was present. The bond was good, but some spalling had occurred.

Subsections 1, 4, and 7; Kentucky Paint

These lines were applied on October 22-23, 1962. On April 8, 1963, some slight spalling and general fading was noted throughout all subsections. The best preserved paint was inferior to either of the thermoplastics.

During the Summer of 1963, the center-lines were repainted in all subsections (see Attachment 2 for costs). At this time, the condition of the edge-lines was satisfactory.

On March 25, 1964, the over-all appearance of these

subsections was good. The center-lines were in an excellent condition; and although the edge-lines were somewhat less discernible than the center-lines, no repainting is necessary.

Subsections 2, 5, and 8; Catatherm Thermoplastic

These lines were applied on October 22-23, 1962. On April 8, 1963, the bonding quality was checked, and it was possible to pry up 2-inch square portions of line. Transverse cracking appeared along all lines of all subsections with the exception of the left edge-line of the west-bound lane of Subsection 5. Transverse cracks averaging 1/32 inch in width extended entirely across the line and were spaced from 1-1/2 to 10 inches apart. All of the line in this test site was considered to be satisfactory even though spalling had occurred in Subsection 5 along the entire left-edge line of the east-bound lane. No repairs were made to these subsections during the Spring of 1963.

On March 25, 1964, the over-all appearance of these subsections was good. Excluding the left edge of the west-bound lane of Subsection 5, transverse cracking was still evident. The bond was generally good; although Subsection 2 had areas of extreme edge spalling, and Subsection 5 had a small amount of edge spalling. Snow-plow damage was noted in Subsection 5. All lines in these subsections were performing satisfactorily and no repair work is needed.

Subsection 3, 6, and 9; Perma-Line Thermoplastic

These lines were applied on October 22-23, 1962. On April 8, 1963, the over-all appearance of these subsections was good; there was no cracking, and very little edge spalling was

noted. The bonding was excellent on all portions checked. A total of 2 feet or 0.02% of the line was considered to have failed.

On May 6, 1963, Perma-Line reworked all lines that did not appear to be performing satisfactorily; and a total of 202 feet or 1.96% of the line was repaired. This included the 2 feet listed as being unacceptable in the Final Construction Inspection Report or noted as being unsatisfactory when performance inspections were made. The method used in these repairs was the same as that used in Test Site 1, Subsection 2.

On March 25, 1964, the over-all appearance of these subsections was excellent. No cracking was noted, but Subsections 3 and 6 exhibited some edge spalling. The bonding quality was excellent. A 1-foot portion or 0.01% of the line was scraped during snow and ice removal and was considered to be unsatisfactory.

TEST SITE 3

I 64-3(14)34; PCC Pavement

Transverse Lines

The transverse lines in this test site were applied on October 19, 1962. These lines are shown in a photograph (Figure 4, Attachment 5) taken during April of 1963. The Kentucky paint lines were repainted for the first time on April 12, 1963 (see Attachment 2 for costs). These lines were inspected on April 9, 1964 (see Figure 5, Attachment 5), and notations of the condition of each line follows:

Line 1: White, Kentucky Paint (1 application of paint and drop-on beads). All of the line was discernible and does not need repainting. Note absence of scaling in comparison with the lines having multi-applications of paint (see Figure 5, Attachment 5).

Line 2: White, Kentucky Paint (2 applications of paint at 3-day intervals, and drop-on beads). The over-all condition of this line was good although one edge was spalled. The line was still discernible and does not need repainting.

Line 3: White, Kentucky Paint (3 applications of paint at 3-day intervals, and drop-on beads). There was scaling and spalling over the entire length. The existing portions of the line were discernible, but the over-all appearance was poor. This line needs repainting.

Line 4: Yellow, Kentucky Paint (1 application of paint and drop-on beads). This line was worn and needs to be repainted.

Line 5: Yellow, Kentucky Paint (2 applications of paint at 3-day intervals, and drop-on beads). This line was almost devoid of paint, and there was evidence of extensive spalling. This line needs repainting.

Line 6: Yellow, Kentucky Paint (3 applications of paint at 3-day intervals and drop-on beads). Almost all of the line was missing. Extensive spalling had occurred, and the line needs repainting.

Line 7: White, Perma-Line Thermoplastic. A slight amount of edge spalling had occurred, but the bond was good. A close examination revealed small alligator cracks and numerous, small craters. The over-all condition, however, was good.

Line 8: Yellow, Perma-Line Thermoplastic. The bond was satisfactory, but there was some edge spalling in the left lane. No cracking had occurred, but some large and small craters were present.

Line 9: White, Catatherm Thermoplastic. There was edge spalling in the left lane, and the over-all condition of the line was fair. The line had extensive alligator cracks, and the bond was very poor in the left wheel track of the left lane.

Line 10: Yellow, Catatherm Thermoplastic. This line had edge spalling --due to poor bonding in the left wheel track of the left lane. Very wide alligator cracks were present. The over-all condition of this line was very poor. Of all thermoplastic transverse lines, this line was in the worst condition.

Subsection 1, Perma-Line Thermoplastic

These lines were applied during October and November of 1962. On April 10, 1963, the general condition of this subsection was only fair; some areas showed very poor bonding. Spot checking showed some areas, however, where the bonding was excellent; and it was possible to chip up only fingernail-size portions of line. The poorer bonding seemed to predominate in areas receiving drainage -- e.g., the inside edges of super-elevated curves. In addition, one area exhibiting poor bonding

was applied under marginal pavement and air temperatures. A total of 6,178 feet or 6.18% of the line in this subsection was considered to be unsatisfactory.

During early May of 1963, Perma-Line repaired or replaced all lines that did not appear to be performing satisfactorily. Approximately 18,145 feet or 18.14% of the line was reworked, and this included the 6,178 feet that was listed as being unacceptable in the Final Construction Inspection Report or noted as being unsatisfactory during inspections. The method used in these repairs was the same used in Test Site 1, Subsection 2.

On April 7, 1964, the over-all condition of this subsection ranged from fair to good (see Figure 6, Attachment 6). Transverse cracking was not prevalent except at joints. In most places, the bond was good; however, there were portions of the line missing that measured from 3 inches to 50 feet. Evidence of the bonding material, "Pliobond", was present on pieces of line that were chipped off. A total of 1,534 feet or 1.53% of line was considered to be unsatisfactory at that time.

Inasmuch as the above unsatisfactory footage cannot be replaced under the warranty provisions, no repairs should be made. The missing portions are not considered to be disturbing to the public; but, if this subsection continues to lose a large percentage of line in the future, repainting of the missing portions with Kentucky paint will be recommended.

Subsection 2, Kentucky Paint

These lines were applied on October 12 and October 15, 1962. On April 11, 1963, some isolated areas of this subsection were completely devoid of a discernible line (see Figure 7, Attachment 7) whereas other areas had a discernible line (see Figure 8, Attachment 7). Fading and spalling were quite general throughout this test site.

The center-lines were repainted first in late April or early May, 1963 (see Attachment 2 for costs). The center-lines were repainted for the second time in late April of 1964 (see Attachment 8 for costs).

On April 7, 1964, the over-all appearance of this subsection was fair. The edge-lines were completely devoid of paint in many areas (see Figure 9, Attachment 9); however, discernible line was present in other areas (see Figure 10, Attachment 9). The edge-lines will definitely need repainting this year.

Subsection 3, Catatherm Thermoplastic

These lines were applied during October, 1962. On April 10, 1963, this subsection ranked substandard in over-all appearance. The bonding quality was generally quite poor; in many areas checked, large portions of the line could easily be pulled up by hand. The bonding was generally better on the right edge- and center-lines. Both alligator and transverse cracking had occurred throughout the subsection. A few isolated, domed blisters, up to 2 inches in diameter, were observed. A total of 9,383 feet or 9.38%

of line was considered to be unsatisfactory.

During July, 1963, Cataphote, in connection with their warranty provisions, repaired or replaced all lines in this subsection that did not appear to be performing satisfactorily. A total of 36,196 ft. or 36.19% of line was reworked. This included the 9,383 feet that was listed as being unacceptable when performance inspections were made.

On April 8, 1964, this subsection ranked poor in over-all appearance (see Figure 11, Attachment 10). The bond was generally poor--especially in the left edge- and center-lines. It was possible to pull up 10-foot portions of line (see Figure 12, Attachment 10). Transverse cracks and large craters were present, and extensive edge spalling had occurred. A large amount of line-footage was missing; and, in many places, the existing line was very brittle. A total of 17,602 ft. or 17.60% of line was considered to be unsatisfactory; and this reflects the damage that occurred during the winter of 1963-64.

This being the second year since the original application, Cataphote is allowed to have 400 lineal feet of unsatisfactory line for any selected 2,000 lineal feet of line or 841.7 feet of roadway length (ref. to warranty provisions, Test Site 1, Subsection 1). There are 15 areas in this subsection that exceed this allowable tolerance, and the excess over 400 feet in each area, according to the guarantee, must be replaced at no cost to the Department. According to inspection notes of the Division of Research, the Cataphote Corporation is thereby committed to replace or make restitution for 3,831 lineal feet of line in this subsection.

Assuming the required repairs are made by the Cataphote Corporation, 13,771 lineal feet of line will still be in an unsatisfactory condition. According to past performances of Catatherm in this subsection, it would be uneconomical to restore the remaining unsatisfactory lines with a thermoplastic at the Department's expense. This subsection appears to be very disordered; and, if repairs are deemed necessary, repainting of missing portions with Kentucky paint will be recommended.

TEST SITE 4

I 64-5(16)93; BC Pavement

Transverse Lines

These lines were applied November 27, 1962. The transverse lines of Kentucky paint have not been repainted. These lines were inspected on April 10, 1964, and notations of the condition of each line follows:

Line 1: White, Catatherm Thermoplastic. The appearance of this line was only fair due to the numerous alligator and transverse cracks over the entire length. The bond, however, was good.

Line 2: Yellow, Catatherm Thermoplastic. The bond quality was good, and no spalling was noted. A number of large craters was present, and alligator and transverse cracking had occurred over the entire line. The appearance of this line was fair.

Line 3: White, Perma-Line Thermoplastic. This line was in an excellent condition. The bond was good; no spalling was noted; and no cracks were present.

Line 4: Yellow, Perma-Line Thermoplastic. The bond quality was good and no cracking had occurred. The over-all appearance of this line was excellent.

Line 5: White, Kentucky Paint (1 application of paint and drop-on beads). This line was slightly worn and dim but does not need repainting. No spalling was noted and the line appeared to be well beaded. The over-all condition was good.

Line 6: Yellow, Kentucky Paint (1 application of paint and drop-on beads). The over-all condition of this line was good. The line was worn but was still discernible.

Line 7: White, Kentucky Paint (2 applications of paint at 3-day intervals, drop-on beads). This line was well beaded and was in an excellent condition. Some flaking had occurred, but the line does not need repainting.

Line 8: Yellow, Kentucky Paint (2 applications of paint at 3-day intervals, and drop-on beads). This line was in an excellent condition even though some scaling had occurred. The line does not need repainting.

Line 9: White, Kentucky Paint (3 applications of paint at 3-day intervals, and drop-on beads). Large portions of the second and third applications of paint had flaked off--exposing the first application. The over-all condition was excellent, and the line does not need repainting.

Line 10: Yellow, Kentucky Paint (3 applications of paint at 3-day intervals, and drop-on beads). No flaking had occurred, and the over-all appearance of the line was excellent.

Subsection 1, Kentucky Paint

These lines were applied on November 15-16, 1962. On April 12, 1963, slight fading of the line was observed, and the general appearance was rated as good. The paint lines, however, were slightly less visible than the thermoplastics.

On April 10, 1964, the over-all appearance was still good. The edge- and center-lines have not been repainted, and these lines will not need repainting this year.

Subsection 2, Catatherm Thermoplastic

These lines were applied during November 1962. On April 12, 1963, the bonding was excellent, and the condition of the subsection was considered to be good; although, trans-

verse cracks were noted over a majority of the surface. The transverse cracks extended entirely across the line and averaged 2 inches apart and 1/16 inch in width. A total of 635 feet, or 0.64% of line, was considered to be unsatisfactory.

On July 18-19, 1963, Cataphote, in connection with their warranty provisions, repaired or replaced all lines in this subsection that did not appear to be performing satisfactorily. A total of 1,471 feet or 1.49% of line was repaired, but this included 380 feet or 0.38% of new line that was applied over a recently-installed, full-width patch. Included in the repair work was the 635 feet that was considered to be unsatisfactory when the Spring 1963 inspections were made. The 580 feet referred to in the Final Construction Inspection Report, dated January 3, 1963, was considered satisfactory upon re-inspection, and repair work was unnecessary.

On April 10, 1964, the appearance was excellent; although transverse cracks, from 2 to 6 inches apart, were present. Transverse cracking was not as prevalent in areas (under bridges) where exposure to the sun was limited. Approximately 20 center-line stripes on the eastern portion of the east-bound lane were spalled along the edges. Snow-plow damage was noted, but the over-all visibility of the line was excellent. The over-all quality of the bond was good; however, the bond on the bridge decks was very poor. A total of 977 feet or 0.99% of the line was considered to be

unsatisfactory; however, almost all of this occurred on bridge decks.

There are two areas in this subsection in which the footage of unsatisfactory line exceeds the allowable tolerance of Cataphote's warranty, and the excess over 400 feet for each area is expected to be replaced at no cost to the Department. The Cataphote Corporation is committed to replace or make restitution for 170 lineal feet of line in this subsection.

Assuming that only the required repairs are made, 807 lineal feet of line will remain in an unsatisfactory condition. Whereas most of this loss of line occurred on bridge decks, it is not particularly critical ; and no recommendations will be made to repair the lines in like kind at the Department's expense.

Subsection 3, Perma-Line Thermoplastic

Perma-Line started work on this subsection on November 15, 1962, but because of menacing weather, received permission to postpone further work until the Spring of 1963.

On April 15, 1963, the over-all appearance of the portion of edge-line in place was satisfactory. The bonding was good except on a bridge deck where the concrete was spalling. Some slight edge cracking was noted, and some subsurface cracking appeared in some areas; but none was exposed at the surface. A total of 41 feet or 0.04% of line was considered to be unacceptable.

On April 15, 1963, Perma-Line resumed work on this subsection and upon completion, April 26, 1963, this site

became subject to final inspection. Attachment 11 is a strip chart showing the extremities of the subsection and the dates of application. An excerpt from the Department's Final Construction Inspection Report for this subsection is also included as Attachment 12.

During April, 1963, 191 feet or 0.19% of line was reworked, but this included 150 feet or 0.15% of line that was re-applied over a bridge deck patch. Included in this repair work was the above-mentioned 41 feet.

On April 10, 1964, the bond was good, and the subsection had an excellent appearance. Snow-plow damage was noted. The bond on the bridge decks was only fair. A total of 809 feet or 0.82% of line was adjudged to be unsatisfactory; but this included 534 feet or 0.54% of line that was covered by an overlay patch on the pavement.

Inasmuch as Perma-Line's warranty does not cover the replacement of these lines, it is recommended that no repairs be made.

## C. GENERAL DISCUSSION

Generally, both the daytime and nighttime visibility of the thermoplastics were more superior to that of the paint stripes. There were sections of paint, however, that compared favorably in all respects with the thermoplastic lines.

Road scum following snow and light rains temporarily affected the nighttime visibility of the edge-lines until they were washed by heavy rains. This situation was particularly evident on the urban section of bituminous concrete pavement (Test Site 2).

Generally, by the Spring of 1963, most of the drop-on (surface) beads had worn away from the thermoplastics (exposing the internal beads). The over-all result of this wear was an improvement in the uniformity of the reflectivity of the lines, even though they were slightly dimmed in comparison with newly applied line.

Following a rain, the thermoplastic edge-lines impounded water which, in many cases, extended onto the roadway as much as 18 inches and persisted along the entire edge-line long after the center portion of the roadway had dried. This condition caused an accumulation of de-icing salts along the edges of the roadway, and in some instances, caused water to drain across the pavement creating an icing hazard. Drainage outlets were cut by Department personnel to alleviate this condition.

Each thermoplastic stripe which crossed an expansion

joint had developed one, and in some cases more, cracks transverse to the line and parallel to the joint. The foregoing was true for both center-stripes and edge-lines. Later observations of these cracks revealed that the thermoplastics in the immediate vicinity of the cracks had spalled.

Better performance of both thermoplastic and paint stripes has been obtained on bituminous surfaces than on portland cement concrete pavement. It should be noted, however, that most of the unsatisfactory lines in the bituminous sections occurred on concrete bridge decks (see Figure 13, Attachment 13). Thermoplastics applied on bituminous surfaces softens and fuses to the asphaltic surface thereby insuring a good bond. This unique quality, on the other hand, cannot be achieved when thermoplastics are applied to portland cement concrete surfaces, and the bond obtained is somewhat less favorable.

Generally, thermoplastics applied transversely on concrete have performed satisfactorily. If the transverse lines were taken as the sole criterion for evaluating performance or suitability of a striping material, the thermoplastics would be, at this stage, very promising from the standpoint of appearance, durability, and economy. Contrary to the performance of the transverse lines, however, the performance of the edge- and center-lines have been unsatisfactory in Test Site 3--thereby, leaving considerable uncertainty or doubt, at this stage, as to the reliability of

these materials beyond that achieveable with paints.

The unit cost of the original application of thermoplastics was approximately 39.5 cents per foot of stripe; whereas the cost of paint was 1.6 cents (actual) per foot of stripe. Thus, if the thermoplastics were to lose 4.1% annually and thermoplastic replacements were made of the same unit cost as the original application, the annual maintenance expenditure would be equal to the cost of renewing all test lines annually with paint. The high initial cost of thermoplastics could therefore be saved and experience has shown that paint lines do not need renewing each year. This viewpoint is further reflected in the low first-year costs of the average and over-all maintenance (0.21 cents per foot of stripe) of the Kentucky paint test sites; however, it is anticipated that the second-year maintenance costs will be greater.

Preliminary indications are that Perma-Line is slightly superior to Catatherm. This seems to hold true for bituminous pavements as well as for portland cement concrete pavement.

Based on their high initial costs and their performances observed thus far, neither of the thermoplastics would be considered to have provided economic service at Test Site 3 (PCC pavement; see Attachment 14). The problem seems to arise primarily from loss of adhesion. The scale that forms on new concrete surfaces flakes off; and, of course, any striping material that was previously applied becomes loosened from the substrata. Afterwards, any striping material--paint included--gives better performance.

An exact analysis of the cost-per-mile-per-day of useful life for each striping material is not possible at this time. Inspection and performance surveys will continue; and, at a later date, a cost analysis will be made.

Attachment 8

TABLE 2

REPAINTING COSTS (ESTIMATES*)
(APRIL 1964)

Center-Line of Subsection 2, Test Site 3
Franklin-Shelby Counties
I 64-3(14)34, SP 37-905, SP 106-806

| | |
|---|---|
| Paint | $105.81 |
| Beads | 9.48 |
| Labor | 28.43 |
| Equipment | 4.74 |
| Total Costs | $148.46 |

* See Footnote, Table 1.

Attachment 12

# FINAL INSPECTION REPORT

The following is a compilation of remarks from Final Construction Inspection Report.

Test Site 4

Perma-Line

Date of Report: May 14, 1963

Satisfactorily completed except as noted below:
Attached hereto is a copy of a memorandum from Mr. James H. Havens, Director of Research, under date of May 6, 1963, which stipulates three (3) short sections on the westbound lane and two (2) short sections along the eastbound lane which did not show up satisfactorily under normal night driving conditions. These sections are to be completed satisfactorily.

You will also note from the attached memo that it is stated that daytime appearance is satisfactory. Daytime appearance was also noted as being satisfactory when representatives of your office and representatives of this office made final inspection.

Attention of all concerned is directed to the following "Quote" from the Specs. "Before final payment of the stripe work, the contractor shall furnish security for this work in the form of a surety bond, or by depositing cash or securities in the sum of 10% of the contract bid price, for the stripes and guaranteeing the maintenance of the material for the stipulated period as herein provided."

*Maintenance Acceptance Report will not be submitted at this time; however, it shall be submitted upon completion of period of guaranty and release of security as referred to above.

Attachment 13

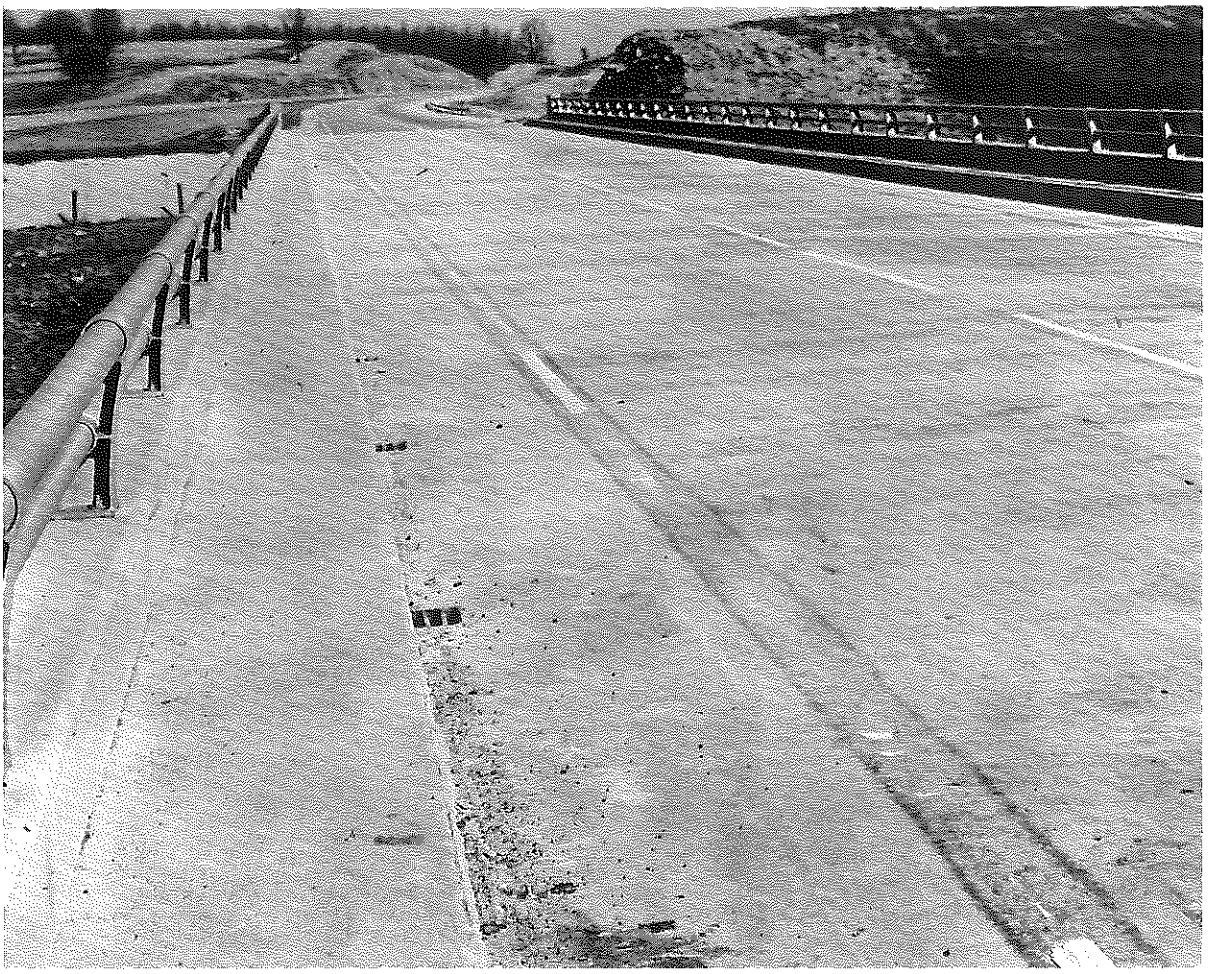

Figure 13: View of Concrete Bridge Deck, I 64, Clark - Montgomery Counties, Showing Spalled and Missing Portions of Plastic Edge-line (Catatherm Subsection). The darkened portion along the edge-line in the foreground indicates a heavy application of bonding primer. This line was placed in November 1962, and the photograph was taken in February 1963.

Attachment 14

TABLE 3

FOOTAGES AND PERCENTAGES OF LINE ADJUDGED TO BE UNSATISFACTORY

| Project | Line Adjudged to be Unsatisfactory, Spring 1963; Repaired Spring 1963 | | | | Line Adjudged to be Unsatisfactory, Spring 1964 | | | |
|---|---|---|---|---|---|---|---|---|
| | Catatherm | | Perma-Line | | Catatherm | | Perma-Line | |
| | Feet | Percent | Feet | Percent | Feet | Percent | Feet | Percent |
| Test Site 1, PCC | 1,259 | 10.33 | 117 | 0.96 | 119 | 0.98 | 13 | 0.11 |
| Test Site 2, BC | 0 | 0.00 | 202 | 1.96 | 0 | 0.00 | 1 | 0.01 |
| Test Site 3, PCC | 36,196 | 36.19 | 18,145 | 18.14 | 17,602 | 17.60 | 1,534 | 1.53 |
| Test Site 4, BC | 1,091 | 1.11 | 41 | 0.04 | 977 | 0.99 | 275 | 0.28 |
| Total | 38,546 | 17.41 | 18,505 | 8.36 | 18,698 | 8.45 | 1,823 | 0.82 |