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Evaluation of Durable Crosswalk and Stopbar Marking Materials (Interim Report)

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Study Title: Evaluation and Application of Roadway Delineation Techniques

The objective of this study is to find the most cost-effective durable marking material to provide long-lasting stopbars and crossbars. Three materials were tested: 1) 3M Stamark tape, 2) Prismo preformed tape, and 3) extruded thermoplastic. The evaluation concerned the durability, reflectivity, and appearance of the materials. Test installations have been in place for about 18 months, and this interim report summarizes findings for that period. The evaluation will continue for another 18 months, and recommendations will be presented in a final report.

Based on current evaluations, the extruded thermoplastic material would be considered the most cost-effective material for crosswalk and stopbar installations.
Research Report  
UKTRP-84-32

EVALUATION OF DURABLE CROSSWALK AND STOPBAR MARKING MATERIALS  
(INTERIM REPORT)

by

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in cooperation with  
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and

Federal Highway Administration  
US Department of Transportation

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This report was prepared with the guidance of the following members of the Study Advisory Committee:

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INTRODUCTION

Painted crosswalks and stopbars at high-volume intersections are subjected to excessive wear. When typical paints are used, they must be restriped frequently or remain in an undesirable condition such as shown in Figure 1.

Because of the durability problem experienced with existing materials, a series of test projects using more durable materials were installed as part of the Pavement Marking Demonstration Program. Materials included in the tests were two different preformed tapes and hot-extruded thermoplastic material.

The objective of this study is to find the most cost-effective marking material to provide long-lasting stopbars and crossbars. Test installations have been in place for about 18 months, and this interim report summarizes findings to date. The evaluation will continue for another 18 months and recommendations will be presented in a final report.

INSTALLATIONS

Three separate contracts were awarded for installation of experimental marking materials. A summary of costs and quantities of those contracts are presented in Table 1. The installations consisted of 6-inch crosswalks and 24-inch stopbars. Bid prices were in terms of cost per foot.

The contract in Boone, Campbell, and Kenton Counties (Northern Kentucky) specified a preformed plastic material (tape) that had a thickness of 90 mils. The material was a cold-plastic tape manufactured by Prismo. The contract in Jefferson County specified a preformed plastic material (tape) that had a thickness of 60 mils. The material used was the Stamark brand tape manufactured by 3M. The contract in Fayette County specified a thermoplastic striping material conforming to ASSHTO Specification Designation M249-79. The material was to be placed at a thickness of 90 mils and the installation involved extruding thermoplastic material. The thermoplastic material used in Fayette County was manufactured by Pave-Mark.

All contracts were completed in the summer of 1983. Over 140,000 linear feet of crosswalks and almost 60,000 linear feet of stopbars were installed. Costs of the two types of preformed tapes were similar, but the cost of the extruded thermoplastic stripe was substantially lower. A smaller installation of Prismo tape was placed in the summer of 1984. An evaluation of that installation will be included in the final report.

DATA COLLECTION

Data were collected to evaluate durability, reflectivity, and appearance. The durabilities of the materials were evaluated by
periodic visual observations. Evaluations considered the percentage of material remaining on the pavement. There was a 90-day proving period following completion of placement of the marking materials. Inspections were conducted by Kentucky Transportation Cabinet personnel, and repairs had to be made at locations at which more than 10 percent of the material failed. Data obtained during the proving periods were used for initial durability information and periodic visual inspections were conducted thereafter.

The second area of evaluation involved the reflectivity of each material. Reflectivity readings were obtained using a portable retroreflectometer. Nighttime observations were also conducted.

Thirdly, the appearances of the materials were evaluated. The contract specified that the material be white, and the maintenance of this color was rated.

ANSI/ASTM D 713-69 was used as a guide in conducting each service test. It describes the rating of traffic paints in terms of appearance, durability, and nighttime visibility. Daytime and nighttime photographs were obtained to document the durability, reflectivity, and appearance evaluations.

RESULTS

DURABILITY

The initial durability was evaluated using results from the 90-day proving periods. No problems were observed for the extruded thermoplastic markings in Fayette County. However, failures were noted and repairs made in both Jefferson County (3M Stamark tape) and Northern Kentucky (Prismo tape).

The number of feet of tape replaced at each intersection was documented for the Jefferson County installations. Repairs consisted of patching portions of the crosswalk or stopbar that were damaged (Figure 2). Occasionally, the entire line would be replaced. Overall, 16 percent of the total length of stopbars and 18 percent of the total length of crosswalks were replaced. Nearly all intersections (98 percent) received some repair work. The percentage of intersections having crosswalks where either minor or major repairs were made to the crosswalks (92 percent) was higher than the corresponding percentage for stopbars (65 percent).

In Northern Kentucky, failure of the entire intersection was evaluated and repairs were made when it was judged that more than 10 percent of the material in the intersection had failed. The determination was made that 52 percent of the intersections had over a 10 percent failure. Repairs generally consisted of patching the damaged areas as was done in Jefferson County. An estimate by a Transportation Cabinet engineer was that, overall, approximately 25 to 30 percent of the material failed. The extent of failure at both preformed-tape locations appeared to be very similar.
Additional visual observations have been performed at the three test locations after all repairs were made. The latest inspections were about one year after installation.

Inspection of the extruded thermoplastic material in Fayette County revealed that after about one year in service at least 95 percent of the material was still in place. The photograph of a typical stopbar shown in Figure 3 is very similar to a stopbar shown in Figure 4 which is a photograph taken a few weeks after placement. The only durability problems noted were very minor chipping and some minor wear in wheel paths, primarily on crosswalks where a high volume of vehicles are turning. An example of the type of crosswalk wear experienced at some high volume turning locations is shown in Figure 5.

Inspection of the 3M Stamark tape installation in Jefferson County revealed that, after the repairs were made, most of the crosswalks and stopbars were in good condition as far as the material remaining on the pavement. A typical stopbar, after about one year in service, is shown in Figure 6. The patched portion of the stopbar may be seen. However, there were still some major failures at crosswalks, as shown in Figure 7, and substantial sections of stopbars missing, as shown in Figure 8. The major problems usually occurred at locations where there was high-volume turning movements. Durability problems involved sections of tape being removed from the pavement.

As in Jefferson County, inspections of the Prismo tape installation in Northern Kentucky revealed that, after repairs were made, most of the crosswalks and stopbars were in good condition. The condition of a typical stripe, after about one year in service, is shown in Figure 9. However, substantial problems persisted at some locations. Replaced sections of tape were experiencing the same problems as the original installation. Typical problem locations were either high-volume turning locations or downhill locations. The usual problem with the Prismo tape was different than that observed for the Stamark. Instead of the tape being removed, the adhesive would stay in its original position while the tape layer would slide forward. An extreme example is shown in Figure 10. Preliminary observation of the new installation (placed in the summer of 1984) showed similar durability problems as detected in the original installation.

REFLECTIVITY

Measurements of reflectivity were obtained using a portable retroreflectometer a few months after installation and about one year after installation. Measurements were taken at 10 to 12 intersections at each of the three locations. Average values recorded are presented in Table 2.

Measurements indicated there was no significant difference in reflectivity between the three materials after only a few months in service. Also, reflectivity declined substantially in the first year. Measurements agreed with nighttime observations. Low reflectivity measurements of about 100 within one year indicate that none of the
materials exhibited good long-term reflectivity characteristics. However, the intersections at which the materials were placed were almost always in areas having roadway lighting so loss of reflectivity would not be as critical.

Nighttime photographs taken a few weeks and about one year after placement of each of the materials are shown in Figures 11 through 16. In Figures 11, 13, and 15, the original reflectivity of the materials may be seen. In Figures 12, 14, and 16, loss in reflectivity after about one year in service is illustrated.

APPEARANCE

As part of the visual inspection, the overall appearance of the material was noted. This generally involved rating the appearance of the crosswalks and stopbars when viewed at a distance of at least 10 feet. The color of the material, as compared to the original color, received particular attention.

Both 3M Stamark and Prismo preformed tapes maintained their appearance and original color with no significant problem. In Figures 17 through 20, photographs of the material a few weeks and about one year after placement are shown. The material had not discolored to a large extent. However, durability problems experienced may be seen in Figure 18.

The appearance of a typical extruded thermoplastic stopbar a few weeks after placement is shown in Figure 21. Appearance about one year after placement is shown in Figure 22. While the overall appearance of thermoplastic stopbars and crosswalks was satisfactory, a discoloration of the material was noted between the wheelpaths. This was the result of stains from oil dropped from vehicles. This problem was worse at high-volume turning locations (Figure 23). The thermoplastic material contained a hydrocarbon resin. Use of an alkyd formulation may solve the problem according to a thermoplastic manufacturer. When the thermoplastic material was viewed closely, it could be seen that the surface was covered with small potholes (Figure 24). This may have been the result of the application temperature being too high. If the temperature was too high, it would have allowed the beads to sink too far into the material and contribute to loss of reflectivity. However, the small holes were not obvious from over a few feet away and did not adversely affect appearance.

SUMMARY AND CONCLUSIONS

The durability, reflectivity, and appearance of Prismo and 3M Stamark preformed tapes and a hot-extruded thermoplastic were evaluated. This report presents interim results after an 18-month evaluation period.

Both preformed tapes experienced durability problems with about 20 percent of the material having been replaced. The thermoplastic
material experienced no significant durability problems. Reflectivity of all three materials was very similar with each experiencing a considerable loss in reflectivity that could limit their use to locations having roadway lighting. Both tapes maintained their appearance well. The thermoplastic material had some discoloration due to oil staining. Switching from a hydrocarbon to an alkyd formulation may solve the problem.

Costs of the two tapes were similar but were two to three times the cost of the extruded thermoplastic.

Based upon current evaluations, the extruded thermoplastic material would be considered the most cost-effective material for crosswalk and stopbar installations. Use of an alkyd thermoplastic should be considered because of the discoloration experienced with the hydrocarbon formulation.

A final report will be prepared after evaluating the materials for another 18 months. Included in that report will be the evaluation of an installation using alkyd thermoplastic placed in Fayette County in November 1984.
TABLE 1. SUMMARY OF INSTALLATION CONTRACTS

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>MATERIAL</th>
<th>COST PER FOOT</th>
<th>TOTAL MATERIAL COST</th>
<th>QUANTITIES (FEET)</th>
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<tr>
<td></td>
<td></td>
<td>6-INCH CROSSWALK</td>
<td>24-INCH STOPBAR</td>
<td>6-INCH CROS WALK 24-INCH</td>
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<tr>
<td>Northern Kentucky (Boone, Kenton, and Campbell Counties)</td>
<td>Prismo Preformed Tape</td>
<td>$2.64 $7.54</td>
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<td>3M Stanmark Tape</td>
<td>$2.28 $6.89</td>
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<td>Hot-Extruded Thermoplastic</td>
<td>$1.05 $2.27</td>
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TABLE 2. PORTABLE RETROREFLECTOMETER (PRR) MEASUREMENTS

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<th>MATERIAL</th>
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<tr>
<td>Prismo Tape</td>
<td>148</td>
</tr>
<tr>
<td>Stanmark Tape</td>
<td>129</td>
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<tr>
<td>Extruded Thermoplastic</td>
<td>131</td>
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Figure 1. Wear of Typical Stopbar and Crosswalk.

Figure 2. Patching of 3M Stamark Tape at Crosswalks (Main and Third Streets in Louisville).
Figure 3. Typical Extruded Thermoplastic Stopbar after about One Year in Service (Tates Creek Pike and Albany Road in Lexington).

Figure 4. Extruded Thermoplastic Stopbar a Few Weeks after Placement (Versailles Road and Mason Headley Road in Lexington).
Figure 5. Wear on Extruded Thermoplastic Crosswalks at High Turning Volume Location (Rose Street and Euclid Avenue in Lexington).

Figure 6. Typical 3M Stamark Tape Stopbar after About One Year in Service (Dixie and Greenwood Road in Louisville).
Figure 7. Failure of 3M Stamark Tape Crosswalk (Main and Third Streets in Louisville).

Figure 8. Damage to 3M Stamark Tape Stopbar (Popular Level Road and Trevillian Way in Louisville).
Figure 9. Typical Prismo Tape Installation after About One Year in Service (Main and Fifth Streets in Newport).

Figure 10. Failure of Prismo Tape Installation (US 27 and Highland Avenue in Campbell County).
Figure 11. Nighttime Photograph of Extruded Thermoplastic Stopbar a Few Weeks after Placement (Versailles Road and Mason Headley Road in Lexington).

Figure 12. Nighttime Photograph of Extruded Thermoplastic Stopbar after About One Year in Service (Tates Creek Pike and Albany Road in Lexington).
Figure 13. Nighttime Photograph of 3M Stamark Tape Stopbar a Few Weeks after Placement (Taylorsville Road and Breckinridge Lane in Louisville).

Figure 14. Nighttime Photograph of 3M Stamark Tape Stopbar after About One Year in Service (Bardstown Road and Waterson Trail in Louisville).
Figure 15. Nighttime Photograph of Prismo Tape a Few Weeks after Placement (US 27 and I 471 in Campbell County).

Figure 16. Nighttime Photograph of Prisko Tape after About One Year in Service (US 27 and I 471 in Campbell County).
Figure 17. Appearance of 3M Stamark Tape a Few Weeks after Placement (Main and Third Streets in Louisville).

Figure 18. Appearance of 3M Stamark Tape after About One Year in Service (Main and Third Streets in Louisville).
Figure 19. Appearance of Prismo Tape a Few Weeks after Placement (US 25 at McAlpins' Entrance in Kenton County).

Figure 20. Appearance of Prismo Tape after About One Year in Service (US 27 and I 471 in Campbell County).
Figure 21. Appearance of Extruded Thermoplastic Stopbar a Few Weeks after Placement (Versailles Road and Mason Headley Road in Lexington).

Figure 22. Appearance of Extruded Thermoplastic Stopbar after About One Year in Service (North Broadway and Second Street in Lexington).
Figure 23. Oil Staining of Extruded Thermoplastic Stopbar (Nicholasville Road and Reynolds Road in Lexington).

Figure 24. Closeup Photograph of Extruded Thermoplastic Stopbar (Tates Creek Pike and Albany Road in Lexington).