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RESEARCH UPDATE U 2003-5

3M STAMARK POLYUREA, LIQUID PAVEMENT MARKING SERIES 1200 & SERIES 1000 (INITIAL REPORT)

REFERENCES: WP 2001-R-3

INTRODUCTION:

In the recent past the Vermont Agency of Transportation has observed an apparent decrease in the life and effectiveness of certain types of pavement markings. This occurs during a period when safety initiatives are increasing. As a result of this, the Agency has evaluated numerous types of materials for application on new pavement surfaces. The objective of this project is to evaluate the performance of two versions of a proprietary liquid polyurea pavement marking material.

MATERIAL:

Stamark Liquid Pavement Marking (LPM) Series 1000 and 1200 manufactured by the Traffic Control Division of 3M Company, Inc. of St. Paul, MN. Both products contain a two-part polyurea liquid base, and retroreflective elements. The series 1200 product uses large drop-on microcrystalline ceramic beads in addition to standard AASHTO Type II beads. Only the AASHTO Type II beads are present in the series 1000 product.

PROJECT:

The evaluation of these materials was incorporated into Vermont Agency of Transportation highway rehabilitation project Lyndon-Barton IM 091-3(10). The markings were placed in the northbound lanes of I-91 between mile markers 137.49 and 146.00. Series 1200 was placed on the first 4.16 miles and Series 1000 on the remaining 4.35 miles.

INSTALLATION:

The LPM products were applied on October 18, and 19, 2001 the temperature on both days was just above 40 °F (the manufacturer's low temperature limit). Snow and rain did fall in the area on the 17th of October, so the installers waited until the pavement was visibly dry to begin the installation. All the yellow lines and skip lines were placed on the first day. The white edge line was completed on the second

day. Two contol materials were also applied in the project; SG-70 Thermoplastic and a Lafarge Waterborne paint. The thermoplastic was applied on October 1, 2001 on a clear day with an ambient temperature of 55 °F and a pavement temperature of 65 °F. No rain had fallen in the area in the past several days. The waterborne paint was applied on November 2, 2001 with an ambient temperature between 45 and 60 °F, the area did experience mixed rain and snow showers on the 1st. The following photographs illustrate the installation of the LPM materials.

APPLICATION OF THE SERIES 1000

APPLICATION OF THE SERIES 1200

OBSERVATIONS:

VTrans staff has made visual observations of the project periodically over the time after installation. Their observations are summarized below.

OCTOBER 24, 2001 (5:00 –9:30PM) BY TRAFFIC OPERATIONS STAFF

The condition of the road surface was moist with some drying due to traffic in the travel lane, and the weather was overcast with no moonlight and mist varying to light ground fog on the evening of observation.

The LPM Markings were observed to be "excellent to superb". Retroreflectivity occurred as far as the headlight beams could reach. The skip lines not only retro-reflect but also reflect upward, which caused the lines to 'flash'. The LPM markings were better than any other material observed, but the breakpoint between the two LPM materials was not apparent.

The thermoplastic lines were observed to be "good to excellent until coarser pavement is reached then good", and much better than the following waterborne paint.

NOVEMBER 8, 2001 BY RESEARCH AND DEVELOPMENT STAFF

"Both the 1000 and 1200 exhibit a high degree of retroreflectivity in dry conditions. In the 1200 area it appears that a repetitive dulled mark appeared along the white edge line."

A follow up email to Operations Personnel indicated that this section of road has been plowed once since the material was installed, which may be the cause of the 'dulled mark'.

NOVEMBER 13, 2001 BY CONSTRUCTION STAFF

The rumble strips were installed in the area of the LPM pavement markings. During installation the power broom passed over the markings three times, and it is believed that there might have been a chance for a loss of beads due to this activity.

JANUARY 22, 2002 BY RESEARCH AND DEVELOPMENT STAFF

The LPM markings were observed to have a "bright" white appearance, and are crisp and well defined. A close up view reveals a low profile material with a porous configuration on the white and yellow lines. The edge lines show damage due to the plow abrasion, which is noticeable particularly at night, but does not affect the overall performance of the delineated lines. The skip line has little to no evidence of this damage.

The thermoplastic markings are clear and well defined during daytime and nighttime observations however some of the 90-mil material has chipped. The waterborne paint appears thinner and is less bright. The white line has tanned in comparison and the yellow is less bright as well. Daytime and nighttime visibility of the product is adequate and clear, however similar plow damage is present.

Observations to date have been made in dry conditions. Nighttime performance did not appear to be significantly different between the two products 1200 and 1000.

MARCH 13, 2002 BY RESEARCH AND DEVELOPMENT STAFF

The 1200 LPM markings remain clear and well defined after one mild winter maintenance season. Material loss was evident due to plow abrasion throughout, on the surface level only. The 1000 LPM binder appears to exhibit similar characteristics as the 1200. The thermoplastic was observed to be clear and defined, some chipping due to plow abrasion was observed, and possibly some early signs of thermal cracking.

RETROREFLECTIVITY DATA:

Retroreflectivity measurements were taken by VTrans staff using an LTL 2000 portable handheld retroreflectometer and are reported in units of millicandelas per square meter per lux (mcd/m^2/lux). Readings were taken in daytime conditions with dry weather. Readings taken during winter conditions used the protocol included in the appendix. The ambient temperature was recorded on each date, to confirm the temperature was within the suggested operating temperature range of 32 and 113 degrees Fahrenheit. Test site locations were chosen on straight roadway sections for all materials. Approach site distances were greater than a quarter of a mile to all test sites. Retroreflectivity readings were taken at 16 individual test sites, each 50 feet in length. Five readings were taken of each line at each test site approximately 10 feet apart. Four test sites were within each of the materials placed on this project, the LPM 1200, the LPM 1000, standard waterborne paint and 90-mil LDI SG70 Thermoplastic. The latter two materials were included in the study as a comparison.

Initial Readings
(mcl/m^2/lux)

Material	Test Site	Mile Marker	White Edge Line	White Skip Line	Yellow Edge Line
LPM 12000	1	138.1	1208.6	1301.6	1291
	2	139.4	1279.2	1444.4	1212.8
	3	140.8	1147.6	1479	1154.6
	4	141.5	1087	1348.6	1091
LPM 1000	1	142.5	318.4	346	249.2
	2	143.5	338	349.4	229.6
	3	144.45	282	342.2	248.4
	4	145.1	304.6	358	244.6
Waterborne Paint	1	146.1	345.6	431.6	90.4
	2	147.9	263.6	448.2	95.6
	3	148.8	388.8	403.6	90.8
	4	150	255.6	421	85.6
Thermoplastic	1	151	231	250.8	268.6
	2	152.2	253.2	302.2	226.4
	3	154.5	318	258.8	202
	4	155.5	216.6	279.6	234.4

The average reading of the four test sites within a material and line type is displayed graphically for each date on the attached charts. The initial reading on the LPM 1200 has not been included in the charts so that the trends are more apparent. The charts have been summarized in the narrative and table on the following pages.

AVERAGE RETROREFLECTIVITY OF THE WHITE EDGE LINE

Overall the LPM 1200 performed the best on the white edge line. Initially it performed much better than the rest of the materials (1180.6 mcd/m^2/lux), but by the time readings were taken on February 26, 2002 (approximately 4 months after installation) the difference in readings between all the materials was much less. This behavior is seen in all the line types. The LPM 1000 performed the next best, followed by the thermoplastic and waterborne paint, until the readings were taken on June 13, 2002 when the thermoplastic surpassed the LPM 1000 in retroreflectivity.

The average reading of all the materials fell below 100 mcd/m^2/lux on the March 14, 2002 reading, however they all recovered except for the waterborne paint, which was replaced with thermoplastic by the June 13, 2002 reading. The most recent readings were taken on February 19, 2003 when all readings of the LPM 1200 and 1000 were below 100 mcd/m^2/lux. Readings on the thermoplastic were not taken until March 14, 2003, and the average was also below 100 mcd/m^2/lux.

Summary of White Edge Line Performance					
	LPM 1200	**LPM 1000**	**Thermoplastic**	**Waterborne Paint**	**Thermoplastic (replaced Paint)**
19-Oct-01	1180.6	310.8	313.4		
19-Nov-01	754.5	314.9	251.8		
03-Dec-01				254.7	
26-Feb-02	123.5	86.5	67.8	36.4	
14-Mar-02	81.9	71	47.6	27.4	
02-Apr-02	120.3	91.8		16.7	
05-Apr-02			85.9		
11-Apr-02	123.1	95.2	77.3	29.7	
17-Apr-02	132.2	99.6	83.5		
26-Apr-02	147.9	109.5	69.6	27.8	
10-May-02	143.4	101.9	78.7	29.4	
13-Jun-02	140.9	101.4	102.9		383.6
16-Jul-02	156.7	106.3	121.8		410.1
26-Sep-02	156.3	109.2	135.1		431.9
20-Feb-03	42.5	40.1			64
14-Mar-03			62.7		

AVERAGE RETROREFLECTIVITY OF THE WHITE SKIP LINE

The LPM 1200 performed the best of all the materials on the white skip line. Thermoplastic was next, followed by the LPM 1000 and the waterborne paint. All materials declined in retroreflectivity until a low point at the March 16, 2002 reading. After that the readings on both LPM products increased until April 26, 2002 when the LPM 1200 began to decline again. The thermoplastic material decreased over April then began to recover in May, reaching the level of the LPM 1200 by the September 26, 2002 reading. Both the LPM products and the thermoplastic average readings were below 100 mcl/lux again on the February 19, 2003 reading, and the March 14, 2003 reading.

Summary of White Skip Line Performance					
	LPM 1200	**LPM 1000**	**Thermoplastic**	**Waterborne Paint**	**Thermoplastic (replaced Paint)**
19-Oct-01	1393.4	348.9	426.1		
19-Nov-01	1019.6	339.8	409.8		
03-Dec-01				272.9	
26-Feb-02	134.4	62.1	77	19.8	
14-Mar-02	80.1	41.4	71.3	17.6	
02-Apr-02	133.4	69.1		9.6	
05-Apr-02			129.6		
11-Apr-02	135.7	68.2	105.9	16	
17-Apr-02	138	75.2	114.4		
26-Apr-02	156.9	84.3	81.2	15.4	
10-May-02	149.3	87.5	110.1	15.1	
13-Jun-02	149.5	91.8	124.9		422.6
16-Jul-02	145.1	91.2	139.3		453.2
26-Sep-02	148.9	95.3	150		413.1
20-Feb-03	53.1	38.7			70.8
14-Mar-03			86.4		

AVERAGE RETROREFLECTIVITY OF THE YELLOW EDGE LINE

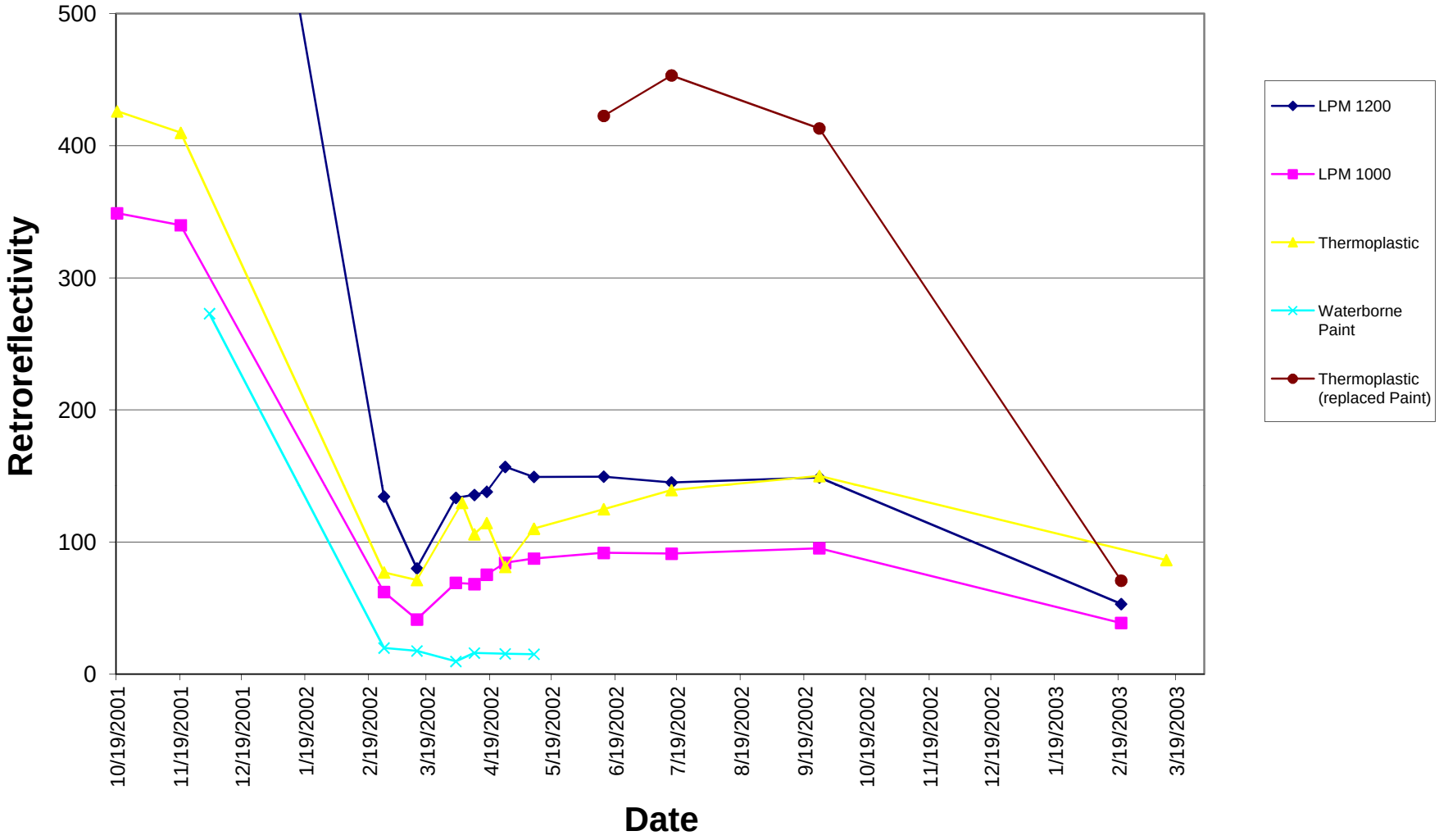
The average retroreflectivity of the LPM 1200 far exceeded the other materials in the yellow line. The LPM 1000 was next highest in retroreflectivity followed by the waterborne paint on some dates and the thermoplastic on other dates. The average difference between the LPM 1200 and the LPM 1000 was over 100 mcd/m^2/lux for the yellow and was between 30 and 60 for the white lines. The recovery of the LPM 1200 was more extreme in the yellow line compared to the white lines, but the recovery of the other materials was not as drastic. The dates of recovery were very similar to the other two materials. The LPM 1200 stayed above the 100 mcd/m^2/lux level on the most recent reading, but the LPM 1000 fell below as well as the Thermoplastic on March 14, 2003.

Summary of Yellow Edge Line Performance					
	LPM 1200	**LPM 1000**	**Thermoplastic**	**Waterborne Paint**	**Thermoplastic (replaced Paint)**
19-Oct-01	1187.4	238	90.6		
19-Nov-01	899.2	197.5	72.7		
03-Dec-01				232.9	
26-Feb-02	121.3	59.5	37.7	46.1	
14-Mar-02	148.7	60.7	45.3	57	
02-Apr-02	238.8	67.2		41.1	
05-Apr-02			57.5		
11-Apr-02	217.9	69.5	56.2	64.1	
17-Apr-02	218.1	69.9	58.8		
26-Apr-02	242.5	82.7	43.9	48.4	
10-May-02	230.1	77.1	62.6	54.1	
13-Jun-02	249.2	80	73.3		85.1
16-Jul-02	238	82.8	80.7		107.5
26-Sep-02	251.8	86.6	90.8		146
20-Feb-03	105.2	37.5			41.8
14-Mar-03			37.3		

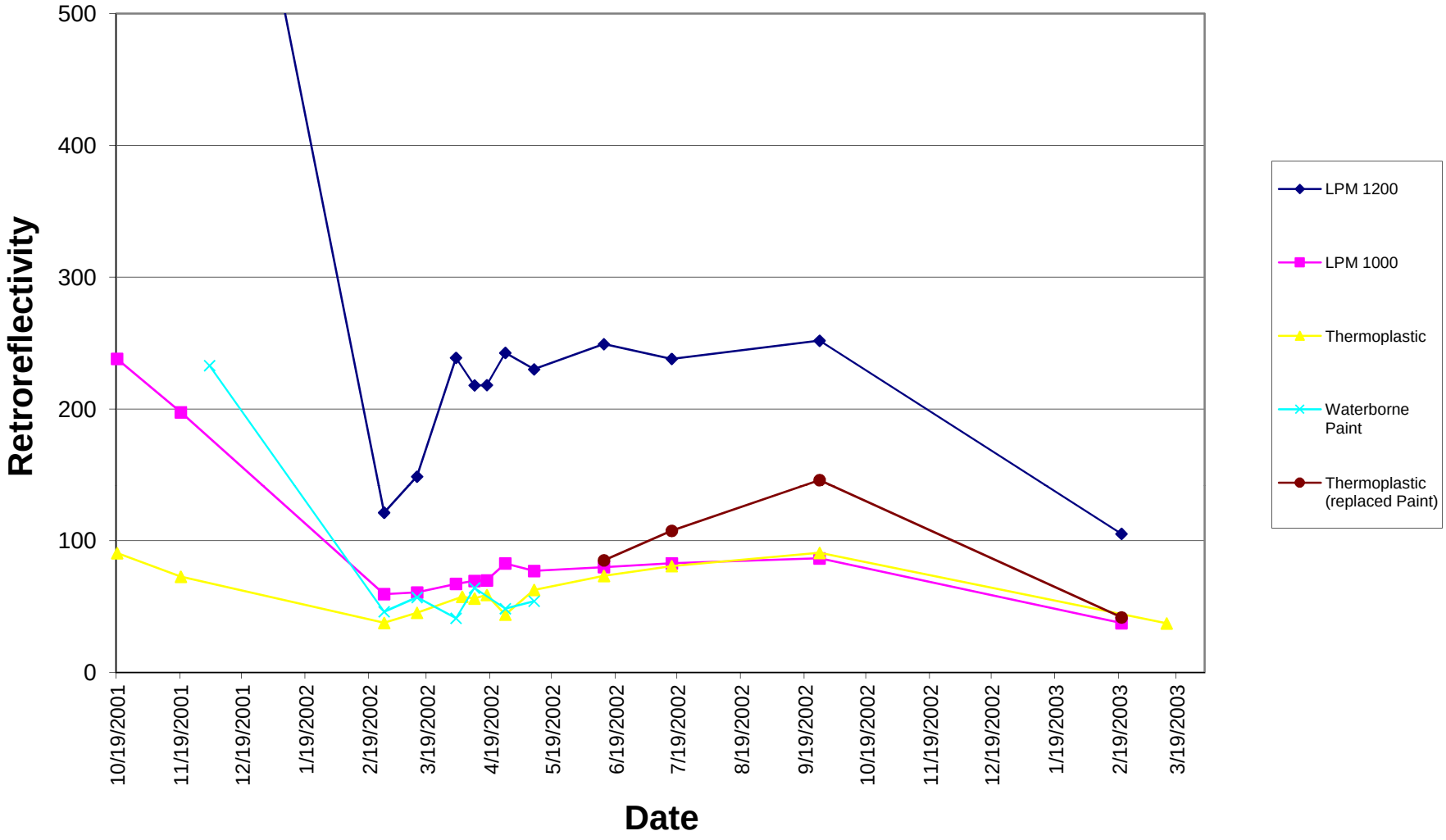
RECOMMENDATIONS:

It is recommended that readings continue to be taken on all materials until the product has been in service for three years, or until the line reaches its service life, so that conclusions about all the materials life cycle costs can be made. An evaluation of the effect of geometry will be undertaken to assess potential causes for plow-induced damage to the marking.

White Skip Line



Yellow Edge Line



White Edge Line