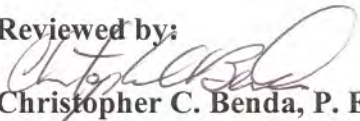


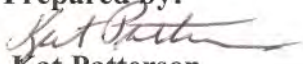
MATERIALS & RESEARCH

Reviewed by:


Christopher C. Benda, P. E.
Acting Materials & Research
Engineer



Prepared by:


Kat Patterson
Transportation Researcher
February 23, 2006

INITIAL REPORT

U 2005-2

EVALUATION OF CROWN TECHNOLOGY'S TUFFLINE HYDROCARBON THERMOPLASTIC

REFERENCES:

WP 2004-R-1

OVERVIEW

Since 1991, thermoplastic pavement markings have been the primary traffic markings used on resurfacing projects in Vermont. Marking materials that have been applied have consisted of both alkyd and hydrocarbon formulations and have been supplied by a number of manufacturers. However, marketplace consolidation has resulted in limited choices for these materials on construction projects. In an attempt to expand options for pavement markings on projects managed by VTrans, a proprietary hydrocarbon thermoplastic marking was installed on one resurfacing project in 2004 to affirm its effectiveness prior to approval.

PRODUCT DESCRIPTION:

Tuffline hydrocarbon thermoplastic, manufactured by Crown Technology, LLC of Woodbury, GA. was applied as edge and centerlines on US 7 as part of the St. Albans- Swanton ST 2335(1)S project. The product literature states that this material can be applied to both asphalt and PCC pavements using conventional screed extrusion, ribbon extrusion or spray equipment. It can also be used over existing alkyd and hydrocarbon thermoplastic.

APPLICATION

The yellow center line was applied on August 6th 2004 while the white lines were applied on August 10th 2004. Both days were sunny with temperatures ranging between 70 to 85 degrees. No problems were noted during the application by the project engineer. The markings were applied using the screed extrusion method on the northerly 3.537 miles of the project from MM 1.53 to MM 5.067 in Swanton. The remainder of the project from MM 1.169 in St. Albans to MM 1.53 in Swanton was marked with Stud-Guard SG 70 manufactured by Ennis Paint of Ennis, Texas.

RETROREFLECTIVITY

There are four test sites placed randomly along the project in the experimental markings. Each test site contains five test areas marked out at 10 feet intervals on both the Northbound and

Southbound white edge lines as well as both the Northbound and Southbound yellow center lines. Test sites 1, 2, and 3 are the experimental Tuffline hydrocarbon by Crown Technology, LLC. Test site 4 is the “control” Thermoplastic, Stud-Guard SG 70 by Ennis Paint. Initial retroreflectivity was sampled on October 7, 2004, with readings taken on this day averaging 368 mcdl for the Tuffline and 455 mcdl for the SG 70 white lines. The readings on the yellow lines averaged 152 mcdl for the Tuffline and 179 mcdl for the SG 70 (see Appendix A & B). The durability rating on a scale from 1 to 10 was 10 for both the white and yellow lines. The durability rating is gathered according to ASTM D713-90, Standard Practice for Conducting Road Service Tests on Fluid Traffic Marking Materials along with ASTM D913, Standard Method for Evaluating the Degree of Resistance to Wear of Traffic Paint.



Figure 1 Test site 3 –Oct. 7, 2004



Figure 2 Test site 2 – March 14, 2005
(Cleaning of lines evident)

After five months of service, a second set of readings were taken on March 14, 2005. Winter cleaning protocol (see Appendix C) was carried out to insure that the lines were clear of salt and dirt from snow removal and salting operations. This can be seen in Figure 2 above. The readings collected at this time on the white edge lines averaged 127 mcdl on the Tuffline markings and 135 mcdl for the SG 70 markings. All data sampled can be seen in Appendix A. The yellow lines were not sampled at this time.

A third set of readings was taken on May 12, 2005. No readings were recorded for the Southbound white edge lines at test site 1 as a maintenance work crew had the section of road closed for a work event. Numerous attempts to sample the readings at test site 1 were made but access to the test site was not possible.

The white edge line readings sampled in May were similar to those taken in March. The average readings collected at this time were 115 mcdl for the Tuffline markings and 160 mcdl for the SG 70 markings. The average readings collected on the yellow center lines were 81 mcdl for Tuffline and 77 mcdl for SG 70. Durability ratings for both March and May were 7 which are in the “good” range. (See Appendix A & B). In Figure 3 below, some damage can be seen on part of the white line. This pattern of damage seems to indicate chipping due to snowplow contact rather than abrasion due to wear.

The most recent set of readings was taken on August 23, 2005. These readings were slightly higher than the May 12, 2005 readings with average white edge line readings of 150 mcdl for Tuffline and 168 mcdl for SG 70. Yellow readings averaged 108 mcdl for Tuffline and 95 mcdl

for SG 70. (Appendix A & B). Durability ratings fell to an average of 6 which remains in the “fair” to “good” range.



Figure 3 Test site 3 – May 12, 2005



Figure 4 Test site 1 – August 23, 2005

It has been shown through previous research that retroreflectivity readings typically decrease from application into the winter maintenance season, yet rebound in the spring or summer of the next year as the road is cleaned. The tables below show this pattern with the increase in the retroreflectivity values for May to August. This compares favorably with roads with similar traffic volumes surveyed in previous studies. The average white edge line readings for both the Tuffline and SG 70 thermoplastic were above the FHWA recommendation of 100 mcdl. Both materials were also above the FHWA recommended value of 80 mcdl for yellow lines which is within serviceable limits.

US 7 White Lines						
Crown Technology's Tuffline (Experimental)						
	10/07/2004		05/12/2005		08/23/2005	
	SB	NB	SB	NB	SB	NB
TS1	335.4	372.2	n/a	55.8	127	100.2
TS2	376.6	385.5	132.2	168	215.4	213
TS3	349.6	388.8	96.6	120.2	118.4	124.2
Stud-Guard SG 70 (Control)						
TS4	466	444	136.4	185	169.8	165.6

Table 1 – Average Retroreflectivity Readings at each Test Site, mcdl

US7 Yellow Lines						
Crown Technology's Tuffline (Experimental)						
	10/07/2004		05/12/2005		08/03/2005	
	SB	NB	SB	NB	SB	NB
TS1	138.4	143.2	46.8	41.6	83.6	83.2
TS2	126	149.2	50.8	91.8	86.2	121.4
TS3	185.6	166.6	162.8	90.8	152.8	116
Stud-Guard SG 70 (Control)						
TS4	195	162	83.2	69.8	90	99.8

Table 2- Average Retroreflectivity Readings at each Test Site, mcdl

SUMMARY

After one winter the condition of the pavement markings showed some damage and loss of durability. No cracking or curling on the edges of the lines has been observed at any location along the test site areas. By August 2005, the average retroreflectivity values for the Tuffline white edge lines markings had reached 150 mcdl for the northbound (NB) lane and 154 mcdl for the southbound (SB) lane. In contrast, the test site with SG 70 (TS 4) averaged 167 mcdl in the NB lane and 169 mcdl in the SB lane. Those areas marked with Tuffline compared closely to those areas marked by the SG 70 material with no significant differences in retroreflectivity. While there was a large decrease from the initial retroreflectivity readings, it must be noted that this trend is similar for most pavement marking systems tested by VTrans. At this time, the average retroreflectivity readings were above the values recommended by FHWA. The percentage of total readings below the recommended FHWA values can be seen in Appendix A & B.

FOLLOWUP

Tuffline thermoplastic is being added to the 2006 Approved Product list with the requirement that a Type "A" certification is completed when it is used on any 2006 construction projects. Further evaluations will be taken to determine the effectiveness of the pavement markings. A full retroreflective summary is attached.

DISCLAIMER

“The information contained in this report was compiled for the use of the Vermont Agency of Transportation. Conclusions and recommendations contained herein are based upon the research data obtained and the expertise of the researchers, and are not necessarily to be construed as Agency policy. This report does not constitute a standard, specification, or regulation. The Vermont Agency of Transportation assumes no liability for its contents or the use thereof.”

**APPENDIX A- RETROREFLECTIVITY VALUES – US 7, ST ALBANS/SWANTON
WHITE EDGE LINES**

North Bound					South Bound			
10/7/04	3/14/05	5/12/05	8/23/05		10/7/04	3/14/05	5/12/05 *	8/23/05
385	21	64	115	TS 1 Tuffline	359	111	no data	129
394	138	64	122		336	101	no data	142
384	157	69	132		341	109	no data	129
353	132	68	126		322	107	no data	104
345	125	14	6		319	98	no data	131
350	137	195	184	TS 2 Tuffline	384	91	116	212
364	211	132	201		393	177	154	249
410	132	140	195		368	195	164	238
407	190	234	306		368	195	144	213
396	190	139	179		370	174	83	165
384	103	148	160	TS 3 Tuffline	349	119	69	178
416	130	135	146		365	37	94	42
391	89	135	140		363	48	109	23
392	132	148	162		328	104	109	174
361	143	35	13		343	113	102	175
423	167	170	147	TS 4 SG 70	448	156	122	171
449	123	130	164		460	157	144	170
435	170	221	179		446	133	151	167
463	99	176	156		484	134	116	179
450	75	228	182		492	133	149	162

Ave.	397.60	133.20	132.25	150.75		381.90	124.60	121.73	157.65
Median	393.00	132.00	137.00	158.00		366.50	116.00	116.00	168.50
Std. Dev.	34.33	43.47	63.32	63.17		54.18	42.69	28.35	56.07

% below				
100	0	20	30	10

0	20	20*	10

* Note that no readings were taken on the South Bound white lines at TS 1 on 5/12/05.

**APPENDIX B- RETROREFLECTIVITY VALUES – US 7, ST ALBANS/SWANTON
YELLOW CENTER LINES**

North Bound					South Bound			
10/7/04	3/14/05	5/12/05	8/23/05		10/7/04	3/14/05	5/12/05	8/23/05
	*					*		
149	no data	45	88	TS 1 Tuffline	126	no data	46	87
143	"	35	79		135	"	47	78
145		43	87		138		48	82
127		43	86		141		47	88
152		42	76		152		46	83
139		95	121	TS 2 Tuffline	132		50	77
150		89	119		134		48	83
167		105	114		126		51	77
146		91	130		133		70	104
144		79	123		105		35	90
175		66	124	TS 3 Tuffline	190		186	179
162		131	165		186		166	153
161		92	120		185		149	121
158		95	70		181		167	182
177		70	101		186		146	129
157		69	100	TS 4 SG 70	200		108	70
165		72	98		195		93	84
159		67	104		193		58	93
167	"	76	101		200	"	75	102
162	no data	65	96		187	no data	82	101

Ave.	155.25		73.50	105.10		161.25		85.90	103.15
Median	157.50		71.00	101.00		166.50		64.00	89.00
Std. Dev.	12.54		24.60	22.45		31.28		49.47	33.20

% below 80	0	*	65	15
---------------	---	---	----	----

0	*	60	15
---	---	----	----

* Note that no readings were taken on the yellow lines on 3/14/05

APPENDIX C- PROTOCOL FOR THE CLEANING OF LINE STRIPPING FOR RETROREFLECTIVE READINGS

Equipment needed:

1. Windshield washer fluid
2. Water
3. Two liquid dispensers
4. Towels or rags
5. Squeeze mop and/or sponges
6. Gas powered leaf blower

PROCEDURE

Step 1 – Mix ½ water and ½ windshield washer fluid into the first liquid dispenser. The other liquid dispenser should have water only.

Step 2 – Thoroughly clean the lines with the windshield washer fluid mixture using the dispenser to spray away as much salt, dirt and other debris as possible.

Step 3 – Thoroughly clean the lines with the water dispenser, spraying away the windshield washer mixture. * Note: Make sure you start at the highest point of the surface to be cleaned and wash down to the lowest point.

Step 4 – Using the squeeze mop and sponges clean away as much excess water as possible. Wipe the line surfaces with a towel or rag to get the surfaces as dry as possible.

Step 5 – Utilizing a gas powered leaf blower or similar device blow the lines off until completely dry.

Step 6 – Begin Reflectometer Testing.