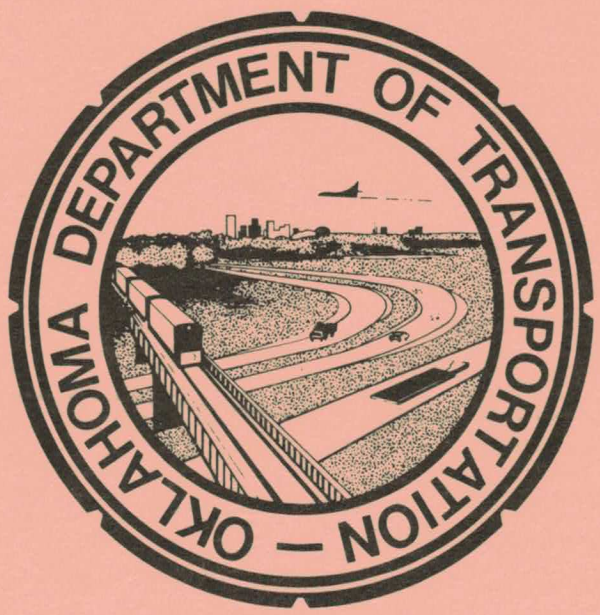
PERFORMANCE OF PLASTIC STRIPING TAPE



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PERFORMANCE OF PLASTIC STRIPING TAPE

by

Tim M. Borg, P.E.
Project Manager

STATE OF OKLAHOMA
DEPARTMENT OF TRANSPORTATION
RESEARCH & DEVELOPMENT DIVISION

Project No. 73-06-1, Item 2718

Under the Supervision

of

C. Dwight Hixon, P.E.
Research & Development Engineer

in
Cooperation With
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Under

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April, 1986

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16. ABSTRACT

Standard thermoplastic traffic marking stripe was compared with 3M "STAMARK" Brand 5730 plastic marking tape. Both products were placed on two new PCC pavement projects and evaluated over two years.

The "STAMARK" was found to be more expensive, easier to place, just as durable, but less reflective at night than standard thermoplastic stripe.

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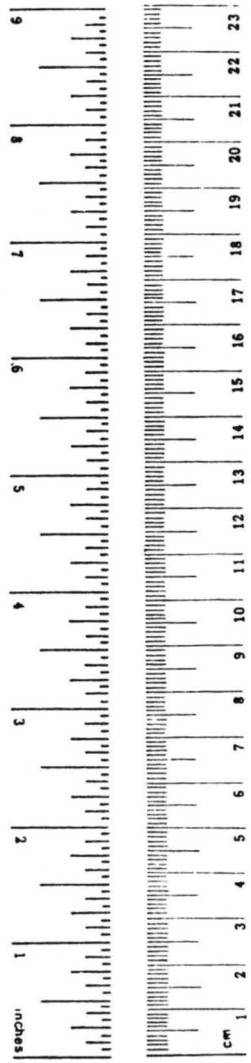
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

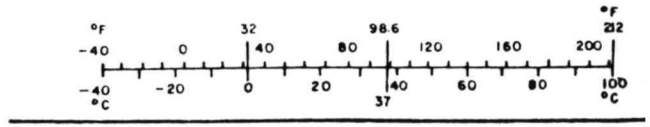
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Sy
		LENGTH		
mm	millimeters	0.04	inches	
cm	centimeters	0.4	inches	
m	meters	3.3	feet	
m	meters	1.1	yards	
km	kilometers	0.6	miles	
		AREA		
cm^2	square centimeters	0.16	square inches	
m^2	square meters	1.2	square yards	
km^2	square kilometers	0.4	square miles	
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	
kg	kilograms	2.2	pounds	
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	
l	liters	2.1	pints	
l	liters	1.06	quarts	
l	liters	0.26	gallons	
m^3	cubic meters	35	cubic feet	
m^3	cubic meters	1.3	cubic yards	
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	



EXECUTIVE SUMMARY

Standard thermoplastic traffic marking stripe was compared with 3M "STAMARK" Brand 5730 plastic marking tape. Both products were placed on two new PCC pavement projects and evaluated over two years.

The "STAMARK" was found to be more expensive, easier to place, just as durable, but less reflective at night than standard thermoplastic stripe.

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INTRODUCTION

Purpose

This study was initiated to evaluate a new product manufactured by the 3-M Company. "STAMARK" Brand 5730 is the name of a retro-reflective, preformed, pliant polymer, plastic striping tape. The plastic striping tape was compared to standard, hot applied, thermoplastic pavement marking stripe.

Scope

Two projects in Oklahoma County specified the plastic striping tape as a proprietary item to be installed along with thermoplastic stripe. The first project was on I-40 between Choctaw Road and the Pottawatomie County Line. The west half of the project used all thermoplastic stripe while the east half of the project used plastic tape for the white lane (skip) lines. It was placed in November, 1983.

A project on I-35 just north of N.E. 63rd Street, northward to just north of N.E. 122nd Street used both types of pavement marking materials. White lane (skip) lines and lines in the gore areas used the plastic striping tape, while edge lines were thermoplastic stripe. It was placed in February of 1984.

Both projects involved placing a new ten inch thick, Portland cement concrete pavement. The surfaces were tined to enhance wet weather skid resistance. It was interesting that some States (1) (2) have found that thermoplastic stripe is cost effective on asphaltic concrete but not on Portland cement concrete.

Background

Traffic stripe has long been recognized as an essential safety feature of modern highways. Chlorinated rubber traffic paint, with reflective glass beads applied simultaneously, has been the standard for many years. However, highways with high volumes of traffic often require unacceptably frequent re-striping. The cost of materials, equipment and labor suggested improved materials that exhibit greater durability would be more economical in the long run. Hot applied, thermoplastic pavement marking material has exhibited excellent durability and reflectivity when applied to pavements according to the Manufacturer's specifications.

Greater durability, lower cost, and convenience of installation have been the goals of newly developed materials. It is these attributes of the 3-M "STAMARK" material that were compared to the currently used thermoplastic material.

MATERIALS AND METHODS

Thermoplastic Traffic Stripe

Oklahoma's Standard Specification for thermoplastic traffic stripe is in Appendix 'A' of this report.

Cleaning and priming the pavement surface was a critical step prior to application. Cleaning was accomplished by shot blasting. Dirt, curing compound or any scaling surface material was removed to provide a sound bond between the thermoplastic stripe and the pavement. Primer was applied to the pre-marked locations by a small buggy pushed by one man. The buggy had a small gasoline powered air compressor that sprayed primer from a small holding tank.

Thermoplastic material was melted in a large, propane heated pot on a flat bed truck. The molten thermoplastic material was then dispensed into a small heated pot on a buggy pushed by one man. As the buggy was pushed, a valve was opened which allowed thermoplastic material to flow into a die forming a four inch wide line on the road. Reflective glass beads were dropped onto the hardening thermoplastic stripe from a small bin on the buggy.

"STAMARK"

A Special Provision was written to allow the use of the plastic striping tape. A copy of that document is in Appendix 'B' of this report.

As with the thermoplastic material, the road surface was shotblasted clean. The tape, however, required no priming or heating. The lane lines were placed using a trailer pulled by a pick-up truck. The small trailer held a reel of tape and by a series of geared pulleys could dispense the correct length of stripe on the pavement. A hard rubber wheel rolled directly on the stripe, assuring contact between the adhesive backing and the road.

Photographs

Photographs of the equipment used to place the plastic striping tape and the thermoplastic stripe are shown in Appendix 'C'.

Quantities

The project on I-35 in northeast Oklahoma City required 73,200 feet of yellow and 111,000 feet of white thermoplastic stripe. The unit bid price was $0.31 per foot. The 47,000 feet of "STAMARK' tape was bid at $1.30 per foot.

The project on I-40 in far east Oklahoma City required 96,154 feet of yellow and 101,660 feet of white thermoplastic stripe. The unit bid price was $0.42 per foot. The 28,452 feet of "STAMARK" tape was bid at $0.92 per foot.

PERFORMANCE

There was no need to differentiate between the performance of a specific material from project to project. Each type of material performed consistently regardless of its location. The average daily traffic (ADT) on I-35 in 1984 was 41,500 vehicles; the ADT on I-40 was 23,000 vehicles.

Durability

The greatest concern for the plastic striping tape was the effectiveness of the adhesive backing. Since the pavement was a deeply tined Portland cement concrete, engineers anticipated the tape would delaminate due to bridging of the tape over individual tined grooves. Also, it was felt the tape would be cut at the shoulder of the tined groove. Neither concern materialized.

The tape has never shown the slightest tendency to come up. Several times, heavy trucks have locked their brakes and skidded over segments of tape with no apparent harm. Generally, the "STAMARK" tape looks as good over two years after installation as when it was originally placed. A five year study (3) in New York described the tape as "extremely durable".

The thermoplastic stripe has also resisted abrasion and worn very well. Upon closer inspection, the thermoplastic stripe has a cracked "alligator skin" texture, characteristic of this material. The cracking is generally a surface manifestation; it does not appear to extend through the stripe to the pavement.

While several factors can influence the durability of a thermoplastic stripe during application, one of the most critical is the quantity of heat applied to the thermoplastic material (4). Excess heat can damage the thermoplastic material.

Daytime Visibility

Immediately after installation, both materials were equally brilliant white. After the first snow (and resultant sanding and salting), the thermoplastic became a dingy, grey-white, while the tape retained its original white. Despite an additional two years in service, neither material has shown an appreciable decrease in its relative whiteness.

Nighttime Reflectivity

Soon after installation, the plastic striping tape was observed to have a lower relative reflectivity when compared to the thermoplastic stripe. A field representative from 3-M came to take brightness readings using an Ecolux Reflectometer in May of 1984. The readings shown are not directly comparable to quantities measured by other types of reflectometers. The readings are offered to lend quantative support to a basically subjective evaluation.

On I-35, the lane lines marked with the tape measured 143 mcd (millicandellas), while tape in the gore areas measured 210 mcd. The adjacent thermoplastic edgelines measured 224 mcd. The 3-M representative felt it was unfair to judge the lane lines

unfavorably since they suffer much more wheel wear than either gore markings or edgelines.

On I-40, the lane lines on the west half of the project were thermoplastic stripe while the east half was the plastic striping tape. Thermoplastic stripe readings with the reflectometer averaged 305 mcd. The average reading of the tape was 225 mcd. The 3-M representative felt the lower reflectivity was due to the tape being able to deform down into the tined grooves.

In February of 1986, samples of the materials were examined under a microscope. The tape appeared to have lost approximately half of its reflective glass beads. While the thermoplastic stripe had lost some glass beads, loss was not as severe. A similar study (5) found the tape to lose reflectivity, that is matrix beads, more rapidly than thermoplastic stripe. A recent FHWA report (6) suggested that nighttime reflectivity of thermoplastic traffic stripe could be significantly enhanced by increased bead application from 1 to 1.8 pounds of beads per 100 feet of stripe.

Also in February of 1986, a subjective test of reflectivity was conducted at night. A compact passenger sedan was used to illuminate the roadway on both I-40 and I-35. On I-40, only two lane lines of the tape could be clearly seen by the driver and passenger. However, three thermoplastic lane lines could easily be seen by both driver and passenger. The driver felt he could see yet a fourth thermoplastic lane line. On I-35, the driver and passenger agreed only two plastic striping tape lane lines

could be seen. A recently completed section of I-44 was marked with thermoplastic stripe. The same night, five lane lines could be seen by the driver and passenger using the vehicle lights for illumination.

An observation was made during a light rain at night on the I-35 project. Rainwater on the pavement further increased the disparity of the relative reflectivity between the tape and the thermoplastic stripe.

CONCLUSIONS

Based on a two year evaluation, some conclusions can be made:

1. Contractors like the ease and safety aspects of applying plastic striping tape over hot applied thermoplastic stripe,
2. The production rate of the tape and thermoplastic stripe are approximately equal,
3. Both provide excellent daytime visibility,
4. Both appear to be quite durable,
5. The tape is two to four times more expensive than thermoplastic stripe, but cost could go down if greater quantities were in demand,
6. The tape has exhibited a tendency to have a lower nighttime reflectivity than the thermoplastic stripe, and
7. With the durability of the tape equal or greater than thermoplastic stripe and thermoplastic stripe being vastly more durable than common traffic paint, the tape would last much longer than common traffic paint.

RECOMMENDATION

Based upon the conclusions of this study, the plastic striping tape has limited uses and should be restricted to areas where reflectivity is not critical. The tape may be an effective material on parking lots, in warehouses or, as suggested by others (7), on highways that are artificially lighted.

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APPENDIX A

Standard Specification for Thermoplastic Traffic Stripe

OKLAHOMA DEPARTMENT OF TRANSPORTATION
STANDARD SPECIFICATIONS
1976 EDITION

SECTION 855
TRAFFIC STRIPE (PLASTIC)

855.01. DESCRIPTION. This work shall consist of furnishing materials and placing thermoplastic compound markings on the roadway in accordance with these Specifications and in close conformity with the locations, lines, dimensions, and color shown on the Plans or established by the Engineer. conformity with the locations, lines, dimensions and color shown on the Plans or established by the Engineer.

855.02. MATERIALS. Materials shall meet the requirements of Section 711.

855.03. EQUIPMENT.

A. Extruded Application (Hot Applied). The material shall be applied to the pavement by extrusion method wherein one side of the shaping die is the pavement surface and the other three sides are contained by, or are part of, suitable equipment for heating and controlling the flow of material.

All parts of the equipment which come in contact with the material shall be easily accessible for cleaning and maintenance. Conveying parts between the main reservoir and the shaping die shall not be allowed to clog up. All mixing and conveying parts up to and including the shaping die shall maintain the material at the plastic temperature, and assure the continuous uniformity in the dimensions of the stripe. The equipment shall be so designed to insure uniform film thickness in the range of 3 /32 inch (2.4 mm) minimum to 3/16 inch (4.8 mm) maximum.

The shaping die shall include a cut-off device remotely controlled to provide clean, square stripe ends and to provide a method of applying skip lines. The use of pans, aprons, or similar appliances which the die overruns will not be permitted. The top dressing of glass spheres shall be applied at the rate of approximately one pound (.45 kg) per 100 feet (30.5 m) of 4 inch (10.1 cm) wide line and in a manner which will firmly imbed them into the line surface at least 1/2 the diameter of the larger gradation sizes.

B. Spray Application (Hot Applied). All markings for lane lines, centerlines, barrier lines, and edge lines of thermoplastic materials when applied by the spraying process shall be applied from a self-propelled truck mounted unit of sufficient size and stability to insure smooth, uniform, and straight application of lines.

The application equipment shall be capable of automatic placement of intermittent line patterns and continuous line patterns in single or double line applications simultaneously. The intermittent timer mechanism shall provide a variable ratio of material applied and variable cycle length such that accurate placement of new patterms, or replacement of existing patterns can be achieved.

The equipment shall be so designed to insure uniform film thickness in the range of 1/32 inch (0.8 mm) minimum to 3/16 inch (4.8 mm) maximum, and to apply the top dressing of glass spheres at the rate of approximately one pound (.45 kg) per 100 feet (30.5 m) of 4 inch (10.1 cm) wide line and in a manner which will firmly imbed them into the line surface at least 1/2 the diameter of the larger gradation sizes.

855.04. CONSTRUCTION METHODS. A. Surface Preparation (Hot and Cold Applied). In order to insure maximum possible adhesion, the Contractor shall clean off all dirt, glaze, grease, curing compound, or other foreign materials from the surface where lines are to be applied.

To insure the satisfactory performance of plastic pavement markings new Portland Cement concrete pavement shall be sandblasted to remove the curing compound from the surface on which pavement markings are to be applied. Sandblasting may be done 7 days after placement of the concrete surface unless otherwise directed by the Engineer. Payment of this operation is included in Section 855.06.

On Portland Cement concrete surfaces, a liquid seal coat shall be applied to the area which is to be striped. The seal coat shall be the type that is compatible with the plastic material used and the surface towhich it is applied.

Plastic pavement markings shall not be placed over longitudinal joints unless special written authorization is given by the Engineer for necessary exceptions.

B. Application of Materials (Hot and Cold Applied).

(1) Hot Applied Plastic Pavement Markings. (Revise as follows). Hot applied pavement markings shall be applied straight and true by the extrusion die method. Lines shall have sharp edges, uniform thickness, good adhesion, and uniform reflectance of a high level. To insure the best possible adhesion, the compound shall be installed in a melted state at temperature of 400°F to 450°F (204°C to 232°C), and in accordance with the manufacturer's recommendations.

The application of hot applied thermoplastic markings shall be done only on clean dry pavement having a road surface minimum temperature of 55°F (12.8°C) and rising.

The drying time shall be defined as the minimum elapsed time after application when the stripe shall have and retain the characteristics required and after which time normal local traffic will leave no impression or imprint on the new stripe. The minimum drying time shall not exceed 2 minutes at 50°F (10°C) at a maximum relative humidity of 70 percent when applied at 3/16 inch (4.8 mm) thickness or one minute when applied at 3/32 inch (2.4 mm) thickness.

Thermo-compound material used under this Specification shall be so compounded and applied as to retain for the life of the stripe: the original characteristics of the bond to the road surface, ability to resist distortions by traffic impact or normal climate changes, and resistance to natural discoloration.

(2) Cold Applied Plastic Pavement Markings. Pavement markings which are preformed of are flectorized plastic material

and applied cold to the surface shall be coated with a factory applied pressure sensitive adhesive and shall be protected in shipping by a suitable release paper.

The minimum temperature for application shall be 60° F (15° C) on the pavement surface and the air temperature shall be 60° F (15° C) or above to insure pliability and conformability to the surface.

The application of the reflectorized plastic marker shall be without the use of heat, solvents, or extra adhesives of any nature, except that a surface sealer is required on Portland Cement concrete surfaces as indicated in these Specifications.

Application shall be made to clean and dry surfaces by removing the release paper, placing the reflectorized marker on the surface, and applying a continuous uniform pressure on the surface until a uniform bond is made. Traffic may then be permitted to pass over the markers.

855.05. METHOD OF MEASUREMENT. Traffic stripe (plastic) will be measured by the linear foot of 4 inch (10.1 cm) wide traffic stripe material actually placed or the equivalent 4 inch (10.1 cm) wide stripe when a narrower or wider stripe is specified in the Plans. Where arrows, words and symbols are placed they will be measured by each unit.

855.06. BASIS OF PAYMENT. Accepted traffic stripe (plastic) as measured above, will be paid for at the contract unit price bid for:

(A)	TRAFFIC STRIPE (PLASTIC) (4 inch (10.1 cm) WIDE)	LIN.FT.
(B)	TRAFFIC STRIPE (PLASTIC) (ARROWS)	EA.
(C)	TRAFFIC STRIPE (PLASTIC) (WORDS)	EA.
(D)	TRAFFIC STRIPE (PLASTIC) (SYMBOLS)	EA.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

APPENDIX B

Special Provision for Plastic Striping Tape

OKLAHOMA DEPT. OF TRANSPORTATION
SPECIAL PROVISIONS FOR
TRAFFIC STRIPE (PLASTIC)(TAPE)

These Special Provisions revise amend, and where in conflict, Supercede applicable sections of Standard Specifications for Highway Construction, Edition 1976.

855.01 DESCRIPTION. This work shall consist of furnishing materials and placing a retro-reflective preformed pliant polymer pavement marking tape on the roadway in accordance with these Specifications and in close conformity with the locations, lines, dimensions and color shown on the Plans or established by the Engineer.

855.02 MATERIALS.

General. The striping material as supplied shall be of good appearance, free from cracks, and edges shall be true, straight, and unbroken. The material shall be available in rolls and there shall be no more than 3 splices per 50 yards (46M) of length.

Preformed words and symbols shall conform to the applicable shapes and sizes as outlined in the "Manual on Uniform Traffic Control Devices for Streets and Highways," dated 1978, or as modified.

The striping material shall be packaged in standard commercial containers so constructed as to insure acceptance by the carrier and prevent damage during shipment and storage.

The striping material as supplied may be stored at temperatures up to 100° F. (37°C.) for periods up to one year.

The supplier will furnish a Type "A" certification on the materials supplied in accordance with Section 106.12 of the Oklahoma Standard Specifications for Highway Construction, 1976 Edition.

Materials shall conform to the following requirements:

a. Composition: The retro-reflective, preformed pavement marking film shall consist of high quality plastic materials, pigments and glass beads uniformly distributed throughout its cross-sectional area and with a retro-reflective layer of glass beads firmly bonded on the top surface. The preformed plastic film shall be precoated with a pressure sensitive adhesive which is compatible with bituminous concrete and portland concrete road surfaces.

b. Skid Resistance: The surface of the retro-reflective preformed film shall provide a minimum skid resistance value of 35 BPN when tested in accordance with ASTM E303-74.

c. Thickness: The thickness of the preformed plastic film without adhesive for lane and edge lines shall be not less than 60 mils (1.5mm) and not more than 90 mils (2.3mm).

d. Tensile Strength and Elongation: The film shall have a minimum tensile strength of 40 pounds per square inch (18kg/6.5cm^2) of cross-section when tested according to ASTM D 638-76, except that a sample 6" x 1" (15.2cm x 2.5cm) shall be tested at a temperature between 70^{0}F (21^{0}C) and 80^{0}F (27^{0}C) using a jaw speed of 10 to 12 inches per minute (25.4cm to 30cm/min). The sample shall have a minimum elongation of 75% at break when tested by this method.

e. Conformability: The preformed film shall be capable of conforming to pavement contours, breaks and faults through the action of traffic at normal pavement temperatures. The preformed plastic film shall have characteristics such that it is capable of fusing with itself and previously applied marking film of the same composition under normal conditions of use.

f. Removability: These tapes are not designed to be easily removed after application.

g. Adhesive: Tapes will have pressure-sensitive backing without liner for intended use of longitudinal and transverse markings. Word/symbols will have pressure-sensitive backing with protective liner.

h. Application Properties: The material shall adhere to asphalt and concrete surfaces when applied according to manufacturer's recommendations at surface temperature of 65^{0}F(19^{0}C) and rising. If the markings must be applied when the surface temperature is below 65^{0}F(19^{0}C), but not below 50^{0}F(19^{0}C), the markings are to be applied in strict accordance with the manufacturer's recommended procedures and/or other special instructions. No protective devices such as traffic cones or barricades shall be required.

i. Glass Beads: Glass beads shall be incorporated to provide immediate and continuing retro-reflection. The size, quality, and refractive index of the glass beads shall be such that the performance requirements for the markings shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.

j. Pigmentation: Color pigments shall be thoroughly blended to provide a pavement marking film that maintains uniform color under both daylight and night lighting conditions throughout the expected life of the film. White pavement marking film shall be similar to Federal Standard Color No. 595-17886. Yellow pavement marking film shall be similar to Federal Standard Color No. 595-13538.

k. Reflectance: The white and yellow films shall have the following initial minimum reflectance values at 0.2^0 and 0.5^0 observation angles and 86.0^0 entrance angle as measured in accordance with the testing procedures of Federal Test Method Standard 370. The photometric quantity to be measured shall be specific luminance (SL)*, and shall be expressed as millicandelas per square foot per foot-candle (mcd ft^{-2} fc^{-1}). The metric equivalent shall be expressed as millicandelas per square meter per lux. The test distance shall be 50 ft. (15 m) and the sample size shall be a 2.0 x 2.5 ft. rectangle (0.61 x 0.76 m).

The angular aperture of both the photoreceptor and light projector shall be 6 minutes of arc. The reference center shall be the geometric center of the sample, and the reference center shall be taken perpendicular to the test sample.

	White		Yellow	
Observation Angle	0.2^{o}	0.5^{o}	0.2^{o}	0.5^{o}
SL (mcd ft^{-2}) fc^{-1}	550	380	410	250

1. Effective Performance Life: The film, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature if the pavement surface remains stable. Although reflectivity is reduced by wear, the pliant polymer shall provide a cushioned, resilient substrate that reduces bead crushing and loss. The film shall be weather resistant and, through normal traffic wear, shall show no appreciable fading, lifting or shrinkage throughout the useful life of the marking, and shall show no significant tearing, roll back, or other signs of poor adhesion.

   Bidder shall demonstrate application system prior to award and complete instructions for application must accompany bid.

855.03 EQUIPMENT. Preformed pavement line markings shall be installed with a mechanical applicator which shall be capable of placing pavement lines in a neat, accurate and uniform manner. The mechanical applicator shall be equipped with a film cut-off device and with measuring devices which automatically and accumulatively measures the length of each line actually placed to within a tolerance of ±2 percent.

855.04 CONSTRUCTION METHODS.

A. Surface preparation. Plastic pavement marking tape may be applied to existing and new pavement surfaces. In order to insure maximum adhesion the Contractor shall clean off all dirt, glaze, grease, curing compound, old striping or foreign materials from the surface where pavement markings are to be applied.

   When the pay item for pavement marking removal is included in the contract the removal of old striping included above shall be paid for by the lineal foot of pavement marking removal.

B. Portland Concrete Surface. To insure the satisfactory performance of preformed pavement markings new Portland Cement concrete pavement shall be sandblasted to remove the curing compound from the surface on which pavement markings are to be applied. Sandblasting may be done 7 days after the placement of concrete surface unless otherwise directed by the Engineer. Payment of this operation is included in Subsection 855.06. A primer may be required to precondition the pavement surface.

C. Asphaltic Concrete Surface. When markings are specified in the contract for newly paved asphalt concrete surfaces and when either specified in the contract, or at the discretion of the engineer, favorable conditions exist, the pavement markings may be applied using the "Inlaid" method. When the "Inlaid" method is to be used the markings shall be applied after the newly placed bituminous concrete pavement has been adequately compacted and when the bituminous concrete pavement has attained a temperature range of 155°F to 125°F (68°C to 52°C).

The preformed pavement markings shall be inlaid into the bituminous concrete surface by means of mechanical roller. The mechanical roller shall be of sufficient weight capacity to inlay the preformed pavement marking to a minimum depth of 65% of the material thickness and to not more than 80% of the material thickness while the temperature range of the bituminous concrete is within 125°F to 155°F (52°C to 68°C). In the event the inlaid preformed pavement markings are distorted by the Contractor's operations, fail to provide a uniform appearance, or are installed improperly, such inlaid pavement markings shall be repaired or replaced at the Contractor's expense in a manner as approved by the Engineer. The inlaid preformed pavement markings shall be installed in the finished surface of the bituminous concrete pavement work prior to conclusion of each day's work.

When the markings are not to be inlaid, standard placement methods as recommended by the manufacturer of the material shall be used.

855.05. METHOD OF MEASUREMENT. Traffic Stripe (Plastic)(Tape) will be measured by the linear foot of 4 inch (10.1 cm) wide traffic stripe actually placed or the equivalent 4 inch (10.1 cm) wide stripe when a narrower or wider stripe is specified in the plans. Where arrows, words, or symbols are placed they will be measured by each unit.

855.06. BASIS OF PAVEMENT. Accepted traffic stripe (plastic)(tape) as measured above, will be paid for at the contract unit price bid for:

(E)	TRAFFIC STRIPE (PLASTIC)(TAPE) 4 INCH (10.1 cm) WIDE	LIN. FT.
(F)	TRAFFIC STRIPE (PLASTIC)(TAPE) ARROWS	EA.
(G)	TRAFFIC STRIPE (PLASTIC)(TAPE) WORDS	EA.
(H)	TRAFFIC STRIPE (PLASTIC)(TAPE) SYMBOLS	EA.

Which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

APPENDIX C

Photographs of Equipment

Figure 1. Shotblasting new pavement in preparation for stripe.

Figure 2. Applying thermoplastic primer.

Figure 3. Thermoplastic applicator cart and furnace truck.

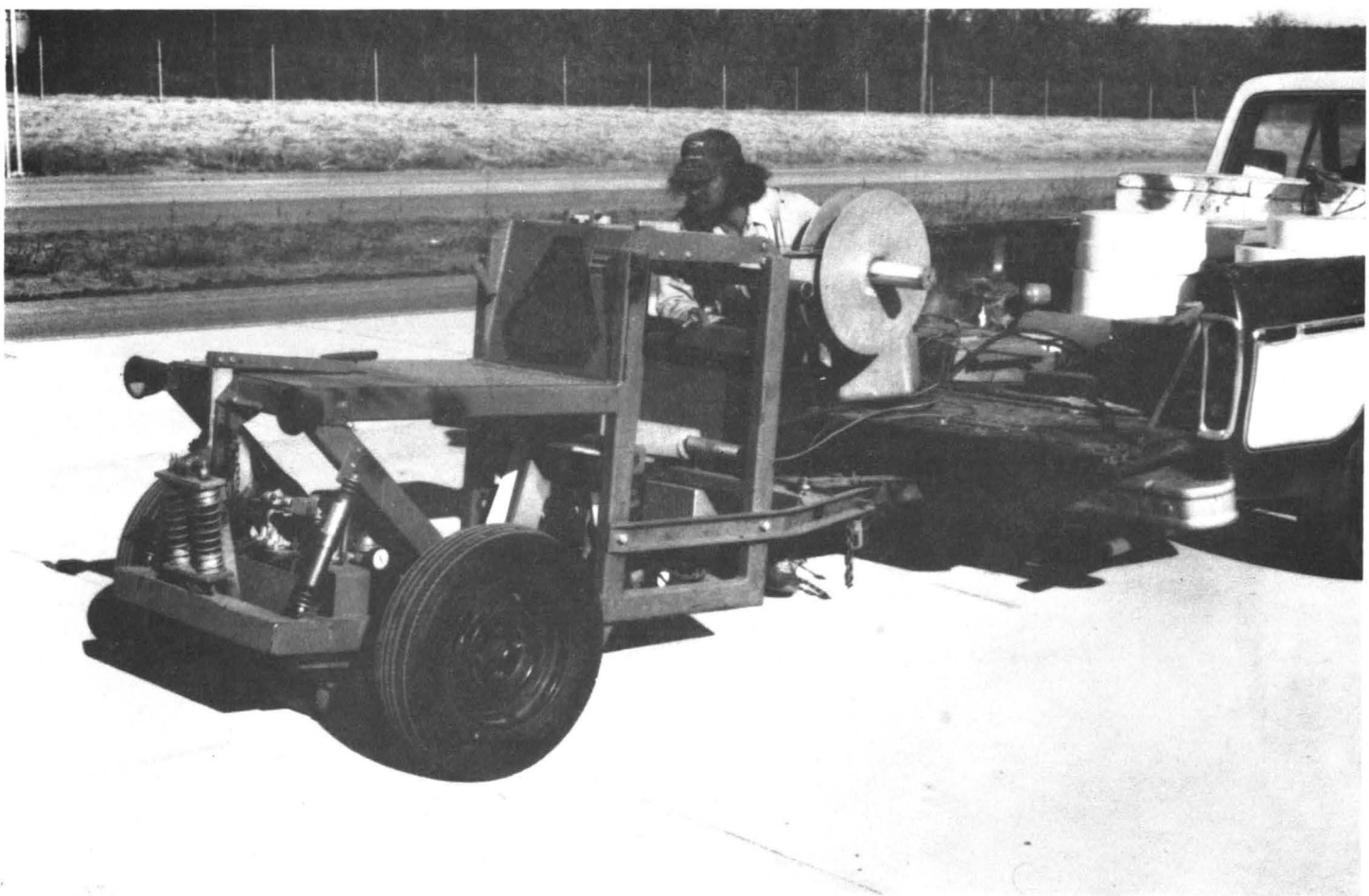

Figure 4. Towed plastic striping tape laydown machine.

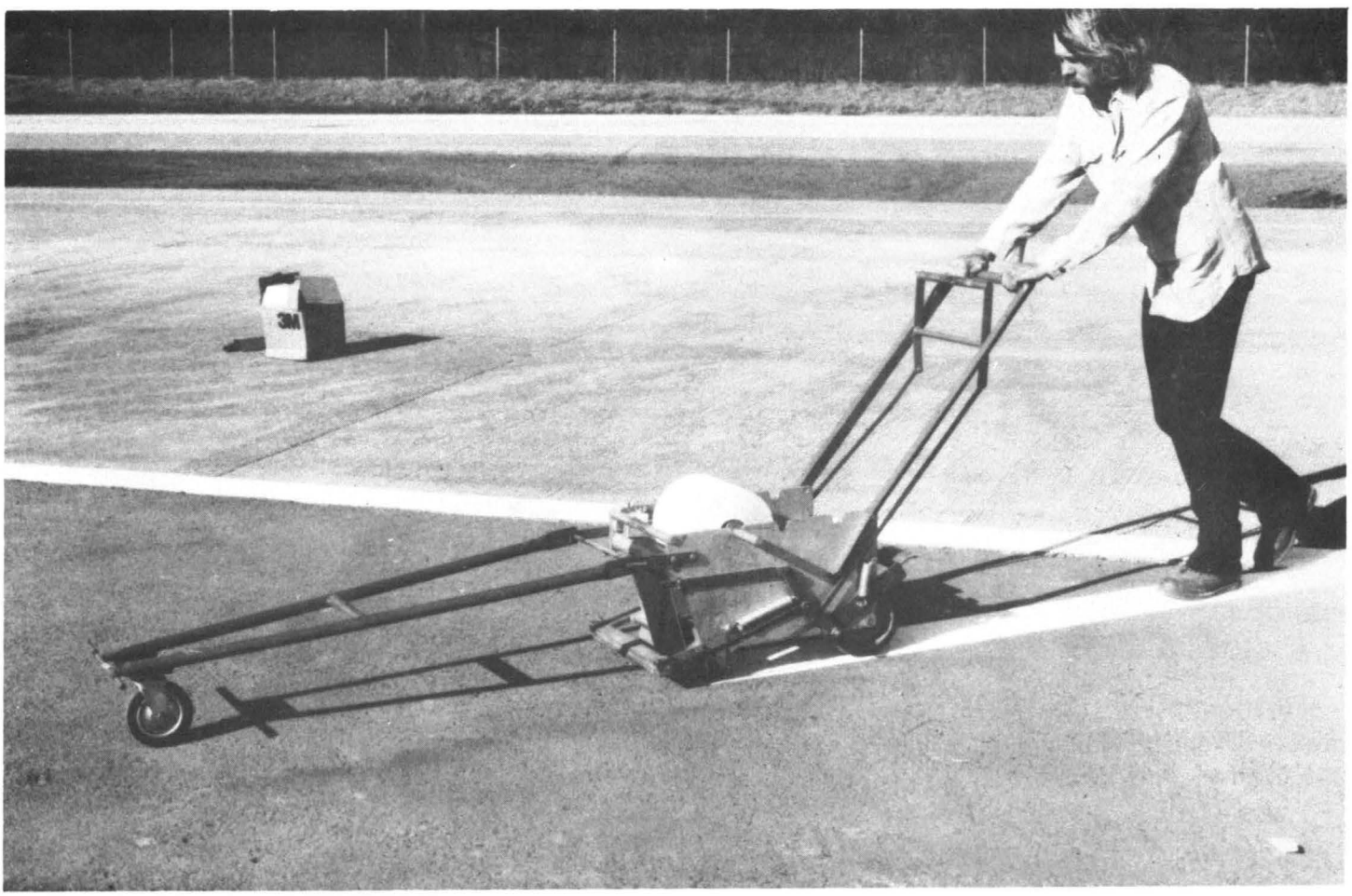

Figure 5. Hand-pushed plastic striping tape laydown machine in gore area.