



Number: E-05-003

Date: June 16, 2005

ENGINEERING DIRECTIVE

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CHIEF ENGINEER

PAVEMENT MARKINGS ON OPEN-GRADED FRICTION COURSE (OGFC)

Effective immediately, Thermoplastic Pavement Markings shall not be used on any Open-Graded Friction Course (OGFC) or Polymer Modified Open-Graded Friction Course (OGFC-P) wearing surface, including all contracts already awarded where pavement markings have not yet been placed. Epoxy Pavement Markings shall be used in place of Thermoplastic Pavement Markings on OGFC or OGFC-P.

Also effective immediately, Reflectorized Pavement Markers (Slotted in Pavement) must be used in place of Snowplowable Raised Reflectorized Pavement Markers on all OGFC or OGFC-P wearing surfaces, including all contracts already awarded where reflectorized pavement markers have not yet been installed.

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ITEM 864.07	PAVEMENT ARROW AND LEGENDS (EPOXY)	SQUARE FOOT
ITEM 868.06	6 INCH REFLECTORIZED WHITE LINE (EPOXY)	LINEAR FOOT
ITEM 868.12	12 INCH REFLECTORIZED WHITE LINE (EPOXY)	LINEAR FOOT
ITEM 869.06	6 INCH REFLECTORIZED YELLOW LINE (EPOXY)	LINEAR FOOT
ITEM 869.12	12 INCH REFLECTORIZED YELLOW LINE (EPOXY)	LINEAR FOOT

SCOPE

Work under these items cover white and yellow epoxy reflectorized pavement striping material that is sprayed onto the pavement. As work incidental to these items the Contractor shall furnish to the Department one portable spectrophotometer and one replacement calibration standard with the Department taking ownership of these pieces of equipment. The spectrophotometer shall be delivered to the Research and Materials headquarters at the beginning of line striping work. Following a surface application of glass beads and upon drying, the resultant marking is a reflectorized stripe of specified thickness and width, that is capable of resisting deformation by traffic. Work under these items shall conform to the relevant provisions of Section 860 of the Standard Specifications and the following:

MATERIAL REQUIREMENTS

A. REGULAR-DRY EPOXY SUGGESTED SUPPLIERS

	SUPPLIER/LOCATION
Epoplex LS50	Epoplex - Stonhard Inc. Maple Shade, NJ
Hotline TM 8212 (Part A White) Hotline TM 8213 (part A Yellow) Hotline TM 8214 (Part B Hardener or Converter)	Baltimore Paint and Chemical Co. Division of Sherwin-Williams Baltimore, MD Edison, NJ
Lumiline, Lumiline II	Accent Stripe, Inc. Orchard Park, NY
Poly-Carb Mark 55.3	Poly-Carb Inc. Solon, OH
Super Lifeline II, III	Linear Dynamics Ball Ground, GA
Thermopoxy Series 100 Part A (Series 101 White) Part A (Series 102 Yellow) Part B (Series 103)	Technical Coatings Corp. Alpharetta, GA

ITEMS 864.07 through 869.12 (Continued)

B. Epoxy Material

1. Composition.

The epoxy resin composition shall be specifically formulated for use as a pavement marking material and for hot-spray application at elevated temperatures. The type and amounts of epoxy resins and curing agents shall be at the option of the manufacturer, providing the other composition and physical requirements of this specification are met.

The epoxy marking material shall be two-component (Part A and Part B), 100% solids type system formulated and designed to provide a simple volumetric mixing ratio (e.g. two volumes of Part A to one volume of Part B).

The epoxy marking material shall be supplied as either a regular-dry or a slow-dry material. Regular-dry may be used for all marking patterns. Slow-dry material is intended for marking hatchlines, edgelines, and other marking patterns located out of the general path of traffic.

All acceptances of uninstalled epoxy marking material shall expire six (6) months after the date of manufacture.

Part A of both white and yellow shall conform to the following requirements:

PERCENT BY WEIGHT OF PART A .	
WHITE	Pigment - 18 Minimum, Titanium Dioxide (ASTM D476, Type II) Epoxy Resin - 75 to 82
YELLOW	Pigment - 18 Minimum, Titanium Dioxide (ASTM D476, Type II) 5 Minimum, Organic Yellow, Epoxy Resin – 73 to 77

The entire pigment composition shall consist of either titanium dioxide or titanium dioxide and organic yellow. No extender pigments are permitted. Yellow pigment shall be lead-free.

The epoxy content of the epoxy resin in Part A will be tested in accordance with ASTM D 1652 and calculated as the weight per epoxy equivalent (WPE) for both white and yellow. The epoxy content will be determined on a pigment free basis. The epoxy content (WPE) shall meet a target value provided by the manufacturer and approved by the Department. A ± 50 tolerance will be applied to the target value to establish the acceptance range.

The amine value of Part B shall be tested in accordance with ASTM D2074(2) to determine its total amine value. The total amine shall meet a target value provided by the manufacturer and approved by the Department. A ± 50 tolerance will be applied to the target value to establish the acceptance range. The manufacturer may specify an alternate test method for determining the amine value subject to the approval of the Department.

ITEMS 864.07 through 869.12 (Continued)

2. Physical Properties of Mixed Components (Part A and Part B).

Unless otherwise noted, all samples are to be prepared tested at an ambient temperature of $73 \pm 3^{\circ}\text{F}$.

a. Color.

Yellowness Index (ASTM D-1925).

- cure 72 hours after sample preparation
- Take yellow index reading, XYZ C/2°, following 72 hour cure and preceding QUV
- Maximum index before QUV: 8.0
- Place sample in QUV for 72 hours
- Maximum index after QUV: 20

Typical White Standard

X78.5
Y81.1
Z90.4
Y14.7

Typical Yellow Standard

X52.7
Y48.1
Z7.6

b. Directional Reflectance.

The white epoxy composition (without glass spheres) shall have a daylight directional reflectance of not less than 84% relative to a magnesium oxide standard when tested in accordance with ASTM E1347.

The yellow epoxy composition (without glass spheres) shall have a daylight directional reflectance of not less than 55 % relative to a magnesium oxide standard when tested in accordance with ASTM E 1347.

c. Drying Time (Laboratory).

When tested in accordance with ASTM D711 as modified below, regular-dry epoxy marking material shall reach a no-pick-up time in 30 minutes or less. Under these same test conditions, slow-dry epoxy marking material shall reach a no-pick-up time in 60 minutes or less. A Bird Applicator or other suitable instrument shall be used to spread a nominal 15 ± 1 mil thick wet film. Reflective glass spheres shall be immediately dropped onto the epoxy film at a rate of 18 pounds per gallon.

d. Drying Time (Field).

When installed at 77°F at the specified wet film thickness and reflectorized with glass spheres, regular-dry and slow-dry epoxy markings shall reach a no-track condition in approximately 30 minutes, and 60 minutes, respectively.

Dry to "no-tracking" shall be considered as the condition where no visual deposition of the epoxy marking to the pavement surface is

ITEMS 864.07 through 869.12 (Continued)

observed when viewed from a distance of 50 feet, after a passenger car is passed over the line.

e. Hardness.

The epoxy composition when tested in accordance with ASTM D2240 shall have a Shore D hardness of between 75 and 100. Samples shall be allowed to cure for not less than 72 hours nor more than 96 hours prior to testing.

f. Infrared Spectrophotometer Analysis (ASTM D2621).

Samples of Part A and Part B shall be analyzed by infrared spectrography. The spectrum of each component shall be a reasonable match to the spectrum of the original formulation accepted by the Department.

C. Reflective Glass Spheres.

Reflective glass spheres for drop-on application shall conform to the following requirements:

The glass spheres shall be colorless, clean, transparent, free from milkiness or excessive air bubbles, and essentially clean from surface scarring or scratching. They shall be spherical in shape and at least 80 % of the glass beads shall be true spheres when tested in accordance with ASTM D-1155, Procedure A.

The refractive index of the spheres shall be a minimum of 1.5 as determined by the liquid immersion method at 77°F.

The silica content of the glass spheres shall not be less than 60 % .

The glass spheres shall have the following gradation when tested in accordance with ASTM D-1214.

DOUBLE DROP METHOD			
TYPE I		TYPE II	
Sieve Opening	% Retained	Sieve Opening	%
Retained			
No. 10	0	No. 20	0 - 5
No. 12	0 - 5	No. 30	5 - 20
No. 14	5 - 20	No. 50	30 - 50
No. 16	40 - 80	No. 80	9 - 32
No. 18	10 - 40	No. 100	0 - 5
No. 20	0 - 5	Pan	0 - 2
Pan	0 - 2		

The glass spheres, Type I, shall be coated with a silane-type adherence coating to enhance embedding in and adherence to the applied binder film. The coated beads shall emit a yellow-green fluorescence when tested by the Danayl Chloride test procedure. The Type II glass spheres shall be treated with a moisture-proof coating. The beads shall show no tendency to adsorb moisture in storage and shall remain free of clusters and lumps. The beads shall flow freely from the dispensing equipment at any time when surface and atmospheric

ITEMS 864.07 through 869.12 (Continued)

conditions are satisfactory for marking operations. The moisture-resistance of the glass spheres shall be determined on the basis of the following test:

Place one kilogram of spheres in a washed cotton bag having a thread count of approximately 52 per square inch (warp and woof) and immerse the bag in a container of water for 30 seconds. Remove the bag and force excess water from the sample by squeezing the bag. Suspend and allow to drain for two hours at room temperature ($73 \pm 2^{\circ}\text{F}$). Then mix the sample in the bag by shaking thoroughly. Pour the sample slowly into a clean, dry glass funnel having a stem 4 inches in length, with a 0.4 inch inside diameter stem entrance opening and a minimum exit opening of 0.25 inches. The entire sample shall flow freely through the funnel without stoppage. When first introduced into the funnel, if the spheres clog, it is permissible to lightly tap the funnel to initiate the flow.

Reflective glass spheres may be accepted at the job site on the basis of the manufacturer's certification, or they may be submitted to the Research and Materials Laboratory for testing.

D. Packaging and Shipment.

Epoxy pavement marking materials shall be shipped to the job site in strong, substantial containers. Individual containers shall be plainly marked with the following information:

1. Name of Product
2. Item Number
3. Lot Number
4. Batch Number
5. Test Number
6. Date of Manufacture
7. Date of Expiration of Acceptance (6 months from date of manufacture)
8. The Statement (as appropriate): "Part A - Contains Pigment and Epoxy Resin," or "Part B - Contains Catalyst"
9. Quantity
10. Mixing Proportions, Application Temperature and Instructions
11. Safety Information
12. Manufacturer's Name and Address

Reflective glass spheres shall be shipped in moisture resistant bags. Each bag shall be marked with the name and address of the manufacturer and the name and net weight of the material.

EQUIPMENT AND APPLICATION REQUIREMENTS

E. STRIPING EQUIPMENT

The equipment shall have a system capable of spraying the epoxy paint in the manufacturer's recommended proportions and be mounted on a truck of sufficient size and stability, and with an adequate power source to produce lines of uniform dimension

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and prevent application failure. It shall be capable of placing stripes on the left and right sides and of placing two intermittent lines simultaneously. It shall also be capable of applying glass beads at the rate of 25 pounds per gallon. All guns must be in full view of the operator at all times. The equipment shall be provided with a metering device to register the accumulated installed footage for each gun each day. Each vehicle shall include at least one operator who shall be a technical expert in equipment operations and epoxy application techniques.

Equipment shall have such a design that the pressure gauges for each proportioning pump are constantly visible to the operator at all times during its operation so that any fluctuation and pressure difference can be addressed immediately.

F. SURFACE PREPARATION

The pavement surface on which the epoxy paint material is placed shall be clean and dry. Existing traffic markings shall be removed by blasting or grinding. The curing compound on Portland cement concrete shall also be removed. Existing markings shall be removed so that at least 95% of the underlying pavement is visible. The abrasive material shall be removed from the pavement surface before the pavement is opened to uncontrolled traffic flow.

G. APPLICATION

1. Epoxy

The epoxy paint markings shall have a thickness of 25 mils $\pm$ 1 mil, calculated without drop-on glass beads. All markings shall have uniform thickness with a uniform distribution of glass beads throughout the line width. The width of lines shall be as specified with a tolerance of 0.25 inches. Markings shall have sharp edges and cutoff at the ends.

2. Glass Beads

The glass beads shall be applied by the double drop method, which requires that Type I and Type II reflective glass spheres be injected into or dropped onto the liquid epoxy marking. Each type shall be applied simultaneously, at a minimum rate of 10 to 13 pounds per gallon of resin with a minimum total application of 25 pounds per gallon. Type I beads shall be applied first, immediately followed by Type II beads. The beads shall adhere to the cured epoxy or all marking operations shall cease until corrections are made.

3. Temperature Limitations

During marking operations, the pavement surface where the epoxy is to be placed shall have a minimum temperature of 40° F and the air temperature shall be at least 35° F. The pavement surface temperature and the air temperature shall be determined at the start of each day of marking operation and at any time

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deemed necessary by the Engineer. The spraying temperatures shall be in accordance with the manufacturer's recommendations.

4. Application Rates

Application rates will be checked by the Engineer at convenient intervals by comparing tallies of materials used to the length of lines placed. For initial application and occasionally during the course of work, the Engineer may also check application to a pre-weighed sheet specifically placed for test purposes. Drop-on spheres shall not be applied in this test.

5. Protecting Newly installed Markings

Newly installed markings shall be protected from tracking during the setting period by one or more of the following methods:

- 1) Cone off wet lines from traffic
- 2) Use a convoy of moving vehicles to prevent traffic from crossing wet lines
- 3) Saturate lines with glass beads to prevent tracking.

PORTABLE SPECTROPHOTOMETER FOR MEASURING COLOR SPECIFICATION

Use

Perform objective color measurements of road signs, pavement markings, barricades, and other traffic safety devices for the purpose of acceptance, approval or maintenance.

Measurement Parameters

Geometry: The spectrophotometer shall have a measurement geometry of 45° circumferential (illumination) and 0° (observation).

Spectral Range: The instrument shall have a spectral range of 400 to 700 nm.

Spectral Interval: The instrument shall have a spectral interval output of 20 nm. The internal computation spectral interval shall be 5nm.

Photometric Range: The instrument shall have a photometric range of 0 to 100% with a resolution of 0.01.

Standards: The instrument shall conform to the following standards:

DIN 5033, 5036, 6174

ISO 7724

ASTM D2244, E308, E313, E1164

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Calibration

Calibration Standards: The instrument shall be supplied with one durable white traceable calibration standard. The instrument shall also be supplied with one black and one green durable calibration standards.

Construction:

Basic Construction: The instrument shall be rigidly constructed to maintain a fixed geometry and must not contain any foldable or collapsible parts.

Illumination: the instrument shall utilize an LED lamp system for sample illumination.

This lamp system shall consist of 30 individual LED's. There shall be 3 LED's per color oriented at 120 degrees from each other to provide accurate light control and a larger sample port size.

The illumination system shall not raise the temperature of the sample being measured either during a single measurement or during multiple, repeated measurements.

Dimensions: The instrument's physical dimensions shall be 3.75 inches wide, 3.5 inches tall and 7 inches long. The instrument shall weigh 32 ounces.

Power Source: The instrument shall be powered by four AA size alkaline, NiCd or MH batteries. The instrument shall be capable of taking at least 5000 measurements on one set of fully charged batteries.

Use and Control

Display: The instrument shall use a 2.4 x 1.2 inch liquid crystal display, 126 x 64 pixels.

Illuminants: The instrument shall be able to measure samples with type A, C, D65, F2, F7, and F11 illuminants.

Observers: The instrument shall be able to measure samples with 2° and 10° observer.

Display Modes: The instrument shall be capable of operating in several different modes including:

- Absolute color data
- Pass/Fail
- Color difference
- Metamerism
- Spectral Curve

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Color Systems: The instrument shall be capable of measuring and displaying color data with different color systems including:

- Yxy
- CIELab
- CEILCh/H
- Lab(h)
- FMC2
- XYZ
- RxRyRz

Indices: The instrument shall be capable of measuring and displaying different color indices including:

- YIE313
- YID1925
- WIE313
- CIE
- Berger
- Color Strength
- Opacity
- Metamerism MI

Color Differences: The instrument shall be able to measure and display color differences including:

- Delta E*
- Delta E(h)
- Delta E_{FMC2}
- Delta E₉₄
- Delta E_{CMC}

Data Storage: The instrument shall utilize internal, memory for storing measurement data. The instrument shall be capable of storing approximately 1000 samples. In addition, the instrument shall be capable of storing approximately 200 standards. A 15-year lithium battery shall independently power the data memory.

Data Output: The instrument shall be equipped with a data port to allow for data output directly to a printer or Windows™ applications.

Equipment

The instrument shall be equipped complete with a users manual, batteries, carrying case, black calibration standard, white calibration standard, green calibration standard, sample area locator, PC interface cable with adapter, wrist strap, and a color theory guide.

One manufacturer of the above piece of equipment is BYK-Gardner Color Guide Portable Spectrophotometer Cat# 530160. The additional set of calibration

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standards may be obtained from Flint Trading, Inc., Thomasville, NC (Tel 336-475-6600).

<u>ITEM 864.31</u>	<u>REFLECTORIZED PAVEMENT MARKER</u>	<u>EACH</u>
	<u>(SLOTTED IN PAVEMENT) ONE-WAY WHITE</u>	
<u>ITEM 864.32</u>	<u>REFLECTORIZED PAVEMENT MARKER</u>	<u>EACH</u>
	<u>(SLOTTED IN PAVEMENT) TWO-WAY WHITE/RED</u>	

Description

The work to be done under this item shall consist of furnishing and installing one-way white and two-way white/red reflectorized pavement markers (slotted in pavement) in accordance with the construction plans, the relevant provisions of Traffic Standard TR.6.3 “Typical Pavement Markings for Freeways”, and the following:

- Markers shall be installed along the broken white lane lines (skip lines) at the midway point between successive skip lines at **80 foot intervals** on the mainline.

Construction Methods

The work shall include cutting the tapered pavement slot to the dimensions shown on the typical details for the one-way or two-way markers, application of the manufacturer’s recommended epoxy adhesive, and placing the reflectorized pavement marker in the proper position within the slot so that the reflective face is visible and perpendicular to oncoming traffic and so that the top of the marker is set 1/8± inch below the top of the adjacent pavement.

Surface preparation and installation shall be strictly in accordance with the manufacturer’s instructions.

Materials

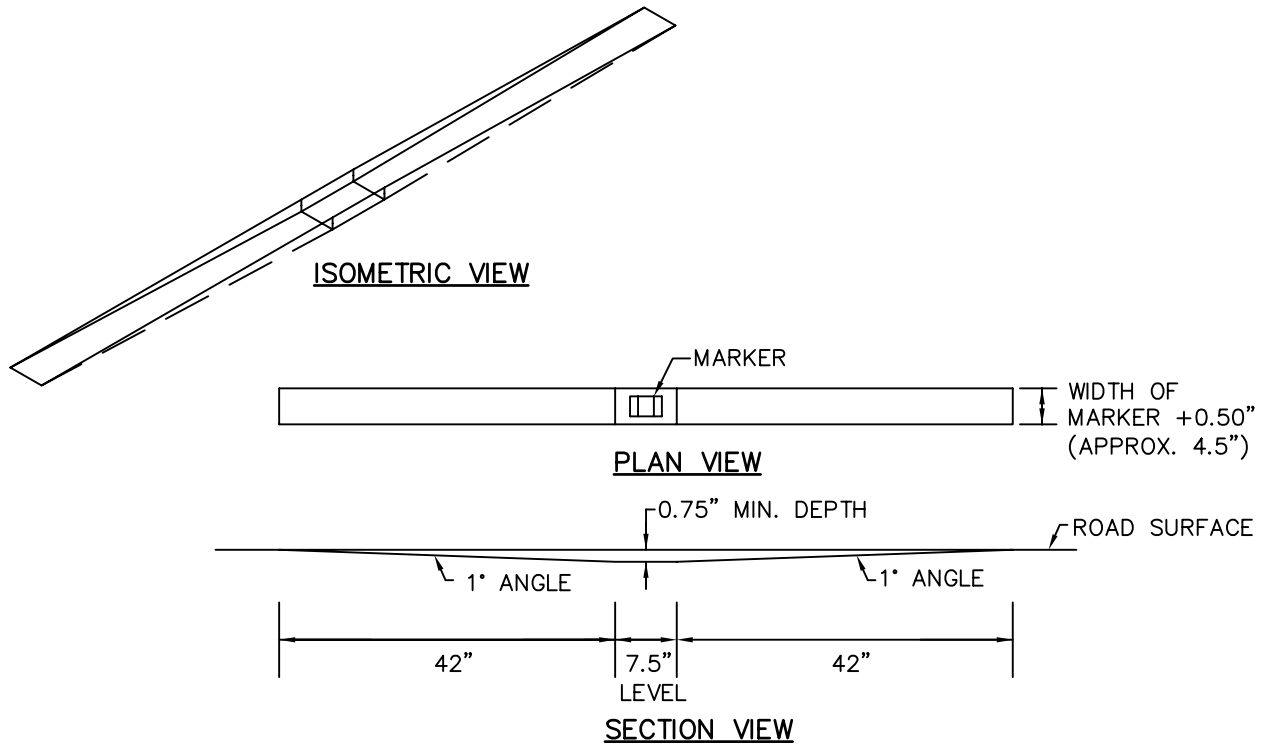
Reflectorized pavement markers shall be 3M Series 290, Avery Dennison Lifelite Model 948 BW, Ray-O-Lite Model 200 or an approved equal.

Method of Measurement

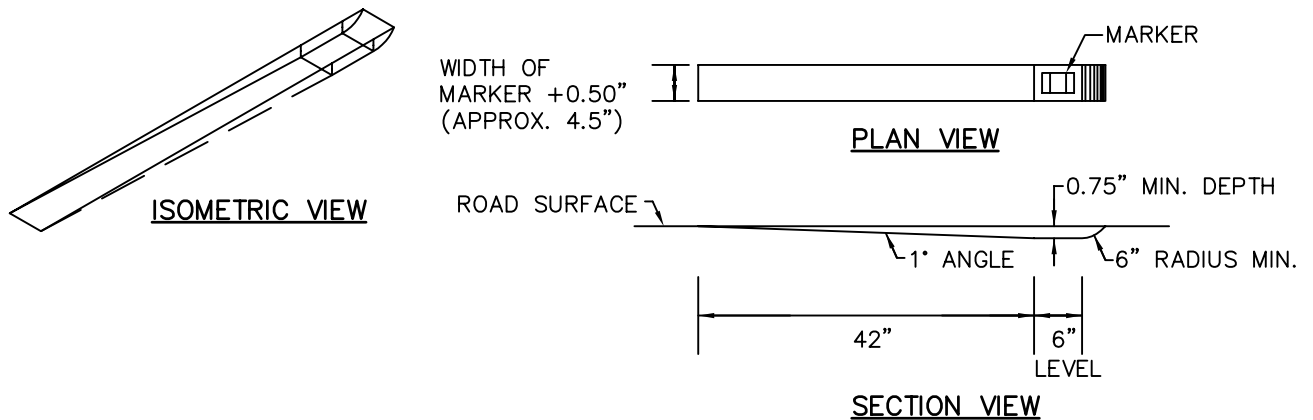
The number of one-way white and two-way white/red reflectorized pavement markers (slotted in pavement), completely furnished and installed, shall be measured by the Unit Each as a complete installation.

Basis of Payment

One-way white and two-way white/red reflectorized pavement markers (slotted in pavement) will be paid at the contract unit price each under Item 864.31 and Item 864.32 respectively, and shall include cutting the tapered pavement slot, furnishing and installation of the reflectorized markers, including all necessary materials, labor, incidentals, and equipment to complete the work.



TWO WAY MARKER APPLICATION



ONE WAY MARKER APPLICATION

RECESSED GROOVE DETAILS

NOTE:

1. THE GROOVE AREA MUST BE DRY AND FREE OF DUST, DIRT OR ANY MATERIAL WHICH WILL ADVERSELY AFFECT THE BOND OF THE ADHESIVE.
2. INSTALL MARKERS WITH APPROVED ADHESIVE. ADHESIVE SHOULD NOT BE ALLOWED TO BUILD UP IN FRONT OF MARKER LENS.
3. THE MARKER AND THE ADHESIVE PAD SHALL NOT EXCEED THE TOP OF THE PAVEMENT SURFACE. DEPTH = .75" MINIMUM.