Raised Reflective Markers for Highway Lane Lines

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•IT is California practice to use a broken (9 ft painted, 15 ft unpainted) white stripe to delineate traffic lines. The painted portion is beaded for night visibility.

It has long been observed by motorists that during periods of inclement weather and moderate-to-heavy rainfall at night that water tends to accumulate on the pavement to a depth sufficient to cover and obscure the beaded painted centerline traffic stripe. Under such conditions, light from a motor vehicle is not reflected back to the driver and he is unable to see the painted stripe. In this situation the driver often finds it difficult to remain in his traffic lane.

HISTORY

Beginning in 1954, the Materials and Research Department began experimentation to solve this problem with the installation of reflectorized white "buttons" or markers, made of epoxy or polyester resins, 4-in. diameter and ¾ in. high, the convex shape corresponding to the outer segment of a sphere (Figs. 1 and 2). These buttons were cemented to the highway surface with an epoxy adhesive, one each in the center of the 15-ft gap in the broken painted stripe. In theory these elevated markers "shed the

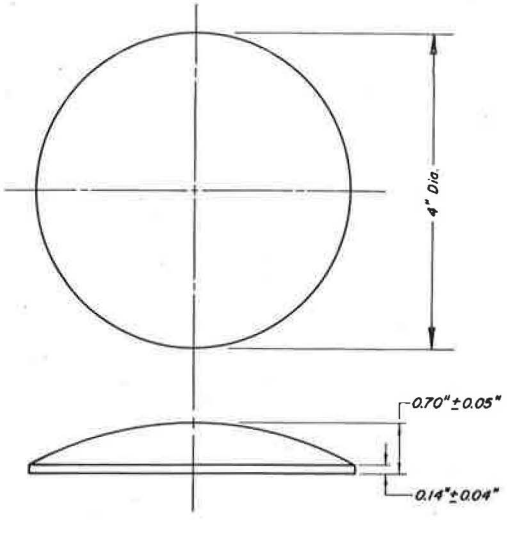

Figure 1. Button-type reflective pavement marker.

Figure 2. Glass-beaded white button.

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water" and are not readily submerged. Such markers are considered as auxiliary devices to provide adequate delineation during periods of wet weather at night. The normal painted stripe is considered thoroughly adequate in clear weather.

Performance since 1954 indicates that these markers should have a service life of at least 20 years on portland cement concrete highways. In order to attain this durability the proper epoxy adhesive must be used and the concrete must be thoroughly cleaned by sandblasting to remove laitance, dirt, oil and grease in the area where the marker contacts the pavement surface. Useful life of the marker mounted upon asphaltic concrete pavements is dependent upon the quality of the asphaltic concrete and its cohesive strength in hot climatic areas.

Beginning in 1955 a test section was installed in which "wedge" type markers (Figs. 3 and 4) were used as a complete replacement for a painted stripe on a portland cement concrete divided freeway. In this test section the distance between wedges varied, the extreme spacing being one wedge every 24 feet. All later installations had four markers, each 3 ft apart in the 9-ft sections where the normal stripe usually occurs. Some of these installations used the beaded wedges and others the beaded buttons. Two-way wedges, as shown in Figures 5, 6, and 7—except that they were beaded, have been used on 2-lane roads or as a no-passing line on nondivided freeways. In the latter case they would be yellow in color and two wedges would be cemented adjacent to one another. Figures 8 and 9 show clear weather nighttime delineation provided by the button and one-way wedge markers, respectively. Figures 10 and 11 illustrate nighttime visibility of these markers during a moderate rainstorm. In another photograph taken during the rain adjacent to the test area where a painted stripe was placed, the painted stripe was invisible.

The California Division of Highways has installed over 100 miles of the "wedge" and "button" shaped raised reflective white markers since 1959 in various sections of the State on both portland cement and asphaltic concrete pavements. In some installations the markers were used as a replacement for the painted stripe and in others they were installed as a supplement to the stripe, usually two in the gap and placed 6 ft apart. When used as a supplement to the painted stripe the intention was to provide nighttime delineation during periods of inclement weather. Other types of "wedges" and "buttons" which were tried and evaluated in service (both photographically and visually) for effective delineation under the specific conditions discussed are shown in Figures 12 through 15.

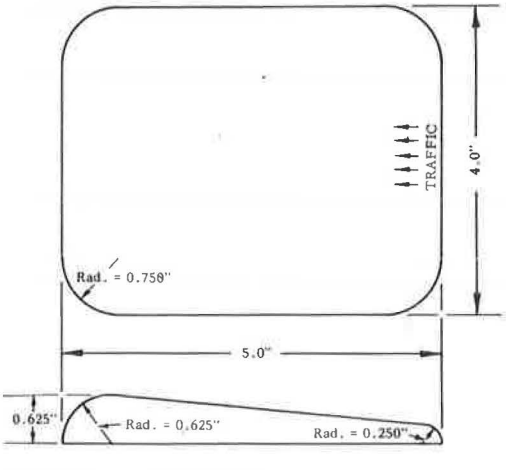

Figure 3. Wedge-type, one-way traffic, reflective pavement marker.

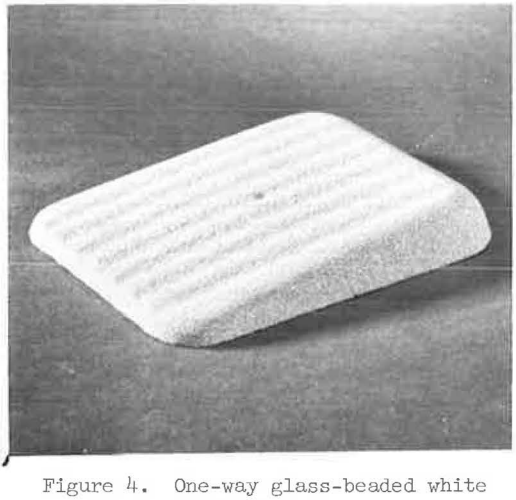

Figure 4. One-way glass-beaded white wedge.

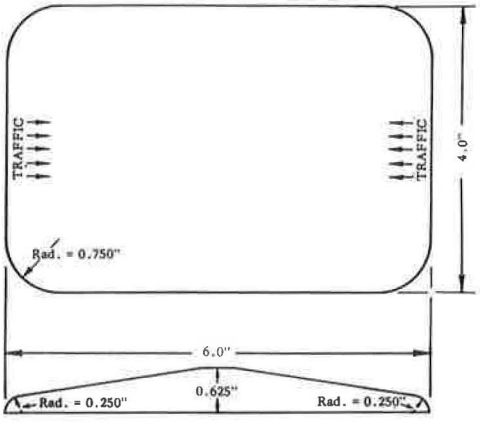

Figure 5. Wedge-type, two-way traffic, reflective pavement marker.

RECENT DEVELOPMENTS

In order to select a marker which is visible in both clear and rainy weather day and night, California has recently used a partially beaded marker. This is of necessity a compromise in order to have the virtues of the fully beaded and non-beaded types present in one marker. Being a compromise it is not as effective as the fully beaded or nonbeaded types under conditions where the fully beaded or nonbeaded types are the best. Specifications for all types of the raised white polyester reflective pavement markers currently used are California Specifications 64-F-41b, October 1964, and 64-F-42b, October 1964.

Figure 6. Two-way wedges, white non-beaded, on the roadway of the Webster Street Tube.

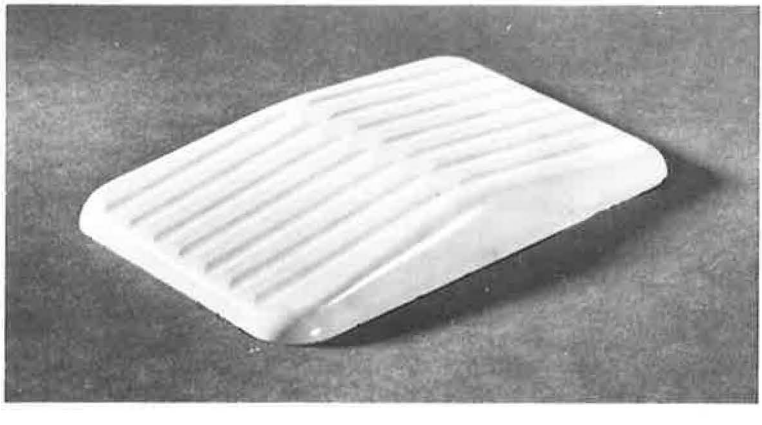

Figure 7. Two-way plain white non-beaded wedge.

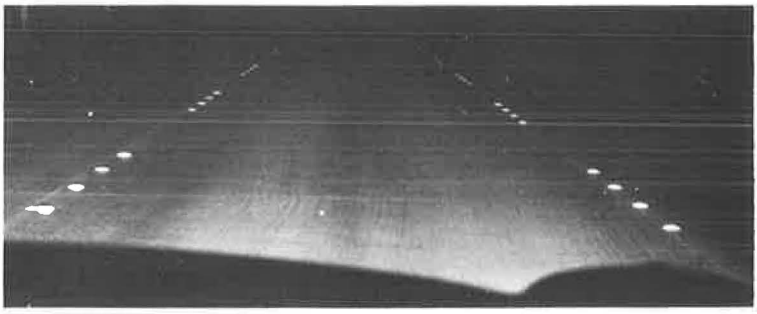

Figure 8. Buttons on the pavement at nighttime, clear weather.

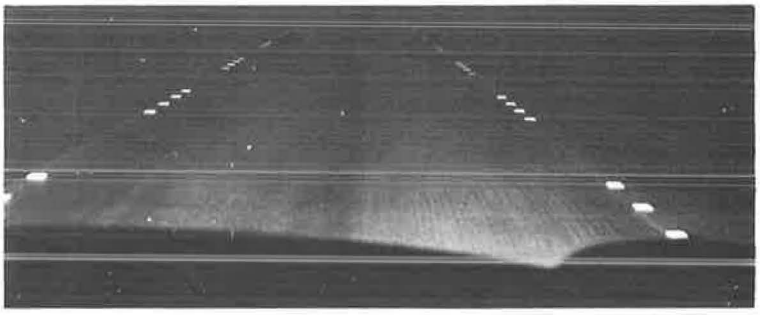

Figure 9. One-way wedges on the pavement at nighttime, clear weather.

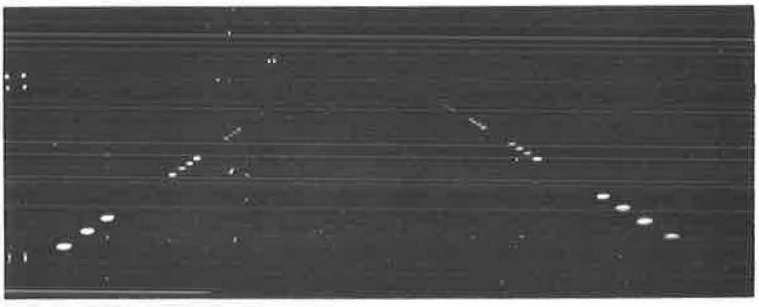

Figure 10. Buttons on the pavement at nighttime, moderate rain.

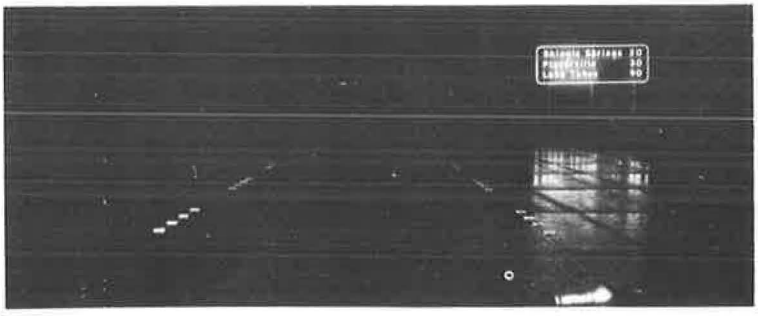

Figure 11. One-way wedges at nighttime, moderate rain.

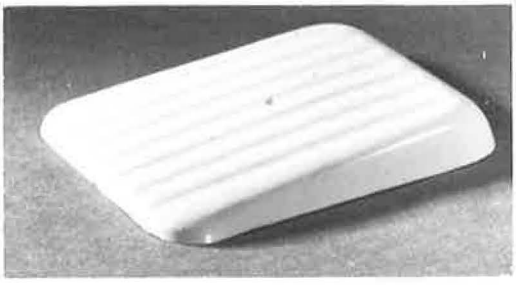

Figure 12. One-way plain white non-beaded wedge.

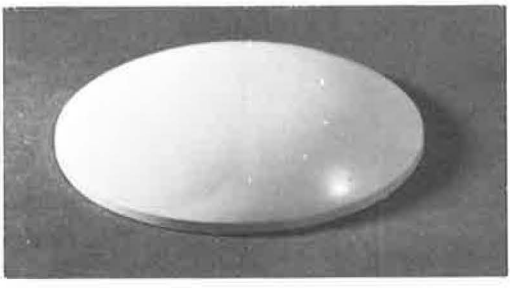

Figure 13. Plain white non-beaded button.

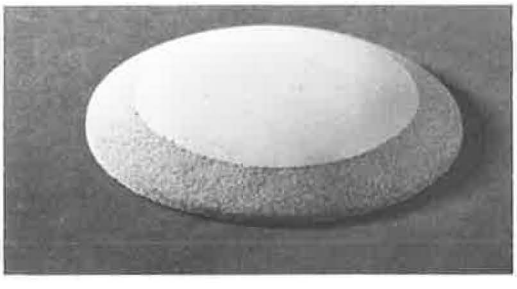

Figure 14. Plain white top button with glass-beaded white rim.

Figure 15. Glass-beaded white top with plain white non-beaded rim.

In April 1964, the Materials and Research Department installed 200 of an entirely new type raised marker on a divided freeway in Sacramento. The marker is wedge shaped and its reflectivity is based on the same principle as reflex reflectors used on guide posts. The reflecting surface is a reflex reflector encased in an acrylic plastic. The interior of the marker is filled with an epoxy resin to provide rigidity. So far this type marker provides brilliant delineation in clear and rainy weather at night but is almost invisible in the daytime. Durability over an extended period of years and its effectiveness in foggy weather is yet to be determined.

This marker (Fig. 16) has been manufactured in three types to reflect either white, amber or red light. A nighttime view of an installation of these markers is shown in Figure 17.

In order to select the proper type of a raised pavement marker for use in lane line delineation it is first necessary to determine which of the following conditions the markers are intended to serve:

1. Direction of traffic, one-way or two-way.
2. Replacement of the painted stripe.
3. Supplementation of the painted stripe.
4. Nighttime delineation only in inclement weather.
5. Delineation only under dry conditions, e.g., in a tunnel.
6. Day and night delineation under all weather conditions.

While not a part of this study, the fact that raised markers serve as a rumble warning strip to drivers changing lanes should be considered as a plus safety factor in any evaluation.

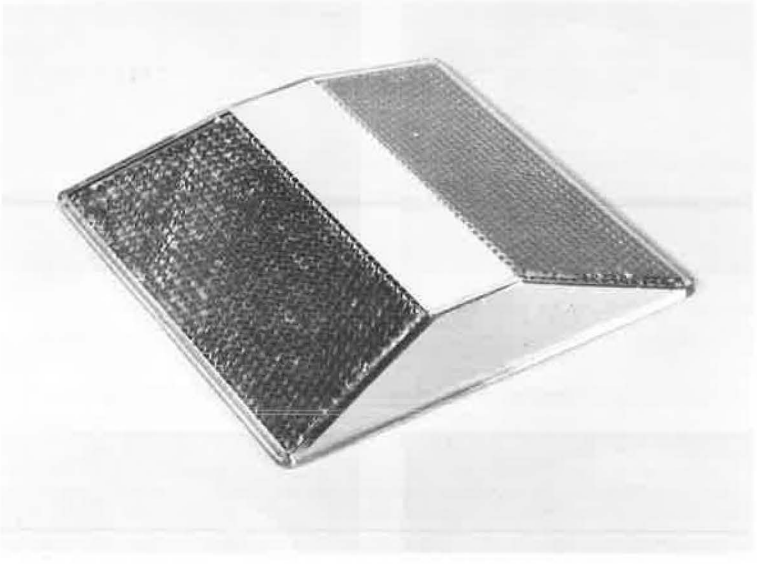

Figure 16. Reflex reflector pavement marker.

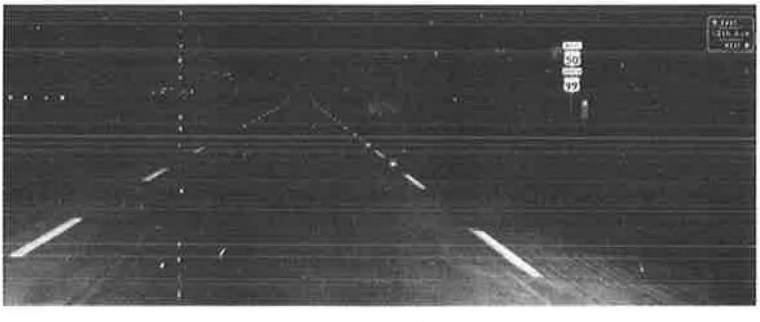

Figure 17. Reflex reflectors at night.

FINDINGS

Table 1 summarizes the uses of the various markers.

Extensive studies made of these experimental installations reveal the following pertinent facts concerning the suitability of the white plastic markers under various conditions.

1. The fully reflectorized markers (beaded) are ineffective for daylight delineation in clear and rainy weather, particularly on portland cement concrete. The glass beads scatter the sunlight causing the markers to have a grayish cast which blends in with the portland cement concrete.
2. The fully beaded button marker is more effective in rainy weather at night than is the wedge marker (Figs. 3 and 11).
3. On asphaltic concrete pavements, the wedge marker is more durable than the button type. Impact of traffic is less likely to cause failure in cohesion of the asphaltic concrete under the marker.
4. The glass beads used in the reflective button or wedge markers should contain the high index of refraction variety (1.90 minimum).

TABLE 1

Type*	Condition						
	Replace	Supplement	Inclement Night Only	Tunnel or Cont. Lights	Day and Night All Weather	One Way	Two Way
1A				X		X	
1B		X	X			X	
1C	X				X	X	
2A				X			X
2B		X	X				X
2C	X				X		X
3A				X		X	X
3B		X	X			X	X
3C	X				X	X	X

*1A = One-way wedge, non-beaded; 1B = One-way wedge, beaded;
1C = One-way wedge, half beaded; 2A = Two-way wedge, non-beaded;
2B = Two-way wedge, beaded; 2C = Two-way wedge, half beaded;
3A = Button, non-beaded; 3B = Button, beaded;
3C = Button, half beaded.

5. Under overhead lighting or in the daytime the nonbeaded markers are more effective than the beaded type in both clear and rainy weather.