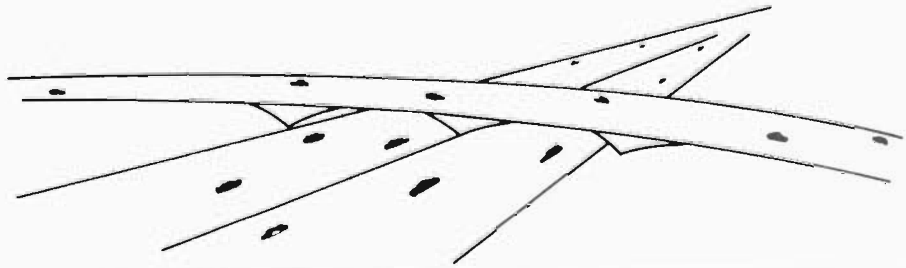

DEPARTMENTAL RESEARCH

Report Number **SS 27.0**

THE OVAL SHAPED RAISED PAVEMENT MARKER

STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

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16. Abstract

Numerous states and numerous offices in the Texas State Department of Highways and Public Transportation have experimented with and used raised pavement markers on highways and freeways since the 1950's. The Houston Urban office started an extensive research and usage of the raised markers on the urban freeways of Houston in the late 1950's. This report reflects those findings.

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THE OVAL SHAPED RAISED PAVEMENT MARKER

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February 1987

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The Oval Shaped Raised

Pavement Marker

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Numerous states and numerous offices in the Texas State Department of Highways and Public Transportation have experimented with and used raised pavement markers on highways and freeways since the 1950's. The Houston Urban office started an extensive research and usage of the raised markers on the urban freeways of Houston in the late 1950's.

The raised pavement markers presented better delineation to the motorist during inclement weather than traffic paint. Also, on the multi-lane freeways the raised marker configured stripes produces a rumble effect when the vehicle tires cross the stripe. This rumble effect alerts the driver to the fact that he is crossing out of his lane. The rumble therefore reduces sideswipe accidents. Thus the added cost of the raised pavement markers was justified.

The problems with the markers were:

1. Shape and height for best visibility
2. Button Strength
3. Durability (related, by not necessarily the same as No. 2)
4. Cost
5. Method of attachment to the pavement

The first buttons by Botts Dots Co. of California were thin, circular, flat plastic markers. The non-reflective markers had a slick top surface. The reflective markers were reflectorized by the means of paint and beads (Figure 1). The markers were too thin to be seen in the rain and the paint and beads quickly became non-reflective because of the accumulation of dirt and grime in the rough paint and bead surface. In addition the paint and bead surface was quickly ground off by the vehicular traffic. Botts then tried a thicker rectangular marker of the same materials (Figure 2). The new markers were more visible in the rain but the same dirt-wear failure occurred as before.

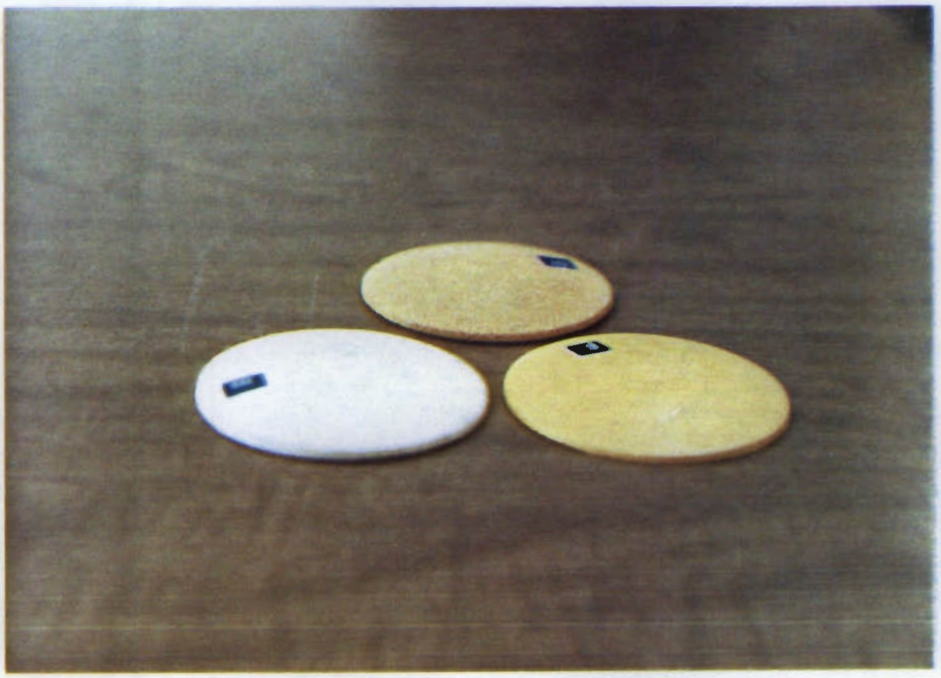

Figure 1: Showing Original Botts Dots Markers
Top Marker is reflectorized
Markers are circa 1950's

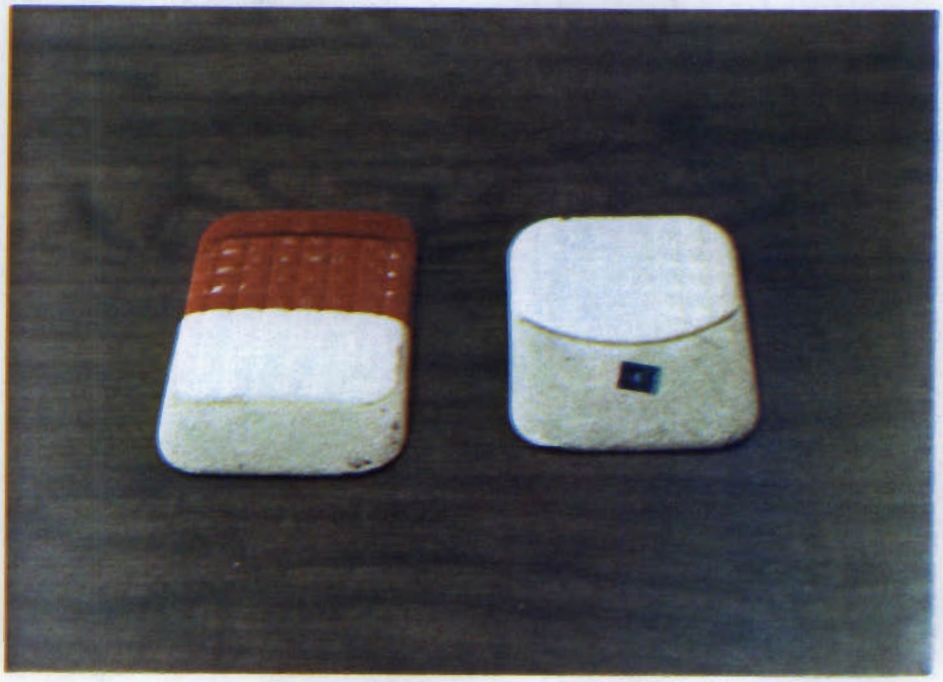

Figure 2: Showing the later version of the Botts Dots Markers. Circa early 1960's

Several manufacturers tried various shapes of markers but finally the dome shaped circular button 7/8" to 1" in height and approximately 4" in diameter proved to be the best shape in the early to middle stages of development (Figure 3).

Figure 3: Most Widely Used Marker

The various companies and users tried several methods of attachment of the markers to the pavement. Some tried nailing the markers to the pavement (Figure 4). Sometimes nails failed and sometimes the markers failed by breaking. Either method of failure produced exposed nails and thus flat tires and sometimes accidents.

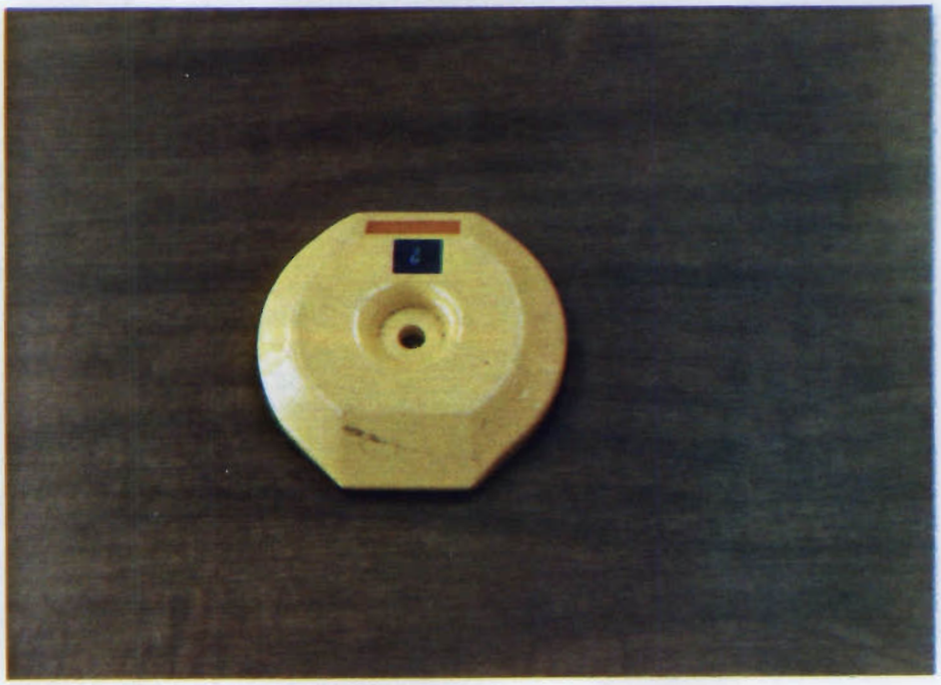

Figure 4: One of Numerous Nail Down Markers

Some markers were cast into the roadway surface (Figure 5). This method proved to be the most positive method of attachment, but it produced other problems. First, the cast in place markers were very labor intensive in placement. This made the cost of this type of attachment prohibitive. It also positively prohibits any revision to the pavement marking placement or alignment. This revision inability cannot be tolerated.

Figure 5: One Type of the Cast in to the Concrete Type Roadway Markers

The markers were attached by various tapes, glues, mastics and epoxies. The epoxy as basically developed by the state was finally adopted.

Numerous bottom surfaces of the markers were tried. Slick, rough, sand incased, waffle and circular concentric rings were all tried (Figures 6 and 7). The waffle and circular concentric ring bottoms trapped air and did not fill up with epoxy (Figure 7) thus less adhesion was realized than was produced by all the smooth or relatively smooth bottom surfaces.

Figure 6: Showing the Plain and Concentric Rings on the Bottoms of Circular Markers

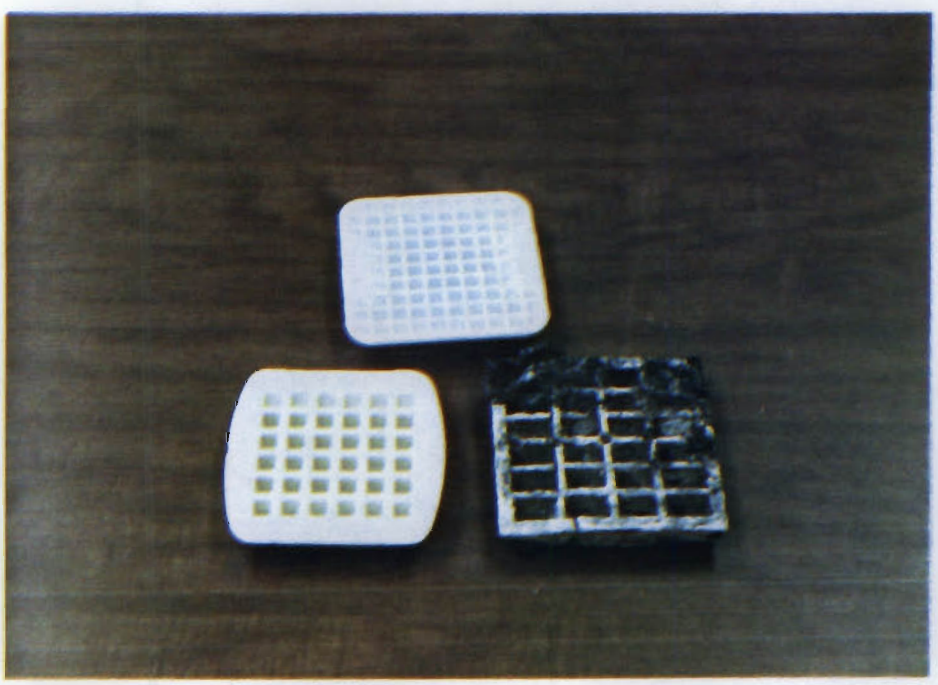

Figure 7: Various Waffle Bottom Markers. Note Epoxy did not fill the Waffle Bottom

Various plastic materials were tried but it was found that only compression molded plastic would be strong enough (Figure 8). Cast plastics broke easily.

Figure 8: A Compression Molded Plastic Marker that Proved Successful in the Field

Extensive work with American Clay Forming of Tyler Texas finally produced a ceramic heat fired clay marker that produced the most desirable circular dome shape (Figure 9). This marker was and is the most widely used non-reflective marker in Texas and numerous other states. The markers were and are attached by the means of epoxy adhesive.

Figure 9: Circular Dome Marker

In the early 1960's the Stimsonite Division of ESNA Corporation introduced a 4" x 4" square, 3/4" high reflective marker. The reflectivity was accomplished by the use of encapsulated reflective prisms. The inclined reflective surfaces were originally 20° to the horizontal (Figure 10). The 20° markers adhered to the pavement well. To gain reflectivity Stimsonite changed the incline to 30° (Figure 10). Reflectivity was increased but the marker loss rate also markedly increased. The increased surface incline produced more severe tire impact, which in turn increased the shearing action and marker loss. The loss included not only increased loss of adhesion but also marker body failure (Figure 11). This type of marker has been strengthened and is the marker predominately used for reflective markers. It must be noted that this type of marker has no daytime delineation.

Figure 10: Stimsonite Reflective Marker. Right Marker has the 20° Incline. Left Marker has the 30° Incline

Figure 11: Typical Body Failures of Stimsonite Marker

In 1975 the author suggested a new marker shape to several marker manufacturers. American Clay forming acted on the suggestion and produced a 4" x 5" x 7/8" (approximate dimensions) oval shaped dome surfaced non-reflective marker with a bisque surfaced bottom (Figure 12). This shape and increased surface area increased adhesion to the pavement. In addition only 4 markers were required to produce the same visible stripe as the 6 circular marker.

Figure 12: Showing Circular Dome Marker and the Original Oval Domed Flat Bottom Marker

The author then made another suggestion to ACF. The suggestion was to cast studs into the bottom of the marker to protrude into the epoxy thus to improve adhesion to the pavement. The pattern of studs would also allow the air to escape when the marker is pressed into the epoxy. Several sizes, lengths and patterns of studs were tried. Finally 1/8" diameter studs with 1/16" + lengths were tried. These studs seem through trial to be the best (Figure 13).

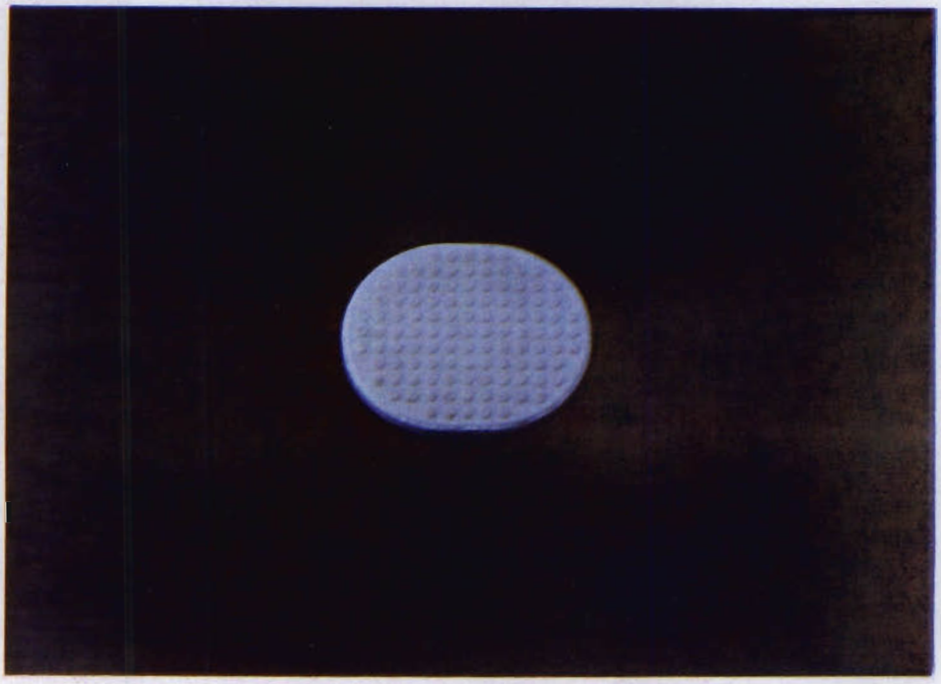

Figure 13: Oval Marker with Final Stud Configuration

A.C.F. tried several means of producing a reflectorized oval marker. Several reflectorized strips were recessed into the marker body. The strips were encapulated with several types and shapes of plastic and glass. They are now experimenting with an encapsulated prismatic reflector even though the reflectorized strip type reflective marker has enjoyed reasonable acceptance (Figure 14).

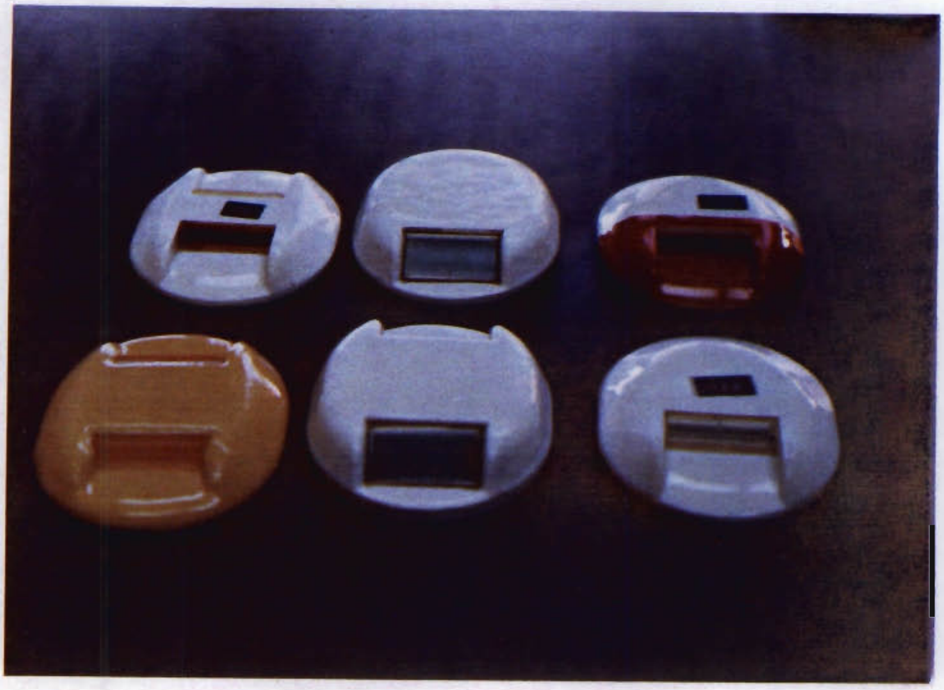

Figure 14: ACF Reflectorized Markers. Outside Markers contain the Encapsulated Reflectorized Strips. Center Markers are the new Encapsulated Prisms

In 1977 the Houston Urban office placed a test section of oval markers. Four hundred oval markers were placed on one lane line of a 3 lane portland cement concrete pavement section of Northbound US-59 in the I-45 interchange. The adjacent lane line was comprised of circular 6 marker stripe configuration. The oval dome markers were placed in the 5 marker configuration Figure 15).

Figure 15: 1977 Test Section of Stud Bottom Oval Markers. Note Maintenance Forces have striped over the Markers. Picture taken on 1-26-87

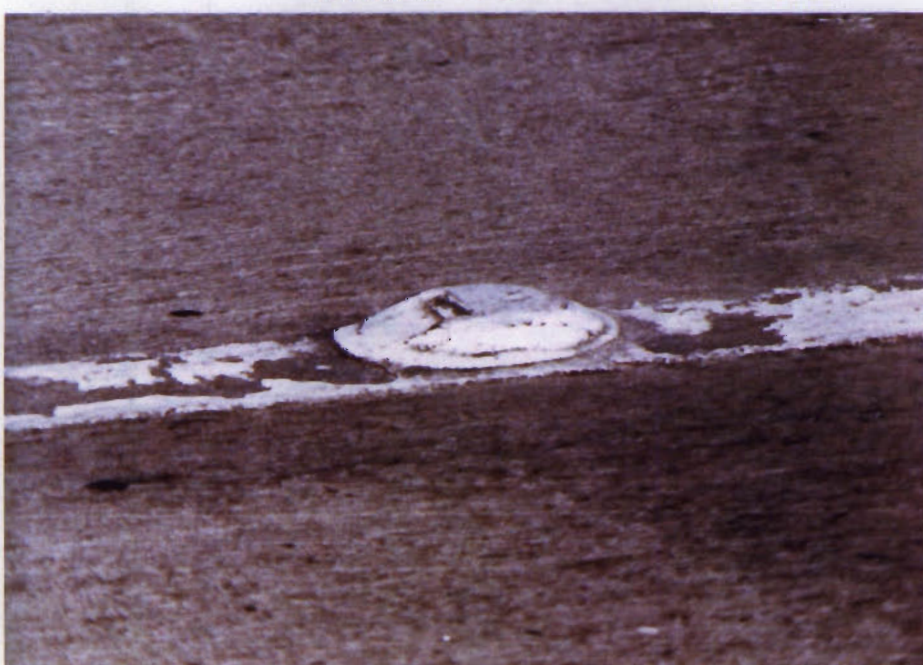

Figure 16: Ten Year old Marker in the 1977 Test Section. Note REflective Rod is Missing. Picture taken on 1-26-87

The US-59 freeway section had a 136,000 average ADT during the 10 years since placement. Heavy weaving movements were and are experienced in that section of freeway. The test section was frequently inspected. In six years the entire circular dome marker lane line was entirely replaced twice. The oval domed mar-

Figure 17: Typical Condition of Ten Year old Nonreflectorized Marker in 1977. Test Section. Picture taken 1-26-87

ker line experienced the loss of only 6 out of 400 markers in the same 6 year period. Never has such small loss figures been seen in all of the marker placements. After the sixth year of the test a previously unknown phenomenon was encountered. After 6 years the epoxy started releasing the markers. Heavy loss of the oval markers was experienced thereafter. Thus it was found that epoxy has a service life. It must be remembered that a marker installation never lasted over 2-3 years before this installation.

The epoxy service life does not seem to be a severe problem. On January 26, 1987 the test section was monitored. It was found that after 10 years of severe punishment 61 markers out of the 400 originally placed were missing. No maintenance of the oval marker lane line had been done in the 10 year period.

District 12 and Houston Urban were combined into one district in 1984. The Oval marker was reviewed by the combined district. The oval domed stud bottom markers are now being placed on all P.C.C. freeways in District 12 (Figure 18 and 19).

The new asphaltic mastic adhesive is now being allowed as an optional adhesive to epoxy. If the contractors choose the new mastic adhesive, District 12 personnel will carefully monitor the installation. The author does not expect 10 year longevity with the use of the mastic. The mastic is a petroleum product. Ultraviolet light and heat from the sun will leech out the solvents in the mastic in the exposed areas of the mastic. Then creep will set in under the markers further leeching the solvents under the markers. The mastic will become hard and brittle and will then lose adhesion. In addition the markers will tend to be pushed down into the mastic to the pavement surface. When this happens the markers will break and thus accelerate adhesion loss.

Figure 18: 1986 Contract Installation on I-45 (Gulf Freeway)

Figure 19: 1987 Contract Installation on I-10 (Katy Freeway)