3M HIGH-INTENSITY REFLECTIVE SHEETING DELINEATOR FAILURE

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MICHIGAN DEPARTMENT OF STATE HIGHWAYS

3M HIGH-INTENSITY REFLECTIVE SHEETING DELINEATOR FAILURE

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Research Laboratory Section
Testing and Research Division
Research Project 54 G-73
Research Report No. R-665

State of Michigan
Department of State Highways
Lansing, February 1968

OFFICE MEMORANDUM

MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

February 15, 1968

To: R. L. Greenman
Testing and Research Engineer

From: L. T. Oehler

Subject: 3M High-Intensity Reflective Sheeting Delineator Failure. Research Project 54 G-73. Research Report No. R-665.

In accordance with your request of November 20, 1967, delineators on M 47 near Owosso, M 72 near Mio, and M 32 in Otsego County were examined on December 5, 1967. The delineators were observed in daylight and under headlight illumination. Similar delineators on M 36 between Mason and Dansville were tested.

The delineators consist of 3M brand (No. 3870) High-Intensity Reflective Sheeting mounted on 3 in. by 12 in. aluminum panels. Available information indicates that the delineators have been in service approximately two and one-half years and were placed on rural State highways to delineate curves greater than three degrees. Delineators are mounted on both sides of each delineator post and the posts are spaced from 30 to 80 ft apart.

Daylight observations indicated that more than 50 percent of the delineators showed evidence of failure. Failure as shown in the white areas of the delineator in Figures 1 and 2 was typical. An explanation for the failure was not readily apparent since neither direction of traffic, direction of exposure, area of contact with the delineator post, nor surface scratches or cuts were observed to be related to failure.

Nighttime observations showed that the areas of failure did not reflect headlight illumination. Figure 3 shows nighttime appearance. It should be noted that the delineators are generally located in areas void of any lights or lighting and therefore even poorly performing reflectors are noticeable. Some of the delineators appeared improperly aimed but this may have resulted from the attempt to delineate both traffic directions with back to back devices or from vehicle collisions.

A 3M delineator that had been in service and contained a typical area of failure was photometered. The delineator had approximately 1/3 the brightness of a new delineator and the area of failure had approximately 1/100 the brightness of a new delineator.

The delineator was examined macroscopically and observations were as follows:

1. The delineator is made of individually sealed cells which are outlined in white on Figures 1 and 2.

2. Each cell consists of glass beads partially embedded in a white resin matrix.

3. The cells are covered with a clear plastic.

4. The surface of the delineator has a rippled appearance indicating poor application technique. A 3M representative stated that the rippling resulted from expansion of the sheeting after a cold application.

5. Edges show evidence of adhesion failure but this can be expected because of the rippling.

6. Most of the cells along the delineator edges have the white appearance related to failure.

7. Delamination, or loosening of the surface plastic, is evident especially near the edges.

Microscopic examination showed the following:

1. Beads in cells of failure have a milk-white appearance.

2. Beads in cells of failure are not embedded in the substrata more deeply than beads in normal cells.

3. Forcing beads of normal cells further into the substrata did not produce the milk-white appearance.

These observations do not explain the reason for failure but bead appearance indicates that the beads may be coated and that this coating has corroded to give a milk-white appearance. It is doubtful that materials within the cell would be responsible for this change and therefore failure of cell seal through the plastic front surface or the adhesive rear surface is indicated.

A 3M representative stated that his company is aware of the failure of the High-Intensity Sheeting and has taken steps to remedy the problem. Application techniques have also been revised to avoid rippling. The sheeting is warmed and stretched prior to application.

Improvement appears essential because the optical performance of the High-Intensity Reflective Sheeting, when compared with the optical performance of button-type reflectors, shows that the use of glass beaded sheeting for delineators is questionable. Good delineators should be as bright as possible and should maintain this brightness more than five years.

Graph I compares the optical performance of 3M High-Intensity Sheeting and a colorless cube corner delineator. The graph shows the effect of the reflector's orientation angle on each reflector's specific brightness when the viewing angle is varied. From inspection we note that the cube corner reflector has a much higher specific brightness than the beaded reflector at all orientation angles until the viewing angle approached 0.5 degrees. As the viewing angle approaches 0.75 degrees, specific brightness of the two materials is approximately equal. The 0.75-degree angle is a good approximation of driver viewing geometry at 300 ft. Graph II shows the optical performance of a new sample of 3M High-Intensity Sheeting and a new cube corner center mount delineator along with the optical performance of similar materials after approximately two and one-half years of service. Again the specific brightness is shown at the three orientation angles of 0, 20, and 30 but only at the one-half degree viewing angle. Again we see that the cube corner reflector has a higher specific brightness than the beaded reflector and also that field service has little effect on the cube corner reflector at geometries approximating short-distance driver viewing. Similar data graphed for 0.2 degree viewing showed that the cube corner reflector lost more than one-half of its original specific brightness. Figure 4 shows the daylight appearance of a new cube corner reflector and also the appearance of the cube corner reflector used to represent optical performance after field service.

These data show that so-called wide angle reflective materials do not necessarily show the greatest brightness and that button-type delineators after severe service lose little of their initial brightness at geometries associated with short-distance viewing.

TESTING AND RESEARCH DIVISION

L. T. Oehler

L. T. Oehler, Director
Research Laboratory Section

LTO/MHJ:sjt

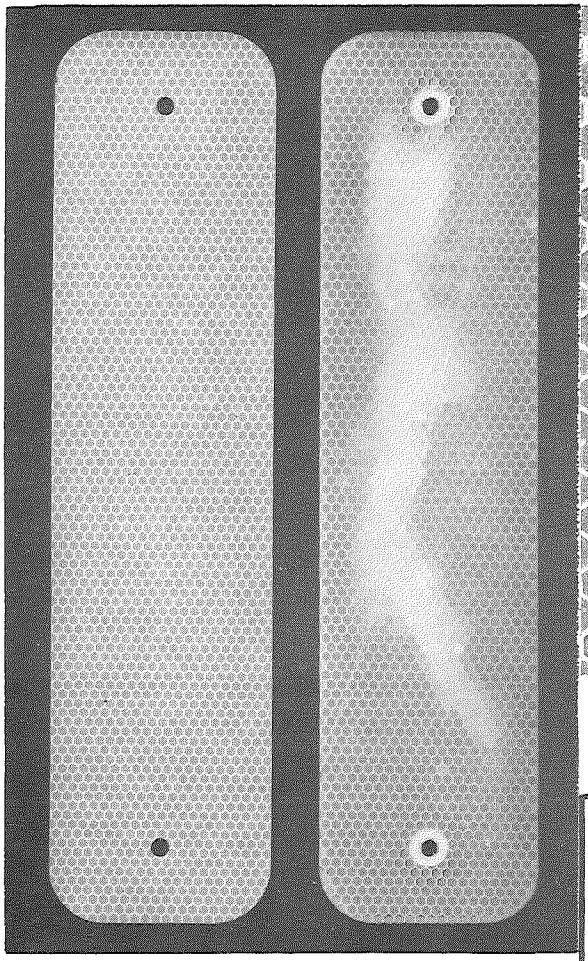


Figure 1. High-Intensity Sheeting delineator's daylight appearance; new delineator and field service sample showing failure.

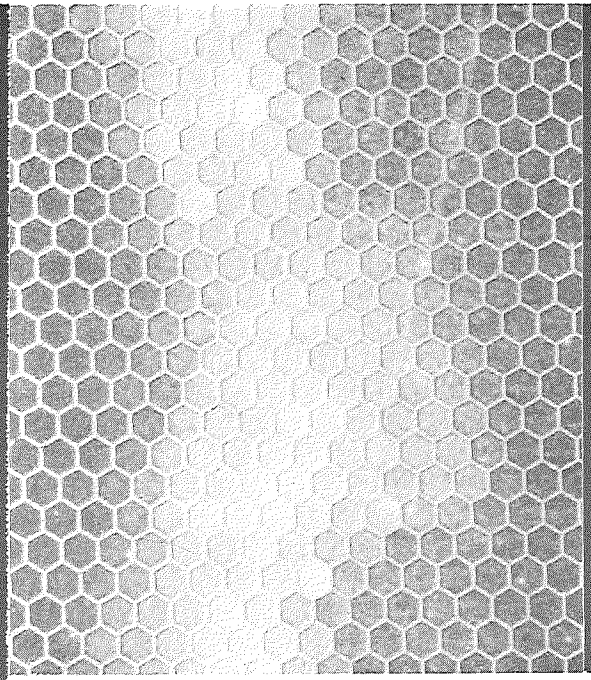


Figure 2. Daylight appearance of failure area.

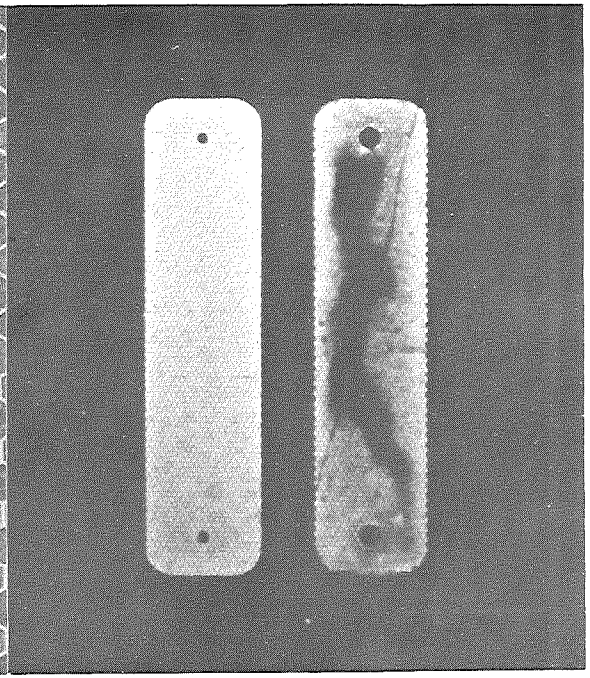


Figure 3. Nighttime appearance of delineators shown in Figure 1.

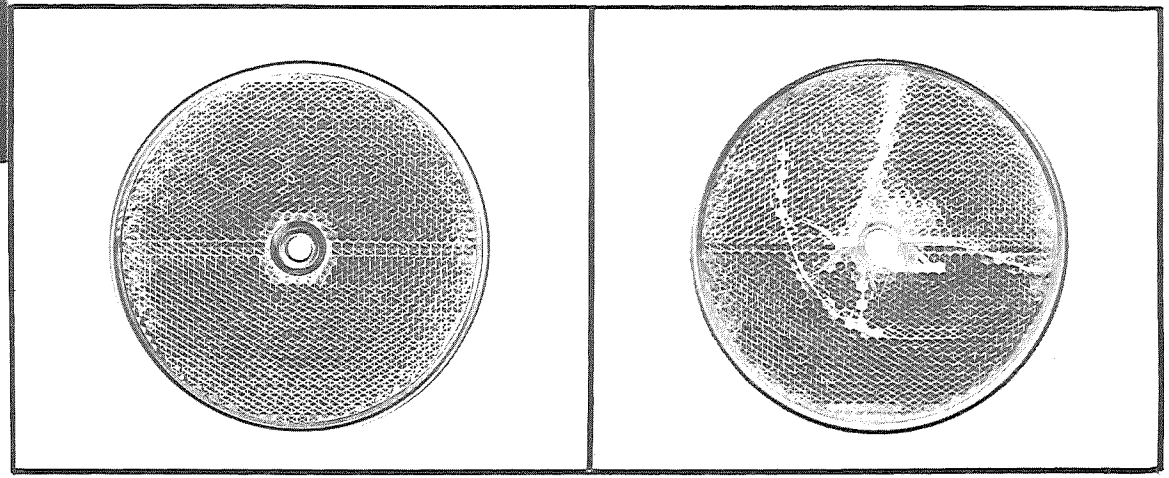
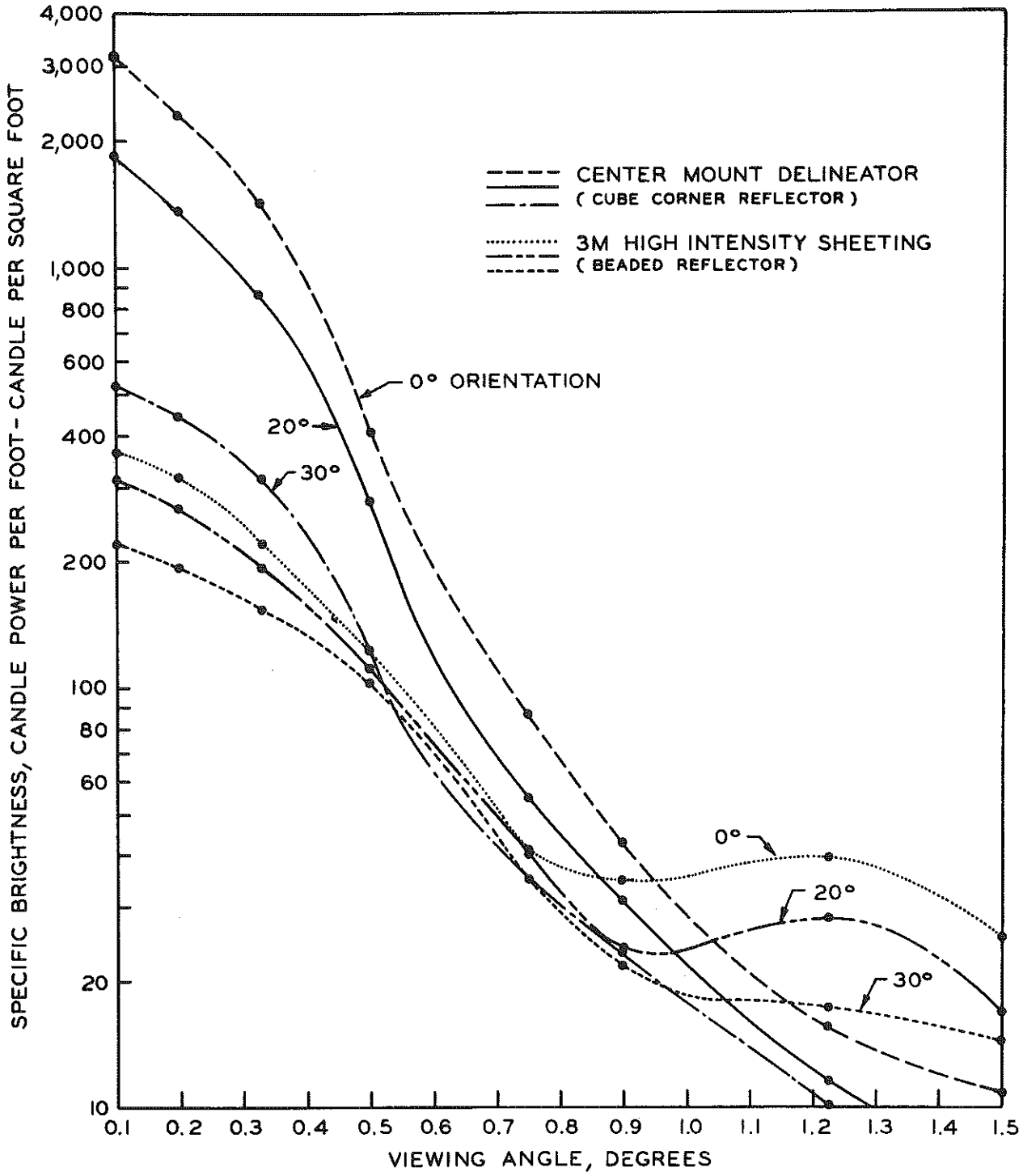
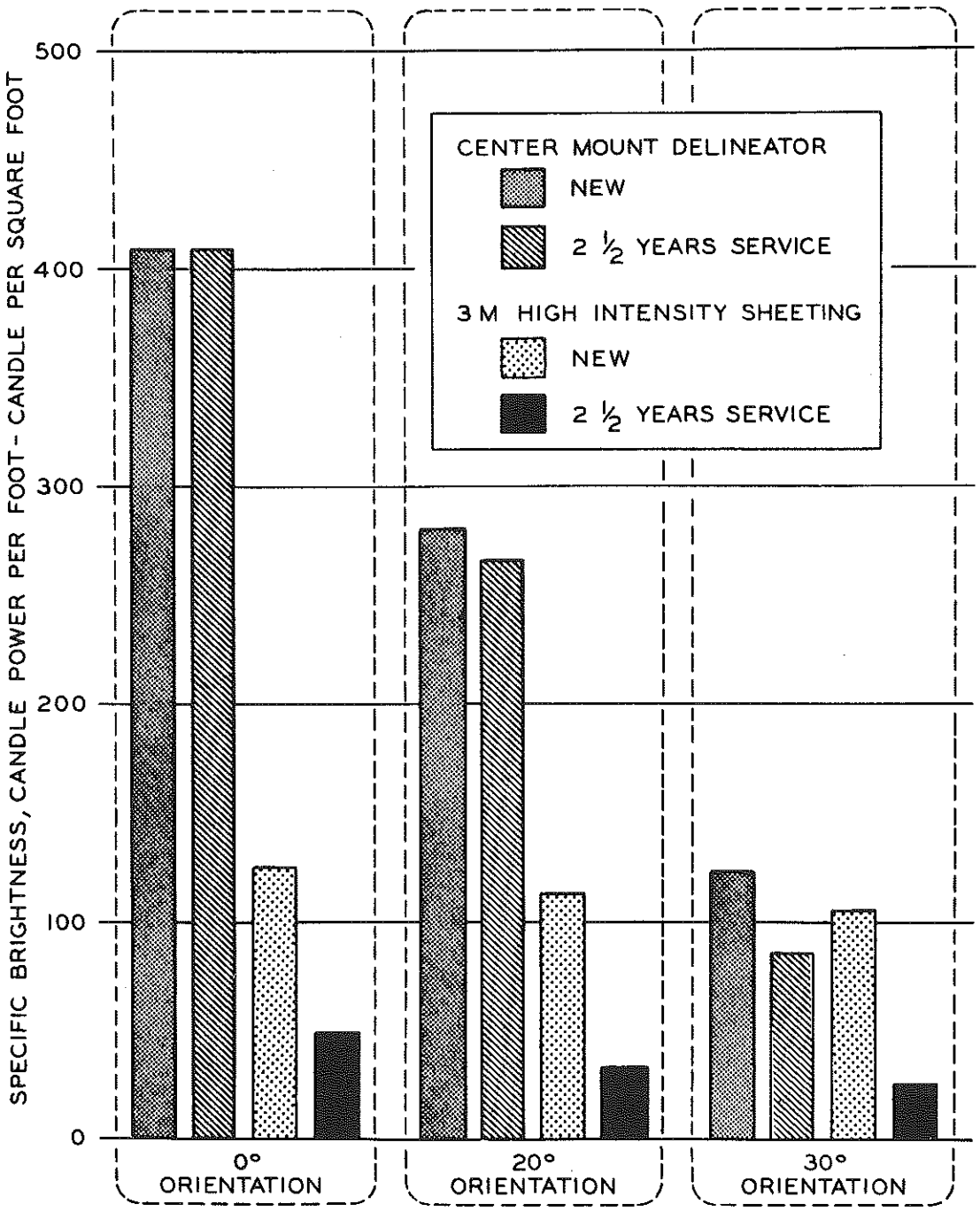


Figure 4. Cube corner delineator's daylight appearance; new and field service sample.



GRAPH I
Effect of orientation on specific brightness
at various viewing angles



GRAPH II
Effect of age on delineator brightness
at 1/2 degree viewing angle