

R-717

OFFICE MEMORANDUM

September 11, 1969



MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

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To: R. L. Greenman
Engineer of Testing & Research

From: L. T. Oehler

Subject: Corrosion-Resistant Guardrail. Research Projects 60 G-102, 62 G-113, and 62 G-122. Research Report No. R-717.

In accordance with your request of May 23, 1969, also transmitting applicable correspondence from G. J. McCarthy and W. A. Sawyer, we have inspected the small footage of corrosion-resistant guardrail (ASTM A 588-type) that the Department has under experimental field exposure.

Before presenting our comments on the inspection we think it timely to summarize our highway guardrail program and specifications, as presented by A. J. Permoda, below.

Guardrails in Use and Test

Prior to World War II guardrail was not extensively used. That which was used consisted of stranded galvanized cable, sometimes overcoated with white paint by maintenance personnel. Maintenance was not a significant problem under low and slow traffic and less demanding deicing and snow removal requirements.

After World War II the cable guardrail gave way to the plate type which evolved through several shapes to the current one, now a national and international standard. The steel guardrail was factory primed and, after installation, overcoated with two coats of white paint to provide good hazard-delineation. However, with increasing traffic and its demands, this paint system could not withstand, (a) the corrosive effect of deicing salts and (b) snowplow abrasions in the cold of Winter and had to be topcoated on about a two-year cycle. Since guardrail mileage had also increased, this was presenting a maintenance problem.

Galvanized Guardrail: In 1957 as an experimental preventative maintenance measure, the Department substituted galvanized guardrail for painted ones on two projects: M 78 east of East Lansing and medians of the two Freeways in Detroit. Topcoating with white paint to improve delineation was judged unnecessary and was not required. The installations met quick acceptance and resulted in the Department's revision of specifications requiring the galvanizing. To our knowledge we were one of the first states to adopt the galvanizing revision.

The two original galvanized installations have been maintenance free, regarding coatings, during their 12 years of service. They are now showing weathering loss of galvanizing on the top portions of the railings which will spread, necessitating coating replacement within several years (Fig. 1). On a few subsequent installations, notably I 96 in Farmington and US 127, north of Jackson, the weathering-away loss of galvanizing has been at a slightly faster rate, for unknown reasons.

In Spring 1962, aggressive spotty deterioration of galvanizing on guardrails was noted on some new installations, notably the then-designated I 196 in Grand Rapids. This Winter-connected deterioration has occurred to varying extent on other installations. A bad case was noted on I 496 in Lansing in early 1969 (Fig. 2); but a short installation, also made in 1968, on US 27 in North Lansing on structure X01 of 33034 showed no attack. Observing this type of chancy deterioration we have noted that it is most apt to occur on new galvanizing before weathering can develop a protective oxide. It is also more apt to occur on certain areas of a highway system. This deterioration, most noticeable at the Spring thaw, is due to impingement of de-icing salts and/or encasement by snow or salt-laden snow, and appears to be governed to some extent by snow removal procedure. Other Northern-belt states are experiencing the same problem.

Aluminum Guardrail: The Department is evaluating the performance of aluminum guardrail on two projects. The first was installed in 1959 on US 27 in North Lansing on structure X01 of 33034. The fronts of the rails have performed very well, but the lap joints at the posts are showing a most aggressive deterioration which could have been minimized had galvanized or wood posts been used (Fig. 3). The second was installed on I 296 in Grand Rapids in 1962. It is a bigger installation, being about a mile long. As of this date, it shows almost none of the lap joint deterioration, though the same painted steel posts are used as in Lansing. The reason for this difference in behavior is not known. However, a disadvantage would be the high thermal coefficient of expansion which causes some strains in the aluminum railing (Fig. 4).

ASTM A 588-type Steel Rails: The Department is evaluating the performance of small footage of corrosion-resistant alloy steel guardrail on two projects. The first was installed on I 96 south of Lansing in February 1963 at two locations: ten lengths at the M 99 crossing and six at the US 27 (M 78) crossing. The second was installed later in 1963 on I 75 north of Pontiac, just north of the US 10 crossing and included 20 lengths on the east and west shoulders.

As of this date, the alloy steel guardrails have a good appearance due to development of a uniform coating of protective oxide, though at an earlier inspection two locations showed blotchiness due apparently to salt splashes. The lap joints showed no accelerated deterioration.

Regarding their daytime delineation, inspecting personnel rated them as being more neutral, i. e., providing less striking contrast than the galvanized railings. However, the daytime delineation was rated as adequate (Fig. 5).

The nighttime visibility was harder to rate, complicated by the small footage in service. The I 75 installations, without the reflective washers, provide reduced delineation. The I 96 installations, with the reflective washers, provided good spot delineation on the night they were inspected and photographed (Fig. 6). Their nighttime delineation under variable weather conditions is not known. (It should be mentioned that the reflective washers are most subject to road dirt pick-up and hence reduced reflecting efficiency, and that the reflective sheeting would need replacement at intervals as it does on signing).

Recommendations

The following recommendations are made regarding the several types of guardrails under test and observation.

1. Aluminum Guardrail -- Defer recommendations pending further observations on the variable performance of test railings.


2. ASTM A 588 Alloy Rails -- The small footage under test has performed well enough to merit additional evaluation on larger footage in other projects, especially regarding its ability to delineate adequately under variable weather. The additional footage should include the reflective washers.

3. Galvanized Guardrail -- The galvanized guardrails in service have lengthened the maintenance recoating cycle to 10 to 15 years compared to the former two-year cycle for the painted rails. Experience shows that the currently specified thickness of galvanizing will last about 15 years, although a minor portion will last fewer years because of localized deicing salt attack, "white rusting."

Because of their good performance including, (a) lower installed cost and lower maintenance cost than painted railings, and (b) proven good delineation, we recommend that galvanized guard rails continue to be used until better types are found. In the meantime the Department should study the possibility of increasing the coatings' life by:

1. Increasing the thickness of the galvanizing and,
2. Requiring a low cost spray-on coating, similar to auto under-body types, to be applied on railings after installation, to prevent the deicing salt attack sometimes noted on new railings.

TESTING AND RESEARCH DIVISION



Engineer of Research
Research Laboratory Section

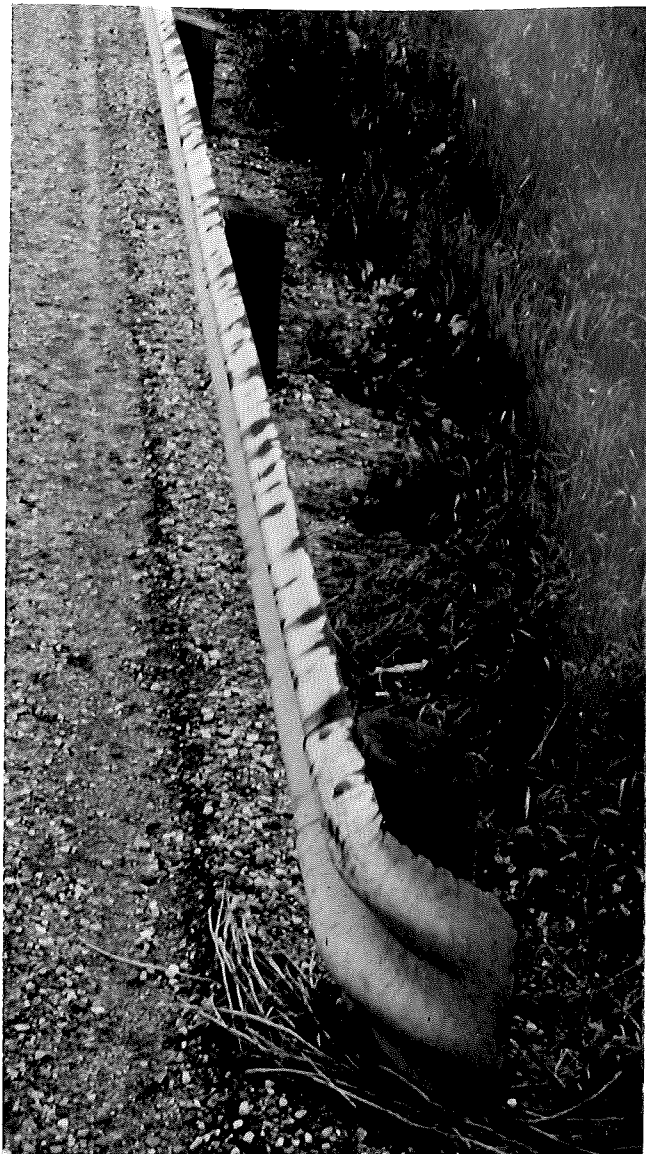


Figure 1 (left). Typical 12-yr old galvanized guardrail, showing spotty weathering-away loss of zinc coating (red rusting) on the top portion, spreading from the cut ungalvanized edge. WB M 78 W of M 47 (June 1969).

Figure 2 (right). Appearance of galvanized end-wing on I 496 in Lansing after one Winter's exposure. This was the worst railing on the project, showing much white and red rusting. Railings installed about November 1, 1968 were unable to develop protective film before Winter. The new buried type end-wing with its reflective washer is particularly susceptible since it resembles a damaged trough.



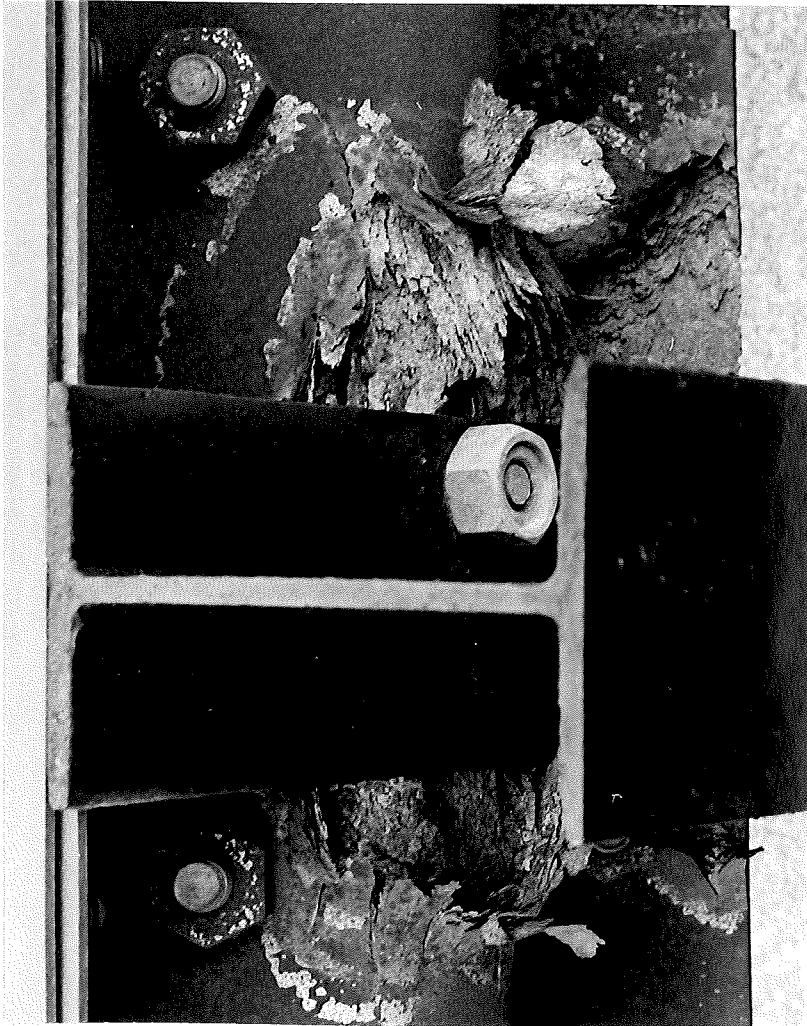


Figure 3 (above). Aluminum guardrail after 10-yr service shows bad corrosion where joined to painted steel post. Attack is judged to be a combination of mostly bi-metallic and some chloride corrosion. US 27 in North Lansing (July 1969).

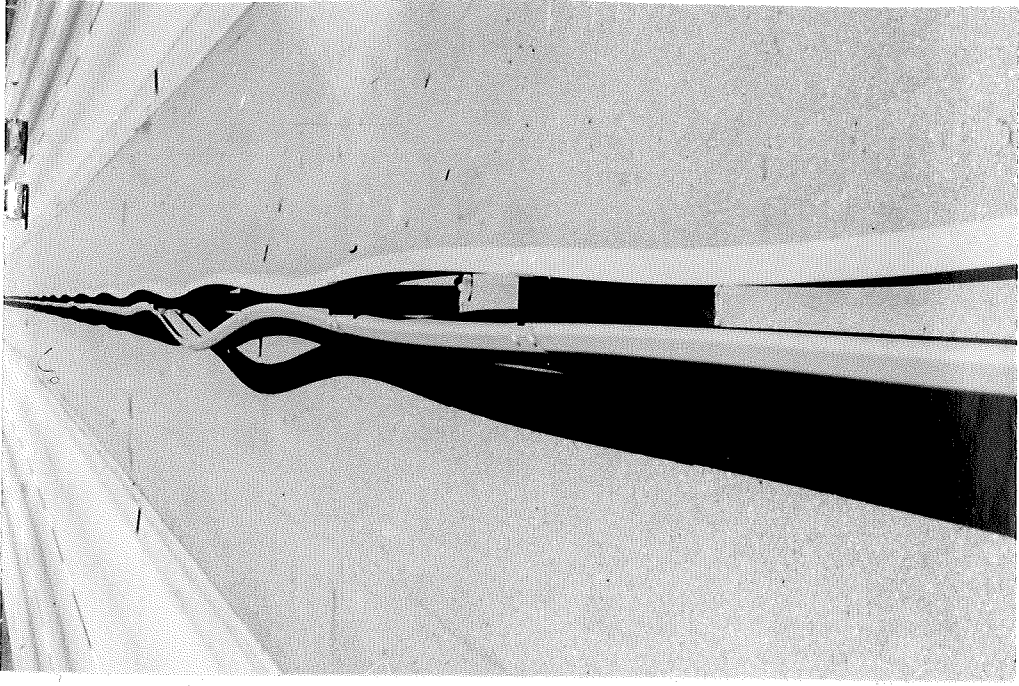


Figure 4 (right). Aluminum guardrail on I 296 in Grand Rapids shows expansion and bulging in the heat of Summer, breaking bolt on one post (left). However, no significant lap corrosion was evident, here, where joined to steel posts (August 1969).



Figure 5. Daytime appearance of galvanized and unpainted alloy steel guardrails on SB I 75 N of Pontiac after about 6 yrs of service. The rails at either end are galvanized as are the four in the middle (damaged replacements).

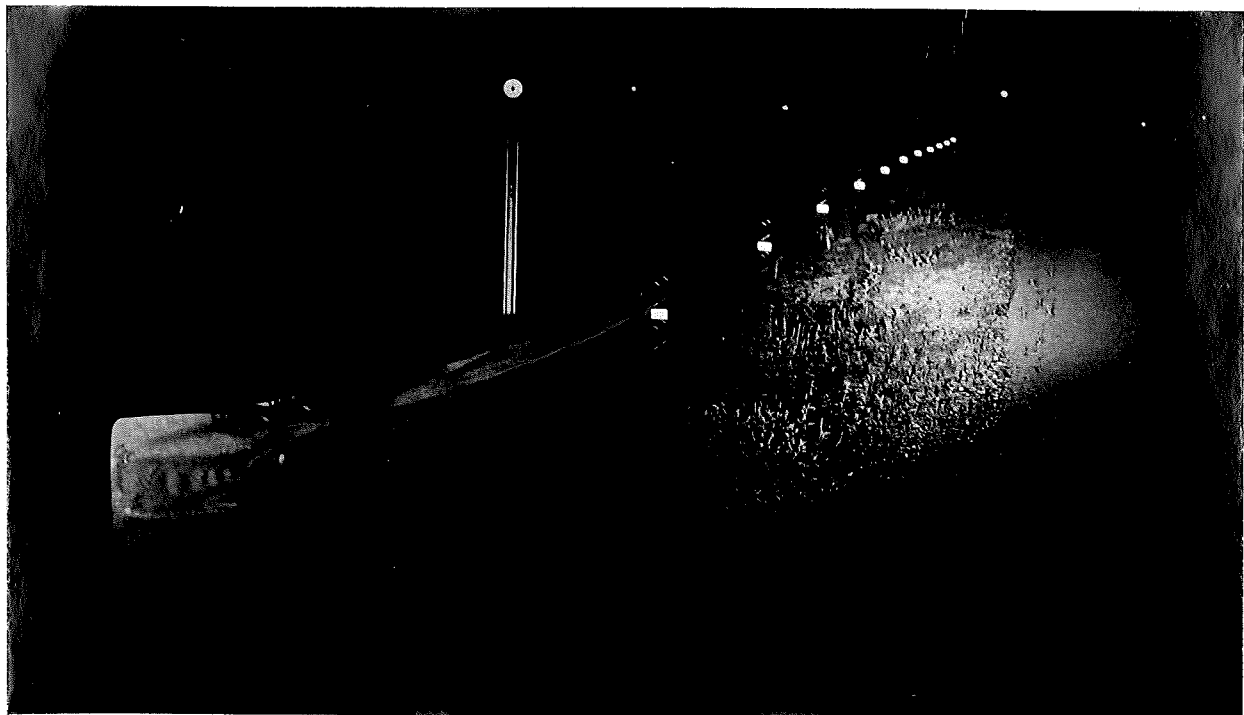


Figure 6. Nighttime appearance of mixed guardrails on I 96 at M 99. End-wing and curved section (left) are galvanized, 10 straight rails (right) with reflective washers are low-alloy corrosion-resistant steel. Reflective washers were wiped clean before photographing.