

EVALUATION OF 588 WEATHERING STEEL GUARDRAIL LAP SPLICES  
PROBLEM SOLVING 91-30

INTRODUCTION

Research and Development recently completed an investigation for the Bridge Design Section regarding A588 steel guardrail posts. This report recommended that the specifications be revised to exclude the corrosion resistant steel posts. Because of this study and Research Report No. R-1155 issued by the Michigan Department of Transportation, the Design Division has questioned the durability of weathering steel guardrail lap splices. They believe the overlapped portion of the guardrail beam may exhibit deterioration similar to the underground portion of the posts. Therefore, the Research and Development Section was asked to evaluate the performance of the lap splices on several projects.

Many States, including Maine, use A588 weathering steel guardrail on certain bridge and highway projects. This type of guardrail is fabricated from a special composition steel product which under normal weathering conditions develops a protective oxide coating that inhibits further corrosion. However, there are limitations to this coating. Weathering steel does not develop a tight oxide coating if the steel remains wet for long periods of time or if it is contaminated by salt.

This investigation is primarily concerned with the concealed portion of the guardrail at the overlapped joints. One would expect this area to be less corrosion resistant because salts and moisture could build up and affect the oxide coating. The lack of alternate wetting and drying also prevents formation of the protective layer.

However, the exposed beam area may seem to be in excellent condition when in fact it is rapidly deteriorating at the joint. Maine has many different environments that could also affect A588 guardrail performance. Coastal Maine as well as interior Maine projects were visually examined for this study. Strength tests, other destructive tests, and thickness measurements were not considered to be part of this problem solving report.

INVESTIGATION PROCEDURES

The Bridge Maintenance Section and the Bridge Design Section compiled lists of projects that were constructed in the 1970's and 1980's with A588 weathering steel guardrail. Several projects from these lists were chosen for this research investigation. The selected sites are situated on bridge and highway projects in Division 2 (Coastal) and Division 7 (Interior). Various ages of guardrail were inspected but the older installations (mid to late 1970's) give the best indication of long term durability.

Division Maintenance crews assisted Research and Development during the field inspections. The crews disassembled one section of the guardrail beam by using a welding torch to cut off the corroded bolts. After removing the beam, the lapped splice areas were visually inspected. A wire brush was also used to remove any loose scale in order to evaluate the protective oxide coating. Black color indicates a non-protective coating and scale or flakes indicate deterioration of the coating. The environmental conditions were also noted and photos were taken for documentation.

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The guardrail locations included in this investigation are listed below:

- 1) Panley Avenue Bridge, West Paris.
- 2) Bog Brook Bridge, Minot.
- 3) Dead River Bridge, Greene.
- 4) Eagle Lake Bridge, Bar Harbor.
- 5) Route 102, Mt. Desert (1980 Project).
- 6) Route 102, Mt. Desert (1982 Project).

#### FIELD OBSERVATIONS

Guardrail investigations were conducted during January and February of 1991. The results of the six guardrail inspections are described below:

##### Panley Avenue Bridge, West Paris, Maine:

This bridge project in interior Maine was constructed twelve years ago and has an extensive amount of A588 guardrail. The inspection revealed that minor corrosion was present when the surface was scraped with a wire brush. There was also evidence that the oxide coating had not formed in valleys and crest of the lap splice. A typical lap splice is shown in photos No 1 and 2. Note the tight oxide coating on the exposed portion of the beam as compared to the irregular surface on the lap splice.

##### Bog Brook Bridge, Minot, Maine:

This projects constructed in 1979, has an extensive amount of A588 weathering steel guardrail on the bridge approaches. There were signs of deterioration on the overlapped joints. Photos No 3 and 4 show that minor pitting and flaking have occurred, especially at the top and bottom portion of the joint.

##### Dead River Bridge, Greene, Maine:

This bridge was constructed in 1977 and the A588 steel guardrail is performing well. There was no evidence of corrosion or black spots present on the guardrail beam or lap splices. This project is in an open area where the sunlight can keep the guardrail dry which improves the performance of the A588 steel. However, photo No 5 indicates that the oxide coating is not providing uniform protection at the lap splice.

##### Eagle Lake Bridge, Bar Harbor, Maine:

This bridge was constructed in 1975 and has one of the oldest A588 steel guardrail installations. This project is located in a coastal environment and contains a large amount of A588 guardrail. Extensive deterioration was observed and when the flakes were removed, a black color confirmed the lack of protective oxide film. Although corrosion is a concern, the rail does not appear to be in any danger of failure. Photos No 6 and 7 show the corrosion. Note the extreme difference between the exposed and concealed portion of the beam.

Route 102 Mt. Desert, Maine: (1980 project)

This project was constructed ten years ago along Echo Lake. This guardrail was not as old as the Eagle Lake guardrail and the deterioration was not as extensive as that described at the Eagle Lake Bridge. However, the A588 guardrail is located in a tree shaded area and exhibits discoloration, pitting, and flaking. There were also black spots after wire brushing the rail overlap areas which indicate poor coating performance. Photo No 8 shows the serious deterioration that has occurred in the coastal environment.

Route 102 Mt. Desert, Maine: (1982 project)

This project was constructed in 1982 and is also located on Echo Lake. It is 1 1/2 miles from the above Mt. Desert project. This location has an extensive amount of A588 steel guardrail, but it is in better condition than the guardrail on the Mt. Desert project. Some flake spots and corrosion have started to appear in the overlap areas but wire brushing did not expose any black color. Photos No 9 and 10 clearly show the advanced deterioration that has occurred after only 8 years.

DISCUSSION AND CONCLUSIONS

- 1) All of the sites investigated confirm that the overlapped portion of A588 steel guardrail beams deteriorate faster than the exposed section of the beam. Moisture and salt concentration in the overlapped area undoubtedly contribute to this increased corrosion.
- 2) The three guardrail sites in the coastal environment have experienced much more deterioration than the three locations away from the coast. The rate of corrosion at the lap splices is also higher on the coast. (Two of the three coastal installations were newer than the interior installations yet they have more extensive corrosion).
- 3) Although the lap splices clearly indicate loss of the protective coating, there are no signs of perforations or extensive metal loss. The structural integrity of the lapped joint does not appear to be affected at this time.
- 4) The exposed portions of the A588 steel beams are performing satisfactorily. The lap splice is the weak link in the guardrail system.
- 5) One of the benefits of using A588 steel guardrail is long life with no maintenance. This research indicates that this claim is not totally valid for all Maine locations. For comparison purposes the galvanized guardrail should be considered maintenance free also because no maintenance is performed even in the coastal environment. (Maintenance personnel have stated that galvanized guardrail is only repaired when damaged by vehicles, plows, etc.). Therefore reduced maintenance is not a reason to use A588 steel rather than galvanized steel guardrail.
- 6) A588 steel guardrail does not appear to be cost effective. The average price for 1989 and 1990 is approximately 1.5 times the cost of galvanized guardrail. There is also additional maintenance costs associated with stocking both A588 steel and galvanized steel guardrail replacement beams.

#### RECOMMENDATION

We recommend that the Design Division review their current policy regarding the use of A588 steel guardrail. This study has confirmed that the lap splices corrode much faster than the exposed portion of the beams especially in the coastal environment. Weathering steel guardrail is also more expensive to install than the traditional galvanized guardrail but it does not provide any additional life or reduced maintenance. Therefore the Design Division should determine if the esthetic value warrants use of this material on future projects.



Photo No. 1 West Paris



Photo No. 2 West Paris

Photo No. 3 Minot



Photo No. 4 Minot



hoto No. 5  
Greene



hoto No. 6  
Eagle Lake



hoto No. 7  
Eagle Lake





Photo No. 8  
Mt. Desert



Photo No. 9  
Mt. Desert



Photo No. 10  
Mt. Desert