CORROSION OF ALUMINUM POSTS FOR BRIDGE RAILINGS

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

CORROSION OF ALUMINUM POSTS FOR BRIDGE RAILINGS

C. J. Arnold
M. A. Chiunti

Research Laboratory Section
Testing and Research Division
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E. V. Erickson, Chairman; Charles H. Hewitt,
Vice-Chairman, Claude J. Tobin, Peter B. Fletcher
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This report presents results of the sampling and metallurgical examinations of portions of the aluminum railing installed on a pedestrian overpass (Structure PO8 of 82194) located just south of the River Rouge high-level bridge on I 75. The investigation was initiated at the request of M. N. Clyde, Testing and Research Engineer.

The purpose of this investigation was to determine the cause of the severe corrosion problem being experienced by the baseplates of the railing at this structure, and provide possible solutions. Figures 1 and 2 show the extent of corrosion on the baseplate of the posts. As can be seen in Figure 2, at some locations the corrosion progressed to the point where the posts have broken loose from the baseplates. As of this writing, temporary repairs have been performed by cleaning the corroded baseplates and rewelding the posts (Fig. 3).

Metallurgical Samples

A total of five samples were removed from different portions of the railing. The samples consisted of approximately 1-in. diameter plugs removed from either the post flange or the baseplate. Four of the samples were removed from baseplates at locations exhibiting different degrees of corrosion. Only one sample was removed from the flange of a post since all of the posts are in about the same condition, and not badly corroded.

All of the samples were removed from the left side (outside of spiral), of the west access ramp. Table 1 shows the location and condition of each sample as determined by visual observation.

TABLE 1

Sample No.	Location[1]	Condition
1	Flange of post 4	Good
2	Baseplate of post 16	Heavy corrosion
3	Baseplate of post 17	Good
4	Baseplate of post 4	Medium corrosion
5	Baseplate of post 15	Previously repaired

[1] Posts numbered in ascending order from bottom to top of ramp.

Samples 1, 2, and 3 were submitted to the Charles C. Kawin Metallurgical Laboratories for chemical analysis.

Results

The results of the chemical analysis are shown in Figure 4. A brief discussion of the results of the chemical analysis of the submitted samples follows.

Sample No. 1 -- Results of the chemical analysis showed this sample to meet the requirements of aluminum wrought alloy 6061 except for the chromium content which is low. This, however, does not seem to be preventing the alloy from performing adequately.

Sample No. 2 -- This sample meets chemical requirements for aluminum wrought alloy 2024.

Sample No. 3 -- This sample meets all chemical requirements for aluminum wrought alloy 6061.

Conclusions

As can be seen from the results of the chemical analysis, the heavily corroded baseplate was determined to meet requirements for aluminum wrought alloy 2024. The plan details of the bridge railing for the subject structure clearly state that the railing assembly (posts, baseplates, rails, and rail caps) should have been constructed of aluminum wrought alloy 6061.

Aluminum alloy 2024 is a high copper content alloy; not the high magnesium, silicon alloy specified. On a descending A to E corrosion scale[1], alloy 2024 is rated E (lowest) for plates thicker than 1/8 to 1/4 in., while alloy 6061 receives a B rating for corrosion resistance when exposed to corrosive environments. In addition to the alloy initially having a very poor resistance to corrosion, the problem was aggravated by the welding process, the highly corrosive atmosphere present at this site, and by the periodic salt applications to the ramp during the winter months.

The problem evidently is the result of the use of improper materials by the fabricator.

Recommendations

Posts with corroded baseplates should be replaced since they will be a source of future problems. Deteriorated posts could be repaired by removing faulty baseplates and replacing them with new ones of alloy 6061, using proper welding procedures (improper welding can lead to further corrosion problems); however, the cost of such an operation would be considerable.

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[1] "Aluminum - Properties, Physical Metallurgy and Phase Diagrams," Table 3, p. 238.

District Maintenance personnel have indicated that they have a source for used posts in good condition that can be obtained for replacement purposes. This seems to be the most reasonable course to follow.

Since the problem is the result of improper materials usage, and posts of the specified materials seem to be performing adequately, we see no reason to make changes in design at this time.

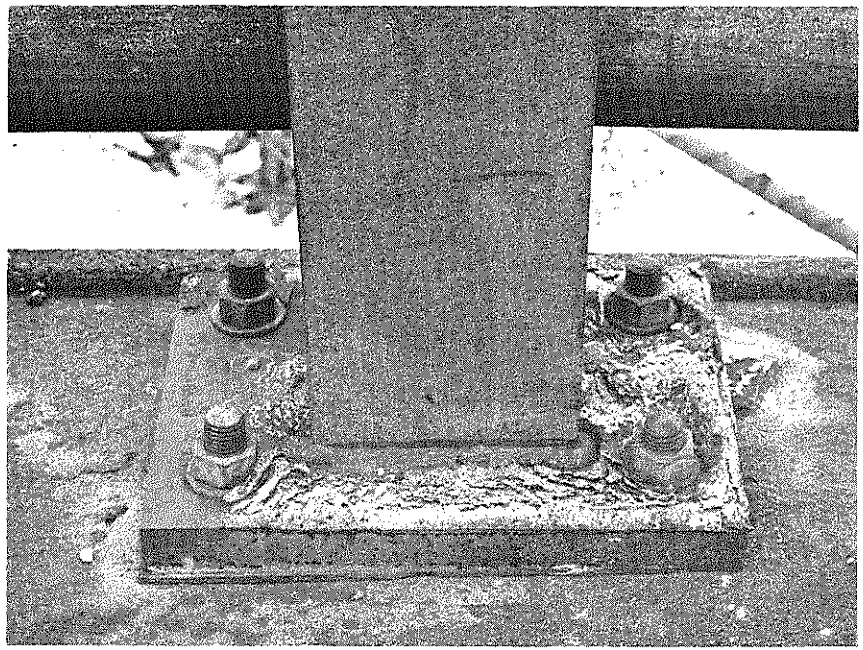
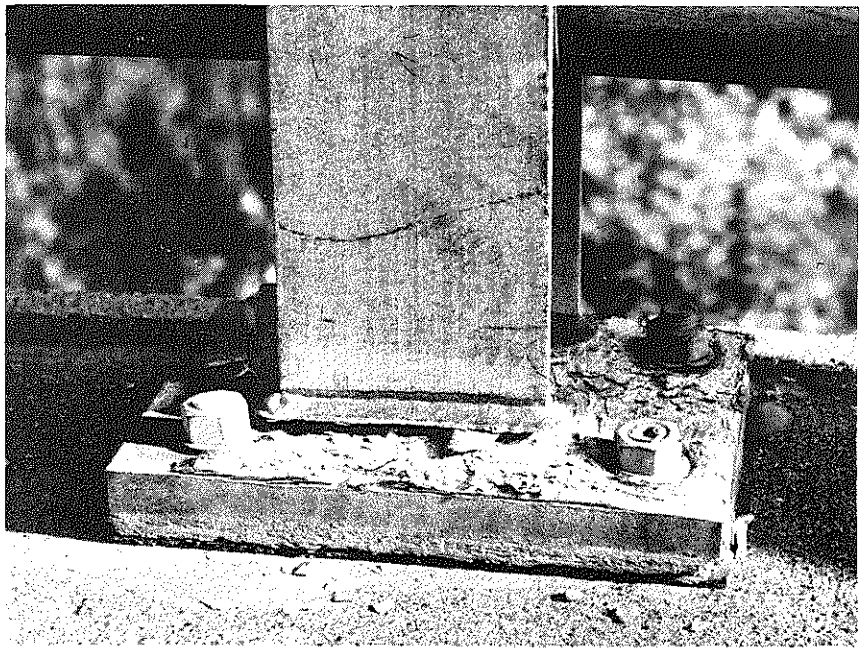


Figure 1. Corrosion of baseplate.

Figure 2. Corrosion has progressed to such a point that the post has broken loose from the baseplate.



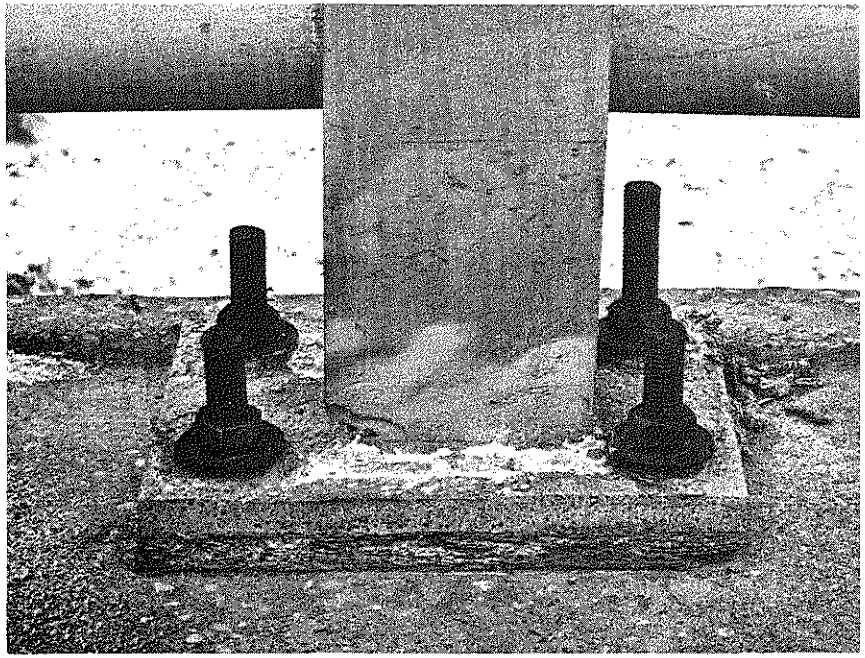


Figure 3. Baseplate-to-outpost connection after repair.

PHONE: (312) 345-4260
New Phone 865-0400

2671 GARDNER ROAD, BROADVIEW, ILLINOIS 60153

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METALLURGICAL LABORATORIES

CHEMISTS • MECHANICAL TESTING • METALLOGRAPHERS • CONSULTANTS

MAILING ADDRESS / P.O. BOX 310 / MAYWOOD, ILLINOIS 60153

State of Michigan
Department of State Highways/Research
Laboratory Section
735 E. Saginaw Street
Lansing, Michigan 48806
ATTN: M.A.Chiunti,Phy.Res.Unit

DATE: 1-4-73

DESCRIPTION:

Letter of 1-2-73

Aluminum Alloy

Lab. Al.1-3

	No.1	No.2	No.3
Chromium	.01	.01	.29
Copper	.18	4.90	.16
Iron	.17	.27	.50
Nickel	.01	.01	.01
Zinc	.01	.12	.08
Silicon	.54	.12	.64
Manganese	.01	.60	.05
Magnesium	.83	1.75	.80
Titanium	.01	.01	.04

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Figure 4. Results of chemical analysis.