On site corrosion survey of Ni-added high-performance weathering steel bridge

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ABSTRACT

Otsuka viaduct was constructed within 200 meters from tidal river. Since a severe corrosive environment was anticipated, Ni-added high-performance weathering steel was used in the bridge. It is important to evaluate corrosive environment of constructed site in order to plan and maintain weathering steel bridges rationally. Therefore, exposure tests and measurements of amount of air-borne salt in this bridge were carried out. Exposure tests were carried out using attachable small pieces made by Ni-added high-performance weathering steel and normal weathering steel (JIS-SMA) to clarified applicability of Ni-added high-performance weathering steel under severe corrosive environment. Results of rust thickness and corrosion loss shows higher advantages of Ni-added high-performance weathering steel for weathering resistance than JIS-SMA.

KEYWORDS: Weathering steel bridge, Corrosive environment, Exposure test

1. INTRODUCTION

Weathering steel has a possibility of reducing maintenance cost, however, it is important to evaluate corrosive environment of constructed site in order to plan and maintain weathering steel bridges rationally. Otsuka viaduct is three-main girders plate girder bridge that was constructed within 200 meters from tidal river. Since a severe corrosive environment was anticipated, i.e. large amount of airborne salt, Ni-added high-performance weathering steel was used in the bridge. Therefore, exposure tests and measurements of amount of air-borne salt at the bridge was conducted in two years from March 2014, as a survey of corrosive environment and corrosion status.

Figure 1 Otsuka viaduct

2. SURVEY METHOD

2.1 Exposure tests using attachable small pieces

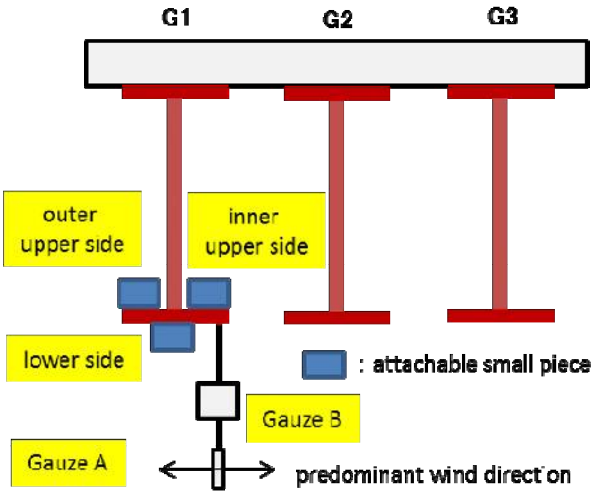
Exposure tests were performed with attachable small specimens (50 x 50 x 2 mm) made of Ni-added high-performance weathering steel and normal weathering steel (JIS-SMA). Rust thickness on specimens were measured in every month during exposure test (two years), and amount of corrosion loss after 100 years was estimated from amount of corrosion loss at the end of exposure test.

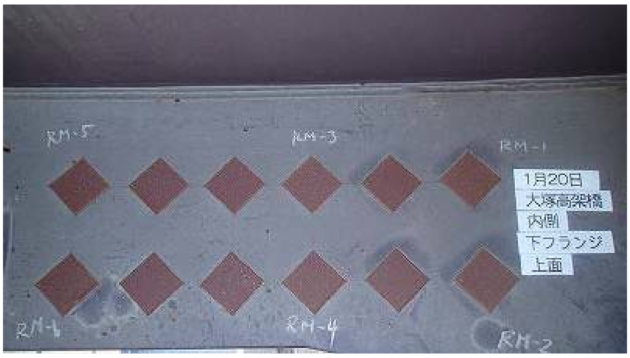
Specimens for exposure test were installed at five points of a girder at near intermediate support. There were three points on bottom flange (outer upper side, lower side and inner upper side), two points on web (outer side and inner side). By comparing rust thickness and amount of corrosion weight loss between these five points, evaluating applicability of Ni-added high-performance weathering steel.

2.2 Measurement of amount of air-borne salt

The amount of air-borne salt around the attachable small pieces was measured by the dry gauze type apparatus established by JIS. Gauze A was installed in the direction of facing to predominant wind direction (orthogonally to bridge axis) under bottom flange, and gauze B was additionally installed facing to bridge axis direction from July 2015. Collection area of each gauze (10x10cm) was assumed to 200 cm^2 due to flow from both sides of gauze, amount of airborne salt was measured in every month.

Figure 2 shows points of attachable small pieces and gauze, Fig.3 indicates gauze installation status, Fig.4 displays installation status of attachable small pieces, and Fig.5 shows rust thickness measurement.





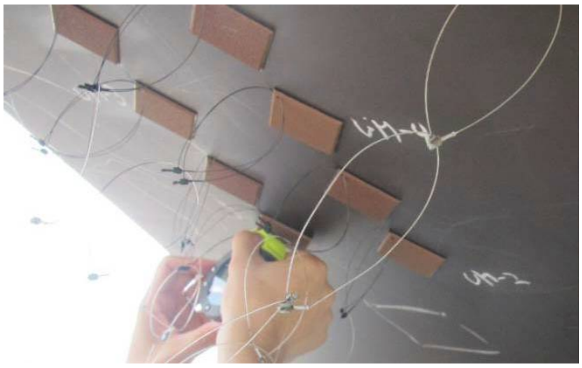


Figure 5 measurement of rust thickness

3. EVALUATION OF TEST RESULTS

3.1 Exposure tests using attachable small pieces

Growth of rust thickness on exposure specimens at bottom flange are indicated in Fig.6. From the results of rust thickness, no significant difference was found in the corrosive environment between outer side and inner side, but rust thickness of SMA was about 1.5 times larger than Ni-added high-performance weathering steel. Results of rust thickness show higher advantages of Ni-added high-performance weathering steel for weathering resistance than JIS-SMA.

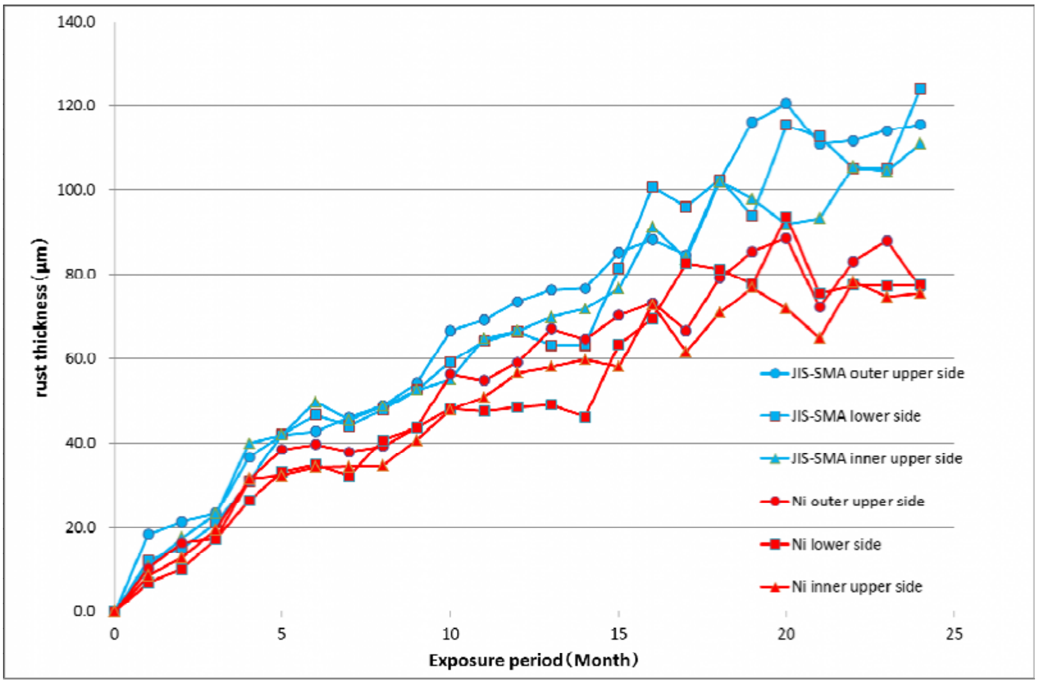


Figure 6 Growth of rust thickness on exposure specimens at bottom flange

From corrosion loss at the end of first year, corrosion loss at 100 years later can be calculated by equation (1).

$$Y \quad A_{SMA} \quad X^{B_{SMA}}$$

position	Steels	One year result					Two year result		
		$A(Y_1)$	X	B^{Upper} B^{Lower}	Y_{100}^{Upper} Y_{100}^{Lower}	Y_{100}	$A(Y_2)$	B	Y_{100}
outer upper side	SMA	0.020	100	0.680 0.530	0.459 0.230	0.345	0.034	0.766	0.679
	Ni	0.016	100	0.530 0.402	0.184 0.102	0.143	0.027	0.755	0.517
lower side	SMA	0.017	100	0.713 0.563	0.453 0.227	0.340	0.032	0.913	1.136
	Ni	0.014	100	0.553 0.424	0.178 0.099	0.139	0.027	0.921	0.971
inner upper side	SMA	0.016	100	0.725 0.575	0.451 0.226	0.338	0.032	1.000	1.600
	Ni	0.014	100	0.553 0.424	0.178 0.099	0.139	0.026	0.893	0.856

3. 2 Measurement of the air-borne salt

Figure 7 shows the measurement results of amount of airborne salt. Airborne salt content fluctuate according to the season, i.e. decreased in the summer season and increased in the winter season. Compared between each collector, amount of air-borne salt of gauze A is larger than that of gauze B, which is twice on average. In addition, annual average of amount of air-borne salt at the bridge site which was calculated by two years measurements was 0.30 mdd(Nacl:mg/100cm^2/day), which is higher than criteria for use of JIS-SMA weathering steel in Japan (0.05mdd)

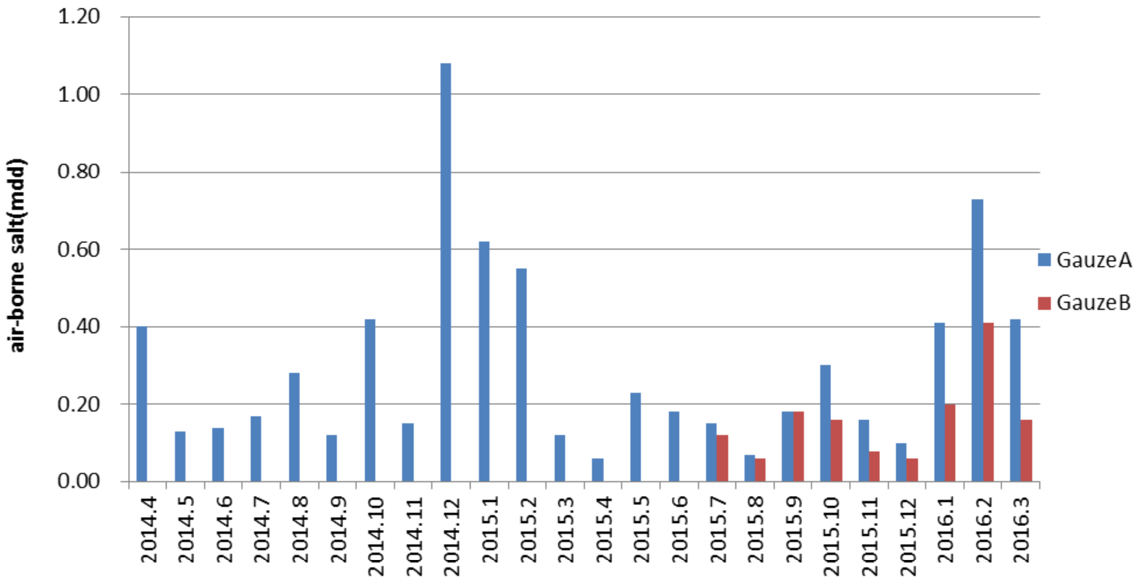


Figure 7 measurement of the air-borne salt

4. CONCLUSIONS

By the measurement of rust thickness and prediction of corrosion loss, it was confirmed Ni-added high-performance weathering steel has high weather resistance and usefulness. Corrosion loss at 100 years later by the exposure specimen for 2 years could not satisfy the performance level I of the corrosion resistance, but there is a possibility that values predicted by two points with close measurement years are shows severe evaluations. Since some exposure test specimens were still installed to clarify this difference, estimate corrosion loss from another data should be analysed.

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