Proceeding of the 9th Japan -Korea Joint Seminar on Bridge Maintenance
July 24-27, 2013, Hokkaido Japan

CORROSION BEHAVIOR OF WELDED PART OF STRUCTURAL STEEL BY ACCELERATED EXPOSURE TEST

Mikihito HIROHATA and Yoshito ITOH

Graduate School of Engineering, Nagoya University

Abstract

In order to examine the corrosion behavior of the welded part of structural steel, the accelerated exposure test with combined system of salt water spray cycles was conducted. The corrosion depths of general part of base metal and welded parts such as the weld toe and the top of weld bead were compared after 800 cycles of the test. The corrosion depths of welded parts were around 54% of that of base metal. The reason was possibly the lower carbon content in the weld metal compared with the base metal. It might be that the corrosion of welded part under this test condition was affected by the material properties rather than the geometric shape of weld bead.

Keywords: Maintenance, Structural steel, Corrosion, Welded part, Accelerated exposure test

1. INTRODUCTION

It is well known that corrosion is the most important problem in maintenance of steel structures. In the case of bridges, corrosion tends to occur around the narrow regions with complex geometric shapes such as the corner of member, the edge of girder and so on. On the other hand, corrosion occurs at narrow and complex shaped welded part [1]. It is also difficult to ensure the thickness of ant-corrosion coating on weld bead.

Although a lot of researches have been conducted on the corrosion behavior of general part of structural steel, it is unknown how the corrosion behavior of welded part of structural steel is different from that of general part. Some factors possibly affect the corrosion behavior of welded part such as the shape of weld bead, the difference of materials between weld metal and base metal (galvanic corrosion), the microstructure of weld metal and welding residual stress.

In order to examine the corrosion behavior of welded part of structural steel, an accelerated exposure test with combined system of salt spray cycles [2] was carried out in this study. The corrosion depths of general part of base metal and welded parts such as the weld toe and the top of weld bead were compared after 800 cycles of the test.

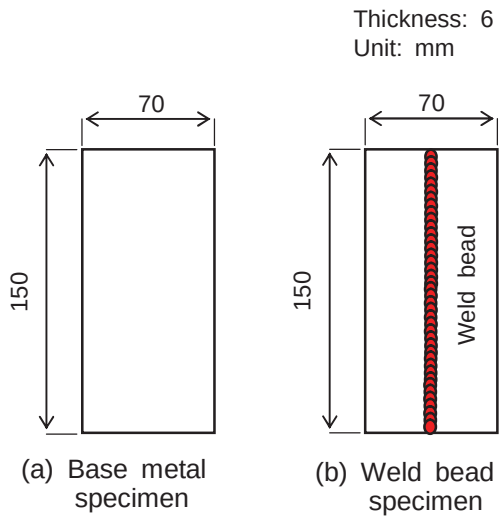

Fig. 1 Shape and dimension of specimen

Table 1 Material properties

Base metal	Grade	SM490A
	Thickness (mm)	6
	Yield stress (MPa)	413
	Tensile strength (MPa)	545
	Elongation (%)	22
Weld metal	Flux cored wire	JIS Z 3313
	Wire diameter (mm)	1.2
	Yield stress (MPa)	528
	Tensile strength (MPa)	584
	Elongation (%)	27
Surface preparation		Blasting (Sa 2.5)

Table 2 Welding conditions

Current (A)	Voltage (V)	Speed (mm/s)	Heat input (J/mm)
210	26	5	1092

(Bead-on-plate welding)

Table 3 Chemical compositions

	Chemical compositions (mass%)				
	C	Si	Mn	P	S
Base metal	0.16	0.28	1.49	0.015	0.035
Weld metal	0.06	0.52	1.43	0.012	0.009

2. EXPERIMENTAL PROCEDURE

2.1 Test specimens

Fig. 1 shows the shape and dimension of specimens. **Table 1** shows the material properties of base metal and weld metal. **Table 2** shows the welding conditions. The structural steel (SM490A) of 150x70x6 (mm) was used for the base metal specimen. The weld bead was put on the base metal by CO_2 arc welding. The weld metal was for the general carbon structural steels. The surfaces of specimens were cleared by blasting.

Table 3 shows the chemical compositions of base metal and weld metal. The amount of "C" and "S" were less in the weld metal compared with the base metal. The amount of "Si" was more in the weld metal compared with the base metal. The former and the latter were an advantage and a disadvantage in anti-corrosion of the weld metal respectively.

2.2 Accelerated exposure test procedure

Fig. 2 shows the accelerated exposure test conditions. The S6 cycle specified in Japanese Industrial Standard (JIS) K 5621 was used [2]. The test period was 200 days (800 cycles). It was reported that there is a correlation between this test condition and the actual environmental conditions [3].

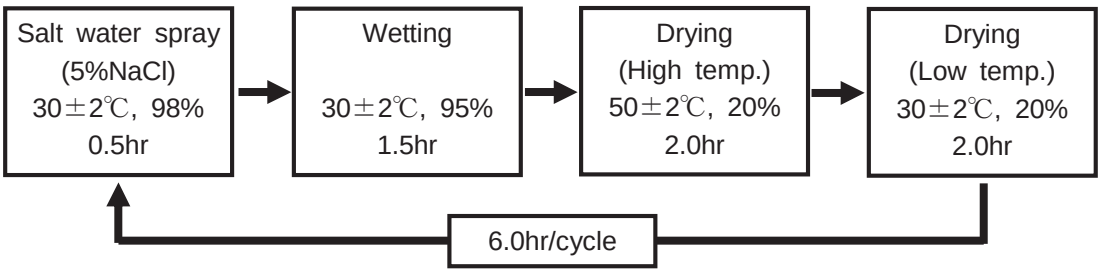

Fig. 2 Accelerated exposure test condition

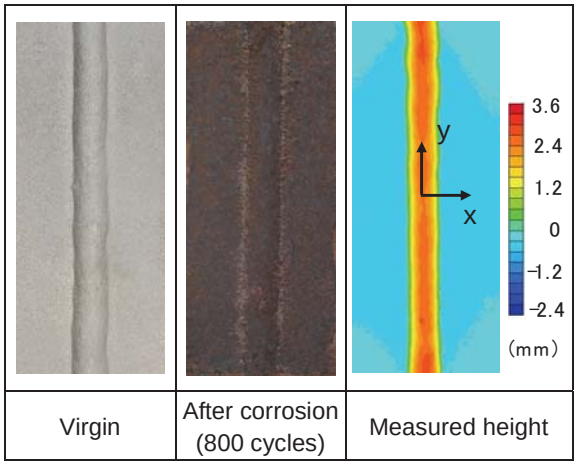

Fig. 3 Appearance of weld bead specimen

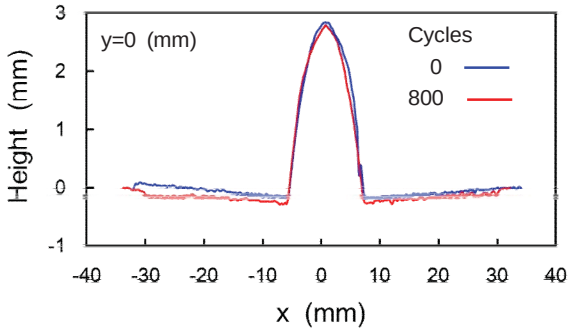

Fig. 4 Change of shape of weld bead specimen

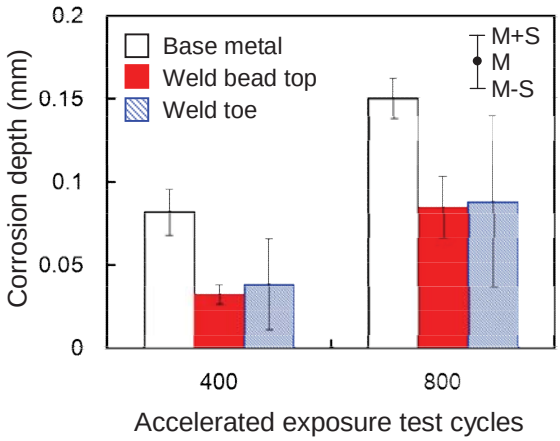

Fig. 5 Corrosion depth of each part

3. RESULTS AND DISCUSSIONS

Fig. 3 shows an example of appearance of weld bead specimen after 800 cycles of the test. The tendency that the salt remained around the weld toe was confirmed. The 3D surface shapes of specimens were measured by a laser displacement meter. An example of the measured result of shape of weld bead specimen is shown in **Fig. 3** and **Fig. 4**. From the measured results, the corrosion depth in each part of weld bead specimen such as the weld toe and the top of weld bead was calculated. Furthermore, they were compared with the corrosion depths of the base metal specimens and the general part of weld metal specimens.

Fig. 5 shows the relationship between the test cycles and the corrosion depth in each part. A clear difference could not be observed between the corrosion depths of the weld toe and the top of weld bead. The corrosion depths of those welded parts were around 54% of that of base metal. The reason was possibly the lower carbon content in the weld metal compared with the

base metal [5]. It might be that the corrosion of welded part under this test condition was affected by the material properties rather than the geometric shape of weld bead.

4. CONCLUSIONS

In order to examine the corrosion behavior of welded part of structural steel, an accelerated exposure test with combined system of salt spray cycles was carried out.

The obtained main results are as follows;

(1) The amounts of "C" and "S" were less in the weld metal compared with the base metal. It was an advantage in anti-corrosion of the weld metal. On the other hand, the amount of "Si" was more in the weld metal compared with the base metal. It was a disadvantage in anti-corrosion of the weld metal.

(2) It was confirmed that the corrosion speeds of the top of weld bead and the weld toe were slower than that of base metal under the accelerated exposure test with combined system of salt water spray conditions.

(3) It was possible that the chemical compositions largely affected on the corrosion speed of weld metal rather than the geometric shape of weld bead.

References

[1] Japanese Society of Steel Construction: Heavy duty coating, 2012 (in Japanese).

[2] Japanese Standards Association: Japan Industrial Standards (JIS) K5621, Anticorrosive paints for general use, 2008.

[3] H. Fujiwara and Y. Tahara: Research on the Correlativity of Outdoor Exposure test of Painting Test Piece with Corrosion Test for Steel Bridge, Journal of Japan Society of Civil Engineers, No. 570/I-40, pp.129-140, 1997 (in Japanese).

[4] H.H. Uhlig and R. W. Revie: Corrosion and Corrosion Control 3rd edition, 1997.