EVALUATION CREVICE CORROSION OF THE UPPER CONNECTION ON STEEL TRUSS BRIDGE

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1. INTRODUCTION

In several corrosion researches recently, especially related to corrosion shapes, most of them were about the corrosion shape on the inner or outer surfaces but the crevice corrosion between the attached surfaces still remain unknown. In this study, the detailed crevice corrosion shape of the gusset plates that were cut from the upper connections of the steel truss bridge was measured by using the laser measurement equipment, and the actual crevice corrosion state of the outside and the inside surfaces of the gusset plates and the flange of diagonal member, as shown in Photo 1, were evaluated on the basis of the corrosion depth distribution of these surfaces. Based on the detailed results of corrosion measurement, the crevice corrosion and the corrosion characteristics of the gusset plate connection were clarified.

2. CORROSION MEASUREMENT METHOD

In order to measure the corrosion shape of the outer surface on the specimen, the specimen was set on the cross-ties as much vertical as possible using the grabbed tool device. The laser measurement equipment was set up as shown in Photo 2. The laser measurement equipment is composed of ①surface roughness measuring device, ② grab tool device, ③A-D converter and ④measurement - control equipment. Table 1 shows the specifications of equipment. Measurement interval of the laser measurement equipment of the specimen as selected as 1mm in order to understand its mechanical performance. The base-plane was set by hands at the visually healthy place and must be sure that corrosion has not occurred on the specimen surface.

3. CORROSION DEPTH CALCULATION METHOD

The corrosion depth is calculated from the following calculation method as shown in Figure 1:

On the left side: $t_{il} = H_{il} - h_{il}$

On the right side: $t_{ir} = H_{ir} - h_{ir}$

where:

t_{il}, t_{ir}: Corrosion depths on the left side and on the right side, respectively

H_{il}, H_{ir}: Distances from the laser meter to the based-surface on the left side and on the right side, respectively

h_{il}, h_{ir}: Distances from the laser meter to the measured point on the specimen surface on the left side and on the right side, respectively.

Then the remaining thickness is calculated as follow:

$$t_R = t_0 - t_{il} - t_{ir}$$

Where:

t_{il}, t_{ir}: Corrosion depths on the left side (inner surface) and on the right side (outer surface), respectively

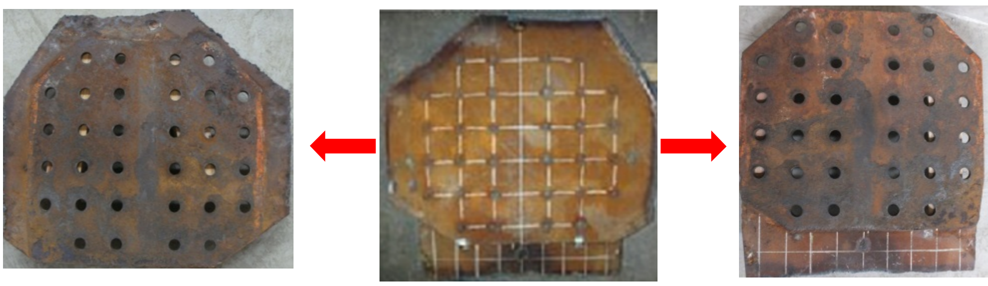
t_R: Remaining thickness of the specimen

t_0: Initial thickness of the specimen

4. CREVICE CORROSION STATE

4.1.Corrosion depth distribution of the gusset plate specimen

The corrosion state of the inner and outer surfaces, of the gusset plate specimen were shown in Figure 2. As can be seen from this Figure, the corrosion of the inner surface, contact surface, occurred only on the edges of the specimen,



Gusset plate specimen *Tensile diagonal specimen*

Photo 1: Finished specimen

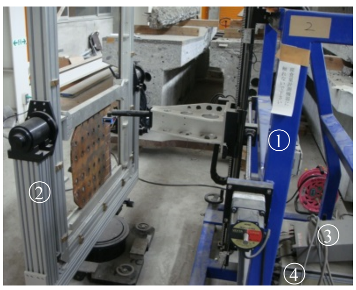


Photo 2: Laser measurement equipment

Table 1: Specifications of equipment

①Laser measurement equipment	
Measurement range (flat)	1000×1000 mm
Measurement range (Perpendicular direction depth)	100mm
Measurement speed (1mm Time interval measurement)	200data/min
Base of frame	Steel
②Grab tool equipment	
Maximum testing specimen dimensions	700×1000 mm
Horizontal rotation range	360^0
Vertical rotation range	360^0
Rotation range of microtremors	± 5 degrees in 2 axis

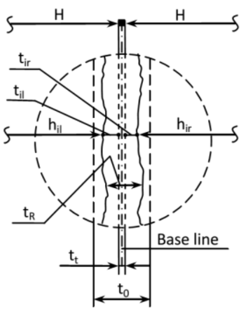


Fig. 1: Corrosion depth calculation

Keywords: Crevice corrosion, Steel truss bridge, Gusset plate connection
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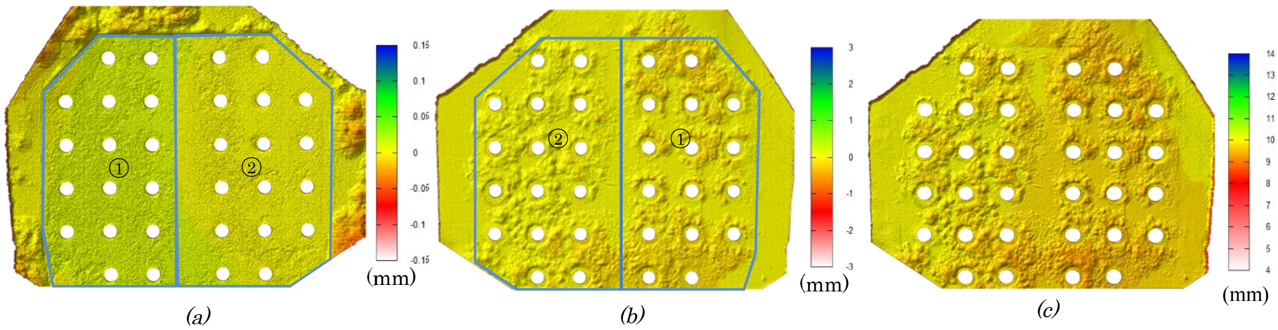

Figure 2: Corrosion depth distribution of the inner surface, (a), outer surface, (b), remaining thickness, (c), of the gusset plate specimen

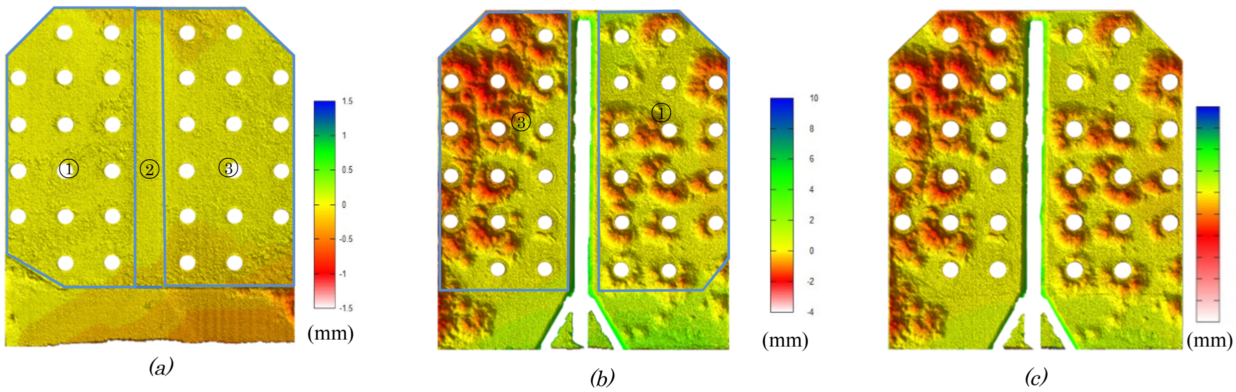

Figure 3: Corrosion depth distribution of the inner surface, (a), outer surface, (b), remaining thickness, (c), of the diagonal member

Table 2: Characteristics of several regions of the gusset plate and diagonal specimen

	Gusset plate		Diagonal member		
	①	②	①	②	③
Initial thickness, t_0	12	12	10	10	10
Average corrosion depth on the right, t_{rave}	(0.0123)	(0.004)	0.006	0.044	0.082
Maximum corrosion depth on the right, t_{rmax}	0.239	0.251	1.456	0.177	1.34
Average corrosion depth on the left, t_{lave}	0.2	0.122	0.238	0	0.51
Maximum corrosion depth on the left, t_{lmax}	1.55	1.11	4.05	0	2.78
Average remaining thickness, t_R	11.8	11.878	9.756	9.956	9.408
Note: the number put between the parenthesis,(..), mean that the thickness increase due to the existed rust; right side is inner surface and left side is the outer surface					

the average corrosion depth is approximately 0 mm due to the rust existed on the whole surface, and the maximum corrosion depth is 0.252mm. While in the other area the corrosion has hardly seen due to the contact of the gusset plate and the flange plate, however, there was a rust layer with the average thickness is 0.011mm. The characteristics of contact regions are summarized in Table 2. The corrosion of the outer surface of the gusset plate occurs around the rivet holes in the shape of dough-nut. The average corrosion depth is 0.14mm and the maximum corrosion depth is 2.7mm. The remaining thickness distribution of the gusset plate specimen as also shown in Figure 2 and the remaining thickness of the contact surface was shown on Table 2

4.2. Corrosion depth distribution of the flange of the diagonal member specimen

Figure 3 shows the corrosion depth distribution of the inner and outer surface of the diagonal member specimen. The outer surface was attached face to face with the inner surface of the gusset plate specimen, so that the corrosion is hardly seen on this surface except the bottom area where the face was directly exposed to the environment. There was a existed rust layer on region ① and the average corrosion depth is 0.006mm and the maximum corrosion depth is 1.456 mm. For the contact surface, the average corrosion depth is 0.044 mm and the maximum corrosion depth is 1.456 mm equivalent to 0.44% of thickness loss. In region ② and ③, the rust and corrossion also can be seen clearly. Corrosion occurred at the top and bottom but more severely on the right corner due to the existing sediment. The characteristics of contact regions are summarized in Table 2. For the inner surface, the corrosion occurred severely on the whole surface especially around the rivet holes. The average corrosion depth is 0.25mm and the maximum corrosion depth is 4.01mm. The remaining thickness distribution of the flange of the diagonal member specimen is shown in the Figure 12 and the remaining thickness of the contact surface was also shown on Table 2. In Table 2, the average corrosion depth and the maximum corrosion depth on the left (inner surface) are considered equal zero because this is the area of web plate of diagonal member.

5. CONCLUSION

On the contact surface, the rust layer existed on the whole surface. The average thickness of this rust layer on the contact surface of the gusset plate is 0.011mm while on the flange of the tensile diagonal member is 0.044mm.

REFERENCE: X.T Nguyen, K. Nogami, S.Takahashi, M.Kurihara, T. Yoda, H. Kasano, J. Murakoshi, N.Toyama, T.Enomoto, “Evaluation for crevice corrosion state of gusset plate on steel truss bridge”, *Proceedings of 12nd Japan – Korea Joint Symposium on Steel Bridges, Okinawa – Japan*, 2013.8