Corrosion deterioration characteristics of Sn-bearing steel and its applicability on steel bridges

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The steel with a small amount of tin (Sn), that is, Sn-bearing steel was newly developed by noting the effect of adding such kind of trace alloy element for improving the corrosion resistance of steel. In order to investigate the corrosion deterioration characteristics around paint coating defect of the Sn-bearing steel, accelerated exposure test was performed. After the test, the appearance and surface shape of paint coated Sn-bearing steel were examined for evaluating the degree of deterioration. The corrosion deterioration was evaluated by focusing on the blister of paint coating around the initial defect scribed in X shape (namely, cross-scribe defect). The blister areas from the cross scribe paint defect of the Sn-bearing steel was respectively 95 % in A-type coating and 43 % in C-type coating of those of the SM490 steel at 2200 cycles. For C-type coating, the use of Sn-bearing steel to bridges has the possibility to prolong the life span of paint coating by around 15 %.

Keywords: steel bridge, Sn-bearing steel, corrosion, paint coating, accelerated exposure test.

The Sn-bearing steel and the general structural steel (SM490) were used for the accelerated exposure tests. To investigate the deterioration behavior of the paint coating from the defects, artificial initial defects shown in *Fig. 1* were made on the painted steel specimens. In the cross-cut specimen, the cross-scribe defect simulated the scratch damage on the actual painting. A series of the accelerated exposure tests with combined cycles of salt spraying, wetting and drying (S6 cycles) was carried out for 550 days (2200 cycles). When the painted steel is corroded from the defect on the paint coating, the formed rust between the steel surface and the paint coating breaks the painting. As the result, the blister of painting occurs. Therefore, the blister area can be used as the measure for evaluating the degree of corrosion of substrate steel. After the accelerated exposure tests, the surface shape around X-cross scribe of the specimens were measured by the laser displacement meter. The measured pitch was 100 μm in both longitudinal and transverse directions. In this study, the area whose height of blister of painting was over 50 μm from the level of sound painting region was defined as blister area. *Fig. 2* shows examples of measured blister areas. *Fig. 3* shows relationships between the blister areas from the X-cross scribe regions and the number of the test cycle.

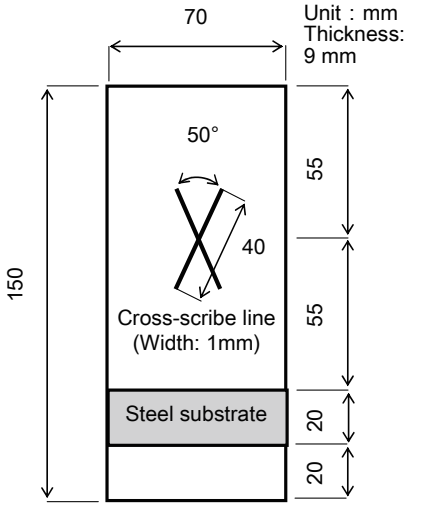

Fig. 1: The shape of cross-cut specimen

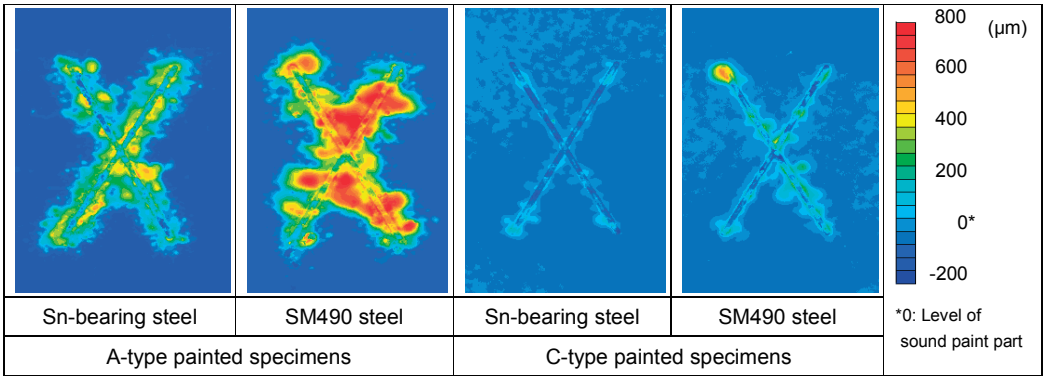

Fig. 2: Blister of X-cross scribed regions (after 2100 cycles)

In A-type painted specimens, the blister areas of the Sn-bearing steel were smaller than those of the general structural steel (SM490). The blister areas of the Sn-bearing steel were around 95 % of those of the SM490 steel after 2200 cycles.

In C-type painted specimens, although the blister areas of the SM490 steel were increased, those of the Sn-bearing steel were not generated even after 1200 cycles. After 1600 cycles, the blister areas of both specimens were slightly increased. For C-type coating, the blister area of the Sn-bearing steel was around 43 % of that of the SM490 steel after 2200 cycles.

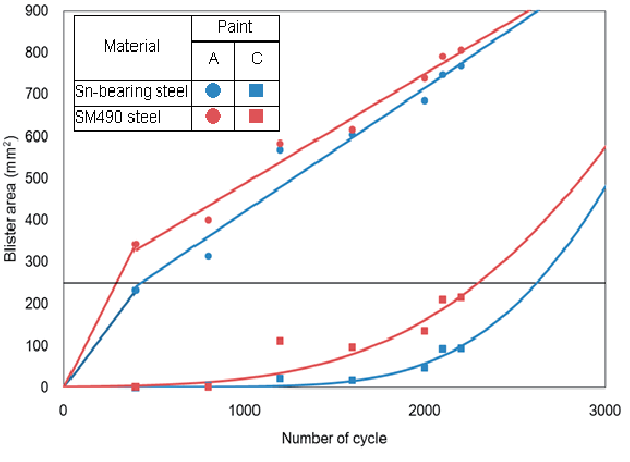

Fig. 3: Estimation line or curve of blister area

It is possible that the use of the Sn-bearing steel in steel bridges prolong the life span of the paint coating. To compare the effects of Sn-bearing steel and SM490 steel on blister area, estimated deterioration curve was applied as shown in *Fig. 3*. Considering the trend of each increase of blister area, straight bi-lines were applied for A-type coating and Gompertz curves for C-type coating according to each deterioration level. In this study, deterioration area ratio of 5 % was considered as repaint stage and the number of cycles at the line was compared. The use of Sn-bearing steel has the possibility to prolong the life span of paint coating by 47 % for A-type coating and by 14 % for C-type coating.

Conclusion

(1) In A-type painted specimens, the blister area from the cross scribe paint defect of the Sn-bearing steel was around 95 % of that of the SM490 steel at 2200 cycles. In C-type painted specimens, the blister areas from the cross scribe paint defect of the Sn-bearing steel was around 43% of that of the SM490 steel at 2200 cycles.

(2) Although the conditions of the experiments in this study were limited, the results indicated the possibility for reduction of the cost for maintenance of steel bridges by using the Sn-bearing steel. For C-type coating, the use of Sn-bearing steel to bridges has the possibility to prolong the life span of paint coating by around 15 %.