Technical Report

Development of Chromate-free Treatment QA with High Bonding Strength

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Abstract

Chromate-free treatment layer QA suitable for the adhesive construction method using an adhesive agent was developed. QA has better bonding strength, corrosion resistance and paint adhesiveness than the chromate-free treatment layer QN. It can be used for applications where these performances are required. Moreover, QA has the same lubricity and conductivity as QN, so it can be used for common applications.

1. Introduction

In the construction material sector, aged buildings and structures are being renovated and a shortage of skilled workers is becoming further actualized. Therefore, there are greater needs for longer service life of social infrastructure and simpler construction. There is also demand for more superior environmentally friendly properties. Under such circumstances, Nippon Steel Corporation had been working to develop chromate-free treatment layer QA that is suitable for the adhesive construction method using adhesive agents. The chromate-free treatment layer QA is used as an aftertreatment of highly corrosion-resistant hot-dip galvanized steel sheet SuperDyma™ (Zn-11Al-3Mg-0.2Si coating), which is used mainly as construction materials.

A chromate-free treatment layer of Nippon Steel mainly consists of a base layer that works as a barrier against corrosion factors and corrosion inhibitors having a self-restoration property.[1, 2] For the QA, a special base layer was applied that can control the elution of the corrosion inhibitors. Accordingly, this suppresses the elution of the corrosion inhibitors, etc. to the adhesive agent layers, realizing high bonding strength. In addition, the elution of the corrosion inhibitors, etc. to corrosive environments and films post-coated on the surfaces of QA layers is suppressed, which realizes high corrosion resistance and high paint adhesiveness. This paper describes the performance of the QA by comparing it to the conventional general-purpose chromate-free treatment layer QN.

2. Test Procedure

Table 1 lists the specifications of the steel sheets used. SuperDyma™ (amount of plated layer: K27) was used as the substrate and QN- and QA-treated steel sheets were used as test pieces. The test procedure is shown below.

2.1 Bonding strength

An acrylic resin adhesive was used to prepare lap shear test pieces with the lap length of 50 mm in accordance with the procedure in JIS K 6850. After being cured, they were subjected to a tensile shear test. The bonding strength was evaluated based on the maximum load.

2.2 Corrosion resistance

Flat sheets for which the end faces were sealed were subjected to a salt spray test (JIS Z 2371). The corrosion resistance was evaluated based on the percentages of white rust generation areas.

2.3 Paint adhesiveness

A melamine alkyd paint (Amilac 1000 made by Kansai Paint Co.,Ltd.) was applied to the surfaces of the steel sheets and then they were baked (dried film thickness: 20 μm). In the cross-cut adhesion

Table 1 Test pieces

Substrate	Surface treatment	Type
Zn-11Al-3Mg-0.2Si hot-dip galvanized steel sheet (amount of plated layer: K27)	QN	Common use
	QA	High bonding strength/high coating adhesiveness

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test, they were cross-cut at intervals of 1 mm and the films were peeled with cellophane adhesive tape. The separation conditions of the films were visually observed. In the Erichsen test, after the test pieces were extruded by 7 mm, the films were peeled with cellophane adhesive tape. The separation conditions of the films were visually observed.

2.4 Lubricity

A sliding contact maker for which the end was a stainless-steel ball with a diameter of 10 mm was slid on the surface of each test piece at a travel speed of 150 mm/min while a load of 1.0 N was applied. The kinetic friction coefficient was calculated based on the stress. Test pieces with anti-rust oil applied on the surfaces were also tested in a similar way.

In addition, anti-rust oil was applied to both faces of a test piece. It was put in between flat dies made from SKD11 (the contact area: 30 mm × 25 mm) and pressed at a load of 0.5 kN. It was pulled out at 200 mm/min and the kinetic friction coefficient was calculated based on the pull-out load.

2.5 Conductivity

The surface insulation resistance was measured in accordance with the procedure in JIS C 2550 (test voltage: 0.5 V, test pressure: 2 N/mm^2 ± 5%).

3. Test Results

3.1 Bonding strength

Figure 1 shows the bonding strength measured in the tensile shear test. Thanks to the effect of the special base layer, the bonding strength of the QA is higher than that of the QN.

3.2 Corrosion resistance

Figures 2 and **3** show the generation of white rust on the flat sheets as a result of the salt spray test. The QA has more superior resistance to white rust than the QN.

3.3 Paint adhesiveness

Table 2 lists the paint adhesiveness test results. The paint adhesiveness of the QA is higher than that of the QN.

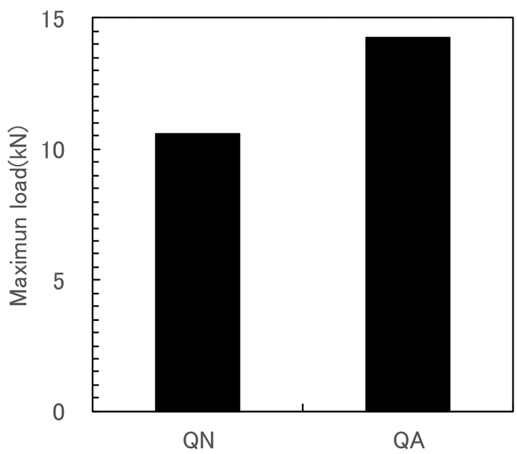

Fig. 1 Results of bonding strength by tensile shear test

3.4 Lubricity

Figures 4 and **5** show the measured kinetic friction coefficients. The lubricity of the QA is at the same level as that of the QN regardless of the test procedure and existence or nonexistence of the oil. These results show that the QA can be processed and handled almost similarly to the QN.

3.5 Conductivity

Figure 6 shows the measured surface insulation resistance. The surface insulation resistance of the QA is at the same level as that of QN.

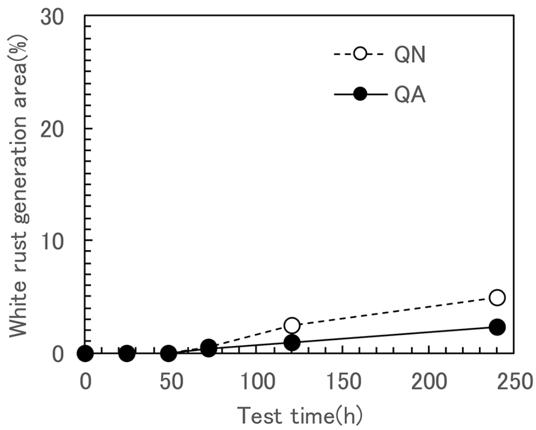

Fig. 2 Results of salt spray test (flat sheet)

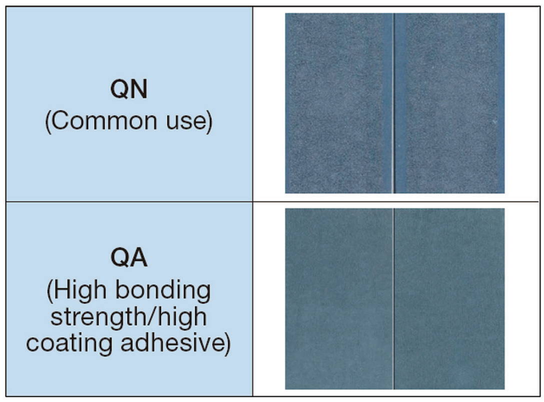

Fig. 3 Appearance after 120 hours of salt spray test

Table 2 Results of paint adhesiveness test

Surface treatment	Primary	
	Cross-cut test	Erichsen test
QN (Common use)	○ (Slight peeling)	△ (Considerable peeling)
QA (High bonding strength/high coating adhesiveness)	○ (Slight peeling)	○ (Slight peeling)

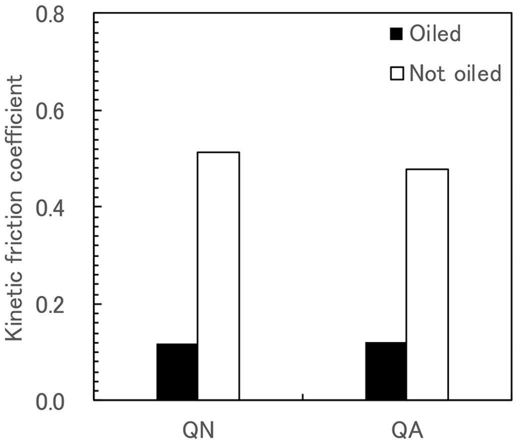

Fig. 4 Kinetic friction coefficients by stainless steel ball sliding test

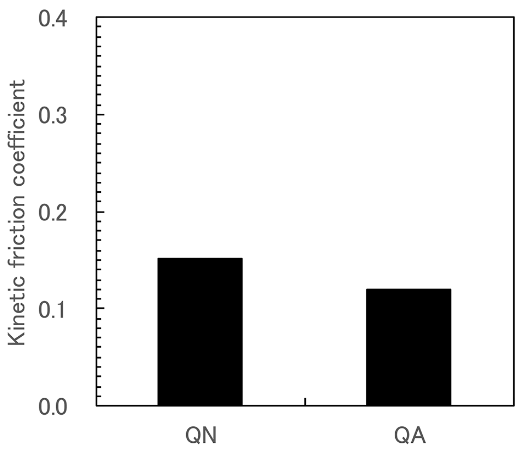

Fig. 5 Kinetic friction coefficients by flat draw bead test

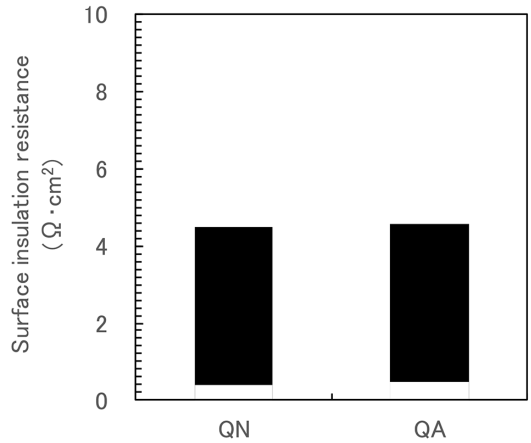

Fig. 6 Results of surface insulation resistance test

4. Conclusion

The chromate-free treatment layer QA developed this time is superior in the bonding strength, corrosion resistance, and paint adhesiveness to the conventional general-purpose chromate-free treatment layer QN. The QA can be used for applications where these properties are required. In addition, the lubricity and conductivity of the QA are at the same levels as those of the QN. Therefore, the QA can be used for common applications.

From the aforementioned characteristics, applications of the QA are expected to expand in the future.

References

1) Morishita, A. et al.: Shinnittetsu Giho. (377), 28 (2002)
2) Fuda, M. et al.: Shinnittetsu Sumikin Giho. (398), 57 (2014)


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