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Long Term Performance of Anti-Corrosion Method Using Titanium Clad Steel

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Summary

A new anti-corrosion method using titanium clad steel plates has been developed and applied to the splash and tidal zones of steel piers. Titanium clad steel plates consist of 1 mm thick titanium plates and 4 mm thick steel plates and are welded to the steel piers. Steel pipes with diameter of 60cm using this anti-corrosion method have been tested and monitored in the actual marine environment for the last five years. The monitoring results show that no corrosion has been found on the titanium clad plates and prove that the new method has sufficient long term durability.

1. Structural forms of the new anti-corrosion method

It has been thought that titanium has excellent anti-corrosion resistance, but it is too expensive to be used for the actual structure. However, we have developed relatively inexpensive titanium clad steel plates, invented a new anti-corrosion method for the splash and tidal zones of steel piers using this material. Titanium clad steel plates consist of 1mm thick titanium plates and 4mm thick steel plates and are welded to the surface of steel piers by TIG welding. Various experiments have been carried out to investigate basic strength and behaviors of this new method, such as mechanical strength of clad plates, electro-chemical effects of electrolytic corrosion, weldability and paintability on clad plates. These tests have all shown satisfactory results. This new method has also shown economical competitiveness compared with other anti-corrosion methods for the severe marine environment, and has therefore been adopted for the steel piers on the Trans-Tokyo Bay Bridge(see fig.1, fig.2 and fig.3), one of the national projects in Japan. We have watched these actual steel piers since they were constructed three years ago, and at the same time we put the test pipes, on which this new anti-corrosion method were applied, into the sea water and monitored for the last five years to investigate the long term durability of this new system.

2. A test on long term durability of the new method

Steel pipes with diameter of 60 cm using this anti-corrosion method have been tested in the actual marine environment for the last five years (see fig.4). The behavior of these prototype specimens have been monitored by observing the thickness change, the electrolytic potential, the electric current from a sacrificial aluminum anode and the surface condition. The steel pipe specimens are covered with the titanium clad steel plates between 1 m above high water level and 1 m below low water level (The length is 4 m). Other than the titanium clad part, the steel pipes in the atmosphere are protected by a heavy duty coating system using fluorocarbon resin and the steel pipes in the sea water are protected by cathodic protection using aluminum anodes.

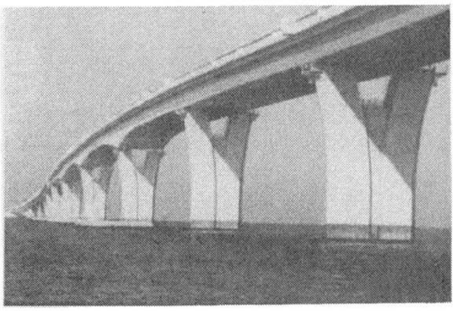

Fig. 1 Trans-Tokyo Bay Bridge

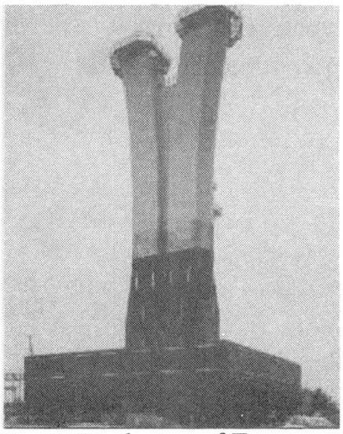

Fig. 2 Steel pier of Trans-Tokyo Bay Bridge

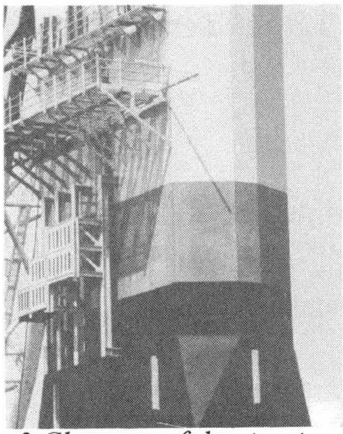

Fig.3 Close-up of the titanium clad part

Fig.5 shows the cross section of titanium clad part after the exposure period. No thickness reduction was observed not only in the titanium clad steel plates, but also in the steel pile adjacent to the titanium clad steel plates(see fig.6). The countermeasures against electrolytic corrosion were the heavy duty coating in the upper boundary in the atmosphere and the cathodic protection using an aluminum anode in the lower boundary in the sea water. Fig.7 shows the change of electric current from an aluminum anode. It was observed that the electric current was settled and the cathodic protection of steel pipe with titanium clad worked successfully.

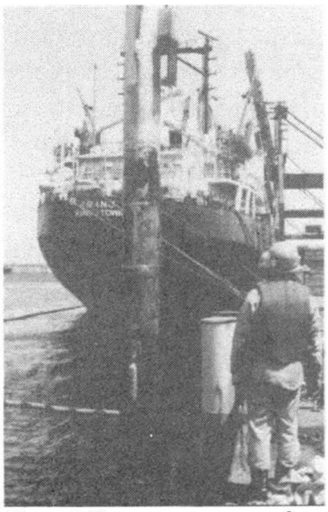

Fig. 4 Exposure test of specimens (when lifted)

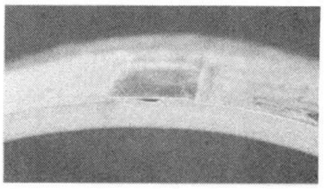

Fig.5 Cross section of specimen

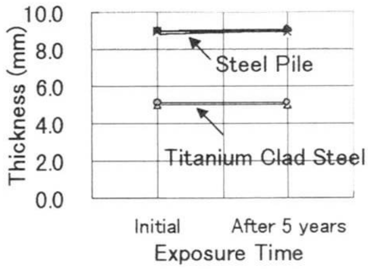

Fig.6 Change of thickness during 5 years

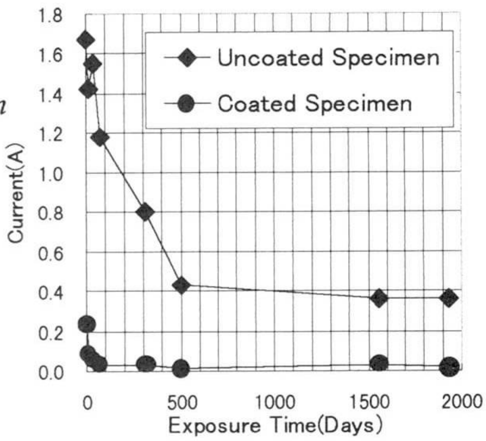

Fig.7 Change of current from a sacrificial aluminum anode

The monitoring results show that the titanium clad steel is perfectly healthy, and electrolytic corrosion does not occur in both upper and lower boundary areas between the steel pipe and the titanium clad part. Therefore, it was confirmed that the titanium clad showed an excellent anti-corrosion property and that the countermeasures against electrolytic corrosion were effective through the actual exposure test.