Performance of PSM Maintenance Technology in the Tropical Environment Based on Test Piece Survey Result
—The first Application of Cathodic Protection in Indonesia—

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1. Introduction

This joint research is a pilot project between PS Mitsubishi Construction (PSM) and the Agency for Research and Development, Ministry of Public Works and Housing of Republic of Indonesia (DRBE). The purpose of this collaborative research is to observe the effectiveness of Zinc (Zn) Cartridge which was developed by PSM as a bridge repair method of sacrificial anode cathodic protection applied and Titanium (Ti) Wire Sensor which was also invented by us as an internal probe in chloride-contaminated concrete.

In this paper, we are reporting on experimental tests on small reinforced concrete slabs with steel embedded in chloride-contaminated concrete to observe the effectiveness of Zn Cartridge and Ti Wire Sensor technology against steel corrosion in Indonesia in a straightforward and simple way.

2. Research Outline

2.1 Specimen Geometry

This study prepared concrete slab specimens with 300 mm in length, 250 mm in width, and 100 mm in depth. Two steel rebars with a diameter of 13 mm and one Ti Wire Sensor were embedded inside a concrete slab. Moreover, the Zn Cartridge system contained a zinc anode with a diameter of 110 mm which was covered by backfill material, and was applied onto the concrete surface. Chloride ions were deliberately added around 10 kg/m^3 during mixing to accelerate the corrosion process in concrete so that concrete could become chloride-contaminated. Figure-1 shows the detailed layout of concrete slab specimens.

2.2 Casting Process and Exposure Condition

After casting concrete and demolding, all specimens were subjected to room temperature in a dry condition for 28 days. After 28 days, the Zn Cartridge were connected to the embedded steel rebar. Silver/silver chloride electrode (SSE) and Ti Wire Sensor were used as reference electrodes for potential mapping on the concrete surface and inside the concrete in this study. The specimens were exposed to a dry-tropical climate condition as shown in Photo-1.

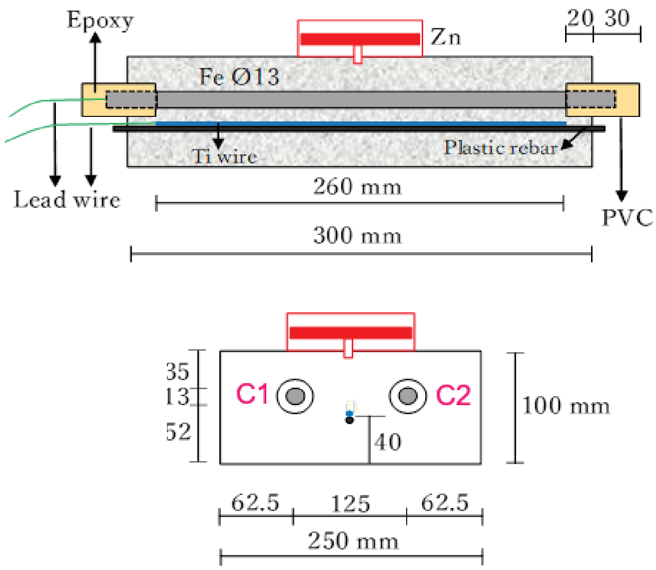

Figure-1 Detailed layout of concrete specimens with Zn Cartridge and Ti wire sensor embedded in concrete

Photo-1 Specimens exposure condition

3.　Results and Discussion

Figure-2 shows the protective current delivered from the Zn Cartridge anode to the entire rebar assembly with a function of exposure time. It shows that the protective current density tends to fall with time. However, even though the protective current flow decreased and was less than the minimum design limit of cathodic protection based on BS EN ISO 12696, it could polarize the steel bar more than 100 mV, indicating good protection.

Figure-3 shows the depolarization value of rebar protected by Zn Cartridge. Depolarization test is a method to observe the effectiveness of Zn Cartridge performance as a sacrificial anode cathodic protection system. Depolarization tests were conducted for 24 hours by disconnecting the protective current flow from Zn Cartridge to rebar. The potential difference between the instant-off potential and the potential measured 24 hours later after switching off the Zn Cartridge anode current is called the 24-hour potential decay, which is an important parameter used to evaluate the effectiveness of Cathodic Protection (CP) operation. Generally, 100 mV depolarization recorded during a twenty-four-hour period is the most accepted criterion for corrosion protection. Figure-3 shows the time dependency of the variation in potential decay of rebar, satisfying the potential decay criterion, which is over 100 mV. It means Zn Cartridges demonstrated excellent corrosion protection of the rebar.

Meanwhile, in Figure-4, two monitoring data of rebar are compared, which were measured by SSE and the Ti Wire Sensor (WS) after the depolarization test, and the data are called rest potential of rebar or natural potential of rebar. From the graphs, it was observed that Zn Cartridge polarized the rebar to the noble values. It indicates that the reinforcements in chloride-contaminated concrete are safe from corrosion. Moreover, Ti wire sensor showed a good performance in detecting and reading the potential of rebar and its effectiveness was equivalent to a common electrode, SSE. It can be concluded that the Ti Wire Sensor is durable, stable, reliable, and economical to be used in concrete structures in the terms of corrosion monitoring of rebar for long-term utilization.

4.　Summary

From the reported work, it can be concluded that Zn Cartridge affords excellent corrosion protection in dry-tropical conditions, and that Ti Wire Sensor is reliable to be used as a reference electrode for corrosion monitoring in concrete.

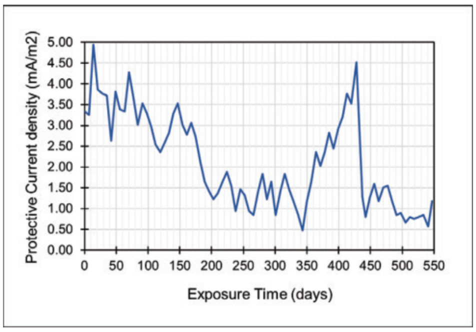

Figure-2 Protective current flow from Zn Cartridge

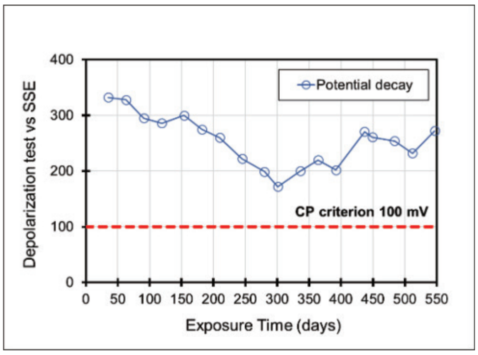

Figure-3 Depolarization test of rebar

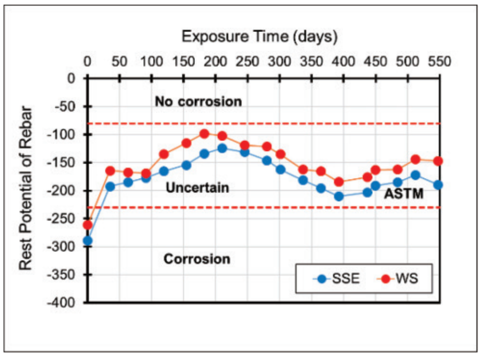

Figure-4 Rest Potential of Rebar connected to Zn Cartridge measured with SSE and Ti Wire Sensor

Acknowledgment

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Key Words : Zn Cartridge, Ti Wire Sensor, cathodic protection, corrosion protection, corrosion monitoring




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