CORROSION SCIENCE AND TECHNOLOGY, Vol.31, No.1(2002), pp.70~73

Remote Monitoring and Controlling System for Cathodic Protection on Concrete Structure

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Cathodic protection on corrodible structure needs a long time working and needs periodically the check-up and modifying protection conditions and then spends lots of money and time for maintenance. However, the use of computer technology can greatly simplify and improve the operation of cathodic protection system. Monitoring factors can be summarized as output voltage, output current, protection potential, instant-off potential, depolarization rate, corrosion rate, corrosion potential etc. In this work, remote monitoring and controlling system for cathodic protection on concrete structure is developed. This system is an advanced and user-friendly cathodic protection system. Also, the properties of cathodic protected rebar of concrete in salt water are evaluated.

Keywords *: concrete, cathodic protection, monitoring, controlling, computer*

1. Introduction

Cathodic protection on corrodible structure needs a long time working and needs periodically the check-up and modifying protection conditions and then spends lots of money and time for maintenance. However, the use of computer technology can greatly simplify and improve the operation of cathodic protection system.

Monitoring factors can be summarized as output voltage, output current, protection potential, instant-off potential, depolarization rate, corrosion rate, corrosion potential etc. In this work, remote monitoring and controlling system for cathodic protection on concrete structure is developed. Also, the properties of cathodic protected rebar of concrete in salt water are evaluated.

2. Experimental

Concrete specimen including a rebar and an anode for cathodic protection is made. Specimen symbol A and B mean river a sand used concrete, and E and F imply a salt added sand used concrete. Also, X, Y, and Z represent non-protection, mesh-type anode used, and ribbon-type anode used protection. Specimen A and E are tested in air, and B and F are tested in a salt water (3.5% NaCl solution) and water line is under rebar.

Open circuit potential, protection potential, on-off potential et al. are monitored and saved in computer. On-line monitoring and controlling system for cathodic protection is operated.

3. Results And Discussion

3.1 Corrosion and cathodic protection potential

Figure 1 shows open circuit potential (E_R) and protection potential (E_{pr}) of specimen A in air. In case of non-protected AX, open circuit potential gradually increases and by destruction test, rebar corrodes a little. In case of protected AY and AZ, protection potential was controlled by the result of on-off potential and destruction test. Rebar corrosion was inhibited by cathodic protection.

Figure 2 shows open circuit potential (E_R) and protection potential (E_{pr}) of specimen B in salt water. In case of non-protected BX, open circuit potential decreases to base direction and by destruction test, rebar corroded severely.

In case of protected BY and BZ, protection potential was controlled by the result of on-off potential and destruction test. Rebar corrosion was inhibited by cathodic protection.

Figure 3 shows open circuit potential (E_R) and protection potential (E_{pr}) of specimen E in air. In case of

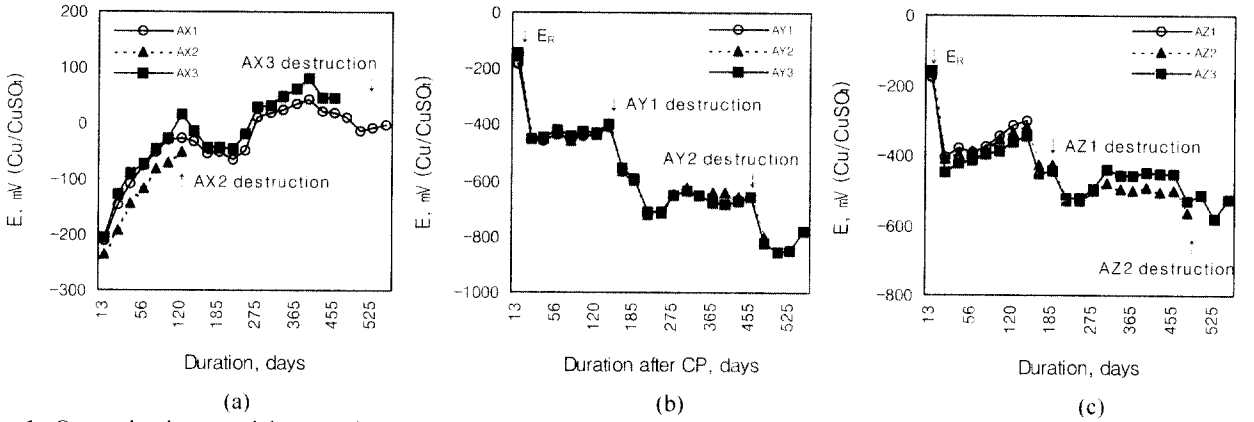

Fig. 1. Open circuit potential (a) and protection potential (b, c) of specimen A in air

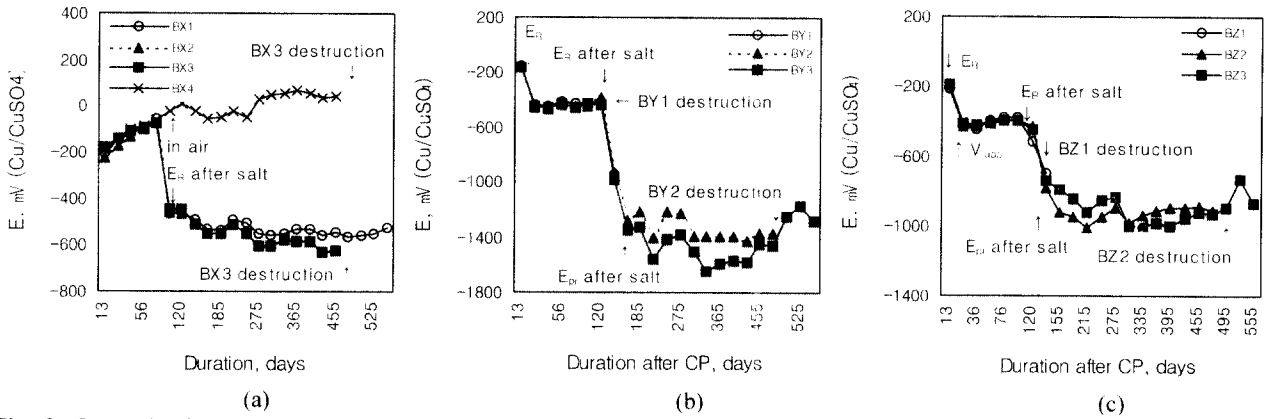

Fig. 2. Open circuit potential (a) and protection potential (b, c) of specimen B in salt water

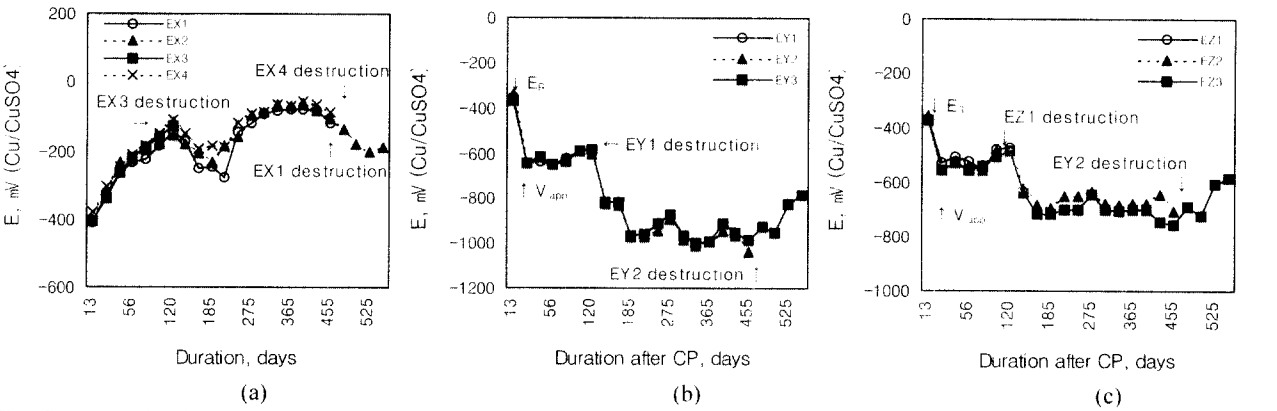

Fig. 3. Open circuit potential (a) and protection potential (b, c) of specimen E in air

non-protected EX, open circuit potential gradually increases, but is lower than specimen A and by destruction test, rebar corrodes.

In case of protected EY and EZ, protection potential was controlled by the result of on-off potential and destruction test. Rebar corrosion was inhibited by cathodic protection.

Figure 4 shows open circuit potential (E_R) and protection potential (E_{pr}) of specimen F in salt water. In case of non-protected FX, open circuit potential decreases to base direction and by destruction test, rebar corroded severely.

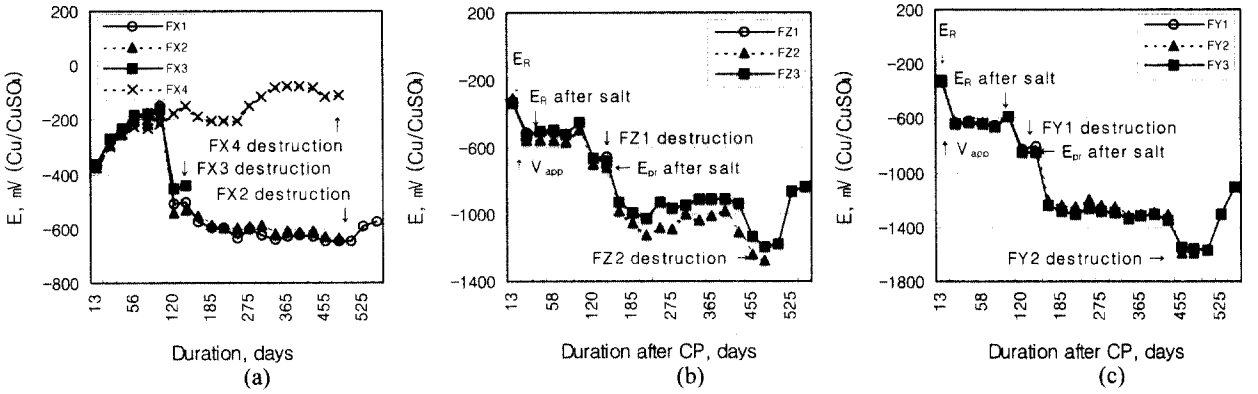

Fig. 4. Open circuit potential (a) and protection potential (b, c) of specimen F in salt water

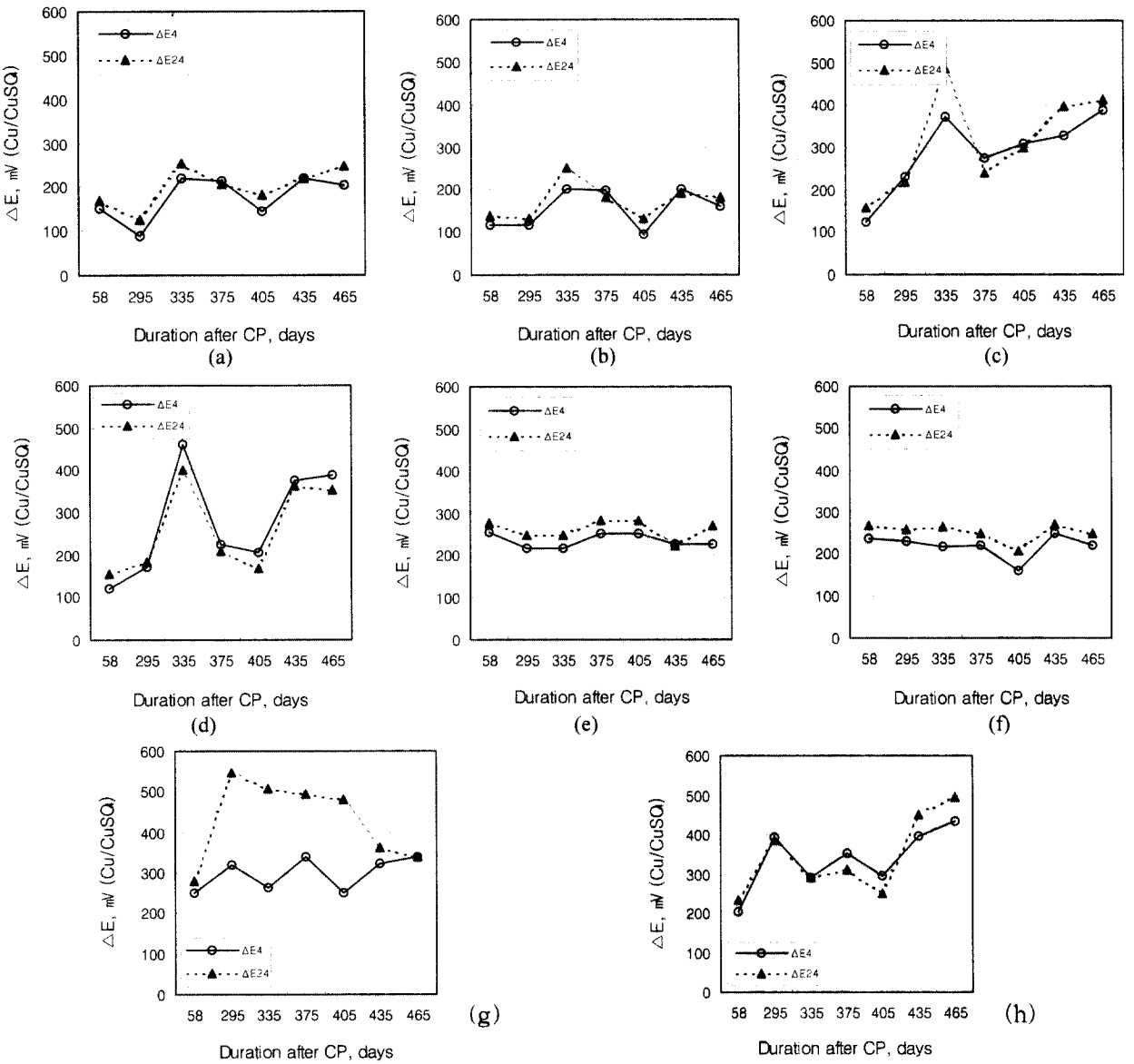

Fig. 5. Instant on-off potentials; (a)(c)(e)(g) used mesh type anode, (b)(d)(f)(h) used ribbon type anode, (a)(b)(e)(f) are tested in air, (c)(d)(g)(h) are tested in salt water

In case of protected FY and FZ, protection potential was controlled by the result of on-off potential and destruction test. Rebar corrosion was inhibited by cathodic protection.

3.2 Instant on-off potential

Even though rebar is protecting cathodically, we should know corrosion and protection status because corrosion condition can be changed. In case of constant voltage protection, -850 mV criterion usually is used. However, neutralization and salt penetration can change rebar condition in concrete. Therefore, instant on-off potential should be measured at 4 hrs or 24 hrs after DC power off.

Figure 5 shows instant on-off potential of each condition. When ΔE(4 or 24) is near 200 mV, it is considered that cathodic protection system is well operated. As shown in Figure 5, some case (a, b, e, f) is well operated and some case (c, d, g, h) is over-protected cathodically, that is, specimen protected in air is well operated but specimen protected in salt water is over-protected.

This result shows that rebar condition is changed and protection system should be controlled.

3.3 Remote monitoring and controlling system for cathodic protection

In Canada pipeline system, the line includes over 39,000 km. The mandate to measure close interval (5 to 10 meters spacing) off potentials across the pipeline system on a 3 to 5 year rotation requires that in many areas, up to 30 rectifier sites must be interrupted simultaneously. The present method of visiting each site is time consuming and leads to significant reduction in survey productivity. Therefore, more useful method is needed.

Figure 6 shows the electrochemical cathodic protection system including monitoring and controlling the parameters. Monitoring factors can be summarized as output voltage, output current, protection potential, instant-off potential, depolarization rate, corrosion rate, corrosion potential etc. In this work, remote monitoring and controlling system for cathodic protection on concrete structure is developed.

4. Conclusions

Rebar corrosion by salt and salt water is inhibited by the electrochemical cathodic protection system. On the result of on-off potential measurement, rebar condition is changed and protection system should be controlled.

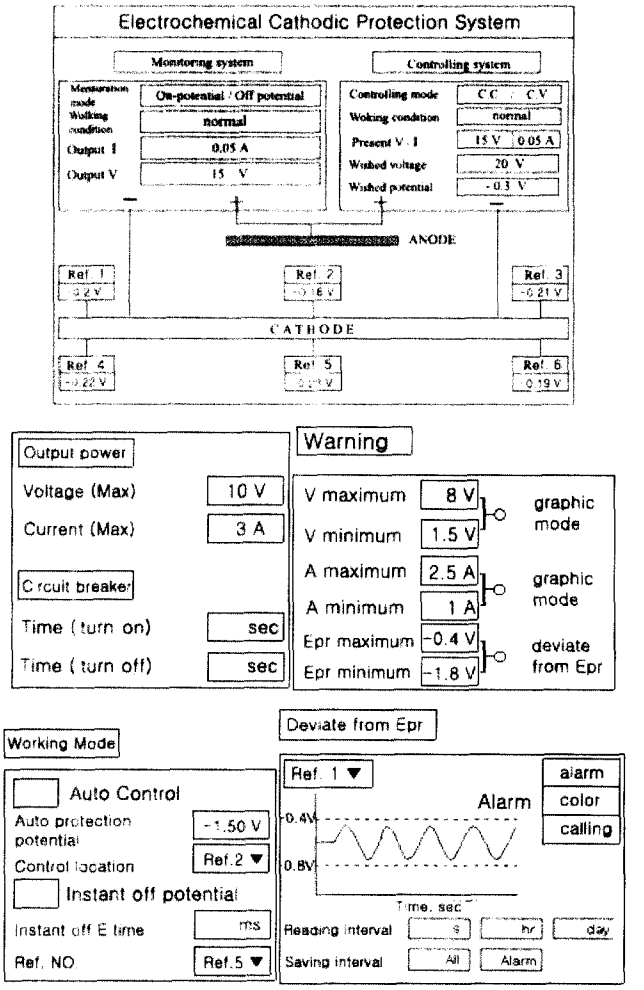

Fig 6. Remote monitoring and controlling system for electrochemical cathodic protection

Monitoring factors can be summarized as output voltage, output current, protection potential, instant-off potential, depolarization rate, corrosion rate, corrosion po tential etc. In this work, remote monitoring and controlling system for cathodic protection on concrete structure is developed, and this system is an advanced and user-friendly cathodic protection system.

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