V-119 STUDY ON CORROSION OF REINFORCING STEEL BY MEANS OF ACCELERATED CORROSION TEST

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1. INTRODUCTION

The corrosion process of reinforcing steel in concrete is a complex problem due to the number of variables involved in making reinforced concrete and as well as in the environment. The aim of this paper is to throw lights on this problem by studing the factors contributed to the cause of corrosion, and to determine their relative importance and to find the steps necessary to encounter the problem. The factors which are investigated are type of steel, bar diameter, epoxy coating, and surface condition of reinforcing bars. Also, influence of concrete quality and concrete cover are discussed.

2.EXPERIMENT

Concrete of slump 8 cm and with different mix proportions are used in this experiment. After casting, the specimens were cured in forms for two days and in water for two weeks. Then, a galvanic corrosion test [1] was carried out on 15X15X40 cm specimen beams reinforced with one reinforcing bar of 13, 19 or 25 mm in diameter. The cover was 2.5, 3.75, or 5.0 cm. The current and the strain of concrete were measured up to cracking. After the galvanic corrosion test, bars taken from specimens were observed, and weight loss were determined.

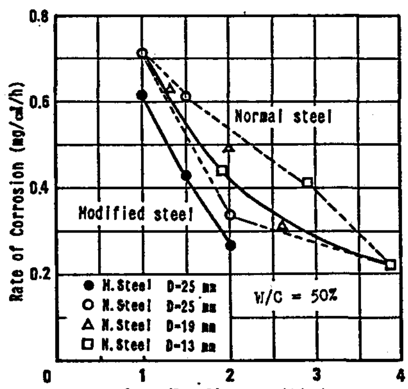

Fig. 1 The relation between rate of corrosion and ratio of cover to bar diameter

3.TEST RESULTS AND DISCUSSION

Figure 1 shows the relation between the rate of corrosion and the ratio of cover to bar diameter for two types of steel. This figure shows that the rate of corrosion of the modified reinforcing steel (Seibun Chosei Tekkin) is smaller than that of normal steel (SD-30). Also, as the ratio of cover to bar diameter increase, rate of corrosion up to cracking is decreased.The effect of surface condition on rate of corrosion and weight loss per unit area up to cracking is shown in figure 2. When the reinforcing bars were used without scaling off the black skin (unclean) the weight loss was increased and time up to cracking was extended but the rate of corrosion was decreased.The relation between the integrated current (A.h) up to cracking during galvanic corrosion test and measured value of weight loss multiplied by cover diameter ratio (W X C/Φ) is shown in figure 3. Two master lines were obtained for various combinations of cover and diameter. This relation is given by the following equation;

$$W \cdot C/\Phi = a\int I.\, dt \quad \text{------------------} \quad (1)$$

where a is experimental factor which depends on type of steel.

a = 0.42 in case of modified steel

a = 0.52 in case of normal steel

The weight loss of modified steel is lesser and time to cracking is shorter than those of normal

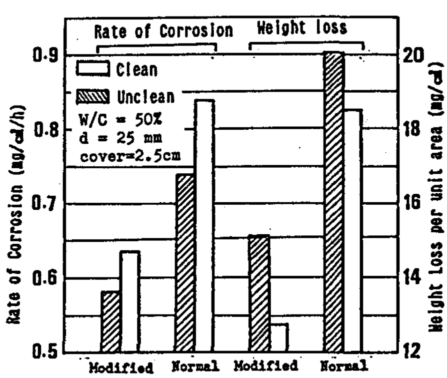

Fig.2 The effect of reinforcing steel surface conditions on the rate of corrosion and weight loss

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steel, this may be due to the difference in chemical and mechanical properties of corrosion products of two kinds of steel.

In all experiments, it was found that , one longitudinal crack was formed on concrete cover and bars was corroded only on the side which faced to the cover. From this fact, The epoxy coating are used for coating one side of reinforcing bars which faced to the cover as all or part of them. The half coated bar was corroded in the opposite side of the cover and the time to cracking was extended by 250% compared to that without coating. Figure 4 shows the influence of epoxy coating of different parts of reinforcing bars on weight loss and rate of corrosion.

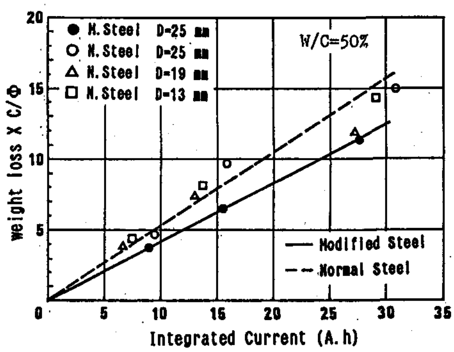

Fig.3 The relation between integrated current and weight loss X C/Φ

The rate of corrosion is increased by incraesing chloride ion content, but their effect was significantly increased when chloride content was up to 600 g/m^3 as shown in figure 5. Also, the rate of corrosion is effected by concrete quality. For example, figure 6 shows the relation between compressive strength of concrete and rate of corrosion, weight loss and the time up to cracking. From this figure, it is found that as the compressive strength of concrete increased the time up to cracking is extended and weigth loss is increased ,but the rate of corrosion is decreased. The rate of corrosion in dense concrete (W/C=20% with 20% silica fume) was very small, due to not only high strength but also its high resistivity and low permeability.

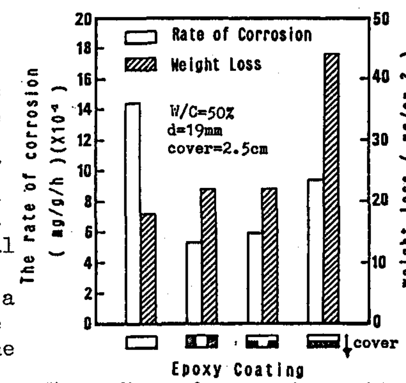

Fig.4 Influence of epoxy coating on weight loss and rate of corrosion.

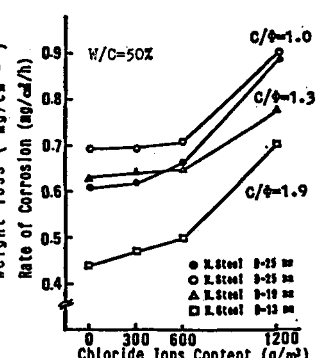

Fig.5 The relation between chloride ions content and rate of corrosion

4.CONCLUSION

The following conclusions are obtained from the present investigation;

1) The rate of corrosion of modified reinforcing steel (Seibun Chosei Tekkin) is smaller than that of normal reinforcing steel.

2) The depth of cover has a significant effect on the rate of corrosion. The diameter of reinforcing steel and thickness of cover should be corelated together in this case.

3) The surface condition of reinforcing bar (black skin or epoxy coated) has significant effect to extend the time to cracking and to reduce the rate of corrosion.

4) Highly dense concrete provides good protection of reinforcing steel due to high strength, high resistivity, and low permeability.

5) The relation between the weight loss (W), cover - diameter ratio (C/ϕ) and integrated current (I.dt) up to cracking can be given by the eguation 1.

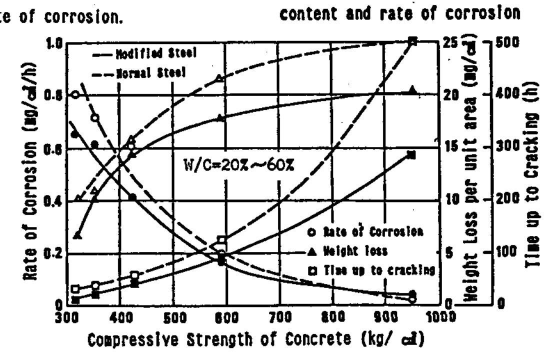

Fig.6 The relation between compressive strength of concrete and rate of corrosion, weight loss and time up to cracking

REFERENCE

1) K.Omori et. al.,"Evaluation of Cracking Characteristic of Reinforced Concrete by Using Electrolytic Corrosion Test ", Proceedings of the 41 st Annual Conference of Japan Society of Civil Engineers, Nov.1986, P.547 .