THE EFFECT OF COVER DEPTH AND WATER－CEMENT RATIO ON THE RELATIVE QUALITY EVALUATION OF CONCRETE IN VARIOUS ENVIRONMENTS

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1. Introduction

Japan will be confronted with deterioration problems in future. Cover concrete quality is important to keep the durability of concrete structures. It is well understood from previous research that the influence priority on cover concrete quality in indoor is decided by the combination of cover depth and W/C. However, to evaluate the quality of concrete cover in real structure, it is necessary to consider the environmental effects on the cover depth and W/C as factors of cover concrete quality evaluation. Too thin cover depth can lead the corrosion of reinforcement bar, furthermore it might induce the difference concrete attributes because large aggregate cannot involve in the thin cover and this layer is easily affected by environment. Environment affects W/C as a factor of cover concrete quality because drying water process makes many different properties and that process is depended on the environment.

Air permeability (KT) has been recognized as one of the indicator of durability because air permeability denotes the resistance of the mass transfer, such as carbonic acid gas or chloride ions. Torrent method is considered as a good quantitative method to measure air permeability. It has been recognized that the moisture contents of concrete is necessary to evaluate relative quality in Torrent method. Water contents influences the electrical resistivity(ER) of the concrete. In this research, Torrent method and ER were conducted to evaluate the cover concrete quality after 1 year curing in indoor and outdoor environment and it was considered the environmental influence degree of two factors, cover depth and W/C, on cover concrete quality.

2. Experimental Programs

2.1. Specimens

Specimens for indoor and outdoor environment were organized in 10 series as shown in Table 1. No Bar in W/C=0.6 have an unsuitable specimens in Torrent investigation. This specimen was excluded from considering results.

Table 1 Specimens number and name

W/C \ cover depth	No Bar	5mm	15mm	30mm
0.45	1	1	1	1
0.6	2	1	2	1

Table 2 Mix proportions

W/C	s/a(%)	Sl(cm)	W(kg)	C(kg)	S(kg)	G(kg)	AE(kg)	Air(%)
0.45	41.6	8.8	168.6	378	735	1032	1.42	4.1
0.60	44.58	8.3	168.9	283	823	1023	1.1	3

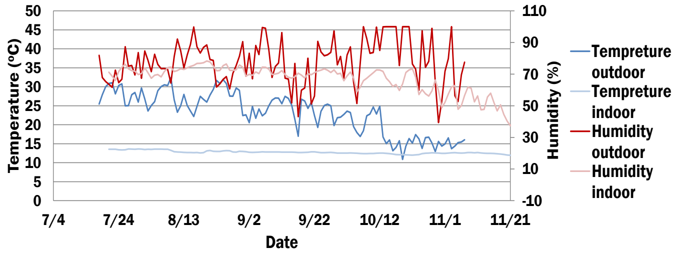

Figure 1 Temperature and Humidity

(1) Materials

Mix proportions are shown in Table 2. Mixes used W/C=0.45 and 0.6 and maximum size of coarse aggregate is 20mm. Reinforcement bar used D19.

(2) Dimensions and curing condition

The specimen dimensions were 200mm cubic. Each reinforcement bar was located in the center of bottom. The cover depth was obtained by varying the depth of reinforcement bars from No Bar, 5mm, 15mm to 30mm. The specimens were demolded after 7 days and placed upside down and stored in indoor and outdoor at Tokyo, Japan for 1 year. The example of mean ambient temperature in indoor and outdoor for 4 months is shown in Figure 1.

2.2. Investigation Method

Torrent test was conducted on the surface of the steel bar. Torrent investigation measured KT on the surface center of specimens and ER on the surface at 7, 14, 28, 90, 255 and 365days. ER was measured twice and took means. In KT-ER figure, the more left and upper the line exists, the better evaluation is, and the more right and more down the line exist, the evaluation is worse.

Keywords: air permeability, cover concrete quality, cover depth, non-destructive test, water cement ratio,
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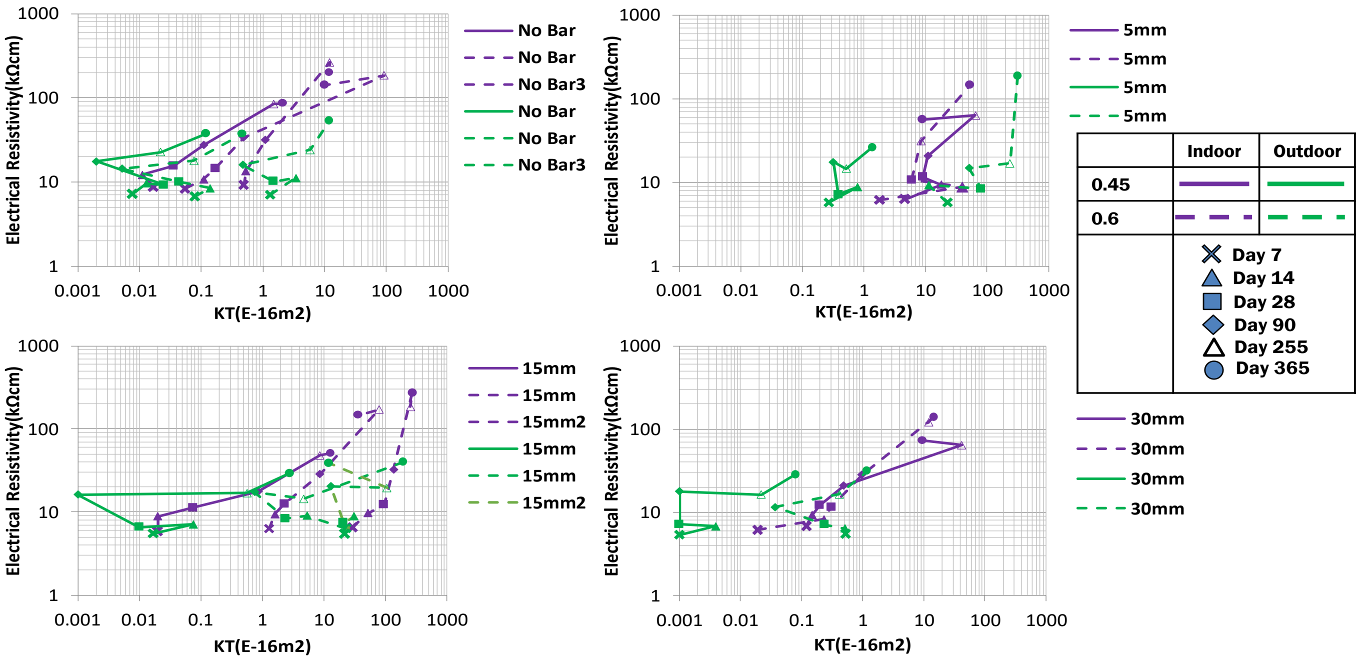

Figure 2 KT-ER relatively evaluation indoor and outdoor

3. Experimental Results

Figure 2 shows the change of KT-ER over time for all specimens stored in indoor and outdoor. In the case of W/C=0.45, No Bar and 15mm were almost same between indoor and outdoor. 5mm in indoor were worse than outdoor. 5mm cover depth was easy to induce material separation and indoor specimens got dried quickly so hydration reaction did not progressed completely and indoor specimens got worse than outdoor. 30mm in outdoor was better than indoor because 30mm specimens in outdoor was supplied sufficient water by rains or humidity to progress the hydration reaction. Therefore, in W/C=0.45, indoor specimens was easily dried and hydration process was not enough so the indoor cover concrete quality might be lower than outdoor specimens. In the case of W/C=0.6, No Bar ,15mm and 30mm lines were very close between indoor and outdoor and had similar evaluations. W/C=0.6 specimens had enough water to make progress in hydration reaction in the specimens themselves even if indoor specimens are exposed to the dried environment. Therefore, the effects of the indoor and outdoor environment was considered to be very small in W/C=0.6. Meanwhile, 5mm in outdoor was worse than indoor. 5mm in outdoor specimens not only had material separation effects as well as W/C=0.45 but also be easy to penetrate water from the pore caused by material separation and induce corrosion. As the KT-ER graph shows, 5mm in outdoor and W/C=0.6 specimen depicted keen change in air permeability. This change is quite likely that the crack was occurred by reinforcement bar corrosion and affected air permeability as a pass of the air.

4. Conclusions

The effect of the indoor and outdoor environment on the W/C as the factors of cover concrete quality evaluation was stronger than cover depth. Some effects made cover concrete quality better but others effects induced cover concrete quality worse and it depends on the W/C even if in the same cover depth and W/C. In this research, the reason why No Bar and 15mm in outdoor and W/C=0.45 specimens were not affected by environment was not revealed. It calls for further investigation to confirm their cover concrete quality were same between in indoor and outdoor or were different but their air permeability were same by some reasons.

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Reference

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