Autogenous healing ability of bond cracks along reinforcing bar

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1. Introduction

Micro cracks occurred in concrete around tensional reinforcing bar were well known phenomenon represented by Goto [1]. These cracks are difficult to find until cracks develop to the surface of concrete. If these micro cracks were recovered before significant growth, it will be more useful in terms of durability. An autogenous healing is a one proper method for this case, because the cracks are widely distributed around reinforcing bar but small enough to recover the autogenous healing. This paper presents autogenous healing ability of cracks developed around tensional reinforcing bar.

2. Experimental Program

A normal concrete and a fly ash concrete were used in this paper, and the mix proportions are shown in Table 1. Rectangle specimens with size of 150x150x500mm with reinforcing bar were used, as shown in Fig.1. There was D22 re-bar in the specimens, and a notch having a thickness of 3mm and depth of 30mm was induced in concrete at the midpoint of each specimen.

Table 1 Mix proportions

	W/C	Unit content(kg/m^3)				
		W	C	S	G	FA
NC	0.45	170	377	780	903	
FC	0.45	170	377	716	903	58

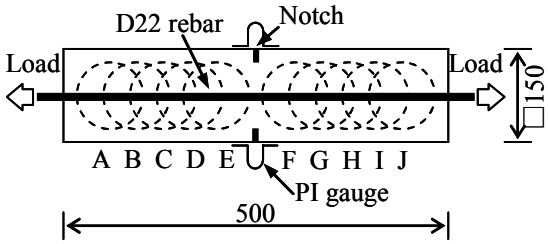

Fig.1 Shape of specimens

Loading test was performed at the age of 28 days, and unloading point was 1mm, which was measured by PI gauge attached both sides of specimen. Six specimens were prepared for each concrete. Three of them were for air permeability test, and air permeability tests [2] were performed before loading, after loading and after recuring in each specimen. Ten measurement points along reinforcing bar were selected naming A to J in Fig.1. Other three specimens were for investigation of cracks patterns. A red ink was injected into two slits along reinforcing bar, as shown in Fig.2, and specimens were cut using concrete cutter. All specimens had recuring after loading during 28 days.

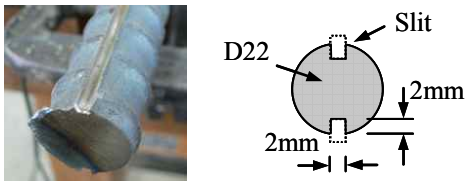

Fig.2 Slits for ink injection

3. Results and Discussions

Figs 3 and 4 show the air permeability coefficients of each specimen before loading, after loading and after recuring of normal concrete and fly ash concrete, respectively. Air permeability coefficients of all specimens became larger after loading due to cracking, and became smaller by recuring in water conditions. But there was no tendency of recovery by recuring in air condition. A significant change was observed at D~G locations, which are near the crack induced by notch. Air permeability coefficients of these parts had a significant increase after loading, and had relatively much recovered by recuring in water condition. A significant difference was not observed between normal concrete and fly ash concrete, but generally air permeability coefficients of fly ash concrete were smaller than those of normal concrete.

Cracks investigation can provide the recuring effect more visually. Figs 5 and 6 show the dyed cracks pattern of each concrete. Cracks along reinforcing bar were shown after loading by dying, but a few cracks were found at specimens with recuring in water condition. On the other hand, specimens with recuring in air condition had almost same cracks with those of just after the loading.

Keywords Autogenous healing, Bond cracks along reinforcing bar, Tensional test, Ink injection
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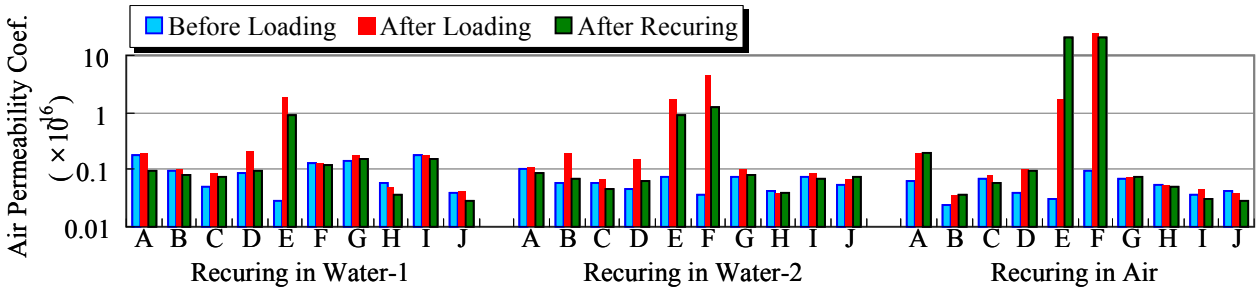


Fig.3 Results of air permeability of a normal concrete

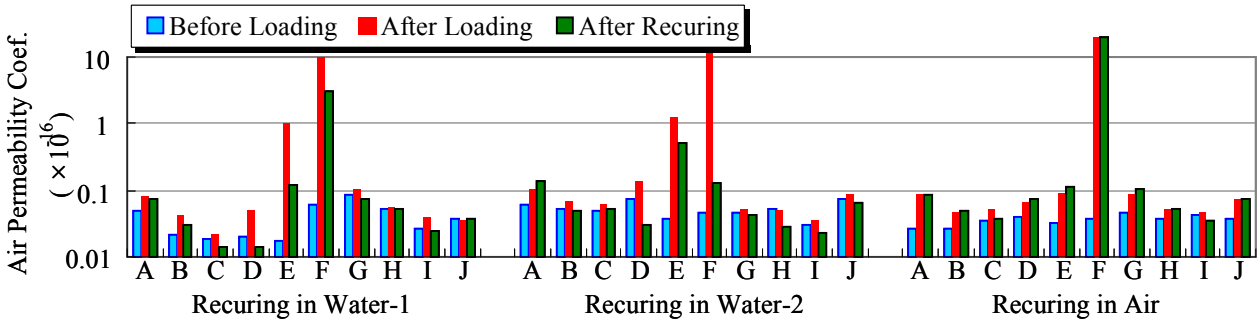
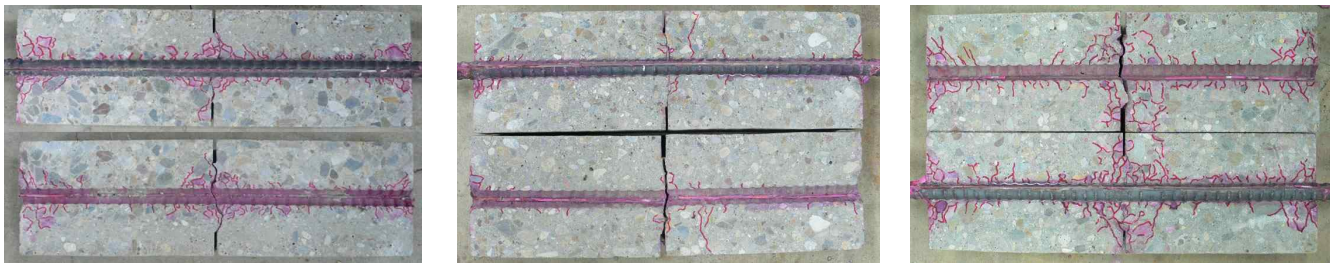
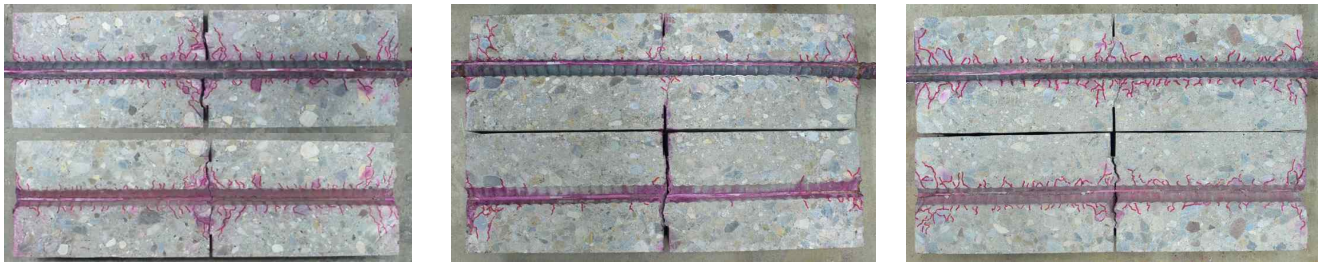


Fig.4 Results of air permeability of a fly ash concrete



(a) After loading (b) Recuring in Water condition (c) Recuring in Air condition

Fig.5 Cracks deformation of a normal concrete



(a) After loading (b) Recuring in Water condition (c) Recuring in Air condition

Fig.6 Cracks deformation of a fly ash concrete

4. Conclusions

The autogenous healing ability of micro bond cracks in concrete were experimentally investigated based on air permeability coefficient and cracks investigation, and following conclusions can be obtained.

1) Air permeability coefficients increased by the cracks around reinforcing bar due to tensile loading. By recuring in water condition, air permeability coefficients were decreased.

2) Through the observation of dyed cracks, cracks along reinforcing bar could be investigated. Most cracks of specimens with recuring in water condition were closed. But cracks of specimens with recuring in air condition were almost same with those just after the loading.

Reference

[1] Goto. Y.: “Cracks formed in concrete around deformed tension bars”, Journal of ACI, Vol 68, pp 244-251, April 1971.

[2] Torrent, R.: “A two-chamber vacuum cell for measuring the coefficient of permeability to air of the cover on site.”, Material and Structures, 25, pp 358-365, 1992