AN EXPERIMENTAL STUDY ON THE APPLICATION OF SELF-REPAIRING SYSTEM TO RC STRUCTURES USING SELECTIVE HEATING

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ABSTRACT

A fundamental study has been carried out to develop a kind of smart concrete that incorporates a self-repairing system. In this study, self-repairing system for reinforced concrete structures using a particular Self-Repairing Device (SRD) is proposed.

SRD is composed of a Self-Diagnosis Composite (SDC), a Heat-Sensitive Pipe (HSP), and a copper plate which connects both of them to make a thermal bridge. This SDC is functionalized as a heating device that can selectively heat around a generated crack by electrification. Then a HSP containing a repair agent embedded in concrete beside the heating device is designed to melt only in the heated zone. The repair agent (epoxy resin) released from the melted surface of the pipe fills the crack and hardens in the crack. Figure 1 shows the schematic diagram of the proposed self-repairing system [1].

In this study, an application of self-repairing system to a RC beam specimen was proposed in which a fibre reinforced cementitious composite (FRCC) layer including SRD was applied to the surface. The RC beam specimens are subjected to three-point bending test to generate cracks. Figure 2 shows the schematic diagram of the employed specimen and procedure of the bending test. These cracks lead to partial elongation of SDC around the generated crack. Electrifying the damaged SRD to activate the proposed self-repairing system can selectively heat around the generated crack. Figure 3 is the result of the temperature distribution by thermographic observations. Before cracking, SDC uniformly heated and maximum temperature is lower than the melting point of HSP (86 °C) (see Figure 3(a)). On the other hand, SDC was selectively heated around the generated crack and has enough high temperature to melt the embedded HSP (see Figure 3(b)). It was confirmed by thermographic observations at the surface of the concrete beam specimen.

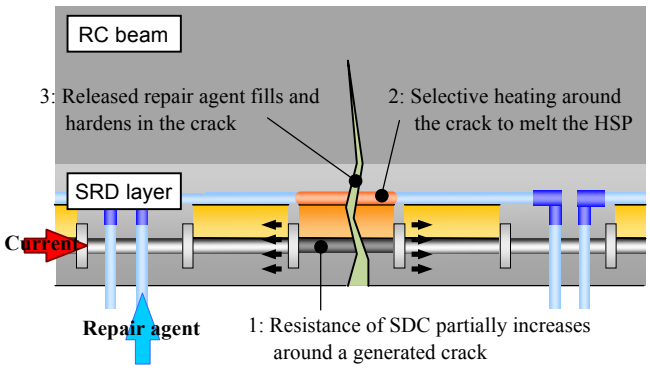


Figure 1: Schematic diagram of proposed self-healing concrete system

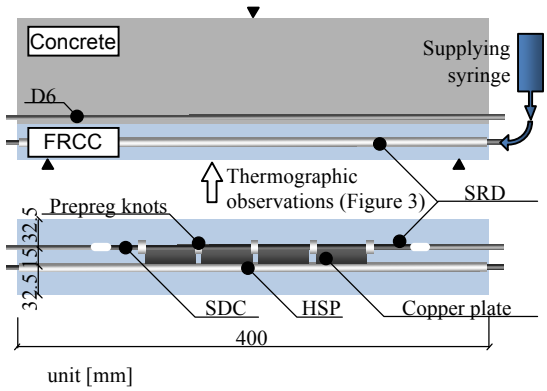
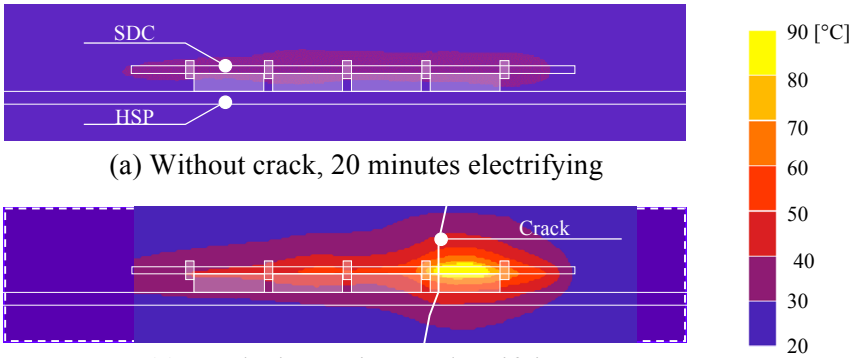


Figure 2: Geometry of the specimen

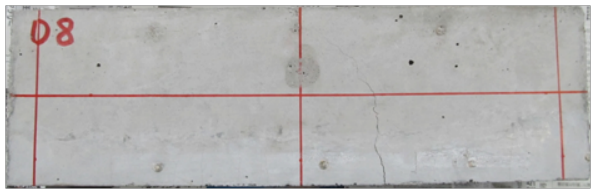


(a) Without crack, 20 minutes electrifying

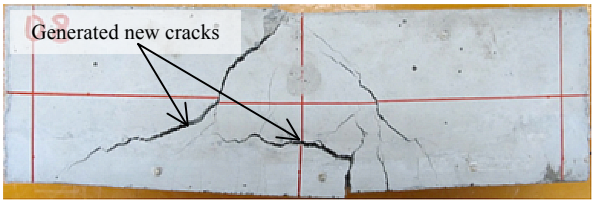
(a) Cracked, 20 minutes electrifying

Figure 3: Temperature distributions on the surface of specimens

After activating the self-repairing system, the specimens were subjected to second bending test again to evaluate the recovery of mechanical properties. The recovery was observed in case of bending crack was introduced. Bending strength in the second test was higher than the first test, and new cracks were observed (see Figure 4). From this it is evident that the proposed self-repairing system is highly effective for the recovery of mechanical properties of the RC beam specimens. However, in case of shear cracks were generated, this system was found to be ineffective to repair the shear cracks (see Figure 5). These results indicate that a suitable arrangement of the SRD in the RC specimen/structures was essential for the effectiveness of the proposed self-repairing system.

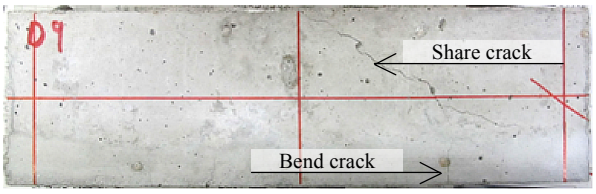


(a) After 1st loading

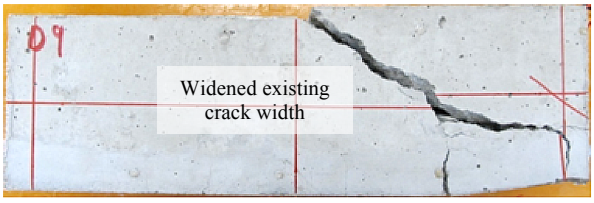


(b) After 2nd loading

Figure 4: Crack geometry of specimen that self-repaired against bend crack



(a) After 1st loading



(b) After 2nd loading

Figure 5: Crack geometry of specimen that self-repaired against share crack

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