INNOVATIVE REPAIR METHODS FOR CIVIL INFRASTRUCTURES BASED ON CRACK SELF-HEALING TECHNOLOGIES USING CEMENTITIOUS MATERIALS

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ABSTRACT

In this study, innovative repair methods based on crack self-healing technologies using cementitious materials were suggested in order to prevent water leakage in civil infrastructure such as slab, tunnel and water-retaining structure. First, shotcrete with self-healing capability for the underground civil infrastructure was examined in comparison with normal shotcrete without self-healing capability. The results of water pass test after cracking show that cracked shotcrete mixtures incorporating self-healing agents exhibit much higher self-healing behavior than cracked normal shotcrete mixtures. For new repair materials with self-healing capability applied to crack sealing method, various repair materials were examined. Cracks with an initial width of 0.2 mm in the case of some mix proportions were almost healed after water passing tests. Finally, the effects of various hydration phases on the self-healing mechanism were analyzed using TG-DTA, Digital Microscopy and SEM(EDS). From these concepts, some particular mix-proportions for new repair method with self-healing capability were suggested.

1. INTRODUCTION

Crack in concrete is one of the biggest problems in terms of durability of infrastructures. Maintenance and repair of cracked concrete are also very important for civil engineering fields. Recently, authors suggested new repair methods based on crack self-healing technologies for underground civil infrastructures as tunnels[1, 2].

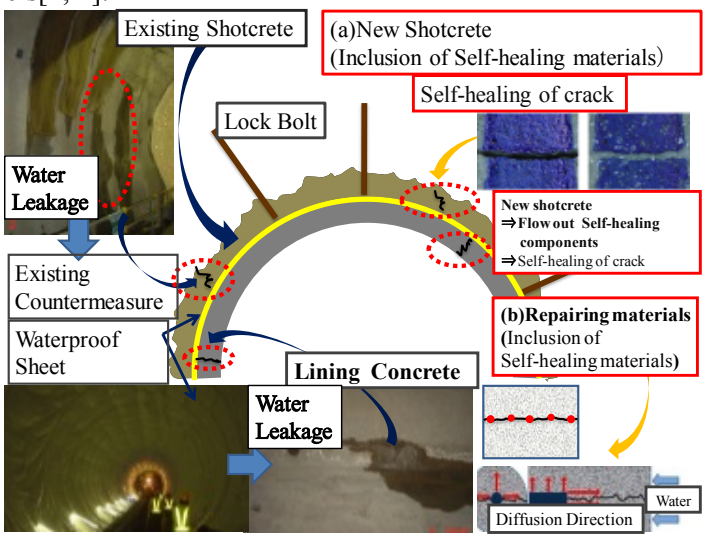

Figure 1: Application concept of self-healing technologies for underground civil infrastructures as tunnels

This study aims to develop the shotcrete incorporating self-healing agents for the underground civil infrastructures without water-leakage as shown in Figure 1(a). Moreover, new repair method applied to crack sealing method is also studied as shown in Figure 1(b). The holes with suitable intervals are prepared for repair work of cracks under water leakage, and they are filled with the cementitious repair materials incorporating self-healing agents. Some experimental studies were conducted in order to investigate the self-healing capability of cementitious repair materials for cracks under water leakage conditions.

2. EXPERIMENTAL PROGRAM

(a) Raw materials

In this research, various mineral admixtures such as expansive agent, geo-materials, and chemical agents were used in order to manufacture the self-healing admixture based on previous research [1, 2].

(b) Estimation of waterproof effects on the new shotcrete incorporating self-healing agents

When the cracks occur in the shotcrete incorporating self-healing agent, it is expected that the self-healing agent begin to diffuse into underground water through the crack. And then, this underground water passes the crack of the lining concrete, new cementitious hydrates form in the crack. Therefore the crack becomes blocked by these hydration products. As mentioned above, waterproof effects of the shotcrete incorporating self-healing agents were mainly investigated in this research.

(c) Estimation of waterproof effects on cementitious repair materials incorporating self-healing agents

In the second stage, waterproof effects of cementitious repair materials incorporating self-healing agents were investigated based on the concept as shown in Figure 1(b). The length of the specimens was fixed around 30cm the same as thickness of general lining concrete in tunnels. Moreover, two types of cylinder specimens (φ100mm and φ150mm) were prepared in order to estimate the diffusion area of repair materials. Small hole (φ2cm X 10cm) from crack surface was prepared and the splitting cracks were induced to specimens in advance. After cementitious repair materials was filled into hole waterproof effects of repair materials were investigated under water leakage condition.

3. CONCLUSTIONS

In this study, the new method of self-healing design to repair cracks in concrete was suggested.

1. The addition of self-healing agents to the shotcrete and repair materials seem to improve waterproof effects, which are attributed to the formation $CaCO_3$, $MgCO_3$, and magnesium silicate phases at crack surface under water leakage condition.

2. This indicates that self-healing agents significantly affect on the formation and size of rehydration between cracks.

3. It is considered that the utilization of appropriate dosages of self-healing agents has a high potential for one of new repairing methods of cracked concrete under the water leakage of civil infrastructures such as slab, tunnel and water-retaining structure.

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