SELF-HEALING IN ECC STIMULATED BY SAP UNDER FLEXURAL CYCLIC LOAD

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ABSTRACT

In the present study self healing of ECC is promoted by the use of Super Absorbent Polymers(SAP) in the mix [4]. The SAP's are filled with water during the mixing process and form in such a way water pockets in the concrete that can be used for hydration of the cement and thus self healing in a later stage. SAP's are known as additive to mitigate autogenous shrinkage in concrete [1]. The self healing capacity of the SHCC is already improved by adding these SAP's in specimens that are cracked and subsequently stored in water [2, 3]. However these SAP's can also work for specimens stored in air. The waterpockets are emptied during or shortly after the first hydration. When the material cracks at a later stage no water is left anymore. After some rain on the structure the SAP's located in the cracked zone are again filled and then slowly release the water for stimulating the self healing mechanism [4]. But in general, the concrete structure are exposed to more than two load repetitons. This study is carried out to investigate self healing capacity under flexural cyclic load. Results are presented in the paper.

There are three different mix proportion of the ECC – PVA only (G1), PVA+SAP 0.5% (G2) and PVA+SAP 1 % (G3) were investigated in this study. All three mixtures had the same composition as the ECC mixture (Cement 1, Limestone 0.8, Fly ash 1.2, Super plasticizer 0.04 and PVA fiber 0.05 by weight), except the amounts of water (G1-0.85, G2-0.92, G3-0.98) and SAP were different. The SAP's were put in a proportion of 0.5% of the cement weight for the G2 mixture with and the G3 had 1%. The fresh ECC was cast into moulds with the dimension of 240 mm × 60 mm × 10 mm. These coupon specimens were moisture cured for 24 hours and then demoulded. After demoulding, the coupon specimens were evenly sawn into four pieces with the dimensions of 120 mm× 30 mm × 10 mm. These specimens were used in the four-point bending test.
The overall process for four-point bending test has two pre-cracking ages (7 days and 28 days) and four curing condition (A, C, W, R) and reference F. For reference F, there was no pre-cracking, but these were tested until final failure. In case of A, C and W, four specimens from all three mixtures were loaded up to 2 mm and unloaded. And then the pre-cracked samples were cured in air (50 % RH at 20 ºC, condition A), cyclic wet-dry (submersion in water at 20 ºC for 1 hour and drying for 3 days, condition C) and water (20 ºC, condition W) respectively for 28 more days before testing to final failure. Finally, in case of R, the specimens were pre-cracked up to 2 mm, afterwards these specimens were cured in cyclic wet-dry condition. And then pre-cracked and curing one more time before final failure test.

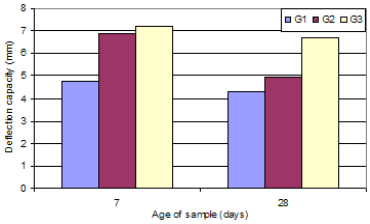

Figure 1: Development of deflection capacity with mix proportion

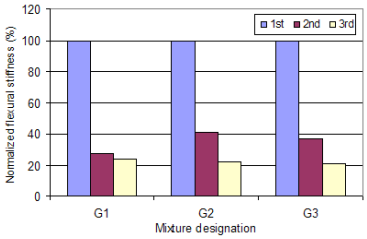

Figure 2: Comparison of normalized flexural stiffness with pre-cracking time of 28 days

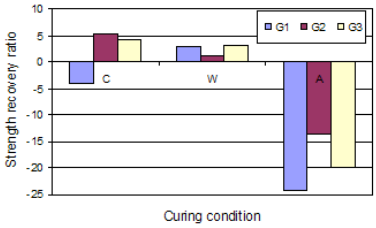

Figure 3: Development of strength recovery ratio with curing condition with pre-cracking time of 7 days

In order to evaluate the performance in strength of cured samples (cyclic wet-dry, water and air cured) and to be able to compare it with the corresponding value of bending strength of virgin specimens, the strength ratio was calculated. The ratio was computed from equation (1).

$$Strength\ Recovery\ Ratio = \left(\frac{Cured - Virgin}{Cured}\right)_{flexural\ stress} \quad (1)$$

As it can be seen from Fig. 3, the strength of cyclic wet-dry cured specimens exceeds the strength of the virgins in mixtures included SAP, G2 and G3. Apparently, this is an evidence that SAP's kept the water in the cracked zone and helped the self healing.

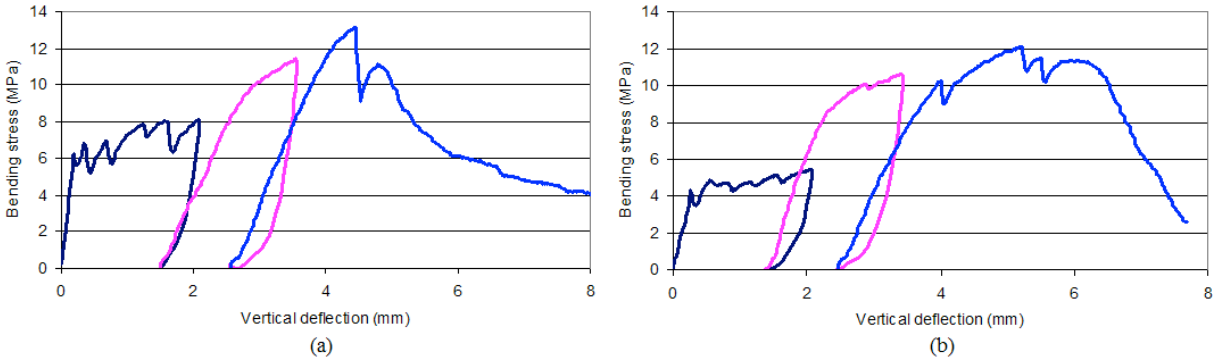

Figure 4: Bending stress-deflection curve of mixture G1(a) and G3(b) under cyclic loading with pre-racking time of 7 days

As shown in Fig. 2 and 4, it can be seen that the stiffness recovery of G2 and G3 is higher than G1 after first loading and curing but it is hard to find the difference after second cycle. It can be explained that most of unhydrated particles reacting with water at first wet-dry cycle, when the crack occurred in the second cycle at the same place there are not enough unhydrated particles any more for self healing.

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