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Simplified method for evaluating the behavior of strain hardening cementitious composite flexural strengthening reinforced concrete members

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ABSTRACT

The ductility of strain hardening cementitious composite (SHCC) in uniaxial tensile behavior was reduced while SHCC was used for flexural strengthening reinforced concrete member, since multiple fine cracks of strain hardening cementitious composite strengthening layer were limited in a ranged area adjacent to crack within reinforced concrete members. In this paper, a simplified method was proposed for evaluating the behavior of strain hardening cementitious composite flexural strengthening reinforced concrete member, able to adopt coarse mesh size with numerical result independent on mesh size. In the proposed simplified method, the multiple fine cracks in strain hardening cementitious composite layer adjacent to the crack in reinforced concrete member were placed in a unique element, and the average tensile behavior of elements for strain hardening cementitious composite strengthening layer was adopted, which was obtained from the proposed zero-span tensile model. The effectiveness of the proposed simplified method was confirmed through the comparison between experiment and numerical simulation.

1. Introduction

Strain hardening cementitious composite (SHCC) was an attractive material used for strengthening reinforced concrete (RC) member, due to its obvious advantages in terms of mechanical and physical properties, such as high compressive and tensile strength, large hardening strain in uniaxial tensile behavior, as well as permeability and compatible thermal expansion. Several investigations on the advantages of structures strengthened by SHCC have been carried out. Lim and Li [1] found the mechanical advantages of an interface crack trapping mechanism within SHCC/concrete composites. Horii et al. [2], Li [3], and Li et al. [4] applied SHCC to strengthen concrete structures, and confirmed the effectiveness of ductility of SHCC on the structural performance.

However, the advantage of high ductility of strain hardening cementitious composite (SHCC) in uniaxial tensile behavior was reduced by the effect of crack within the reinforced concrete (RC) member while SHCC material was adopted for flexural strengthening RC member, since multiple fine cracks of SHCC in uniaxial tensile behavior were distributed evenly, but those of SHCC used for flexural strengthening RC member were limited in a ranged area adjacent to crack within RC member.

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In order to reflect the behavior of strain hardening cementitious composite (SHCC) used for flexural strengthening reinforced concrete (RC) member, very fine mesh size should be adopted in numerical simulation while uniaxial tensile behavior of SHCC material was adopted. However, it was not economic using very fine mesh size in the numerical analysis of practical structure, which required a large number of elements.

In this study, a simplified method was proposed for evaluating the behavior of strain hardening cementitious composite (SHCC) flexural strengthening reinforced concrete member using coarse mesh size, which considered the multiple fine cracks in SHCC layer adjacent to the crack in RC member placed in a unique element. The use of coarse mesh size could be utilized in

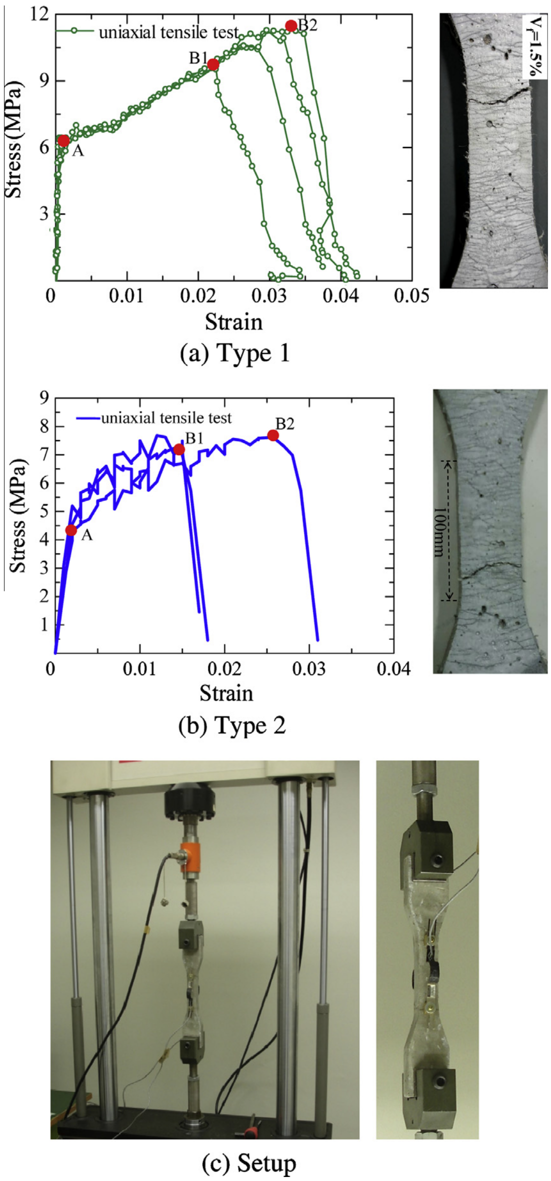

Fig. 1. Result obtained from uniaxial tensile test.

Table 1
Mix proportion of UHP-SHCC [5].

Water/binder (%)	Unit content(unit: kg/m^3)						
	Water	Cement	Silica fume	Fine sand	PE fiber	Super- plasticizer	Air reducing agent
18	263.7	1338.6	334.7	167.3	14.6	33.5	7.4