Shear Performance of PVA-ECC Beams that Mixed with Coarse Aggregate

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1. Introduction

Polyvinyl Alcohol Engineered Cementitious Composite (PVA-ECC) is a high performance fiber reinforced cementitious composite that has gained considerable attention in recent years due to its superior tensile ductility and self-controllable crack width. Due to the absence of coarse aggregate, however, it has recently been found that cracks in PVA-ECC are susceptible to shear. Suryanto *et al* demonstrated the possible use of coarse aggregate to increase the resistance of the cracks to shear [1]. This gave the opportunity to use PVA-ECC as bridge decks where shear fatigue is prevalent as a result of complex stress field. To further investigate this potential application prior to performing large-scale bridge deck tests under moving load, this paper outlines the results of anti-symmetric four-point-shear tests on precracked and non-precracked PVA-ECC beams incorporating and not incorporating coarse aggregate. Details of the tests are summarized in Table 1.

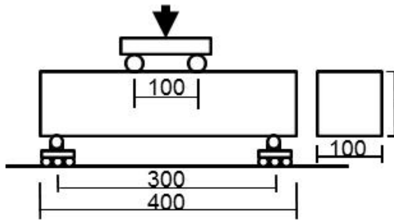
Table 1 Details of test specimens

Test series		Material	Beam size (mm)	Longitudinal reinforcement (%)	a/d	Reinforcement
static	precracked	Normal ECC	100*200*1200	4.59%	2.29	4D16 USD685
		ECC+CA				
	non-precracked	Normal ECC				
		ECC+CA				
fatigue	precracked	Normal ECC				
		ECC+CA				

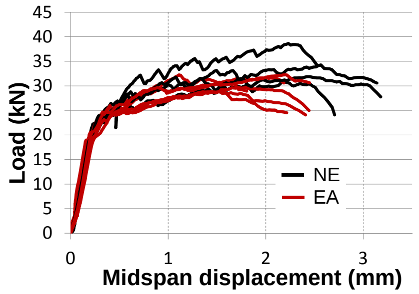
2. Material test

Bending and compression tests were performed to obtain the properties of PVA-ECC with and without coarse aggregate (hereafter abbreviated NE and EA, respectively) [2]. The specimens for bending tests were in a prismatic shape and had dimensions of 100×100×400 mm, while those for compression tests were in a cylinder shape and had dimensions of 100 mm in diameter and 200 mm in length. The results of the tests are shown in Figure 1. As can be seen, coarse aggregate lowers tensile strength and ductility of NE.

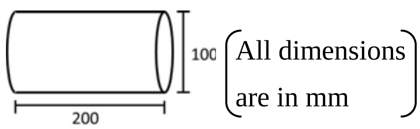
・Bending test



(All dimensions are in mm)



・Compression test



	MPa
NE	37.84
EA	34.50

Figure 1 Material tests

3. Anti-symmetric four-point-shear test

Two series of tests were carried out: precracked and non-precracked test series. Figure 2 shows, for clarity, the details of the tests. The precracked series was specifically proposed in this paper to simplify complex stress conditions that may occur in a real bridge deck under moving load. In this series, pre-cracks were first introduced to the beam prior to loading. At this loading stage, the beam inner span was taken as 200 mm (see Fig. 2a). After introducing precracks,

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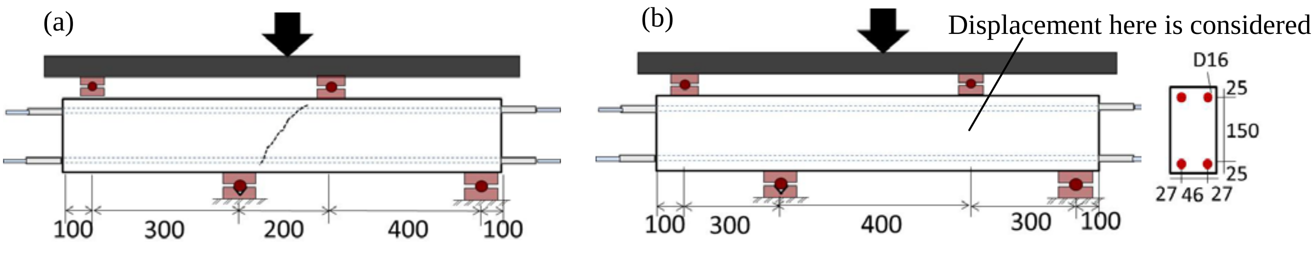

(All dimensions are in mm)

Figure 2 Specimen details and loading conditions

this inner span was then enlarged to 400 mm (Fig. 2b). The beams were then reloaded to failure. In the non-precracked series, the beam inner span was kept constant at 400 mm and the beam was simply loaded to failure.

[1] Static load test (precracked versus non-precracked)

The results of static load tests are shown in Figure 3. When there were no precracks, it was observed that Beam EA attained comparable or even slightly higher shear capacity than Beam NE, even though the EA demonstrated worse flexural property than NE (see the results previously shown in Fig. 1). This might indicate the contribution of coarse aggregate in providing internal shear carrying mechanisms. In the presence of precracks, however, larger reduction in shear capacity was observed in Beam EA than in Beam NE. The mechanisms contributed to this large capacity reduction are still not clear.

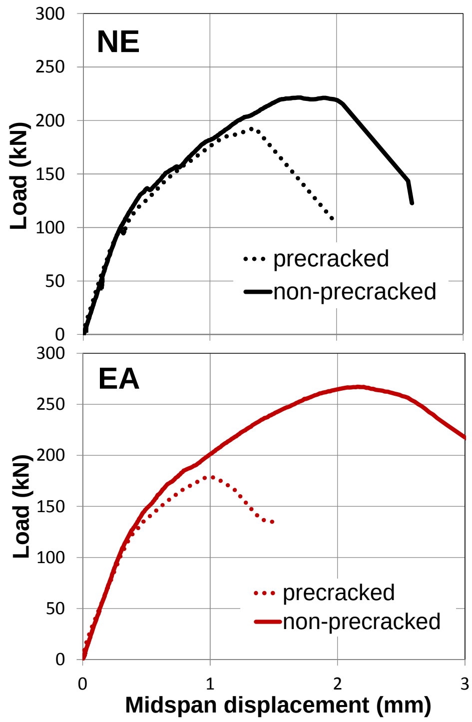

Figure 3 Results of static test

[2] Fatigue load test (precracked)

The maximum and minimum loads were set at 60% and 10% of the shear capacity obtained from the static tests under non-precracked condition. The test results are shown in Figure 4. It is evidenced that Beam EA demonstrates longer fatigue life than Beam NE. As compared to the result under static loading condition, this finding suggests that the contribution of coarse aggregate can be expected more if the material is under fatigue loading condition.

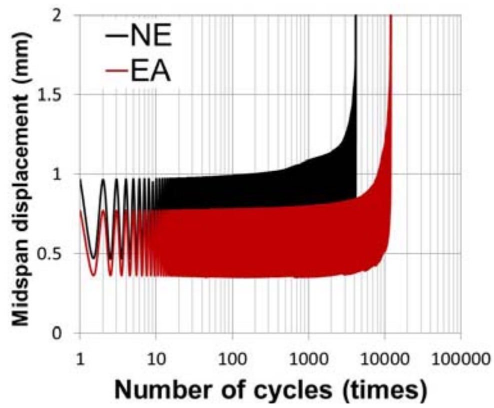

Figure 4 Result of fatigue test

4. Conclusion

Although the use of coarse aggregate in PVA-ECC lowers its tensile property, a comparable or slight increase in shear capacity can be expected at structural member level, with a possible of significant fatigue life extension. More importantly, this paper demonstrates the critical role of shear transfer under complex stress conditions, and it is important to always consider this aspect of behavior when developing innovative materials for civil infrastructures.

References

1. Suryanto, B., 2009. "Mechanics of High Performance Fiber Reinforced Cementitious Composite (HPFRCC) under Principal Stress Rotation," PhD Thesis, University of Tokyo.
2. Shimizu, K., Kanakubo, T., Kanda, T., and Nagai, S., 2006. "Evaluation of Tensile Properties of PVA-ECC Using Bending Test," J. Struct. Constr. Eng., AIJ., No. 604, pp.31-36. (in Japanese)