Bending Characteristics of Fiber-Reinforced Cementitious Composite with Recycled Carbon Fiber

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1. INTRODUCTION

The authors have focused on fiber-reinforced cementitious composites (FRCC) with recycled carbon fiber (CF) for the purpose of the reduction of environmental impact and creation of the new materials with added value. The previous study [1] has reported the fabrication of recycled CF-FRCC and the comparisons of bending characteristics between the different types of recycled CF. As the results, recycled CF by the solvolysis method shows better behavior rather than that by the pyrolysis method.

The objective of this study is to investigate the bending characteristics of FRCC with recycled CF by solvolysis methods in specimens by commonly used dimensions. The section analysis is also conducted to evaluate the bending capacity.

2. EXPERIMENT OVERVIEW

The list of the specimens is shown in Table 1 and illustrated in Fig. 1. Total 6 specimens for compression test and 10 specimens for four-point bending test are prepared. The used fiber is recycled carbon fiber by the solvolysis method (CF-SO) as same as that used in the previous study [1]. The fiber is cut in 10mm long. Table 2 shows the mix proportion of FRCC. The fiber volume fraction is set to 0.5% and 0.75%. In the bending test, axial deformations in constant bending moment zone are measured to calculate the curvature.

3. TEST RESULTS

Table 3 shows the results of compression test. FRCC with fiber volume fraction of 0.75% show lower compressive strength than that of 0.5%.

Fig. 2 shows the bending moment-curvature curves obtained in the bending test. The deflection hardening property, in which the bending moment increases after first cracking, can be observed in all the specimens. After the peak, the curves showed slight softening branch, and the crack rapidly opened. Fig. 3 shows the comparison of the maximum bending stress (maximum bending moment divided by section modulus) including the results of the previous study [1].

Table 1 List of specimens

Specimen	Dimensions	Fiber volume fraction	Number of specimens
CF-SO-0.5%	Compression: ϕ100x200mm Bending: 100x100x400mm	0.5%	Compression:3 Bending:5
CF-SO-0.75%		0.75%	Compression:3 Bending:5

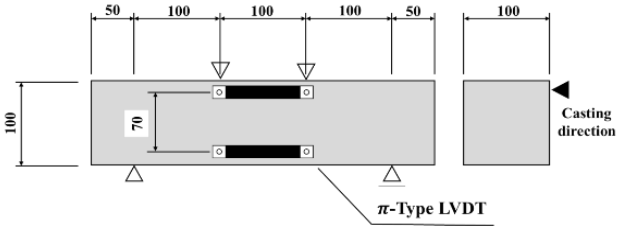

Fig. 1 Dimensions of specimen for bending test

Table 2 Mix proportion of FRCC

Specimen	Unit weight(kg/m^3)					
	W	C	S	FA	CF	Ad
CF-SO-0.5%	380	678	484	291	9	6
CF-SO-0.75%					13.5	

W：Water　C：High early strength Portland cement
S：Silica sand No. 7　FA：Fly ash type II　CF：Carbon fiber
Ad：High range water reducing admixture

Table 3 Results of compression test

Specimen	Average compressive strength (MPa)	Average elastic modulus (GPa)
CF-SO-0.5%	40.8	17.2
CF-SO-0.75%	32.4	15.8

The maximum bending stress of CF-SO-0.5% in this study is smaller than that of CF-SO-0.5%[1] due to the scale effect. The maximum bending stress of CF-SO-0.75% is not so different with the result of CF-SO-0.5%. It is considered that the fibers are not dispersed evenly in the case of 0.75% volume fraction.

4. SECTION ANALYSIS

Section analysis is conducted to compare the tensile characteristics of CF-FRCC. The analysis is also carried out for the

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results of the previous study [1]. The stress–strain models used for analysis are shown in Fig. 4. The parabolic model is chosen in compression side based on the compression test results. For tension side, the bi-linear model is established to show the best fitting of the maximum bending moment between the test results and analysis. Table 4 lists the analysis results and experimental ones. As the results of the establishment of tensile stress-strain models, the tensile strengths for CF-SO range from 5MPa to 8MPa. The large difference between CF-SO-0.5% and CF-SO-0.75% is not observed. Comparing the previous results, the tensile strength of CF-SO-0.5%[1] is about 0.6 times that of CF-V-0.5%[1]. It is considered to be due to the difference of the dispersion of fibers as observed in the previous study [1].

Fig. 5 shows stress distributions in cross-sections of the specimens at the maximum bending moment. The horizontal axis indicates the stress of FRCC, showing compression in the left (negative) and tension in the right (positive). It can be observed that the tensile stress becomes around two-third of the tensile strength at the tension edge.

5. CONCLUSIONS

The deflection hardening property is observed in FRCC with recycled CF by the solvolysis method. The maximum bending stress of 100mm cross-section specimens is smaller than that of 40mm specimens. As the results of the establishment of tensile stress-strain models through section analysis, fiber volume fraction difference between 0.5% and 0.75% is not observed. The suitable fiber volume fraction is considered to be around 0.5% for FRCC with solvolysis method recycled carbon fiber.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Sasaki, H., Li, S.C., Kanakubo, T., Fabrication of Fiber-Reinforced Cementitious Composite with Recycled Carbon Fiber, 土木学会年次学術講演会講演概要集, 2023

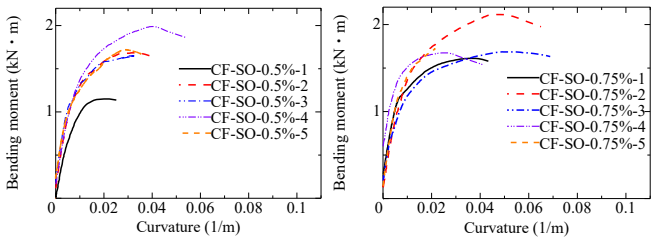


Fig. 2 Bending moment-curvature curve

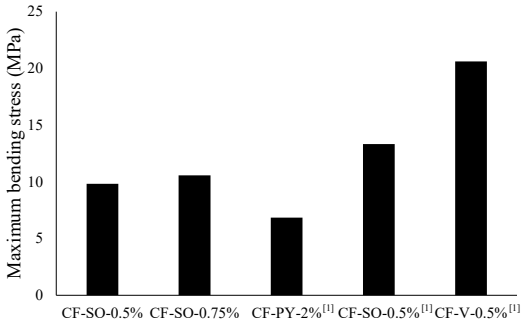
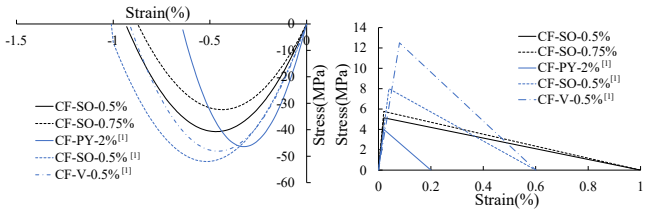


Fig. 3 Maximum bending stress



(a) Compression side (b) Tension side

Fig. 4 Stress-strain model for section analysis

Table 4 List of maximum bending moment

Specimen	Comp. strength (MPa)	Experiment	Section analysis	
		Max. bending moment (kN·m)	Max. bending moment (kN·m)	Neutral axis from comp. edge (mm)
CF-SO-0.5%	40.8	1.638	1.639	33.2
CF-SO-0.75%	32.4	1.761	1.761	35.9
CF-PY-2%[1]	46.4	0.0731	0.0728	14.6
CF-SO-0.5%[1]	52.0	0.142	0.146	15.1
CF-V-0.5%[1]	48.1	0.220	0.211	15.9

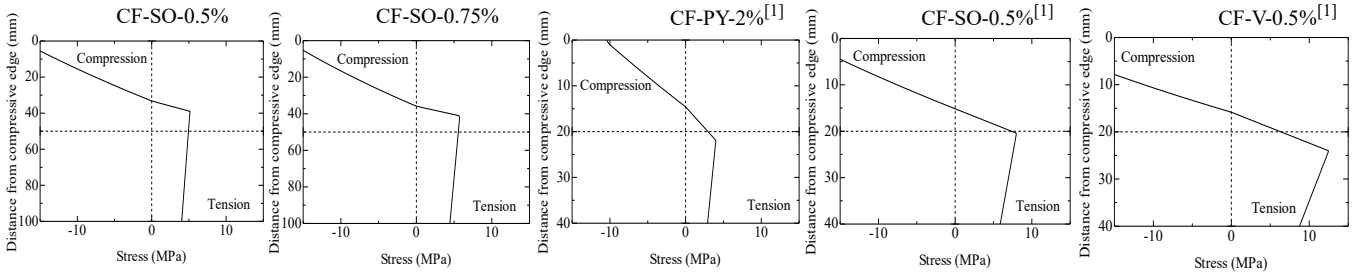


Fig. 5 Stress distribution in cross-section at the maximum moment