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[V-405] Influence of Matrix Strength on Bending Behavior of DFRCC with Bundled Aramid Fiber

Influence of Matrix Strength on Bending Behavior of DFRCC with Bundled Aramid Fiber

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DFRCC, Bundled aramid fiber, Matrix strength, Four-point bending test

This study focuses on the influence of matrix strength on bending behavior of DFRCC with bundled aramid fiber. In this study, matrix strength and volume fraction of fibers are considered as main parameters. Four-point bending test was conducted to find out the relationship between bending behavior and the two parameters. It can be clarified from the results that the addition of bundled aramid fibers significantly improves the ductility of the matrix in bending behavior. As for DFRCC specimens with different matrix strength, average maximum bending moment increased with increasing of compressive strength.

Influence of Matrix Strength on Bending Behavior of DFRCC with Bundled Aramid Fiber

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1. INTRODUCTION

Ductile fiber-reinforced cementitious composite (DFRCC) is cementitious material in which short discrete fibers with a certain volume fraction are mixing in mortar matrix to improve brittle behavior of composite especially in tensile and bending field.

This study focuses on the influence of matrix strength on bending behavior of DFRCC with bundled aramid fiber. In this study, matrix strength and volume fraction of fibers are considered as variables. Four-point bending test was conducted to find out the relationship between bending behavior and the two parameters.

2. EXPERIMENT OVERVIEW

2.1 Material

Three mix proportions of DFRCC applied in this study are shown in Table 1. Materials in the three mix proportions are different in the ratio of cement to fly ash to obtain different target compressive strength. Table 2 shows the mechanical properties of bundled aramid fiber used in this study and Fig 1 shows the visual appearance of it.

2.2 Specimen

The main experimental parameters are matrix target strength (24, 36, 48MPa) and volume fraction of fibers (None, 1%, 2%), so nine series of specimens are determined for experiments. Bending specimens are rectangular specimens of 100×100×400mm. [1] For each series, five bending specimens were manufactured.

2.3 Loading and measurement

Four-point bending test was carried out using a universal testing machine of 2MN capacity. Image of four-point bending test is shown in Fig 2. Load was applied to the specimen on the trisection points of span, and loading speed was set as 0.5mm/min. Testing area is the constant moment region of 100mm in length. Two displacement transducers were set up on compression and tension sides of testing area. Measurement items for all specimens were load and the two axial deformations. With the two axial deformations, curvature can be calculated from dividing the difference in strains between tension and compression sides by the vertical distance between the two transducers (=70mm). [1]

Table 1. Mix proportions of mortar matrix

Series	W/B	C	FA	S	SP	SR
Fc24	0.392	1	1	1	B× 0.62%	C× 2%
Fc36	0.392	1	0.43	0.71		
Fc48	0.392	1	0.11	0.56		

※ B=C+FA

W: Water　C: Cement　FA: Fly Ash　S: Fine sand

SP: Water reducing agent　SR: Shrinkage reducing agent

Table 2. Mechanical properties of bundled aramid fiber

Diameter (mm)	Length (mm)	Tensile strength (MPa)	Elastic modulus (GPa)
0.5	30	3432	73

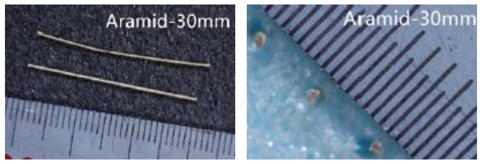

Fig 1. Visual appearance of bundled aramid fiber

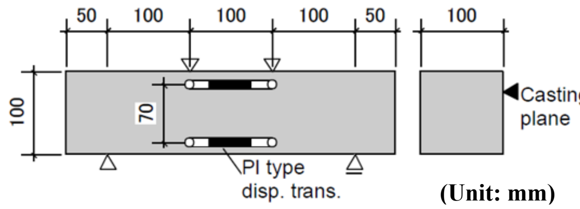

Fig 2. Image of four-point bending test

Table 3. Compressive properties of DFRCC

Series	Compressive strength (MPa)	Elastic modulus (GPa)
Fc24-N	20.0	11.2
Fc24-1%	19.4	11.2
Fc24-2%	18.8	10.7
Fc36-N	37.1	14.9
Fc36-1%	34.8	15.2
Fc36-2%	35.1	14.5
Fc48-N	52.6	17.4
Fc48-1%	53.7	17.8
Fc48-2%	53.0	17.0

3. EXPERIMENTAL RESULT AND DISCUSSION

3.1 Matrix strength and elastic modulus

Compressive test for cylinder specimens (φ100×200mm) was conducted to confirm the compressive strength and

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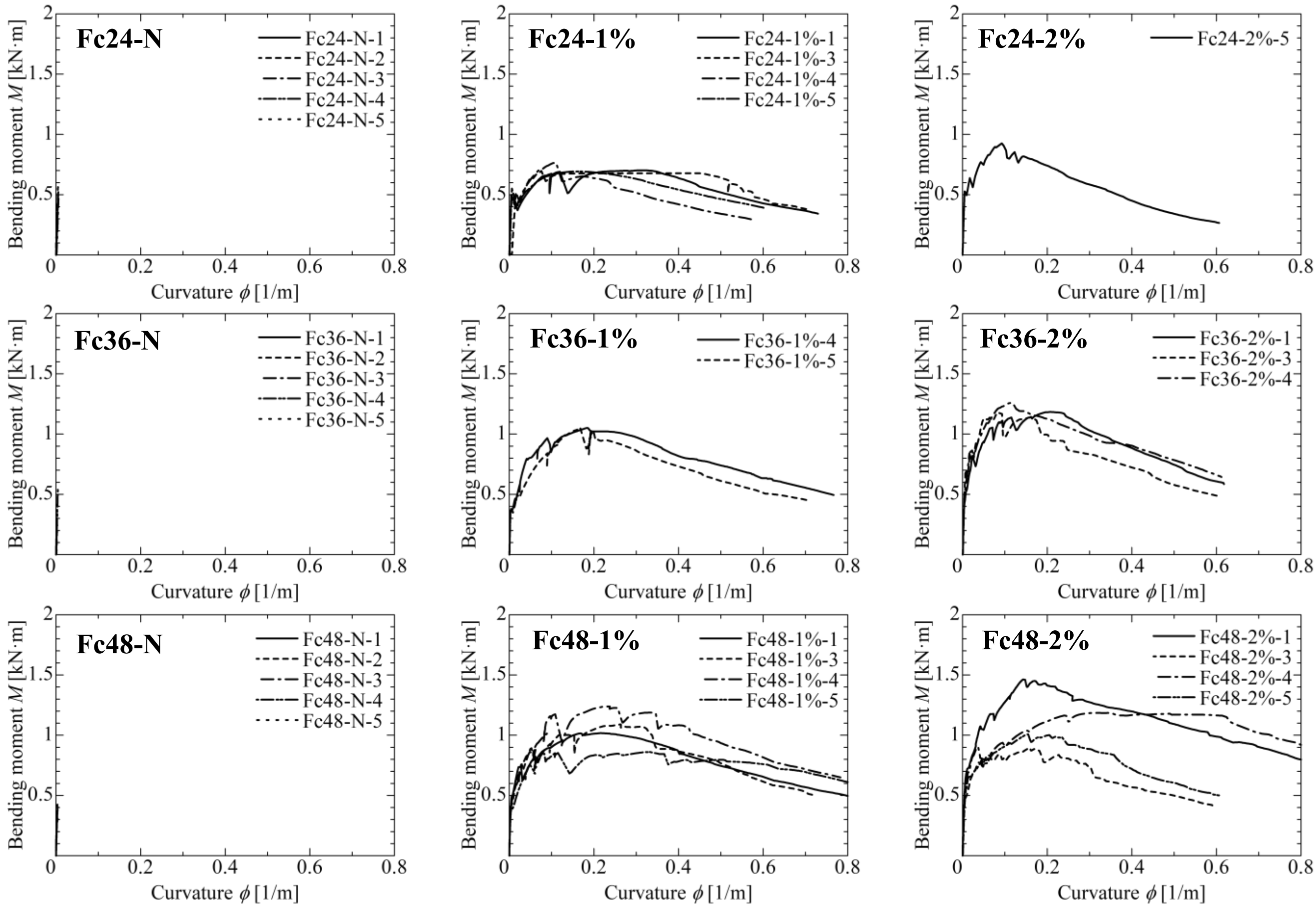

Fig 3. Bending moment - curvature curves (*M* - *φ* curves)

elastic modulus of DFRCC. Table 3 lists the compressive properties of DFRCC. As reveled by the results, although experimental strengths were not completely consistent with target strengths, they showed obvious difference to each other.

3.2 Results of bending test

Bending moment - curvature curves (*M* - *φ* curves) for each series are shown in Fig 3. The specimens, in which the localized crack opened out of the testing area, are not included in Fig 3. Bending moment of DFRCC specimens decreased gradually after peak in a wide range, indicating that addition of fibers significantly improves the ductility.

Fig 5 shows the cracks distribution of specimens in Fc36 series as representative. It can be seen that specimen without fiber only had one obvious crack in the middle range throughout depth, while DFRCC specimens had plural independent cracks in middle and lower range.

Fig 4 plots the relationship between maximum bending moment M_{max} and compressive strength. Compared with mortar matrix without fiber, average M_{max} of DFRCC specimens shows much higher. Average M_{max} of DFRCC specimens increased with increasing of compressive strength and increased more from Fc24 to Fc36 than Fc36 to Fc48. It should be noticed that obvious dispersion can be detected in Fc48-2% series.

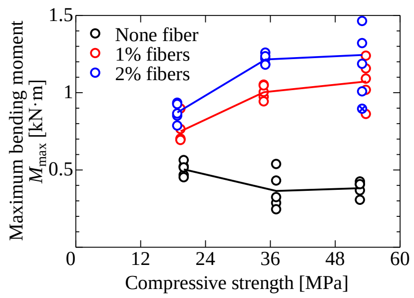

Fig 4. Relationship between M_{max} and Compressive strength

Fibers	Cracks distribution
None	
1%	
2%	

Fig 5. Cracks distribution of specimens in Fc36 series

4. CONCLUSION

- Addition of bundled aramid fibers significantly improves the ductility of the matrix in bending behavior.
- As for DFRCC specimens, average maximum bending moment increased with increasing of compressive strength.

ACKNOWLEDGEMENT

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REFERENCES

[1] JCI-S-003-2007: Method of test for bending moment - curvature curve of FRCC.