第V部門
2026年9月2日(水) 8:50 ~ 10:10 | 7号館1階D103（北海学園大学）
短繊維補強コンクリート（材料）1
座長：渡邊 有寿（鹿島建設）

9:50 ~ 10:00

[V-39] Section Analysis on Bending Characteristics of Basalt Fiber-Reinforced Cementitious Composite

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キーワード：FRCC、Basalt fiber、Bending test、Section analysis、Tensile characteristics

In this research, the tensile constitutive law of basalt fiber-reinforced cementitious composites (BFRCC) was investigated through section analysis using four-point bending test results. Specimens with fiber volume fractions of 0.5% (BF-0.5) and 0.75% (BF-0.75) were analyzed using a stress–strain model with a parabolic compression model and bilinear tension model. Tensile strength values of 2.34 MPa and 2.17 MPa, and ultimate strains of 3.71% and 2.48% were obtained for BF-0.5 and BF-0.75, respectively. Stress distribution analysis confirmed that fiber bridging enables BFRCC to carry tensile stress across the entire tensile region.

Section Analysis on Bending Characteristics of Basalt Fiber-Reinforced Cementitious Composite

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1. INTRODUCTION

The authors have reported the fundamental mechanical characteristics of basalt fiber-reinforced cementitious composites (BFRCC) through the compression test and four-point bending test in the previous report[1]. Though the compressive strength decreased with increasing fiber volume fraction, bending strength increased with increasing fiber volume fraction. In this report, to evaluate the effect of basalt fiber incorporation on the tensile performance of the matrix, the tensile constitutive law of BFRCC is investigated through section analysis, using the results of the bending test described in the previous report.

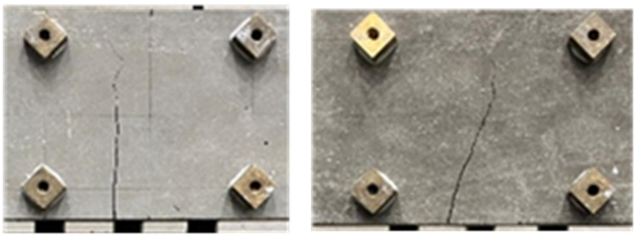
2. OVERVIEW OF THE BENDING TEST RESULT

The fiber volume fractions of the BFRCC specimens tested were 0.5% (BF-0.5) and 0.75% (BF-0.75), respectively. A four-point bending test by rectangle test pieces with a dimension of 100×100×400 mm was carried out. The π-type displacement transducers were set to measure the average stains of compression and tension side in pure bending section to obtain the curvature.

Fig. 1 shows the typical examples of the specimens after loading. Only a single crack was observed visually, and the load decreased as this crack widened. For BF-0.5 specimens, one specimen was observed in which the deflection increased while maintaining the load near the peak. However, the other specimens failed in a brittle manner simultaneously with crack opening. For BF-0.75 specimens, the deflection at the maximum load was greater than that of BF-0.5 specimens, and a plateau-like response was observed near the peak. The observed maximum bending moment is listed in Table 1. The maximum load of all specimens almost twice that of the mortar specimens, indicating that the fibers enhanced the tensile performance.

3. METHOD OF SECTION ANALYSIS

The model of stress – strain relationship for BFRCC assumed in this report is shown in Fig. 2. The compression side is expressed by a parabolic model based on the compression test results shown in Table 2. The tension side is assumed to be a bilinear model that can represent the tensile behavior in the simplest manner. The parameters are the tensile strength, σ_{max}, and the ultimate strain, ε_{tu}. The slope of the first line is taken as the elastic modulus obtained from the compression test.



BF-0.5　　BF-0.75

Fig. 1 Specimens after loading

Table 1 Experimental maximum bending moment

Specimen number	Maximum bending moment (kN・m)		
	MT	BF-0.5	BF-0.75
1	0.31	0.62	0.72
2	0.32	0.53	0.60
3	0.31	0.59	0.79
4	0.40	0.74	0.76
5	0.29	-	0.69
Average	0.33	0.62	0.71

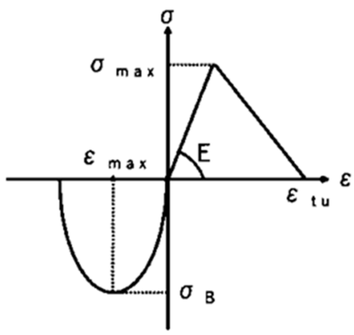


Fig. 2 Stress – strain relationship model

Table 2 Compressive characteristic values

Specimen	Compressive strength, σ_B (MPa)	Strain at peak, ε_{max} (%)	Elastic modulus, E (GPa)
BF-0.5	32.5	0.349	13.7
BF-0.75	28.5	0.351	11.9

Keywords　FRCC, Basalt Fiber, Bending Test, Section Analysis, Tensile Characteristics
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In this study, the tensile strength and the ultimate strain are determined by a method that minimizes the squared error between the experimental and analytical results at ten equally spaced points on the experimentally obtained bending moment – curvature curve up to the maximum.

4. ANALYSIS RESULT

Table 3 and Fig. 3 present the characteristic values for the tensile strength and ultimate strain, and the tensile stress – strain model obtained by the section analysis, respectively. From the bending test results of mortar (MT) specimens, the bending strength calculated based on the elastic theory is 1.96 MPa, and the tensile strength of BFRCC is greater than this value. The tensile characteristic values for BF-0.5 exhibited higher σ_{max} and ε_{tu} than those for BF-0.75, that is consistent with the compression test results shown in Table 2, where BF-0.75 shows lower elastic modulus and compressive strength than BF-0.5.

Fig. 4 compares the bending moment – curvature relationship between the experiment and analysis results. As expected, since the tensile characteristic values are determined so as to minimize the squared error, there is good agreement between the experiment and analysis up to the maximum. The plateau-like behavior observed near the peak can also be confirmed in the analysis results, indicating a deflection-hardening behavior. Table 5 lists the comparison of the maximum bending moment between the experiment and analysis results. The ratio of the experimental results to the analysis ranges from 0.98 to 1.12.

Fig. 5 shows the stress distribution in the section at the maximum bending moment obtained by the section analysis. At the maximum, the tensile zone of the BFRCC is carrying tensile stress over the entire region, which is considered to be the tensile performance provided by fiber bridging.

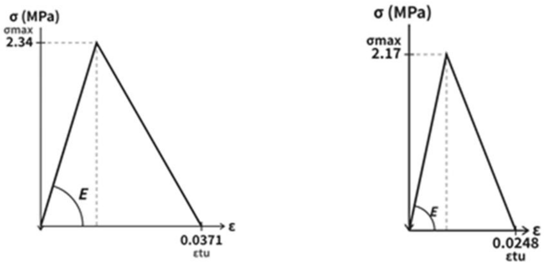
5. CONCLUSIONS

(1) Through the section analysis with the stress – strain model for BFRCC by a parabolic model in compression and a bilinear model in tension, the bending moment – curvature relationships obtained by the bending test could be represented.

(2) Analytical stress distribution suggested that BFRCC is carrying tensile stress over the tensile region, which is considered to be the tensile performance provided by fiber bridging.

Table 3 Tensile characteristic values by analysis result

Specimen	Tensile strength σ_{max} (MPa)	Ultimate strain ε_{tu} (%)
BF-0.5	2.34	3.71
BF-0.75	2.17	2.48



BF-0.5 BF-0.75

Fig. 3 Tensile stress – strain model

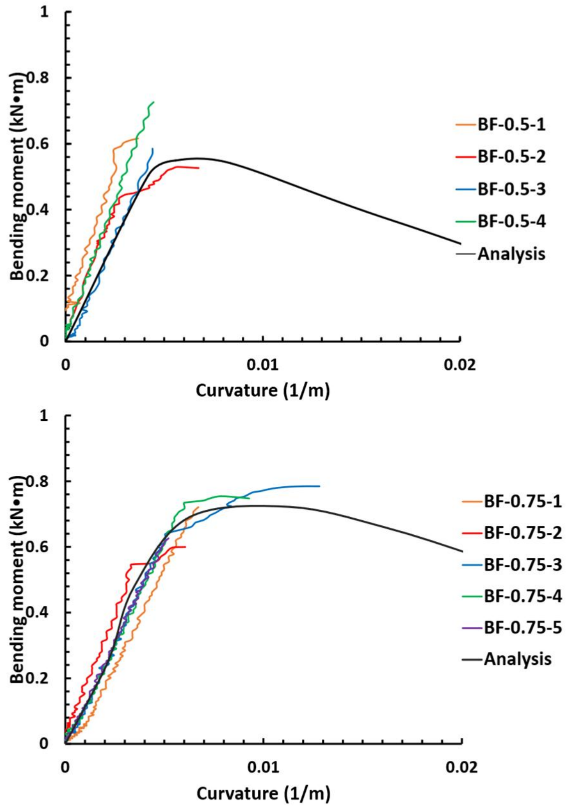


Fig. 4 Bending moment – curvature relationship

Table 5 Comparison of maximum bending moment

Specimen	Max. bending moment (kN・m)		Experiment / analysis
	Experiment	Analysis	
BF-0.5	0.62	0.55	1.12
BF-0.75	0.71	0.72	0.98

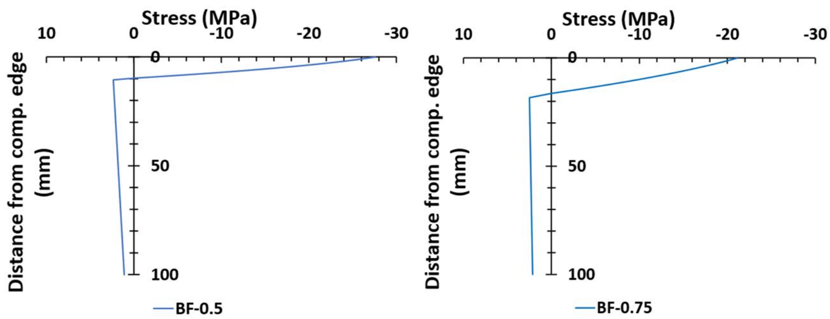


Fig. 5 Stress distribution at the maximum bending moment

REFERENCES

1) Li, K., Brandon, B.J, Kanakubo, T., Mechanical Characteristics of Basalt Fiber-Reinforced Cementitious Composite (BFRCC), JSCE Annual Meeting, 2026.