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）

9:40 ~ 9:50

# [V-38] Mechanical Characteristics of Basalt Fiber-Reinforced Cementitious Composite (BFRCC)

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キーワード：FRCC、Basalt fiber、Flow test、Compression test、Bending test

This study investigates the mechanical characteristics of basalt fiber-reinforced cementitious composites (BFRCC) with varying fiber volume fractions (0%, 0.5%, and 0.75%). A flow test, compression test, and four-point bending test were conducted. Compressive strength and elastic modulus also decreased as fiber volume increased, possibly due to delayed hydration effects. In contrast, bending performance improved notably, with maximum load capacities reaching 1.89 and 2.17 times that of the control mixture for 0.5% and 0.75% fiber volume fraction, respectively.

# Mechanical Characteristics of Basalt Fiber-Reinforced Cementitious Composite (BFRCC)

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## 1. INTRODUCTION

Concrete has the advantage of high compressive strength, and relatively lower cost. However, as one type of artificial brittle materials, concrete is relatively insufficient in terms of tensile strength, bending resistance, impact resistance, and toughness. To address this, fiber-reinforced cementitious composites (FRCC) with added short fibers is developed and researched. Basalt fiber is one of the fibers used in FRCC[1]. In this study, to check the workability, a flow test is carried out and compression and bending tests of basalt FRCC (BFRCC) are conducted to evaluate its performance.

## 2. EXPERIMENT OVERVIEW

The fiber incorporated into the FRCC is basalt fiber, as shown in Fig. 1. Table 1 shows the mechanical properties of basalt fiber and Table 2 shows the mix proportion of BFRCC. The variable parameter in this study is the basalt fiber volume fraction as 0% (MT: mortar), 0.5% (BF-0.5), and 0.75% (BF-0.75).

A compression test by cylinder test pieces with a dimension of φ100 ×200 mm was carried out. The loading was conducted using a universal testing machine with a capacity of 500 kN. A four-point bending test by rectangle test pieces with a dimension of 100×100×400 mm using a 500kN universal testing machine was carried out to investigate the bending characteristics of BFRCC. As shown in Fig. 2, two π-type displacement transducers on the specimen's front surface and three linear variable displacement transducers (LVDTs) on the specimen's back surface were used to measure axial deformation of compression side and tension side in pure bending section, load point and central deflections.

## 3. FRESH PROPERTY

The test method was a zero-drop flow test based on JIS R 5201: Physical testing methods for cement[2], meaning the cone was lifted vertically without any mechanical jolting or impact.

The photos of the flow test and the flow values are shown in Fig. 3 and Table 3, respectively. The flow values decreased with increasing fiber fraction. The control mixture (MT) had the highest flow value of 373 mm, whereas BF-0.5 and BF-0.75 recorded flow values of 209 mm and 138 mm, respectively. This indicates that basalt fibers reduce mixture fluidity and workability, with the BF-0.75 mixture exhibiting approximately 0.56 times the flow value of the control mixture.

**Fig. 1** Basalt fiber

**Table 1** Mechanical properties of basalt fiber

| Length (mm) | Diameter (μm) | Tensile strength (MPa) | Elastic modulus (GPa) | Density (g/cm³) |
|---|---|---|---|---|
| 12 | 11 | 2000 | 100 | 2.65 |

**Table 2** Mixture proportion of BFRCC

| Series | W/C | FA/B | Unit weight(kg/m³) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | W | C | FA | S | BF | Ad |
| MT | 0.56 | 0.30 | 380 | 678 | 291 | 484 | 0 | 6 |
| BF-0.5 | | | | | | | 13.25 | |
| BF-0.75 | | | | | | | 19.88 | |

C: high-early-strength Portland cement;
FA: fly ash type II; S: silica sand; W: water;
BF: basalt fiber; Ad: high-range water-reducing admixture

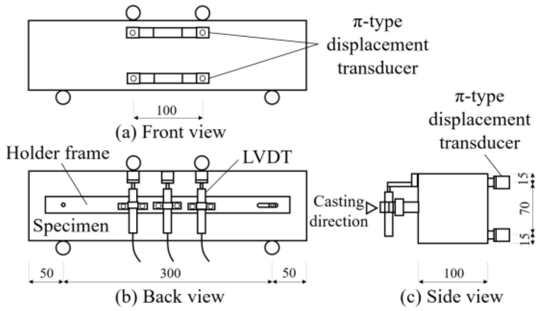


**Fig. 2** Four-point bending test

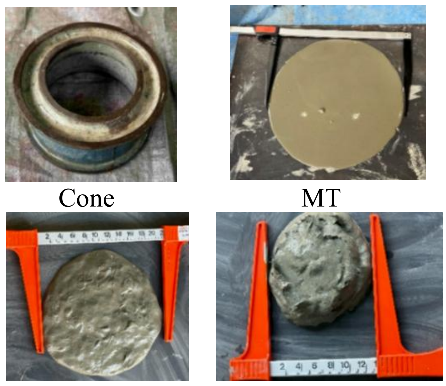


**Fig. 3** Flow test

Keywords　FRCC, Basalt Fiber, Flow Test, Compression Test, Bending Test
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**Table 3** Flow test results

| | | MT | BF-0.5 | BF-0.75 |
|---|---|---|---|---|
| 1 | Average (mm) | 376 | 205 | 135 |
| 2 | Average (mm) | 370 | 213 | 141 |
| Flow value (mm) | | 373 | 209 | 138 |

## 4. COMPRESSION TEST

Table 4 presents the compression test results at 39 days of curing.

The control mixture (MT) demonstrated the highest strength of 56.9 MPa, while BFRCCs exhibited lower strengths, averaging 32.5 MPa for BF-0.5 and 28.5 MPa for BF-0.75. The elastic moduli of BFRCCs show also reducing from the control mixture. Since the fibers were well dispersed and no fiber balls were observed, it is difficult to assume that the mechanical properties of the fibers are a factor leading to a reduction in compressive behavior. In studies where basalt has been used as mineral admixture in concrete, it has been reported that setting and the heat evolution peak are delayed, indicating a retardation of early hydration[3]. This suggests that chemical effects associated with basalt fiber may be involved. Further investigation is required.

## 5. BENDING TEST

Table 5 shows bending test results. BF-0.5-5 was excluded due to the displacement reading error. Fig. 4 shows the load-deflection curves. The deflection is the average ones measured at the loading points. Compared with MT, BF-0.5 carried 1.89 times the maximum load, and BF-0.75 carried 2.17 times, demonstrating a clear increase in bending capacity with higher fiber fraction.

## 6. CONCLUSIONS

(1) The flow values decreased with increasing fiber volume fraction. BFRCC with 0.75% fiber exhibited approximately 0.56 times the flow value of the control mixture.

(2) Compressive strength decreased with increasing fiber volume fraction.

(3) Bending strength increased with increasing fiber volume fraction.

## REFERENCES

1) Hao Zhou, Bin Jia, Hui Huang, Yanling Mou. Experimental Study on Basic Mechanical Properties of Basalt Fiber Reinforced Concrete. Materials 2020, 13(6), 1362.

2) Japanese Industrial Standards. JIS R 5201:2015 Physical testing methods for cement.

3) Laibao Liu et al., Investigating the influence of basalt as mineral admixture on hydration and micro structure formation mechanism of cement, Construction and Building Materials 2013, 48, 434-440.

**Table 4** Compression test results

| Specimen | Compressive strength (MPa) | Elastic modulus (GPa) |
|---|---|---|
| MT | 56.9 | 17.8 |
| BF-0.5 | 32.5 | 13.7 |
| BF-0.75 | 28.5 | 11.9 |

**Table 5** Bending test results

| Specimen number | Maximum load (kN) | | | Maximum bending moment (kN·m) | | |
|---|---|---|---|---|---|---|
| | MT | BF-0.5 | BF-0.75 | MT | BF-0.5 | BF-0.75 |
| 1 | 6.10 | 12.33 | 14.43 | 0.31 | 0.62 | 0.72 |
| 2 | 6.46 | 10.59 | 11.99 | 0.32 | 0.53 | 0.60 |
| 3 | 6.23 | 11.69 | 15.69 | 0.31 | 0.59 | 0.79 |
| 4 | 8.03 | 14.79 | 15.09 | 0.40 | 0.74 | 0.76 |
| 5 | 5.82 | - | 13.73 | 0.29 | - | 0.69 |
| Average | 6.53 | 12.35 | 14.18 | 0.33 | 0.62 | 0.71 |

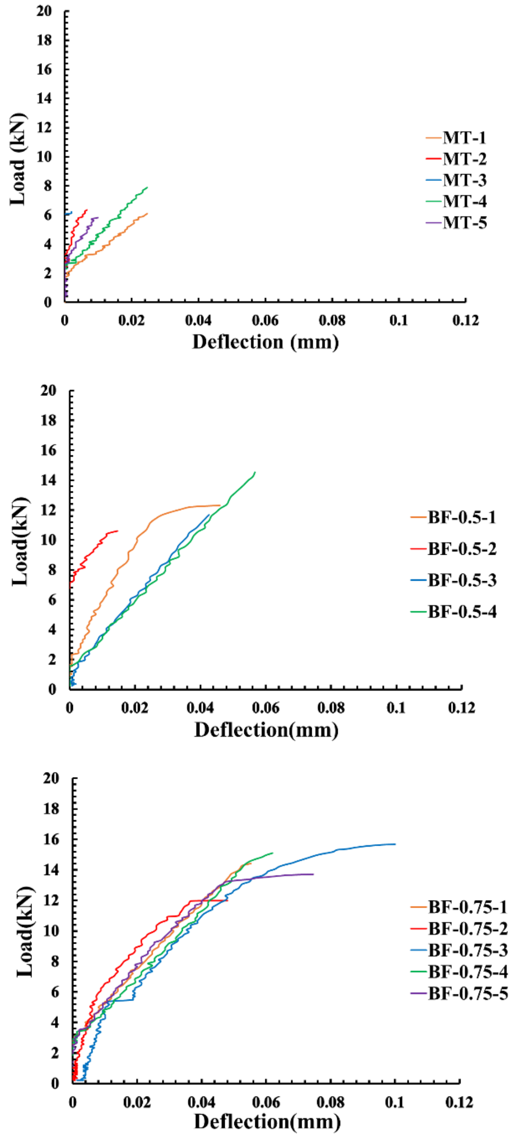


**Fig. 4** Load-deflection curve