ポスター発表｜第V部門

2025年9月12日(金) 9:00 ~ 10:20 Ko（熊本城ホール）

新材料・新工法（構造）／短繊維補強コンクリート（構造）

座長：松岡 智（共和コンクリート工業）

[12AM1-Ko-09] Compressive Characteristics of Aramid Fiber-Reinforced Cementitious Composite Prisms

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キーワード：FRCC、Aramid fiber、Compression test、Stress-strain relationship、Popovics model

In this research, the compressive characteristics of aramid-FRCC prism members were studied. An axial compression test of rectangular prism specimens was conducted to determine the reduction factors compared to the cylindrical specimens. A compressive stress-strain relationship model was developed using Popovics model with compressive properties of cylindrical specimens and reduction factors as parameters. The developed model showed a good fit with the experimental results. The compressive strength ratio of rectangular prism to cylindrical specimens showed that the compressive strength decreased due to the differences in cross-sectional shape and dimension.

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Compressive Characteristics of Aramid Fiber-Reinforced Cementitious Composite Prisms

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1. INTRODUCTION

Fiber-reinforced cementitious composite (FRCC) is an advanced cementitious material that incorporates short, randomly distributed discrete fibers to increase the performance of structural members. Understanding the compressive characteristics of a material is important in the design of structural members. In this study, an axial compression test of rectangular prism specimens is carried out to understand the compressive characteristics of aramid-FRCC members, and a compressive stress-strain relationship model is developed.

2. EXPERIMENTAL PROGRAM

Three rectangular prism specimens with a dimension of 180 × 180 × 480 mm with a test section of 280mm and three ϕ100mm by 200mm cylindrical test pieces are prepared to study the compressive properties of aramid-FRCC. Fig. 1 shows the fiber used in this study. The mixture proportion of the matrix and the mechanical properties of aramid fiber are listed in Table 1 and Table 2, respectively. A π-type displacement transducer on each side of the specimen is used to measure the test section deformation and a linear variable displacement transducer (LVDT) at each top corner is used to measure the overall displacement. The loading setup and measurement of the specimen are shown in Fig. 2.

3. EXPERIMENTAL RESULTS

The state of fracture of the specimens after loading is shown in Fig. 3. The load decreased suddenly after the maximum load, and only the top of the specimen was damaged, after which the deformation increased while the load was maintained. This post-peak result is caused by the fibers, which suppressed the spalling of the FRCC. The compressive stress-strain relationship from the experiment is shown in Fig. 4. The stress is calculated by dividing the load by the cross-sectional area. The strain is

Fig. 1 Aramid fiber

Table 1. Mixture proportion

Specimen ID	W/C	FA/B	Unit weight (kg/m^3)			
			W	C	FA	S
AF-0.5%	0.56	0.30	380	678	291	484
Cement: High early-strength Portland cement Fly ash: Type II of Japanese Industrial Standard (JIS A 6201) Sand: Size under 0.2 mm Super plasticizer: Binder x 0.6% Fiber volume fraction: 0.5%						

Table 2. Mechanical properties of fiber

Fiber	Diameter (μm)	Length (mm)	Tensile strength (MPa)	Elastic modulus (GPa)
Aramid	12	12	3432	73

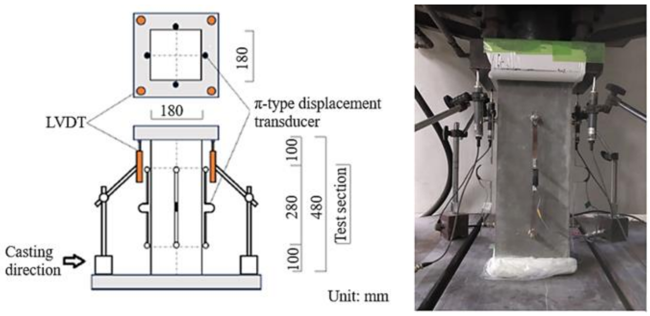

Fig. 2 Setup of loading and measurements

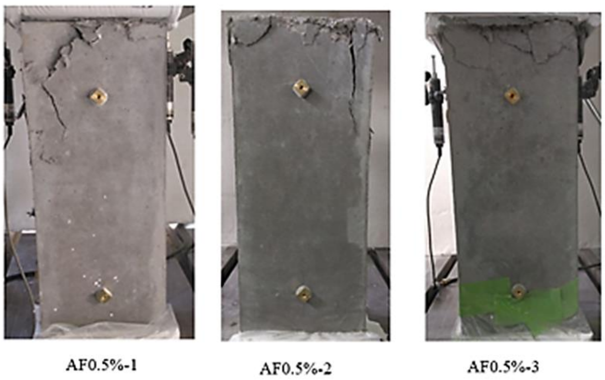

Fig. 3 Fracture property

Keywords FRCC, Aramid fiber, Compression test, Stress-strain relationship, Popovics model
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calculated by dividing the deformation by the test section, 280mm. The deformation is calculated using the measurement obtained by the π-type displacement transducers up to the maximum load, and after the maximum load, it is calculated by adding the overall displacement measured by LVDTs to the measurements obtained by π-type displacement transducers. A comparison of the compressive properties of the cylindrical and rectangular prism specimens is shown in Table 3. The compressive strength, f_c, and the strain at compressive strength, ε_o, of the rectangular prisms are smaller than the cylindrical specimens, confirming the reduction in compressive strength due to the difference in cross-sectional shape and dimension.

4. MODELING OF COMPRESSIVE STRESS-STRAIN RELATIONSHIP

The Popovics model which is used to model the stress-strain relationship is shown in Eq. (1).

$$\frac{\sigma_c}{k_1 f_c} = \frac{\varepsilon_c}{k_2 \varepsilon_o} \cdot \frac{n}{(n-1).(\varepsilon_c/k_2\varepsilon_o)^n} \qquad (1)$$

Where, σ_c is the compressive stress; ε_c is compressive strain; f_c is the compressive strength of the cylindrical specimen; ε_o is the strain at compressive strength of cylindrical specimen; n is Popovics constant that indicates the shape of the curve; k_1 and k_2 are reduction factors.

The parameters of the Popovics model are listed in Table 4. The reduction factor of the rectangular prism specimens, k_1, and k_2, are determined by reduction rate of compressive properties shown in Table 3. The ultimate strain, ε_u, for cylindrical specimens is set to be 0.5% based on the experimental results, and for rectangular prisms, it is determined by multiplying the ultimate strain (ε_u = 0.5%) of the cylindrical specimens by reduction factor k_2. Popovics constant, n, is obtained by fitting the calculation of the compressive stress-strain relationship between the experimental result to the model. Fig. 5 compares the average of the experimental results and the model for the rectangular prism specimens. The fitting between the experimental result and the model is good.

5. CONCLUSION

1. The compressive strength ratio obtained from the experimental results of rectangular prisms was 0.85, and it confirmed that the compressive strength decreased due to the differences in cross-sectional shape and dimension.
2. A stress-strain relationship for rectangular prism specimens is modeled using Popovics model with the compressive characteristics of cylindrical specimens and the reduction factors as parameters. A good fit was obtained with the experimental results.

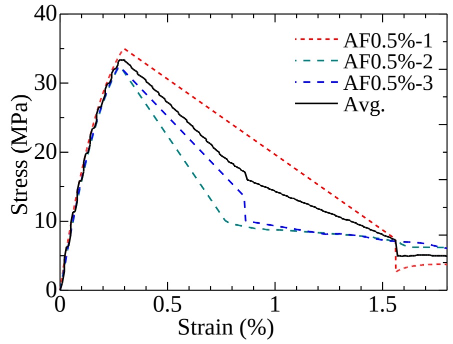

Fig. 4 Stress-strain relationship of rectangular prism

Table 3. Comparison of compressive properties of rectangular prism and cylindrical specimens

Specimen type	f_c, MPa	ε_o, %	Rectangular prism/ cylindrical specimen	
			f_c ratio	ε_o ratio
Cylindrical	39.4	0.48	-	
Rectangular prism	33.3	0.29	0.85	0.60

Table 4. Parameters of the Popovics model

Specimen type	k_1	k_2	Ultimate strain, %	n
Cylindrical	1	1	0.50	2.22
Rectangular prism	0.85	0.60	0.30	2.71

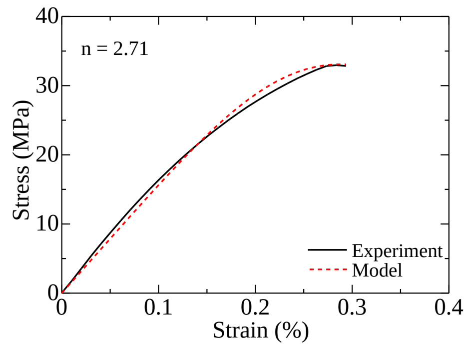

Fig. 5 Comparison of the model and experiment result

REFERENCE

[1] Popovics, S., A Numerical Approach to the Complete Stress-Strain Curve of Concrete, Cement and Concrete Research, Vol. 3, pp.583-599, 1973

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