ポスター発表 | 第V部門

2025年9月12日(金) 14:40 ~ 16:00 Oe（熊本城ホール）

補修・補強（材料）／短繊維補強コンクリート（材料）

座長：審良 郁夫（オリエンタルコンサルタンツ）

[12PM2-Oe-04] PVA-FRCC平板の曲げ試験

*張 航[1]、金久保 利之[1] (1. 筑波大学)

キーワード：FRCC、PVA、曲げ試験、ひび割れ

著者らは，PVA-FRCC平板試験体のひび割れ特性を把握するため，4点曲げ試験を実施した。試験体は，長さ400mm，幅100mm，厚さ10mmの平板である．直径100μmのPVA繊維の体積混入率は3%，直径27μmおよび40μmの繊維の体積混入率は2%とした。実験の結果，すべての試験体において複数ひび割れ特性が確認され，大部分のひび割れ幅は0.5mm未満であった．荷重－たわみ関係より，ひび割れ発生後にひずみ硬化特性を示す可能性が示唆された。

The authors conducted a four-point bending test to investigate the crack characteristics of PVA-FRCC plate specimens. The dimensions of the specimen are 400mm long, 100mm wide, and 10mm thick. The volume fraction for 100μm-diameter PVA fiber type is set to 3%, ones for 27μm and 40μm-diameter fiber are set to 2%. The results show that all the three types of PVA-FRCC plate specimens exhibit multiple-crack characteristic, and the width of most cracks are less than 0.5mm. The load-mid span deflection relationship of all these three types of PVA-FRCC plate specimens indicate a potential strain hardening characteristic after the first appearance of cracks.

Bending Test of Polyvinyl Alcohol Fiber-Reinforced Cementitious Composite Plates

筑波大学　学生会員　○Hang Zhang
筑波大学　正会員　Toshiyuki Kanakubo

1. INTRODUCTION

Fiber-reinforced cementitious composites (FRCCs) are extensively utilized in practical engineering applications due to their superior ductility. The authors have proposed a stress-strain model of PVA-FRCC based on visualization simulation experiments [1] and investigated the bridging law by uniaxial tension test and Monte Carlo simulation of PVA-FRCC [2]. However, since the difficulty of controlling influence factors and the lack of experimental standards for uniaxial tension test, in order to study the multi-crack characteristics of PVA-FRCC on tension side, the authors conducted a four-point bending test on plate-shaped PVA-FRCC specimens. In authors' previous experimental research [2], FRCC using diameter of 100μm PVA fibers with a volume fraction of 2% was investigated. In this study, bending tests are conducted using the plate specimens with a 3% volume fraction of the same fiber, along with other test specimens with a 2% volume fraction using finer fibers to investigate the crack and strain characteristics.

2. EXPERIMENT OVERVIEW

Ten plate specimens are prepared for each series of PVA-FRCC following the mixture proportion shown in Table 1. The dimensions of the plate specimen are 400mm long, 100mm wide, and 10mm thick. The mechanical properties of PVA fibers used in this experiment are shown in Table 2. The volume fraction for 100μm-diameter PVA fiber type is set to 3%, ones for 27μm and 40μm-diameter fiber are set to 2%. Four-point bending test is applied in this research. Fig.1 shows the loading set-up. Due to the limited space between the specimen and the test bench below, a digital camera fixed on a tripod is set in front of the test machine, which the crack image of the pure bending section can be taken by reflection from a mirror set under the specimen. The crack observation area is set to the pure bending section with a width of 35mm, 15mm away from the edge of the specimen. Three linear variable displacement transducers (LVDTs) are set at the mid-span and the supports to measure the displacements. The mid-span deflection is calculated by subtracting the average displacement measured by the LVDTs at the supports from the displacement measured at the mid-span. A compression test used Φ100mm-200mm cylinder pieces is conducted on FRCCs, and the results are shown in Table 3.

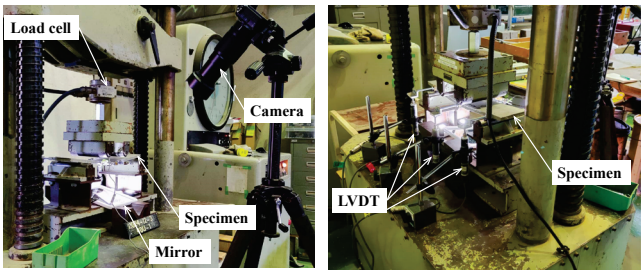
Table 1　Mixture proportion

Series	W/B	FA/B	Unit weight (kg/m^3)			
			W	C	FA	S
PVA	0.39	0.30	380	678	291	484

W: Water, C: High early-strength Portland cement,
FA: Fly ash type II, S: Silica sand.

Table 2　Mechanical properties of fiber

Series	Diameter (μm)	Length (mm)	Tensile strength (MPa)	Elastic modulus (GPa)
PVA027-2%	27	6	1800	46
PVA040-2%	40	12	1560	41
PVA100-3%	100	12	1200	28



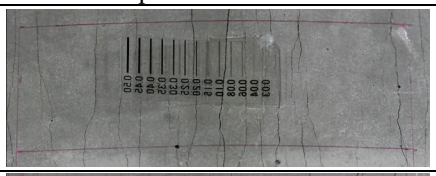
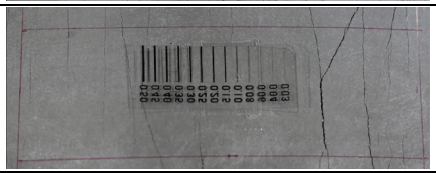
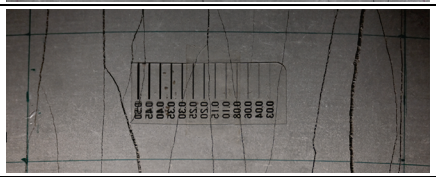
(a) Front view　(b) Back view

Fig. 1　Loading set-up

Table 3　Compression test results

Series	Average compressive strength (MPa)	Average elastic modulus (GPa)
PVA027-2%	45.5	15.0
PVA040-2%	32.3	12.6
PVA100-3%	53.4	21.1

Table 4　Typical crack pattern

Series	Crack pattern at ultimate state
PVA027-2%	
PVA040-2%	
PVA100-3%	

Keywords　FRCC, PVA, Bending test, crack
Address　〒305-8573 茨城県つくば市天王台 1-1-1 筑波大学 TEL 029-853-5045

3. TEST RESULTS

3.1 Typical crack pattern

Table 4 shows the typical crack patterns. It can be observed that a lot of cracks developed on the surface of specimens, most of which width are less than 0.5mm, which indicates all these three types of PVA-FRCC plate specimens show a multiple-crack characteristic. For PVA027-2% and PVA040-2% specimens, the numbers of cracks that can be observed are significantly larger than that of PVA100-3% specimens, and the crack spacings are also smaller than those of the PVA100-3% specimens. For all specimens, as one of the cracks continues to open, the specimens eventually reach the failure state.

3.2 Load-mid span deflection relationship

Fig.2 shows the load-mid span deflection relationship of each series of specimens. For all three series specimens, after the first appearance of cracks, the stiffness leads to a decreasing firstly, then the load increased again with continuous increase of mid-span deflection, showing the potential strain hardening characteristics. For the specimens PVA040-2% and PVA027-2%, after reaching the maximum load, as the deflection continues to increase, the load leads to a creeper decrease, while the load of PVA100-3% specimens leads to a relative slowly decrease until finally reach the failure state.

4. CONCLUSIONS

1) The results of the bending test show that all the three types of PVA-FRCC plate specimens exhibit multiple-crack characteristic, and the width of most cracks are less than 0.5mm. For PVA027-2% and PVA040-2% specimens, the numbers of cracks are significantly larger than that of PVA100-3% specimens.
2) The load-mid span deflection relationship of all the three types of PVA-FRCC specimens indicate a potential strain hardening characteristic after the first appearance of cracks.

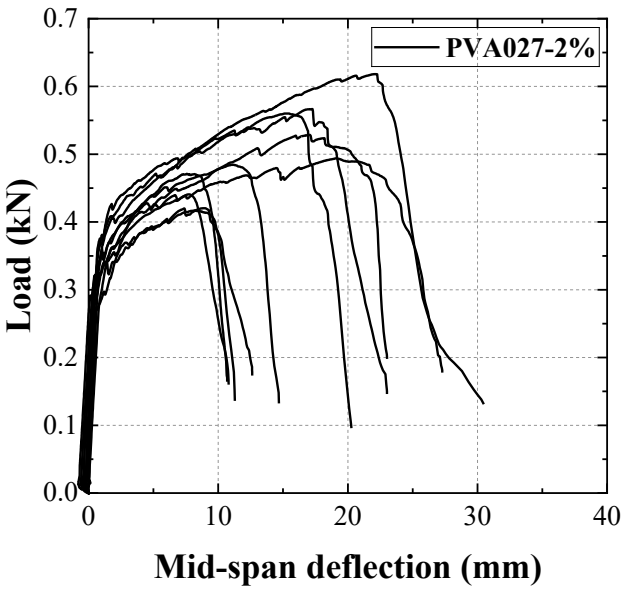
REFERENCES

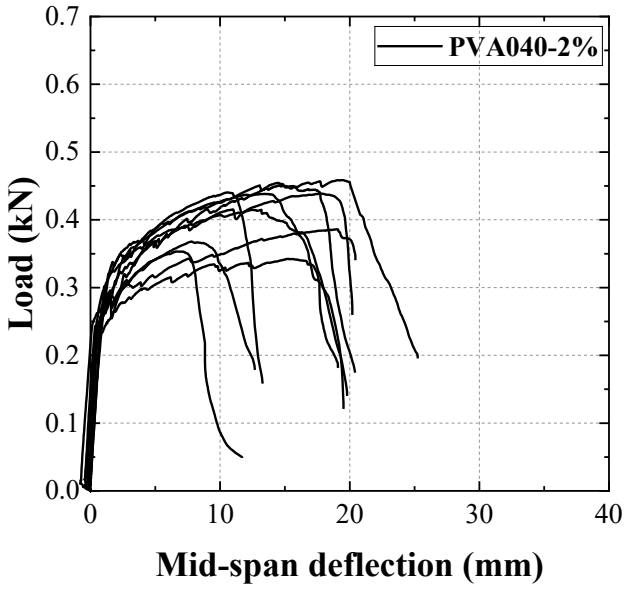
[1] Zhang, H., Kanakubo, T., Flexural Characteristics of Functionally Layered Fiber-Reinforced Cementitious Composite with Polyvinyl Alcohol Fibers, Journal of Composites Science, Vol.7, No.7, 293 (14pp.), 2023.

[2] Tian, W., Zhang, H., Kanakubo, T., Uniaxial Tension Test for Fiber-Reinforced Cementitious Composite with Thin Fiber, JSCE 2024 Annual Meeting, V-389, 2024.

ACKNOWLEDGEMENTS

PVA fiber was provided by Kuraray Co., Ltd.





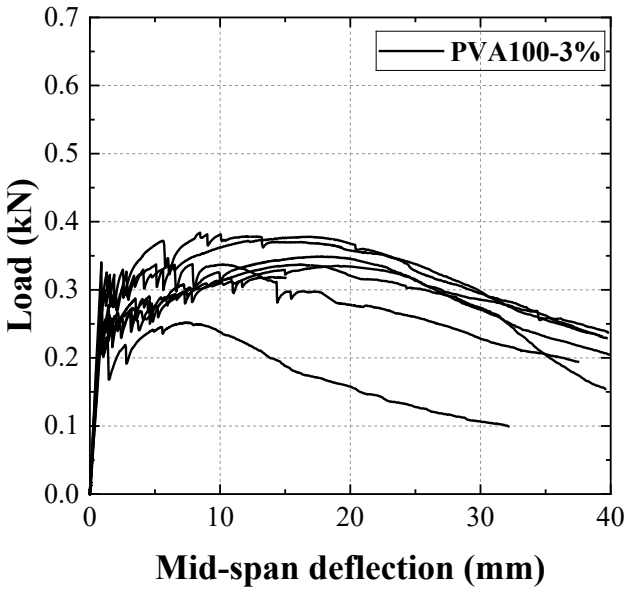


Fig.2 Load-mid span deflection relationship