INFLUENCE OF FREEZING AND THAWING CYCLES ON BENDING STRENGTH OF CONCRETE WITH SHORT FIBER

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1. INTRODUCTION

In Kyrgyzstan, strategically important roads pass through mountainous terrain where avalanches often claim human lives. To ensure safe and uninterrupted passage of trucks and cars, it is necessary to build snow sheds that are resistant to the harsh continental climate of Kyrgyzstan. In the JSCE Concrete Manual. No. 16 Standard Specifications for Concrete Structures-2007 "Materials and Structures" report that the addition of steel fibers improves the mechanical properties of concrete. Concrete reinforced with steel fibers has high resistance to cracking, increases fatigue strength, resistance to freeze and thawing and provides durability. Synthetic fibers are generally inferior to steel fibers in terms of mechanical reinforcement. However, the former is difficult to corrode and are easily molded in the manufacturing process. They have a low density and deform easily, which makes construction easier. In concrete reinforced with short fibers using synthetic fibers, as in concrete reinforced with steel fibers, the bending strength and other mechanical properties increase with the percentage of short fibers [1]. In addition, it is reported that during freeze-thaw cycles, concrete with polypropylene fibers reduced the mass loss rate by 2.06% and increased the relative dynamic modulus of elasticity by 7.29% compared to conventional concrete [2]. Considering the economic advantages of synthetic fibers, experimental tests on bending strength of concrete reinforced with polypropylene short fibers subjected to freeze-thaw cycles were carried out in this work.

2. METHODOLOGY AND ANALYSIS

To determine the effect and role of short polypropylene fibers on the bending strength of concrete, two groups of samples were prepared - one with no fibers and the other with short polypropylene fibers, mixture proportions are shown in Table 1 [3] [4], properties of polypropylene short fibers are shown in Table 2. The initial curing time was 28 days. Control specimens of concrete before bending test and basic specimens before freezing saturated with 5% aqueous sodium chloride solution at (20±2) ° C. Environmental conditions for freezing and thawing are shown in Table 3 [5]. Then the bending test was performed according to JCI-SF4.

Table 1 Mixture proportion

No.	W/C (%)	s/a (%)	Unit amount (kg/m^3)					(g/m^3)		
			W	C	S	G	Short fiber	Ad	SP	AE
1	55.0	46.0	173	315	798	934	0.910	0.000	3.149	0.013
2			175	318	806	943	0	1.591	0.000	0.013

Table 2 Material properties of short fibers

Diameter (μm)	Length (mm)	Tensile Strength (MPa)
18	12	500

Table 3 Environmental condition for freezing and thawing

Freezing environment	Thawing environment
Air, minus (18 ± 2) ° C, 2.5 hour	5% aqueous sodium chloride solution, (20 ± 2) °C, 2 (±0.5) hour

3. RESULTS

3.1 Mass changes

The surfaces of the samples after 60 freeze-thaw cycles are shown in Figure 1. As shown in Figure 2, it can be confirmed that after 60 cycles of freezing and thawing, the changes in mass were less than 0.6% for samples containing polypropylene fiber (a), and less than 1.2% for samples without fiber (b).

No fiber

Polypropylene fiber

Figure 1 Surface changes

Keywords: Polypropylene fiber, freezing-thawing, bending test
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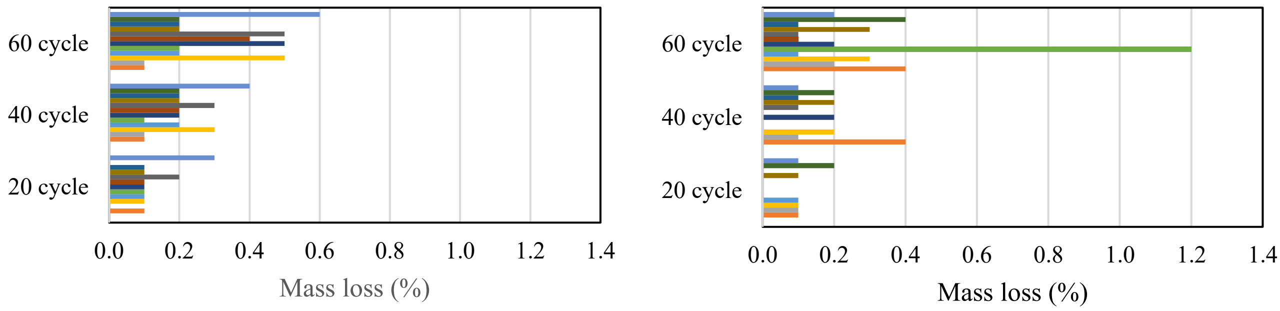

(a) Polypropylene fiber (b) No fiber

Figure 2 Changes in mass loss

3.2 Bending strength

Two examples of the load-displacement curve are shown in Figure 3. The results of the bending test after initial hardening showed that the bending strength of samples with fiber content was slightly higher than samples without fiber content, as shown in Figure 4. After 60 cycles of freezing and thawing, the samples were not subjected to destruction, and strength is continued to gain. The bending strength after 60 cycles of freezing and thawing was the same tendency for both samples. Therefore, although experiments of more than 60 cycles have been continued, the above results suggest that the concrete containing polypropylene fiber is stronger against the load during freeze-thaw action than the no-fiber concrete.

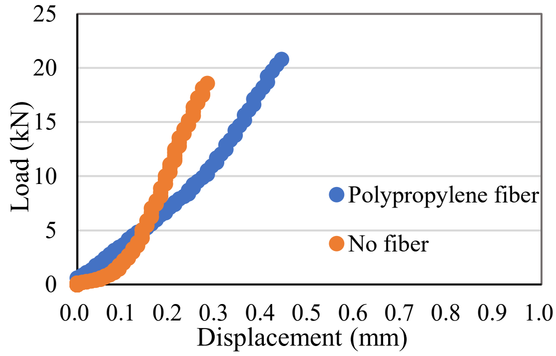

Figure 3 Load-displacement curve examples

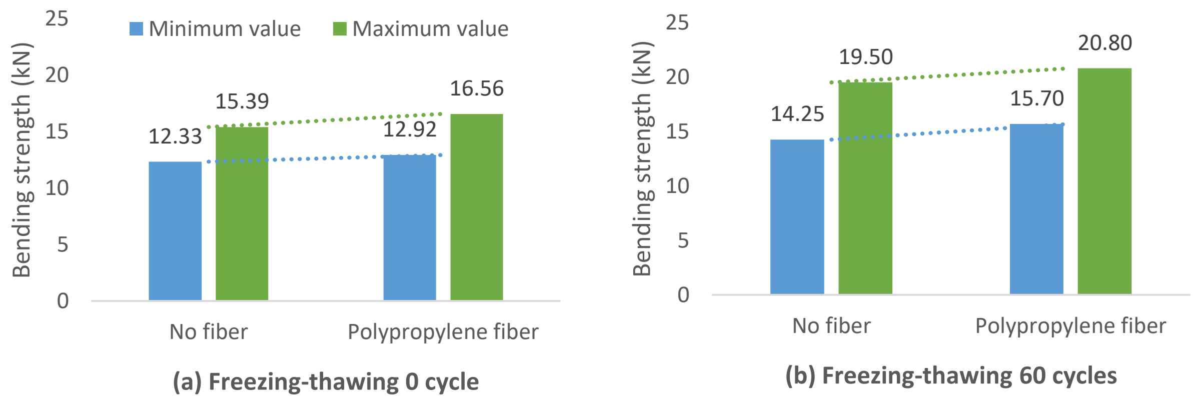

Figure 4 Bending strength

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