

Basalt Fiber for Volcanic Slag Lightweight Aggregate Concrete Research on the Impact of Performance

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Abstract: In order to study the effect of basalt fiber on the mechanical properties and durability of volcanic slag lightweight aggregate concrete, the experimental study on the flexural strength, compressive strength and freeze-thaw resistance of volcanic slag concrete with different basalt fiber content were carried out, the basalt fiber was surface treated with NaOH and water glass, the results show that the surface treatment of basalt fiber can significantly improve the mechanical properties, durability and other properties of volcanic slag lightweight aggregate concrete.

1. Introduction

Lightweight aggregate concrete has many advantages, such as light weight, high strength and so on. Jilin Province has rich volcanic slag resources, which can be taken locally to prepare volcanic slag lightweight aggregate concrete. But the lightweight aggregate concrete also has some inherent problems, such as brittleness and easy cracking^[1]. A large number of studies have shown that fiber can inhibit the shrinkage of concrete and improve the tensile strength of concrete, thereby improving the toughness and shrinkage of lightweight aggregate concrete. Basalt fiber, as a new type of inorganic nonmetallic material, not only has the characteristics of high strength and high elastic modulus, but also a kind of natural environmental protection material, which has become a hotspot in fiber concrete research in recent years ^[2-5]. In the paper, the effects of basalt fiber on the compressive strength and flexural strength of volcanic slag lightweight aggregate concrete under different dosage were studied. At the same time, the basalt fiber was used to study the freeze- influence of the lightweight aggregate concrete.

2. Experimental part

2.1 Raw materials and their main parameters

(1) Cement: P•O42.5 ordinary portland cement;

(2) Fly ash: The use of secondary fly ash, 45 μ m square hole sieve more than 62.3%, specific surface area of 550.7 square m²/kg;

(3) Water-reducing agent: A water-reducing agent having a water-reducing rate of 25%;

(4) Volcanic slag: Fire mountain slag in Huinan of Jilin Province. The main performance parameters are shown in Table 1;



(5) Basalt fiber: Jilin Province XinJiu Group production of basalt fiber. The main performance parameters are shown in Table 2.

Table 1. The main performance parameters of volcanic slag.

Particle size(mm)	Bulk density (kg/m ³)	Tube press strength(MPa)	1h Water absorption (%)	Thermal conductivity (W/m•K)
0-8	945	5.6	16.8	0.0802

Table 2. Physical properties of basalt fiber.

diameter (μm)	Length(mm)	Density(g/ cm ³)	Tensile Strength(MPa)	Elastic Modulus (GPa)	Elongation at break(%)
12	15-17	2.68	3500-4500	93-110	3

2.2 Modification of basalt fiber

The basalt fiber was placed in a water glass (modulus 3.0) solution having a NaOH concentration of 0.5 mol/L at a temperature of 60°C for 1 hour, remove the sample after the sample placed in distilled water, washed several times to neutral, and then into the 105 °C oven drying 24h, after cooling and weighing spare.

2.3 Preparation and testing of test pieces

The content of basalt fiber and modified basalt fiber were 0%, 0.05%,0.1%,0.2%, 0.3% ,0.4% of the cement content in the volcanic slag lightweight aggregate concrete specimen. The flexural strength and compressive strength of the test specimen were tested after 28 days of conservation under standard conditions. After obtained the best fiber content, used to make anti-freeze-thaw specimens, after the specimens were placed in the freezing and thawing equipment, the mass loss rate and the strength loss rate of the specimens were measured every 50 cycles, until the specified freeze-thaw cycles are achieved. Observation of volcanic slag lightweight aggregate concrete section by TM3030 Scanning Electron Microscope.

3. Results Discussion and Analysis

3.1 Effects of basalt fiber on mechanical properties of volcanic slag concrete

The influence of basalt fiber on flexural strength, compressive strength and buckling ratio of volcanic slag concrete is shown in Figure 1, Figure 2 and Figure 3.

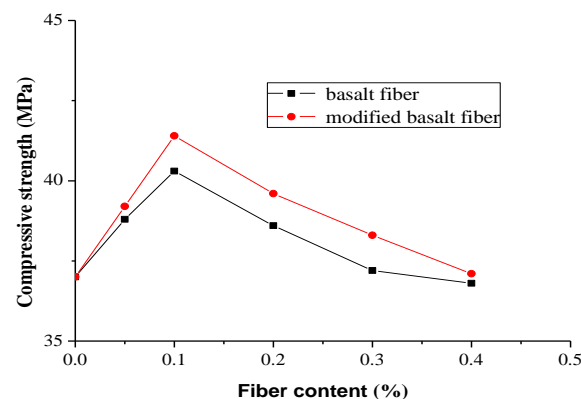


Figure 1. Effect of basalt fiber on compressive strength of volcanic slag lightweight aggregate concrete.

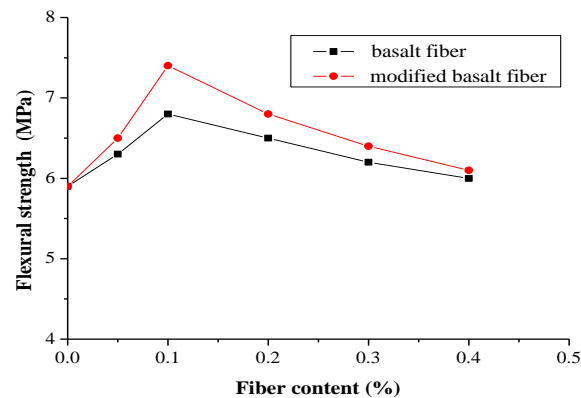


Figure 2. Effect of basalt fiber on flexural strength of volcanic slag lightweight aggregate concrete.

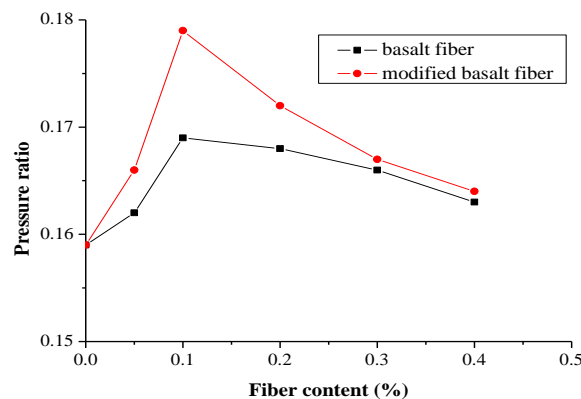


Figure 3. Effect of basalt fiber on toughness of volcanic slag lightweight aggregate concrete.

From Figure 1 and Figure 2, it can be seen that with the increase of basalt fiber content, the flexural strength and compressive strength of volcanic slag lightweight aggregate concrete show a rising trend first and then decrease after the optimum dosage. The optimum content of basalt fiber is about 0.1%. And the flexural properties of the modified basalt fiber in the same content range are better than those of the unmodified basalt fiber volcanic slag lightweight aggregate concrete. According to Figure 3, basalt fiber can significantly improve the toughness of volcanic slag lightweight aggregate concrete, and the modified basalt fiber has greater impact on the toughness of volcanic slag lightweight aggregate concrete. Considering the flexural strength, compressive properties and fracture pressure ratio and other factors, the final 0.1% is the optimal dosage of modified basalt fiber and basalt fiber, and the surface treatment of basalt fiber on the volcanic slag light aggregate concrete mechanical properties to improve the effect better.

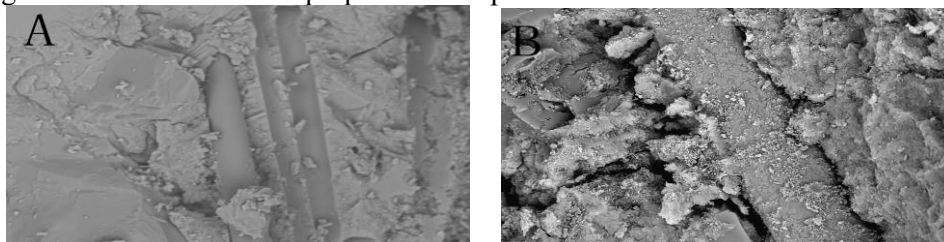


Figure 4. The interface between basalt fiber and volcanic slag lightweight aggregate concrete cement SEM.

In order to further show that the basalt fiber can enhance the strength of the volcanic slag concrete, the fracture cross section of basalt fiber and volcanic slag concrete were characterized by SEM electron microscopy. It can be seen from the A in Figure 4 that the dispersion of ordinary basalt fiber in volcanic slag concrete is better, and when the concrete is subjected to damage, the fiber failure is dominated by pulling or pulling. By the B in Figure 4 shows that the basalt fiber surface after surface modification is more rough, and the bonding interface of concrete is better, inhibit the volcano slag light aggregate concrete generation and propagation of internal micro cracks, improve the compactness of the volcanic slag lightweight aggregate concrete. Therefore, the surface treated basalt fiber has better effect on improving the mechanical properties of volcanic slag concrete.

3.2 Effect of basalt fiber on frost resistance of volcanic slag concrete

The specimen making and curing methods for testing the freeze-thaw resistance are the same as those of testing and testing the mechanical properties of specimens. The blank control group was D0, the experimental group with 0.1% basalt fiber was D1, and the experimental group with 0.1% modified basalt fiber was D2. The influence of basalt fiber on frost resistance of volcanic slag concrete is shown in table 3.

As shown in Table 3, after 300 freeze-thaw cycles, the strength loss rate of D0 was 22.25%, the loss rates of D1 and D2 were 19.89% and 17.37% respectively; the mass loss rate of D0 was 4.25%, and the mass loss rates of D1 and D2 were 3.94% and 3.55% respectively. These data indicate that the surface treated basalt fiber can improve the frost resistance of volcanic slag lightweight aggregate concrete more effectively.

Table 3. Effect of basalt fiber on frost resistance of volcanic slag lightweight aggregate concrete

Freeze Time	Strength loss rate (%)			Mass loss rate (%)		
	D0	D1	D2	D0	D1	D2
0	0	0	0	0	0	0
50	2.31	1.2	0.8	0.57	0.35	0.31
100	5.24	2.84	2.31	1.04	0.84	0.79
150	8.10	5.33	4.05	1.54	1.31	1.25
200	11.42	8.25	7.54	2.42	1.82	1.70
250	16.86	12.86	11.26	2.96	2.65	2.44
300	22.25	19.89	17.37	4.25	3.94	3.55

4. Conclusion

(1) Basalt fiber is added to the volcano slag lightweight aggregate concrete, can improve the flexural strength and compressive strength of concrete, and enhance the toughness of concrete, thereby inhibiting light aggregate concrete brittleness cracking defect.

(2) Basalt fiber, after surface treatment, not only changed the surface chemically inert, but also in the interface layer formed on the surface of a layer of high strength, improve the pore structure near the fiber, improve the fiber bearing capacity of external load, volcanic slag lightweight aggregate concrete mechanical properties and freeze-thaw resistance can effectively improve.

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