

Influence of surface modified basalt fiber on strength of cinder lightweight aggregate concrete

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Abstract. In order to improve the bonding and bridging effect between volcanic slag lightweight aggregate concrete cement and basalt fiber, The basalt fiber was subjected to etching and roughening treatment by NaOH solution, and the surface of the basalt fiber was treated with a mixture of sodium silicate and micro-silica powder. The influence of modified basalt fiber on the strength of volcanic slag lightweight aggregate concrete was systematically studied. The experimental results show that the modified basalt fiber volcanic slag lightweight aggregate concrete has a flexural strength increased by 47%, the compressive strength is improved by 16% and the toughness is increased by 27% compared with that of the non-fiber.

1. Introduction

Lightweight aggregate concrete with light, heat insulation, fire and seismic and many other advantages, has become the amount of ordinary concrete after the new building materials. But high-strength lightweight aggregate concrete is still a prominent flaw, that is, the material brittle, that is, its tensile, bending, impact resistance and toughness and other poor performance. Therefore, how to enhance the toughness of lightweight aggregate concrete is the key to the development of high-performance lightweight aggregate concrete. As the fiber has a good toughening, cracking, anti-wear properties, the chopped fiber used in mortar and concrete, the fiber through the bridge cracks can improve the cement matrix toughness, tensile strength and bending strength, so that the inherent brittleness problem of cement concrete products has been greatly improved.

Basalt fiber is a new type of inorganic fiber material. It is a kind of glassy basalt ore formed by volcanic eruption. It is a fiber which is quickly drawn by melting at high temperature. It has the advantages of small thermal conductivity, high elastic modulus, high tensile strength, good dispersibility, good compatibility with cement-based materials. However, the basalt fiber surface is smooth, with the cement matrix binding force is weak, it is difficult to form an effective bridge. In view of this, the effects of surface modification of basalt fiber on the flexural strength and compressive strength of volcanic slag lightweight aggregate concrete were studied.

2. Experiment process

2.1. Test raw materials and basic performance

(1) Cement: P.O 42.5 R ordinary Portland cement; (2) Fly ash: meeting the national standards of grade II; (3) Basalt fiber: Jilin Jiuxin basalt Industry Co. Ltd. production, the main technical performance is shown in Table 1. (4) Volcanic slag: Huinan County, Jilin Province, the volcanic slag, the main



performance parameters in Table 2 (5) Super plasticizer: Powder polycarboxylate water reducing agent (6) Water: tap water.

Table 1. physical properties of basalt fiber

Name	Diameter (μm)	Length (mm)	Density (g/cm^3)	Tensile strength (Mpa)	Modulus of elasticity (Gpa)	Elongation at break(%)
Basalt fiber	12	11-15	2.68	3500-4500	93-110	3

Table 2. The main performance parameters of volcanic slag

category	Particle size(mm)	Bulk density (kg/m^3)	Cylinder strength(Mpa)	Water absorption(%)
Volcanic coarse aggregate	4.75-8	815	5.9	11.7
Volcanic slag fine aggregate	0.18-4.75	1200	5.9	13.2

2.2. Sample preparation

The basalt fiber was washed in absolute ethanol and dried. The solution was immersed in 1mol/L NaOH solution at 55°C for 3hours, and washed to neutral. During the experiment, it was found that the basalt fiber had moderate surface roughness and less structural damage in the case of 1mol/L NaOH corrosion. The surface treatment of sodium silicate turbidity solution containing 0.5mol/L, 1mol/L, 1.5mol/L and 2mol/L mixed with silica fume was carried out respectively, removed and placed in a 60°C oven for 24 hours, cooled and ready for use.

In the study of basalt fiber content on the volcanic slag light aggregate concrete strength, the basalt fiber content accounted for cement quality 0.1% -0.5%. After determining the optimum amount of fiber, in the preparation of modified basalt fiber volcanic light aggregate concrete process, as the basic content, mixed with surface modified basalt fiber. The specimen preparation process is as follows: First mixing cement, fly ash, and volcanic slag stirring 1min, basalt fibers added, stirring was continued for 2min, after adding water, reducing agent, stirring 3min, so that the basalt fiber in the slurry distribution evenly. In 40mmx40mmx160mm mold molding, room temperature placed 24h after the release, in standard conditions until 28 days of maintenance.

3. Test results and discussion

3.1. Effect of Basalt Fiber Content on Mechanical Properties of Blast Furnace Lightweight Aggregate Concrete

The effect of unmodified basalt fiber content on the flexural strength and compressive strength of volcanic slag lightweight aggregate concrete is shown in Figure 1 and Figure 2.

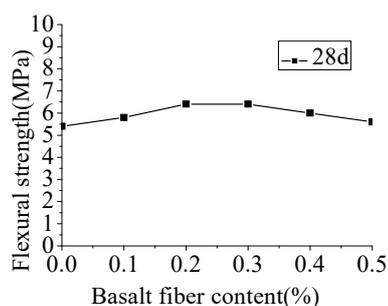


Figure 1. Basalt fiber content for light

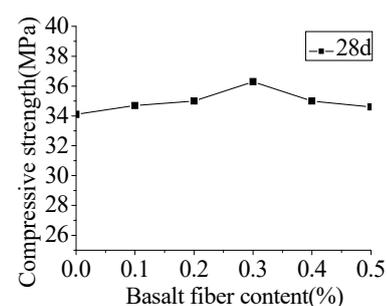


Figure 2. Basalt fiber content for light

aggregate effect of concrete flexural strength aggregate effect of concrete compressive Strength

It can be seen from Figure 1 and Figure 2 that the compressive strength and flexural strength of volcanic slag lightweight aggregate concrete are increasing with the increase of basalt fiber content. When the content of basalt fiber is 3 %, Compressive strength appears an optimal point, but the intensity increase is not very large. The SEM diagram of unmodified basalt fiber is shown in Figure 3, the SEM diagram of unmodified basalt fiber and cement stone is shown in Figure 4. It can be seen that because of the smooth surface of basalt fiber, the amount of cement hydration products is little, and the interface bond with cement stone is poor. When the volcanic slag lightweight aggregate concrete is easy to pull out with the matrix, the fiber bridge is weak, the volcanic slag light aggregate concrete overall mechanical performance is not greatly improved. In view of this, it is necessary to modify the basalt fiber surface to improve the adhesion of the basalt fiber to the cement matrix.

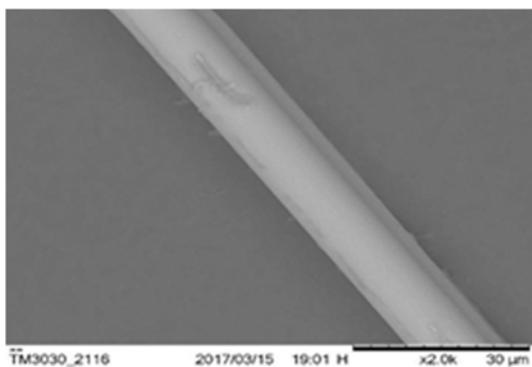


Figure 3. SEM images of unmodified basalt fibers

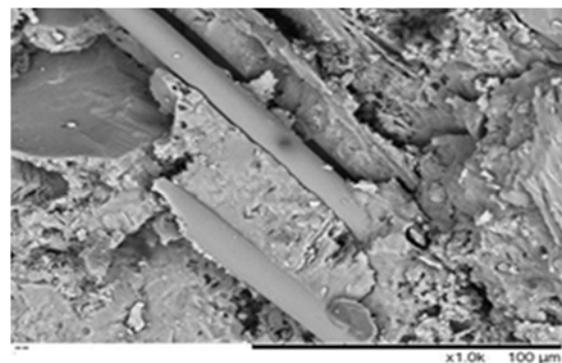


Figure 4. SEM diagram of interface between unmodified basalt fiber and cement stone

3.2. Influence of surface modified basalt fiber on mechanical properties of volcanic slag lightweight aggregate concrete

Figure 5, Figure 6 and Figure 7 for the etching of NaOH solution for 3 hours with different concentrations of sodium silicate and silica fume mixed liquid after treatment of basalt fiber on the volcano slag lightweight aggregate concrete flexural strength, compressive strength and toughness of the impact.

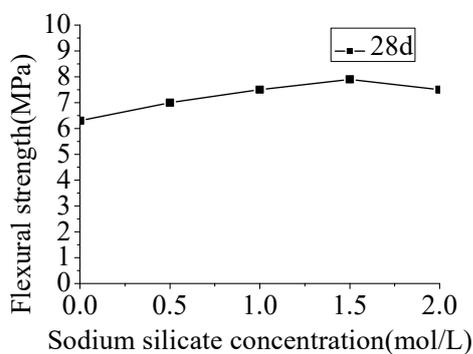


Figure 5. Effect of basalt fiber treated with different concentration of Sodium silicate on flexural Strength of lightweight aggregate concrete

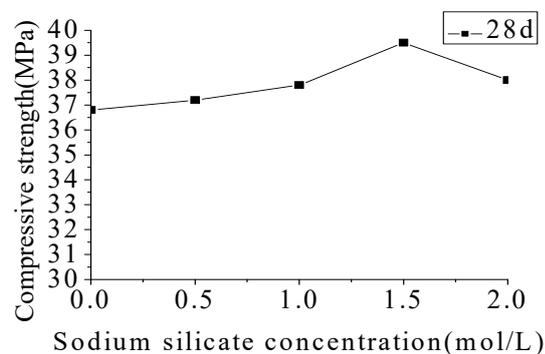


Figure 6. Effect of basalt fiber treated with different concentration of Sodium silicate on compressive strength of lightweight aggregate concrete

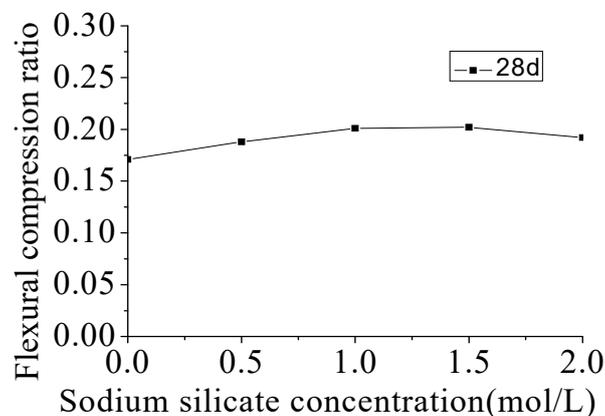


Figure 7. Effect of basalt fiber treated with different concentration of Sodium silicate on Flexural compression ratio of lightweight aggregate concrete

From figure5, figure6 and figure7, with the increase of sodium silicate solution concentration, the basalt fiber volcanic slag lightweight aggregate concrete is resistant to bending and compressive strength gradually increases, when the concentration of sodium silicate solution is 1.5mol/L, the flexural strength of concrete is up to 7.8MPa, Which is 21% higher than that of unmodified basalt fiber volcanic slag lightweight aggregate concrete, which is 47% higher than that of volcanic slag lightweight aggregate concrete without basalt fiber. The basalt fiber surface is subjected to alkali corrosion roughening treatment and then subjected to repair treatment, effectively increase its binding force with the cement stone matrix, in the process of pulling out the interface friction, play a better bridging effect. The highest compressive strength reached 39.6MPa, 8% higher than unmodified, and 16% higher than that without fiber. The strength of the concrete composite is generally determined by the size of the interaction between the material components. When the strength of the reinforced material is greater than that of the cement matrix and the interface is well bonded, the strength of the concrete is enhanced. At the same time, the surface modification of the basalt fiber makes the volcanic slag lightweight aggregate concrete bending strength increased greatly, increased flexure ratio improves the toughness, brittleness and crack resistance of concrete, which helps to prevent crack propagation. From the SEM of figure8, the roughness of the basalt fiber increases after treatment.

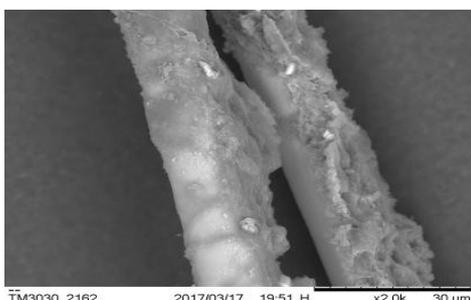


Figure 8. SEM of modified basalt fiber surface

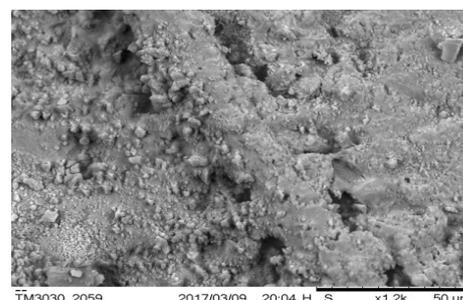


Figure 9. SEM of surface modified basalt fibers and cemen

Basalt fiber is an inorganic material, and the elastic modulus and tensile strength, in the concrete from the micro-reinforcement to enhance the role, fibers absorb energy in the process of drawing out or pulling off, preventing cracks from developing, thereby significantly improving the ductility and toughness of concrete. As can be seen from figure 9, after the alkali solution is roughened, the sodium silicate treated basalt fiber remains intact in the volcanic slag concrete matrix and the surface cement hydration products moreover, the bonding effect is better and the matrix is more compact. This explains that the toughening effect of modified basalt fiber on volcanic slag lightweight aggregate concrete is better than that of unmodified basalt fiber reinforced fiber, and also shows that the bond between the surface modified basalt fiber and cement interface is good.

4. conclusion

The alkali treated basalt fiber was repaired by sodium silicate solution, and the contact of the volcanic slag lightweight aggregate concrete cement paste, which significantly improved the volcanic slag lightweight aggregate concrete bending strength, compressive strength and toughness. Compared with the non-fiber, the flexural strength is improved by 47%, the compressive strength is increased by 16%, the toughness is increased by 27%, not only the mechanical properties are improved but also the plastic cracking of the volcanic slag lightweight aggregate concrete.

Acknowledgments

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