Effect of fly ash on strength of cinder lightweight aggregate concrete

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Abstract. The effect of fly ash content and particle size on the compressive strength of volcanic slag lightweight aggregate concrete was studied. Experimental results show that the mixed fly ash can reduce cinder early compressive strength of lightweight aggregate concrete, with the prolongation of continuously, the secondary hydration of fly ash is completely, the late compressive strength are improved significantly. The particle size of fly ash on cinder affect the strength of lightweight aggregate concrete a reasonable scope, when fly ash after 5-10 minutes of mechanical grinding with cinder of light aggregate concrete effect is best.

1. Introduction

Lightweight aggregate concrete is a new type of building material with many advantages, such as light weight, good earthquake resistance, good thermal insulation and fire resistance. Application in high-rise buildings and long-span structures, because of its higher specific strength, can reduce the cost of transportation and installation of building components, with outstanding economic and social benefits. Volcanic slag is a kind of porous rock formed by the expansion of magma during volcanic eruption due to gas action. Under the background of global energy consumption increasing, artificial fire lightweight aggregate has less and less, cinder lightweight aggregate can be in a certain extent, alleviate the pressure of sand is in short supply, as well as the development of regional economy, building energy conservation, and proceed with the wall materials innovation produces positive effect.

At present, there are many researches on fly ash content on cement-based materials by scholars at home and abroad, but there are few reports on the influence of fly ash particle size on cement-based materials, In this paper, the influence of fly ash with different dosage and particle size on the compressive strength of cinder lightweight aggregate concrete at different ages was studied.

2. Test part

2.1. Raw materials and their properties

(1) Cement: P.O 42.5 R ordinary Portland cement, (2) Fly ash: grade II fly ash provided by changchun faw group is used after grinding. (3) Super plasticizer: Powder polycarboxylate water reducing agent, (4) Light-weight aggregate: The volcanic slag produced in Hui-nan County, Jilin Province, and the main performance parameters are shown in Table 1. (5) Water: tap water.

Table 1 Main performance parameters of volcanic slag

Particle size(mm)	Packing density （kg/m^3）	Pressure strength （MPa）	1h Bibulous rate （%）	Thermal Conductivity （W/m.K）
5-12	820	5.8	17.6	0.0802

2.2. Test method and basic mix ratio

In this experiment, the cement content and sand rate were fixed and the dosage and water consumption of water reducing agent were unified. Table 2 shows the basic mix ratio of cinder light aggregate coagulation. The replacement rate of cement is 5%, 10% and 15% respectively, Cinder complete light concrete compressive strength of the specimen size is 100 x 100 x 100 non-standard mold, forming mold release after curing under standard curing condition, maintenance of test cinder after the age all lightweight concrete compressive strength of the specimens.

Table 2 Basic mix ratio of cinder lightweight aggregate concrete

Cement	Cinder aggregate	Cinder fine aggregate	Water reducing agent
1	1.5	1.5	0.5%

3. Test results and analysis

3.1. Influence of fly ash content on compressive strength of volcanic slag lightweight aggregate concrete.

The influence of fly ash content on compressive strength of volcanic slag lightweight aggregate concrete is shown in Figure 1.

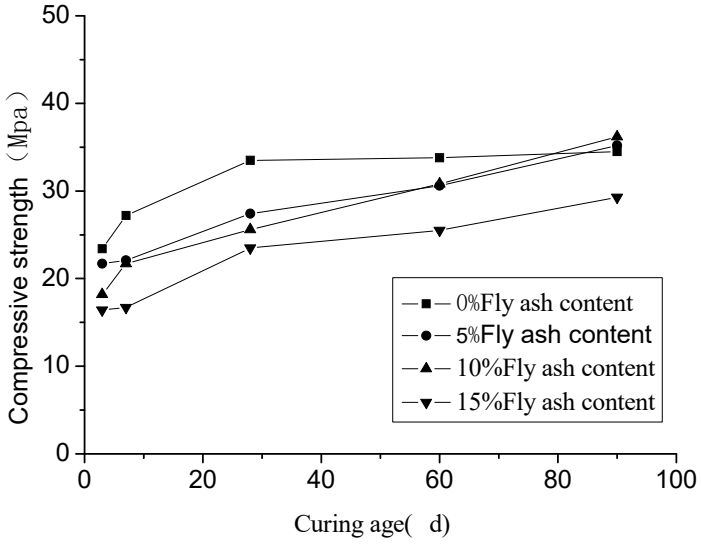


Fig. 1 Fracture strength curve of fly ash concrete in age

Figure 1 shows that the compressive strength of volcanic slag lightweight aggregate concrete increases with the increase of curing age. Within 28 days of curing age, the compressive strength of fly ash mixed with volcanic slag light aggregate concrete and volcanic slag light aggregate concrete without added fly ash was reduced to varying degrees, and fly ash was added. The greater the amount, the more pronounced the drop in concrete strength. For example, when the fly ash content is 5%, the compressive strength of cinder lightweight aggregate concrete decreases by 18.2% at the age of 28days.When fly ash content is 10%, the compressive strength of cinder lightweight aggregate concrete decreases by 23.5%.When the fly ash content is 15%, the compressive strength of cinder lightweight aggregate concrete decreases by 29.8%. As the curing age increasing, continue to occur secondary hydration of fly ash, in the age of 60 days to 90 days, different dosage of fly ash cinder compressive strength of lightweight aggregate concrete corresponding rise. When the age is 90 days and the fly ash content is 5% and 10%, the compressive strength of the cinder lightweight aggregate concrete is 2% and 3.4% higher than that of the cinder lightweight aggregate concrete without fly ash. Meanwhile, when the fly ash content is 15%, the reduction of compressive strength is also reduced to 15%. The results show that the fly ash of cinder light aggregate concrete is a process of long-term effects, low early strength, post strength improved, when the content is too high not use cinder of light aggregate concrete strength of growth. Taking into account, it is concluded that the ash content in the range of 5% to 10% is the best to enhance the strength of the cinder lightweight aggregate concrete.

3.2. Effect of size of fly ash on compressive strength of cinder lightweight aggregate concrete.
It is found that the filling material can make more effective use of the fine surface characteristics and activity of the granule besides the limited size and shape of the granule. In order to explore the optimal effect of fly ash at different grinding times, the experimental study was carried out according to 10% of the fly ash content, and the test results were shown in figure 2.

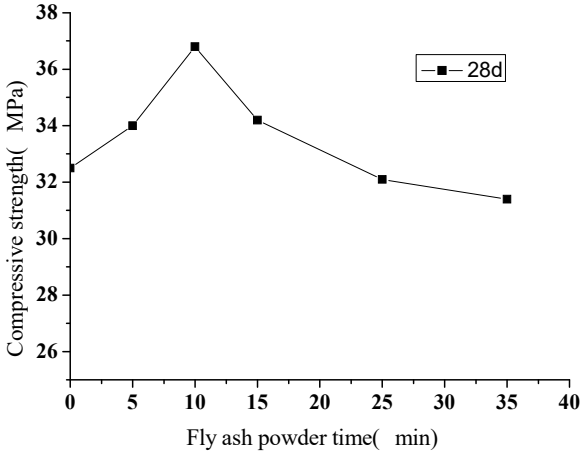
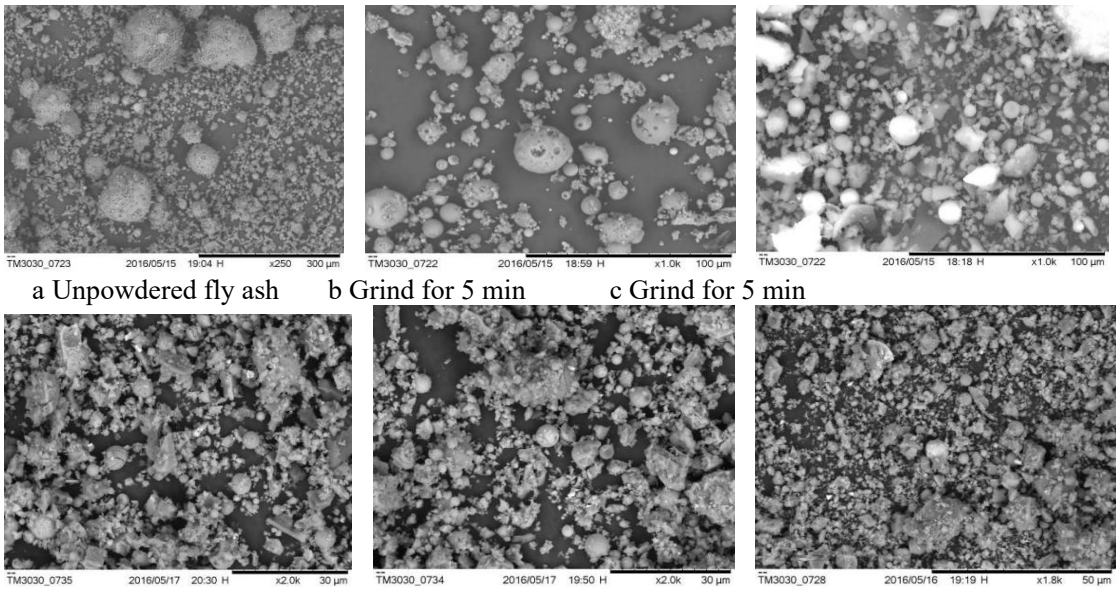


Fig. 2 Effects of fly ash with different powder time on strength of cinder lightweight aggregate concrete

The grinding time of powder is within 10min, and the smooth spherical glass in fly ash plays the role of lubrication and rolling in lightweight aggregate concrete. At the same time, the finely ground fly ash has a good micro-aggregate effect in the cinder lightweight aggregate concrete, filling the internal space of the concrete and improving the compressive strength. As the grinding time increased to 35 min, due to the long grinding time destroyed the spherical glass beads form of fly ash, specific surface area increased, mixed into concrete, the water demand of concrete mixture increased water-cement ratio increases, so the compressive strength is reduced. Fly ash is formed by rapid cooling

under high temperature molten state, shape is spherical beads, surface pore and contains impurities, less reactive group, after mixing with gelling material it is difficult to have a strong adhesion. The interface between the microbeads and the matrix is the weakest point of the light-weight aggregate concrete. When the external force acts as a spalling failure at the interface, it restricts the morphological effect. Therefore, mechanical grinding is used to increase the surface activity of the fly ash. The fly ash SEM after grinding at different times of the ball mill is shown in Figure.3.

As can be seen from the SEM images of fly ash under different grinding times in figure 3, the original fly ash microbeads are similar to balls in shape, with a large amount of impurities attached to the body surface, and the texture is very loose. As shown in figure 3-b and figure 3-c, after 5-10 minutes of grinding, part of the ball with a large particle size is destroyed and its particle size gradually decreases, porous microspheres were crushed into fine scales, the surface of impurities is also partly to reduce, the adhesion of the sphere are separate, part of the beads are destroyed, when there are still some small beads, morphology of fly ash. Therefore, after mechanical grinding fragments of the fly ash is made of porous glass spheres and separated adhesion of beads, effectively play the micro aggregate effect and morphological effect makes the cinder later strength improved. As the grinding time of powder exceeds 10min, the microscopic morphology is shown in figure 3-c, figure 3-e and figure 3-g. Due to the long grinding time destroyed the spherical glass beads form of fly ash, specific surface area increased, lost its beads effect of fly ash, mixed into concrete, concrete mixing water demand increase, results in the decrease of compressive strength.



a Unpowdered fly ash b Grind for 5 min c Grind for 5 min

d Grind for 15 min e Grind for 25 min g Grind for 35 min

Fig. 3 Microstructure of fly ash under different grinding time

4. Conclusion

The mixed fly ash can reduce cinder of light aggregate concrete early strength, as the curing age continuously extend, the secondary hydration of fly ash makes cinder late light aggregate concrete continues to grow. The particle size of fly ash has certain influence on the strength of cinder lightweight aggregate concrete, after 5-10 minutes of mechanical grinding fly ash mixed with cinder of light aggregate concrete, both has the good micro aggregate filling effect, and has good effect, the cinder of light aggregate concrete enhancement effect is best.

Acknowledgments
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