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The Study on Utilization of Portland Cement for Preparation of Aerated Concrete

Qizhi Zhang

Huanghuai University, Zhumadian 463000, China
20070359@huanghuai.edu.cn

In the wall material technology, the use of aerated concrete can effectively improve the green building. However, many problems in the production and use of autoclaved aerated concrete have hindered its application and application. In order to solve the problem that the production cycle of autoclaved aerated concrete is long and the autoclave energy is high, the autoclave aerated concrete is prepared by using Portland cement. The effects of raw materials on compressive strength were studied.

1. Introduction

Aerated concrete began in the 20th century, 30 years, with the initial simple process (preparation-ingredients -mixing-pouring-static stop-cutting-steaming) and technical equipment, after 50 years of production technology exploration and technology research and development and innovation, It is no longer confined to autoclaved aerated concrete itself. In fact, the current definition of aerated concrete is more broadly defined as all aerated concrete, including aerated concrete blocks and foam concrete. (Cement, slag, fly ash) or the way it is used (autoclaved aerated concrete AAC, non-autoclaved aerated concrete), the type of cementing material (cement, slag, fly ash) NAAC. At present, the two major directions of domestic and international research are: the modification of autoclaved aerated concrete and the research and development of non-autoclaved aerated concrete.

2. Test method

The size of the test piece is 70.7mm×70.7mm×70.7mm, a group of three; before the compression test, the specimen placed in the (60±5)℃ drying oven to the moisture content of 8% to 12% of the state (moisture content of the test value obtained by the test method (3)); test the rate of loading control (2.0±0.5) kN/s. The specific strength formula is: Specific strength=compressive strength / dry density, (N•m/kg)

3. Influencing factors of compressive strength of aerated concrete

The properties of raw materials and the ratio of composite materials are the main factors affecting the development of concrete strength. This paper mainly studies the influence of the kind, properties and content of materials on the compressive strength of aerated concrete. Firstly, the effects of fineness and content of aluminum powder, mineral admixture and early curing system and alkali content on the dry density and strength were studied. The effect of gypsum and PVC fiber on the strength was also studied (Lothenbach et al., 2008; Amara et al., 2017; Qin and Zhang, 2017; Warmadewanthi et al., 2017).

3.1 Aluminum powder content and fineness of the impact

The composition is shown in Table 1. The compressive strength and dry density of aerated concrete decrease with the increase of aluminum content, but the effect of the content on the two is different. In the range of 0.25%~0.40%, the decrease trend of the dry density of the specimen is obvious. When the content is more than 0.4%, the dry density is still decreased, but the degree of change is slow, indicating that the excess aluminum content May result in a decrease in the reaction rate of the aluminum powder or a requirement for the stability of the slurry (moderate viscosity value). For compressive strength, when the content of more than

0.35%, the compressive strength of the specimen is the most obvious, the effect of dry density on the strength of the role of increased (Jawed and Skalny, 1978; Vivian, 1950).

Table 1: Mix proportion of raw materials

Match number	Ordinaiy Portland Cement	water	Aluminum powder	Calcium stearate	NaOH
1	1	0.5	0.0025	0.005	0.02
2	1	0.5	0.0030	0.005	0.02
3	1	0.5	0.0035	0.005	0.02
4	1	0.5	0.0040	0.005	0.02
5	1	0.5	0.0045	0.005	0.02
6	1	0.5	0.0050	0.005	0.02

3.2 Effects of mineral admixtures

Mineral admixtures can reduce the early strength of concrete due to the early dilution effect of cement, but the secondary hydration reaction can improve its long-term performance. The secondary hydration reaction of the volcanic ash material is the reaction of Ca(OH)2 at the normal temperature of the hydration of the admixture with the cement hydration to produce the hydrated gel component, thus improving the strength of the concrete. Under the excitation of strong alkaline components, the hydration reaction of the volcanic ash material can be completed at an earlier age, as is the use of more alkali-activated gelatinous materials. In order to achieve the purpose of aerobics and gas stabilization, this experiment incorporates excessive alkali components, so the hydration activity of mineral admixtures may be excited at an early stage. For the reasons mentioned above, this section mainly deals with the effect of two factors on the compressive strength of aerated concrete for fly ash and silica fume, the study of admixture and the admixture and early curing temperature (Bakharev et al., 1999).

3.2.1 Effects of mineral admixtures

Figure 1 shows that the compressive strength of aerated concrete with 5% silica fume is higher than that of the blank group under the same dry density, and this advantage is more obvious for the higher dry density specimen. The compressive strength of fly ash is smaller than that of blank group, and the effect of fly ash on low density specimen is more significant, indicating that the compressive strength of the specimen is 20% Big deterioration.

The results show that the mineral admixture can increase the hydration degree of cement in the unit volume. However, due to the presence of the dilution effect, the overall effect of the gelling material in the system decreases, leading to the early decrease of the strength, which increases with the decrease of the mineral admixture activity. The silica surface area is large, and the content of amorphous SiO2 is between 85% and 96%, so it has higher activity and reacts with the alkali in the system at an early stage to improve the strength (Keriene et al., 2013; Melo et al., 2014; Collins and Sanjayan, 2000).

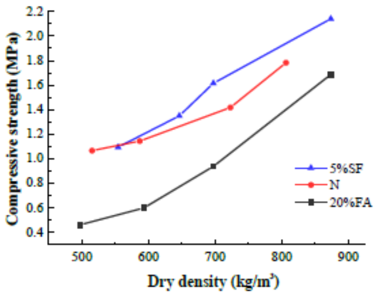


Figure 1: The effect of SCM on compressive strength of NAAC (7d)

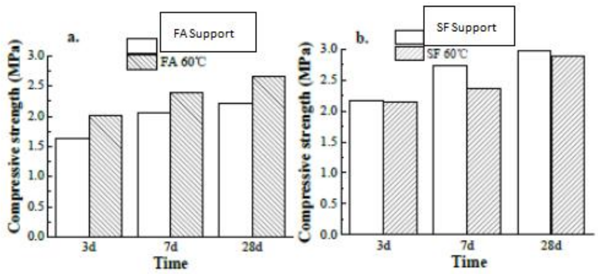
3.2.2 Effects of mineral admixture and early curing temperature

The test results on the upper section show that the addition of more fly ash will affect the compressive strength of aerated concrete. In the study of alkali-activated aerated concrete, it was found that the use of high-temperature curing method can improve its early compressive strength. Therefore, this section will discuss the effect of early curing temperatures on the compressive strength of aerated concrete added with mineral admixtures, using the compounding ratio and the maintenance mode as shown in Table 2 (Bakharev et al., 1999; Krivenko and Kovalchuk, 2015; Neto et al., 2008).

Table 2: Mix proportion of raw materialsand the curing methods

	Cementitious materials							
Number	Ordinary Portland Cement	Fly ash	Silica fume	water	Aluminum powder	Calcium stearate	NaOH	Curing temperature and time
1	0.90	0.1	0	0.5	0.005	0.005	0.02	Support
2	0.90	0.1	0	0.5	0.005	0.005	0.02	60℃ 24h
3	0.95	0	0.05	0.5	0.005	0.005	0.02	Support
4	0.95	0	0.05	0.5	0.005	0.005	0.02	60℃ 24h

Test results shown in Figure 2, the early high-temperature curing for the mixed fly ash concrete strength has improved significantly, but the impact of silica-doped specimen is not obvious. The reason may be that in the early silica fume and the system of excess NaOH has a certain degree of hydration reaction, and then the silica fume content is relatively low, so the role of high temperature curing is not, there may be because the curing temperature Or the length of time is not enough



a. fly ash-cement *b. silica fume-cement*

Figure 2: The effect of high temperature curing and SCM on compressive strength of NAAC (7d)

3.3 Effect of alkalinity on compressive strength of aerated concrete

NaOH content affects the process of aluminum powder, which determines the dry density after hardening This section mainly explores the effect of high alkali content on the strength performance of aerated concrete, and compares and analyzes the influence degree of high alkalinity on the strength of aerated concrete and ordinary concrete (Gouda, 1986; Shi et al., 2006; Esmaily and Nuranian, 2012; Hlaváček et al., 2015).

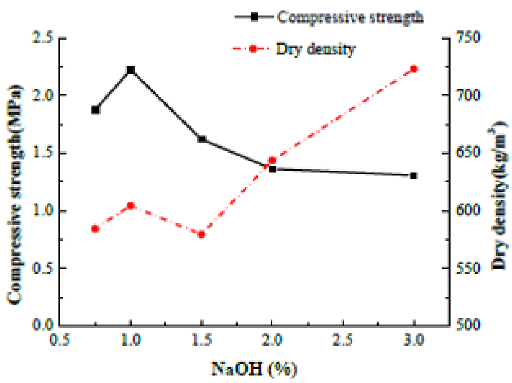


Figure 3: The effect of NaOH addition on compressive strength and dry density of NAAC (3d)

As shown in Figure 3, the early strength (3d) of the aerated concrete increases first and then decreases with the NaOH content. When the NaOH content reaches 1.5% of the mass of the cementitious material, the strength is greatly damaged and the dosage continues to improve, the intensity of deterioration is more serious. As mentioned earlier, the effect of NaOH is not a single factor. When its content is high, the dry density of aerated concrete is also greatly affected, which is mainly related to its gas generation process, which is discussed in Chapter 3. The specific strength values are used to characterize the effect of alkali on compressive strength, and the results are shown in Table 3.

Table 3: mix proportion and specific strengthof cement paste

Ordinary Portland Cement	Water	Aluminum powder	Calcium stearate	NaOH Content	Alkali content NA2O%	3d specific strength(N•M/Kg)
1	0.5	0.005	0.005	0.0075	1.03%	3208
1	0.5	0.005	0.005	0.0100	1.23%	3678
1	0.5	0.005	0.005	0.0150	1.62%	2795
1	0.5	0.005	0.005	0.0200	2.00%	2121
1	0.5	0.005	0.005	0.0300	2.78%	1810

3.4 PVA fiber content

For ordinary concrete, the addition of organic fibers will reduce the compressive strength of concrete, mainly the introduction of new fiber transition zone, and organic fibers are generally hydrophobic, resulting in the adhesion of concrete is affected. This section examines the effect of PVA fibers on the compressive strength of aerated concrete. The combinations used are shown in Table 4.

Table 4: Mix proportion of raw materials

Number	PVC Content	Ordinary Portland Cement	Water	Aluminum powder	Calcium stearate	NaOH	Plaster	PVA fiber
1	0	1	0.525	0.005	0.005	0.3	0.2	0.0000
2	0.10%	1	0.525	0.005	0.005	0.3	0.2	0.0010
3	0.15%	1	0.525	0.005	0.005	0.3	0.2	0.0015
4	0.20%	1	0.525	0.005	0.005	0.3	0.2	0.0020
5	0.25%	1	0.525	0.005	0.005	0.3	0.2	0.0025

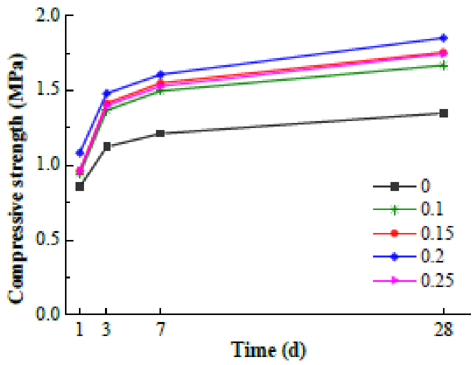


Figure 4: The effect of PVA fiber on compressive strength of NAAC at different ages

Figure 4 shows the effect of PVA fiber incorporation on the compressive strength of aerated concrete at each age. The results show that the fiber can improve the compressive strength of aerated concrete. When the fiber mass content is in the range of 0.1%~0.2%, the compressive strength of the specimen increases with the PVA content. When the dosage is increased, the compressive strength decreases. The effect of fiber on the compressive strength of aerated concrete is divided into two aspects:

1. The incorporation of fiber will affect the rate of slurry formation and limit the expansion of the slurry, so that the pore diameter generated in the slurry is limited by fiber, the pore size is more uniform, which is beneficial to the stress transfer of the specimen during the compression process, Thereby increasing the intensity;

2. Fibers play a bridging role in the matrix. During the process of compression, the curve shows a linear change before the critical damage point. After the critical value, the large hole in the specimen is destroyed and the hole wall is disintegrated. In the process, the fiber can be connected with the external force Resulting in cracks, and carrying a certain stress value, to prevent the development of cracks and enhance the effect. As the aerated concrete strength is low, so the fiber to enhance its role is more obvious.

Table 5: Mix proportion of raw materials

Number	NaOH-Gypsum content (%)	Ordinary Portland Cement	Water	Aluminum powder	Calcium stearate	NaOH	Plaster	Fiber
1	2-4	1	0.525	0.005	0.005	0.02	0.04	0.0015
2	3-5	1	0.525	0.005	0.005	0.03	0.05	0.0015

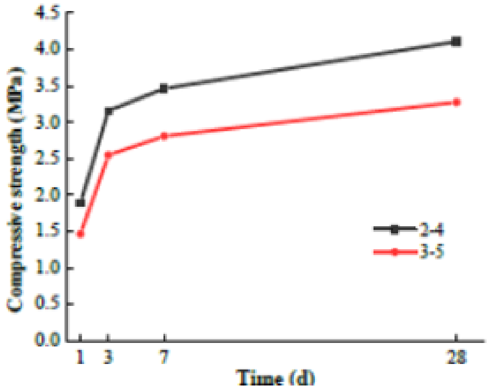


Figure 5: The effect of combination of PVA fiber and gypsum on compressive strength of NAACatdifferent ages

The results show that PVA fiber can obviously improve the compressive strength of aerated concrete. Figure 5 shows the strength development curve of PVA fiber and gypsum optimized ratio to show the strength change after two-factor modification, using Table 5. For the addition of 2% NaOH, 4% gypsum and the use of 0.15% fiber reinforced aerated concrete, 480kg / m3 3d strength can reach 3MPa, 7d at 3.5MPa or so.

4. Conclusion

In this paper, the effects of aluminum powder content and fineness, mineral admixture, PVA fiber content and different combinations of these factors on the compressive strength of aerated concrete were studied. The following conclusions were obtained:

(1) The compressive strength and dry density of aerated concrete decrease with the increase of the content of aluminum powder, and the dosage is in the range of 0.25% ~ 0.40%. The decrease trend of dry density is more obvious. When the content is more than 0.35% The effect of dry density on the strength of the increase is more obvious; fine aluminum powder is more easily dispersed in the system, forming a smaller and more uniform bubble structure, the strength is also higher;

(2) Compressive strength of aerated concrete with 5% silica fume is improved, and its advantages are more obvious for higher dry density specimen. The compressive strength of 20% fly ash is different The effect of early high temperature curing on the strength of aerated concrete mixed with fly ash has obvious effect, but the effect of adding silica ash is not obvious.

(3) The amount of alkali is too high cement early hydration too fast, the local produce too much hydration products, resulting in uneven distribution between the products, and product structure changes, and late hydration delay; When the dosage is higher than 1.5%, the compressive strength increases. In the sand test, the compressive strength of 3d and 28d of the specimen decreased with the increase of alkali content.

(4) PVA fiber can greatly improve the compressive strength of aerated concrete. When the fiber mass content is in the range of 0.1%~0.2%, the compressive strength of the specimen increases with the PVA content. When the dosage is increased, the compressive strength decreases. The compressive strength of the aerated concrete with the dry density of 480kg / m3 after the gypsum modification is up to 3.5MPa.

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