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Influence of Iron Tailings Powder on the Performance of Alkali Slag Foamed Concrete

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Abstract

The effect of adding iron tailings powder on the mechanical properties of alkali slag foamed concrete was studied. Keeping the foam concrete apparent density, cement content and admixture content unchanged, and change the amount of iron tailings powder. When the content of iron tailings powder increases from 10% to 30%, the compressive strength of the alkali slag foamed concrete gradually increases; When the content of iron tailings powder increases from 30% to 50%, the compressive strength of the alkali slag foamed concrete gradually decreases, and the strength loss is obvious. Keeping the apparent density and the content of each component unchanged, and change the fineness of the iron tailings powder. As the fineness of iron tailings increases, the strength of alkali slag foamed concrete gradually increases. The shrinkage rate of foamed concrete decreases with the increase of the tailing powder content, but when the content is 10%~30%, the shrinkage rate of the specimens at the same age tends to be stable.

Keywords

Iron tailings powder; Foam concrete; Alkali slag.

1. Introduction

Alkali slag concrete is a hydraulic cementing material obtained by using alkali metal compounds as alkali components to excite slag. It is widely used because of its easy access to high strength and steady growth of later strength, fast hardening and high early strength, excellent pore structure, good water resistance, freeze-thaw resistance and other properties. At the same time, due to the wide range of raw material sources and low prices for the production of alkali slag concrete, the development of alkali slag concrete is more meaningful today when energy and resources are tight [1, 3].

Iron tailings powder is a waste slag produced in the process of iron ore mining. The main component is silica, which cannot be used or has very low utilization value under current technical conditions. There are huge reserves of tailings ponds throughout the country. It is not only a major source of danger and environmental pollution, but also poses a great threat to the lives and property safety of the people downstream of the tailings ponds. How to deal with a large amount of tailings has become an urgent problem to be solved.

Foaming agent, also known as foaming agent, can produce foam through chemical and physical changes under certain conditions to form a closed-cell or inter-cell structure. Adding a proper

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amount of foaming agent during the concrete preparation process will produce tiny airtight uniform bubbles in the concrete. Effectively improve the physical and mechanical properties of concrete, improve the fluidity and durability of concrete, save cement and reduce density, thereby saving energy and improving the environment [4].

Foam stabilizer is an additive that helps foam retention, improves foam strength, and can extend foam life. Foam stabilizers can be divided into two categories according to the mode of action: The first type causes a small increase in the viscosity of the solution. This type of foam stabilizer is added as an active substance to the foaming liquid to enhance the interaction between surface adsorption molecules through a synergistic effect It can increase the strength of the surface adsorption film, improve the quality of the film, increase the elasticity of the film, and reduce the air permeability of the foam, thereby improving the stability of the foam. The second type of foam stabilizer is a viscosity-increasing foam stabilizer, which mainly slows down the drainage rate of the foam by increasing the viscosity of the liquid phase, improves the stability of the foam, and can significantly extend the half-life of the foam [5]. The use of foam stabilizers in foam concrete can significantly improve the quality of concrete.

Foamed concrete is a porous material that is uniformly mixed and hardened by prefabricated foam and cement (mortar) slurry. As a new type of thermal insulation, energy-saving and environmentally friendly wall material, foamed concrete is a building material based on solid industrial waste. It has excellent properties such as light weight, heat preservation, fire resistance, sound insulation and shock resistance. The use of alkali slag cement to make foamed concrete materials and incorporate a large amount of iron tailings powder, while reducing the cost of building materials, can also solve the problem of a large number of tailings pollution [6]. Therefore, it is necessary to study the influence of iron tailings powder on the mechanical properties of alkali slag foamed concrete. This article mainly studies the influence of iron tailings powder content and fineness on the compressive strength of alkali slag foamed concrete.

2. Test Content

2.1. Main Ingreadient

Slag powder (specific surface area> 400kg/m3), S95, Angang Slag Development Company; Iron tailings powder (Table 1 for chemical composition), Liaoyang Gongchangling flotation ore powder; Portland cement (PO.42.5), Liaoyang Tianrui Cement Co., Ltd.; Stimulant, potassium permanganate; Foam stabilizer, hard calcium; Homemade admixture.

Table 1. Main chemical composition of iron tailings powder (%)

CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_3	K_2O	Na_2O	Cl^-	Loss
5.51	62.56	5.54	15.67	3.64	0.06	0.71	0.74	0.02	5.55

2.2. Testing Method

Mixing of materials: Calculate the amount of slag powder, tailings powder, cement, admixtures and other materials required for the test according to the required mixing ratio, and mix them thoroughly to make a premix. The distribution ratio of each group is shown in Table 2.

Production of standard sample block: accurately weigh the amount of water required for the test, fully stir and hydrate the premix, then add foaming agent, and adjust the volume density of the sample through the amount of foaming agent added; Inject the foaming slurry into the mold, leave it to foam, and remove the mold after it is set to make a standard compressive

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strength test specimen of 100mm×100mm×100mm and a shrinkage test specimen of 40mm×40mm×160mm.

Test index: Test the compressive strength and shrinkage rate of samples after curing for 3 days, 7 days or 28 days.

Table 2. Main components of iron tailings powdered alkali slag foam concrete

Component	content(%)
Slag powder	20-70
Tailings powder	10-50
Cement	20-35
Stimulant	5-10
Admixture	1-5
Foaming agent	3-5
Water-cement ratio	0.35-0.45

2.3. Test Standard

The compressive strength and shrinkage test piece shall be in accordance with the regulations of JG237 and JC/T603-2004 standard.

The shrinkage rate is calculated according to the formula (1).

$$S_n = \frac{(L_0 - L_n) \times 100\%}{130} \quad (1)$$

S_n-Cement mortar test piece dry shrinkage rate at n-day age, %; L_0-initial measurement reading, mm; L_n-measurement reading at n-day age, mm.

3. Analysis of test Results

3.1. Influence of Iron Tailings Powder Content on the Compressive Strength of Alkali Slag Foamed Concrete

For the alkali slag foamed concrete with an apparent density of 700 g/cm^3, the ratio of iron tailing powder and slag powder was changed under the condition that the cement content was 25% unchanged, and the influence of its compressive strength was investigated. The testing results are shown in Table 3 and Figure 1.

Table 3. Influence of the amount of iron tailings powder on the compressive properties of alkali slag foamed concrete

Apparent density (g/cm^3)	Dosage(%)			Compressive strength(MPa)		
	Tailings powder	Slag powder	cement	3d	7d	28d
700	10	60	25	1.23	1.49	1.84
	20	50	25	1.46	1.86	2.30
	30	40	25	1.78	2.08	2.59
	40	30	25	0.78	1.16	1.69
	50	20	25	0.34	0.45	0.70

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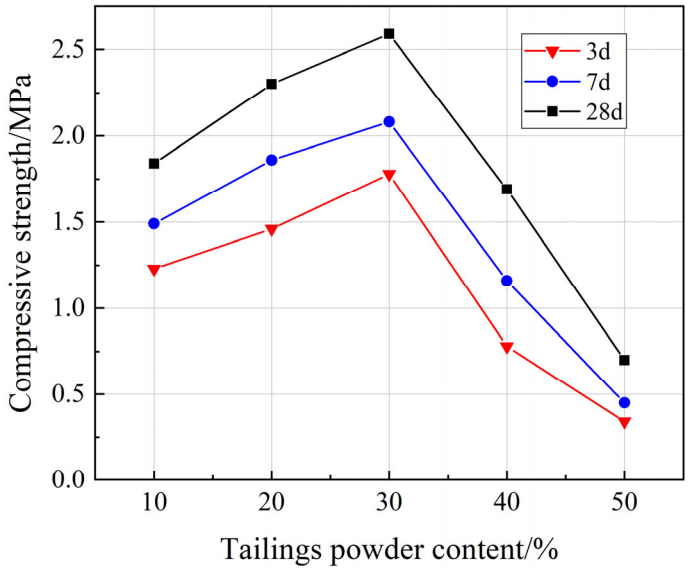

Figure 1. Relationship between mineral powder content and compressive strength

From Table. 3 and Figure 1, it can be seen that when the content of iron tailings powder increases from 10% to 30%, the compressive strength of the alkali slag foamed concrete gradually increases; when the content of iron tailings powder increases from 30% When it reaches 50%, the compressive strength of alkali slag foamed concrete gradually decreases, and the strength loss is obvious.

When the iron tailings powder content is moderate, the iron tailings powder particles can be fully dispersed in the matrix to supplement the types of matrix particles, thereby playing a reinforcing role; However, as the content of iron tailings powder continues to increase, the interface of the matrix is damaged and the cohesive force decreases. The particles of iron tailings powder cannot be dispersed well and deposits are generated, which leads to a decrease in the compressive strength of the alkali slag foamed concrete.

3.2. Influence of Iron Tailings Fineness on the Compressive Performance of Alkali Slag Foamed Concrete

For the alkali slag foamed concrete with an apparent density of 700 g/cm^3, the fineness of the iron tailings powder was changed under the condition that the content of iron tailings powder was 30% unchanged, and the influence of its compressive strength was investigated.

Table 4. Influence of Iron Tailings Fineness on the Compressive Performance of Alkali Slag Foamed Concrete

Apparent density (g/cm^3)	Tailings fineness(mesh)	Comoressive strength(MPa)		
		3d	7d	28d
700	50	1.59	1.82	2.15
	100	1.81	1.96	2.37
	150	1.98	2.20	2.41
	200	2.06	2.35	2.60

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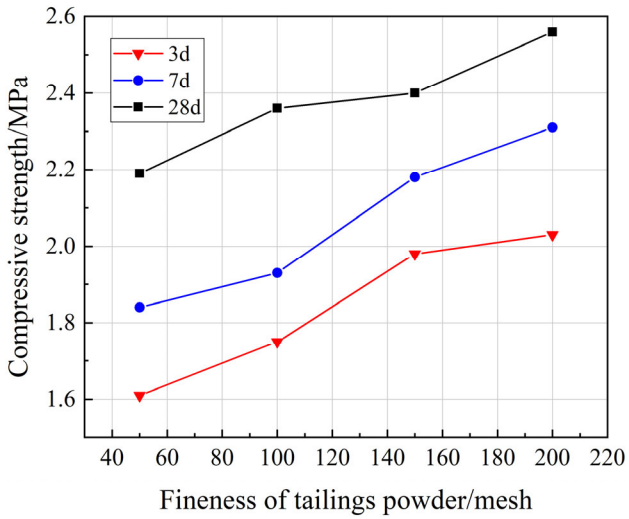

Figure 2. Relationship between fineness of mineral powder and compressive strength

It can be seen from Table 4 and Figure 2 that as the fineness of the iron tailings powder increases, the strength of the alkali slag foamed concrete gradually increases. When the fineness of the iron tailings powder is 200, the compressive strength of the iron tailings alkali slag foamed concrete with an apparent density of 700 g/cm^3 after 28 days of curing can reach 2.60 MPa.

As the fineness of iron tailings powder increases, its specific surface energy increases, which is more conducive to the dispersion of iron tailings powder into the matrix. This makes the interface between the iron tailings powder and the matrix tighter and the structure more compact, which ultimately affects the alkali The strength of slag foamed concrete is increased.

3.3. Influence of Iron Tailings Powder on the Shrinkage Performance of Foam Concrete

It can be seen from Figure 3 that when the amount of iron tailings powder is fixed, the shrinkage rate of foamed concrete gradually increases. During the 7-d age period, the growth rate of the shrinkage rate is greater than that of other ages; the amount of iron tailing powder is increased by When 0% increased to 30%, the shrinkage rate at the same time decreased with the increase of the content, but when the content of iron tailings powder increased to 40%, the shrinkage rate increased instead.

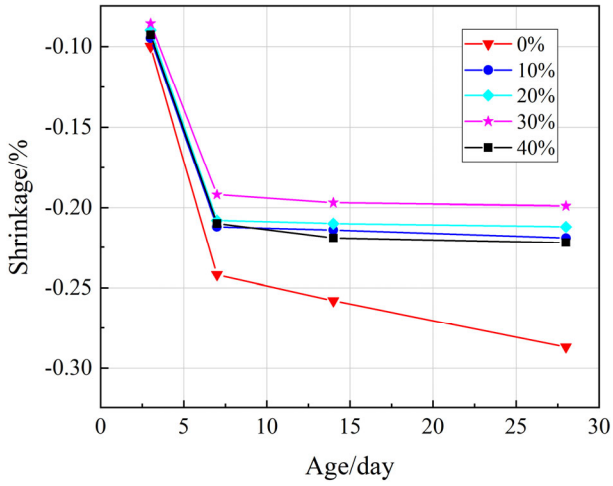

Figure 3. Relationship between mineral powder content and shrinkage

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4. Conclusions

A. When the content of iron tailings powder increases from 10% to 30%, the compressive strength of the alkali slag foamed concrete gradually increases; when the content of iron tailings increases from 30% to 50%, the alkali slag foamed concrete The compressive strength gradually decreases, and the strength loss is more obvious.

B. As the fineness of iron tailings increases, the strength of alkali slag foamed concrete gradually increases.

C. The incorporation of iron tailings powder has a positive effect on the shrinkage rate of foam concrete. When the mixing amount is 10%~30%, the change in the same age is small, but when the mixing amount reaches 40%, the shrinkage rate increases significantly, 28d The shrinkage rate can reach -0.27%, and the volume shape changes significantly, which has a negative impact on the work performance.

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