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APPLICATION OF METALLURGICAL STEEL SLAG IN FOAMED CONCRETE

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In this paper, in order to improve the utilization of metallurgical steel slag, the strength and water resistance of magnesium sulfide cement foam concrete with metallurgical steel slag as admixture were studied. The hydration products were characterized by scanning electron microscope (SEM). The results show that the structure of magnesium sulfide cement foamed concrete is more compact, the strength is not lost, the water resistance is improved to a certain extent, and the cracking of foamed concrete is inhibited to a certain extent by the appropriate amount of metallurgical steel slag.

Keywords: steel slag; magnesium oxysulfate cement; compressive strength; water resistance; thermal conductivity

INTRODUCTION

Metallurgical steel slag is a solid slag body which is composed of slag making materials, smelting reactants, eroded furnace body and replenishing furnace materials, impurities brought in by metal charge and slag making materials specially added to adjust the properties of steel slag in the process of iron and steel production [1]. It is a solid waste of metallurgical industry. Annual emissions are very large, a lot of steel slag dumping not only occupies a lot of land, but also seriously pollutes the ecological environment, and also causes a great waste of resources, so the comprehensive utilization of steel slag is imperative[2].

Therefore, this study uses metallurgical steel slag as admixture to study the influence of different dosage of metallurgical steel slag on the strength and water resistance of magnesium sulfide cement foamed concrete.

EXPERIMENT ANALYSIS

Effect of metallurgical steel slag on compressive strength of magnesium sulfide cement foamed concrete

In this experiment, the basic ratio of magnesium sulfide cement foamed concrete is: $MgO/MgSO_4$ molar ratio 9:1, $MgSO_4$ solution concentration 30°Be, foam content 1 200 ml (body density 400 kg/m^3), water reducing agent content 0,4 %, fiber content 0,4 %. On this basis, metallurgical steel slag was added into foamed concrete with 5 % - 45 % of the mass of light fired magnesium powder. The experimental results are shown in Table 1.

The influence of metallurgical steel slag on the compressive strength of foamed concrete is shown in Figure 1.

Table 1 **Experimental data of magnesium oxysulfate cement foam concrete**

No.	Dry volume density / kg·m^{-3}	Metallurgical steel slag / %	7d / MPa	28d / MPa
1	400,2	0	1,12	2,10
2	401,5	5	1,04	2,09
3	403,9	10	0,93	2,10
4	402,6	15	0,89	2,01
5	403,4	20	0,84	1,91
6	401,1	25	0,74	1,82
7	402,6	30	0,68	1,71
8	403,8	35	0,61	1,68
9	400,5	40	0,55	1,58
10	403,9	45	0,52	1,49

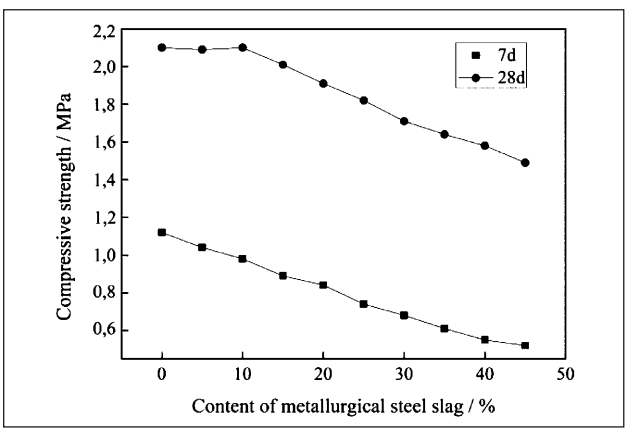

Figure 1 The impact of metallurgical steel slag on compressive strength

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From Figure 1 that the incorporation of metallurgical steel slag has a great influence on the early strength of foamed concrete, and the compressive strength declines rapidly with the increase of the content of metallurgical steel slag. When the content of metallurgical slag is 10 %, the 28 days compressive strength reaches 2,08 MPa, which is basically unchanged compared with the test block without metallurgical slag of 2,10 MPa. According to the experimental data, 7 days strength decreased significantly, the reason is that with the increase of dosage of metallurgical slag, the sulfur oxide magnesium cement hydration affects $5Mg(OH)_2 \cdot \cdot MgSO_4 \cdot 7H_2O$(5·1·7), Mg^{2+} and OH^- adsorption in metallurgical steel slag particles surface structure is loose, decreases in the concentration of Mg^{2+} and SO_4^{2-} content less 5·1·7 and metallurgical steel slag mixed with too much liquidity on pulp after making the stability of foam. Metallurgical steel slag mixed with a small amount of compressive strength of 28 days of foam concrete block[3], this is because the right amount of metallurgical slag increases the bubble pore uniformity, metallurgical steel slag in the $Mg(OH)_2$, alkaline and sulfate under the environment of the hydration reaction and reaction to generate silicate gel filling in the middle of the sulfur oxide magnesium hydration products[4], make the structure more compact, strength loss.

Effect of metallurgical steel slag on water resistance of magnesium sulfide cement foam concrete

From Figure 2, when the content of metallurgical steel slag is less than 15 %, the softening coefficient increases significantly, and when the content is 15 %, the softening coefficient reaches 0,93 at most. After 15 %, the softening coefficient begins to decline. Combined with SEM Figure 3 shows that metallurgical steel slag particles spherical, sulfur oxide magnesium cement hydration products 5·1·7 phase adsorption in metallurgical steel slag particles surface, structure is more compact, reduced the degree of accumulation, the water seeping into sulfur magnesium cement hydration products will dissolve oxygen, and metallurgical steel slag

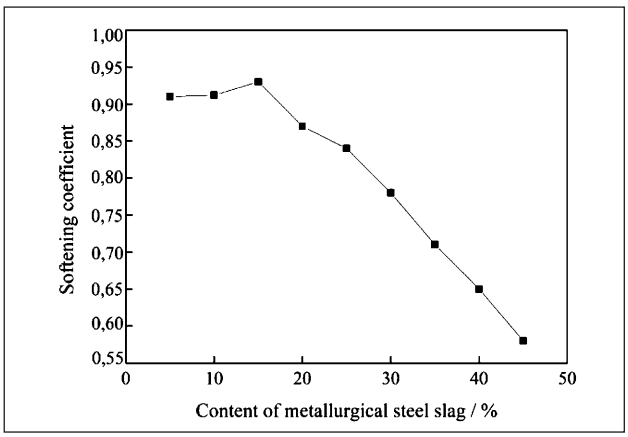

Figure 2 The impact of metallurgical steel slag on softening coefficient

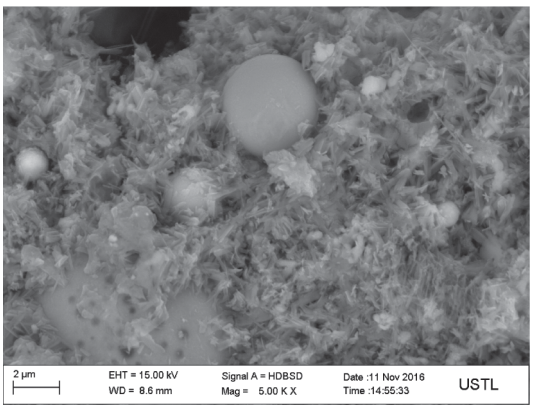

Figure 3 The SEM of magnesium oxysulfate foamed cement with metallurgical steel slag

after joining filling between the needle, crystal plate, make the structure more compact, and metallurgical steel slag added to generate a small amount of magnesium silicate gel filled in the gaps, from two aspects of the damaged cement wool stoma of continuity, so adding metallurgical steel slag after sulfur oxide magnesium cement foam concrete can improve the water resistance to some extent[5]. Appropriate incorporation of metallurgical steel slag plays a dispersal role, reducing the hydration heat of foamed concrete plays a certain inhibitory role on concrete cracking, and the water resistance is also improved to a certain extent.

Effect of metallurgical steel slag on thermal conductivity and water absorption of magnesium sulfide cement foam concrete

From Figure 4 that the thermal conductivity of magnesium sulfide cement foamed concrete begins to decrease with the increase of the content of metallurgical steel slag, indicating that the thermal conductivity of magnesium sulfide cement foamed concrete can be reduced with the help of metallurgical steel slag. The reason is that the addition of metallurgical steel slag makes the uniformity of foamed concrete improve and the aperture become smaller, and the metallurgical steel slag can fill in the capillary voids to improve the integrity of the bubble wall, and the metallurgical steel slag alleviates the microcosmic and macroscopic cracks of foamed concrete. With the increase of the content of metallurgical steel slag, the water absorption rate of magnesium sulfide cement foam concrete decreases first and then increases. This is because a small amount of metallurgical steel slag is added to fill the micropores on the bubble wall, making the bubble holes more compact and even, and improving the bubble structure, leading to a decrease in water absorption rate. As the content of metallurgical steel slag continues to increase, the relative content of cementite material is affected and the bubble structure is broken, leading to the increase of water absorption.

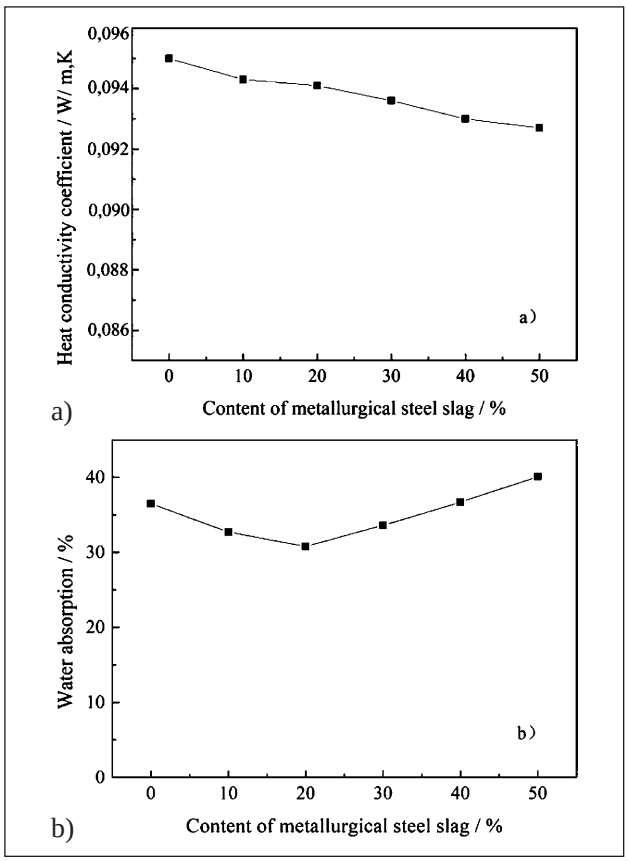

Figure 4 The impact of metallurgical steel slag on thermal conductivity and water absorption: a) thermal conductivity; b) water absorption

CONCLUSIONS

The compressive strength of magnesium sulfide cement foamed concrete basically remains unchanged for 28 days with the content of metallurgical steel slag in the range of 0 - 10 %. When the content of metallurgical steel slag is 0 – 15 %, the softening coefficient of magnesium sulfide cement foamed concrete shows an upward trend, and the softening coefficient begins to decline after exceeding 15 %. The thermal conductivity of magnesium sulfide cement foamed concrete tends to decrease with the increase of the content of metallurgical steel slag, and the water absorption tends to decrease first and then increase with the addition of metallurgical steel slag.

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Note: The responsible translator for English language is L. F. Zhang, Anshan, China