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STUDY ON THE EFFECT OF METALLURGICAL WASTE ON THE CRACKING RESISTANCE OF MAGNESIUM OXYSULFATE CEMENT COATINGS

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Preliminary Note – Prethodno priopćenje

In this paper, in order to achieve the resource utilization of metallurgical industry waste, the cracking resistance of magnesium oxysulfate cement coatings using granulated blast furnace slag powder and iron tailings powder as fillers was studied, x-ray Diffraction (XRD) and scanning electron microscope (SEM) were used to characterize the hydration products. The results show that an appropriate amount of slag powder and iron tailings powder can make the internal structure of the coating more compact, the surface smooth and effectively reduce the generation of cracks.

Keywords: granulated blast furnace slag; $MgO/MgSO_4$ cement; coatings; x-ray research; cracks

INTRODUCTION

Granulated blast furnace slag and iron tailing powder are solid wastes generated by metallurgical industry. Stockpiling not only occupies a lot of land, but also brings huge pollution risks to air, soil and water resources, resulting in heavy environmental burden [1]. Under the background of "carbon peak and carbon neutrality", it is urgent to strengthen the comprehensive utilization of metallurgical slag. Therefore, this experiment uses magnesium oxysulfate cement as the substrate, granulated blast furnace slag powder and iron tailings powder as fillers, and diatomaceous earth as functional material to study the effect of granulated blast furnace slag powder and iron tailings powder on the crack resistance of magnesium oxysulfate cement coatings.

EXPERIMENT ANALYSIS

Basic ratio of coatings

The basic ratio of magnesium oxysulfate cement coating in this experiment is as follows: the molar ratio of $MgO/MgSO_4$ is 7:1, 9:1, and 11:1, and the concentration of $MgSO_4$ solution is 30 % Be. Based on this, the granulated blast furnace slag powder is added with 5 %, 10 %, 15 %, 20 % and 25 % of the mass of lightly burned magnesium oxide powder. Iron tailings powder is used as the filler, and 20 % of the mass of lightly burned magnesium oxide powder is added[2].The experimental plan and results are shown in Table1, Figure 1.

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Table 1 **Different proportions of magnesium and sulfur coating**

No.	Molar ratio	Slag powder /%	Iron tailings powder /%	28 d / MPa
A1	7:1	5	20	24,3
A2	7:1	10	20	29,8
A3	7:1	15	20	34,6
A4	7:1	20	20	38,5
A5	7:1	25	20	44,6
B1	9:1	5	20	23,8
B2	9:1	10	20	28,4
B3	9:1	15	20	32,5
B4	9:1	20	20	36,9
B5	9:1	25	20	34,6
C1	11:1	5	20	23,7
C2	11:1	10	20	27,0
C3	11:1	15	20	35,8
C4	11:1	20	20	33,3
C5	11:1	25	20	31,1

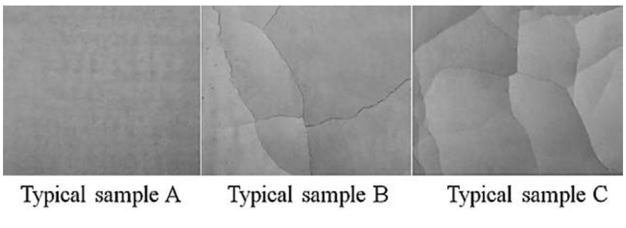

Figure 1 Surface state of coating

The experimental results show that the surface of Group A samples with a $MgO/MgSO_4$ molar ratio of 7:1 is relatively smooth and flat, with no cracks appearing, and the 28 days compressive strength reaches 44,6 MPa; The B group samples with a molar ratio of $MgO/MgSO_4$ of 9:1 showed longer cracks on the surface, but the number was relatively small, the 28 days compressive strength reaches 36,9 MPa; The C group samples with a molar ratio of $MgO/MgSO_4$ of 11:1 all exhibited a large number of cracks, with varying lengths of cracks alternating with each other, resulting in the lowest strength, the28 days compressive strength reaches 35,8 MPa. As the molar ratio of $MgO/MgSO_4$ increases, cracks gradually appear on the surface of the coating, and the number gradually increases, while the strength gradually decreases.

Effect of granulated blast furnace slag powder on coating cracking

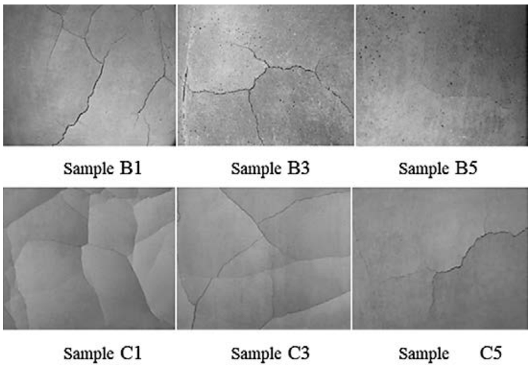

Figure 2 Surface state of coating

From Figure 2, it can be seen that when the amount of iron tailings powder is fixed and the molar ratio of $MgO/MgSO_4$ is 9:1 and 11:1, the cracking phenomenon on the coating surface is alleviated with the increase of granulated blast furnace slag powder. When the content of slag powder is 5 %, there are many surface cracks on the samples of Group B and Group C, and the cracking phenomenon is severe. As the content of slag powder increases from 5 % to 15 %, and then to 25 %, the crack length becomes shorter, the number gradually decreases, and the surface is smoother and smoother. The increase the content of granulated blast furnace slag powder can effectively reduce the generation of cracks.

XRD analysis of coatings

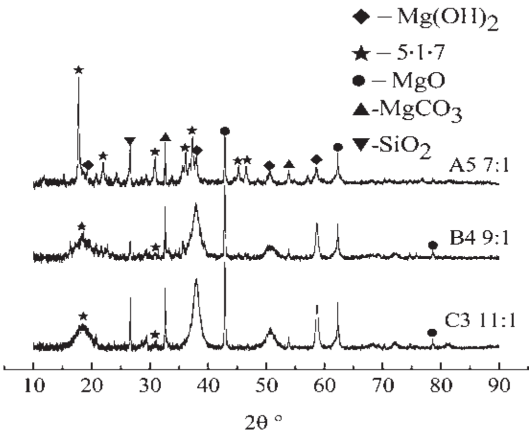

Figure 3 XRD of magnesium oxysulfate cement coating

From Figure 3, it can be seen that when the molar ratio of $MgO/MgSO_4$ is large and the amount of granulated blast furnace slag powder is fewer, due to the slow hydration reaction rate of slag[3], the generated hydration products are less and insufficient to completely wrap on the surface of a large number of MgO particles, leading to rapid hydration of MgO, generating a large amount of $Mg(OH)_2$ and volume expansion, resulting in a large number of cracks on the coating surface; As the amount of slag powder gradually increases, the number of hydration products generated by the hydration reaction increases, enveloping the surface of MgO particles, delaying the generation rate of $Mg(OH)_2$, allowing for slow release of internal stress, and alleviating the cracking phenomenon of the sample.

SEM Image Analysis of Coatings

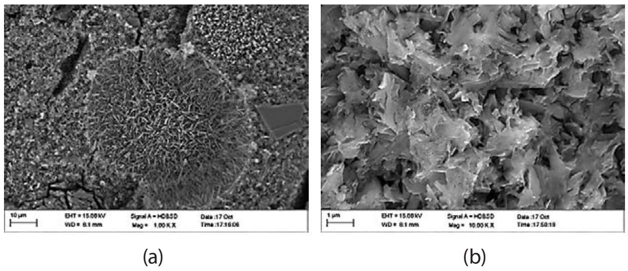

Figure 4 Microstructure of sample A5

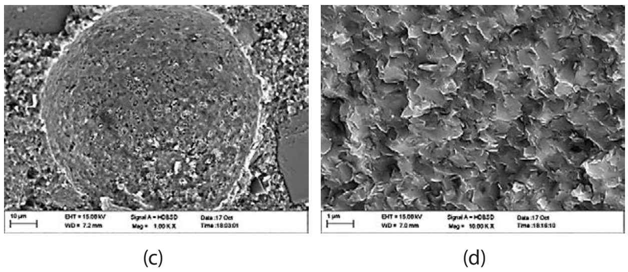

Figure 5 Microstructure of sample B4

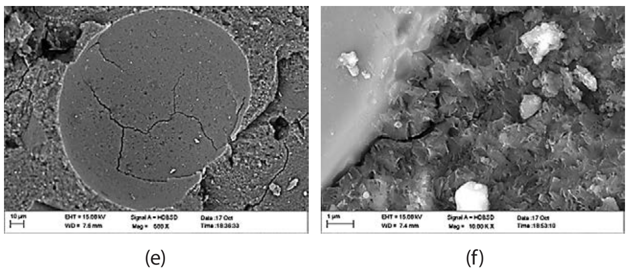

Figure 6 Microstructure of sample C3

It can be seen from Figure 4 that a large number of needle bar like $5Mg(OH)_2 \cdot MgSO_4 \cdot 7H_2O$(5•1•7for short) crystal phases are generated in the internal pores of the A5 coating sample with the molar ratio of $MgO/MgSO_4$ of 7:1, which cross each other to form a network structure. The gel generated by the hydration of slag powder and the iron tailing powder that does not undergo hydration reaction are filled together in the network structure pores[4], forming a compact stack, effectively inhibiting the expansion stress generated by the hydration of MgO, It prevents the cracking of the coating, resulting in higher strength. From Figures 5 and 6, it can be seen that when the molar ratio of $MgO/MgSO_4$ increases to 9:1 and 11:1, there are very few needle like 5•1•7 crystal phases inside the coating sample, but a large number of layered $Mg(OH)_2$ crystals are generated. This indicates that with the increase of MgO content, it rapidly hydrates to generate a large amount of $Mg(OH)_2$[5], and the generated expansion stress causes cracks inside and on the surface of the coating, leading to a decrease in strength.

CONCLUSIONS

When the molar ratio of $MgO/MgSO_4$ is 7:1, the surface of the magnesium oxysulfate cement coating is flat and smooth, without cracking; As the molar ratio of $MgO/MgSO_4$ increases to above 9:1, cracks appear on the surface of the coating and gradually intensify; When the molar ratio of $MgO/MgSO_4$ is fixed, with the increase of granulated blast furnace slag powder, the surface cracks of the coating gradually decrease, and the surface is smoother and smoother, indicating that granulated blast furnace slag powder can effectively reduce the generation of cracks.

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