가속 탄화 조건에서 ɣ-C_2S 첨가가 모르타르 함유 GGBFS의 특성에 미치는 영향

Effect of ɣ-C_2S Addition on the Properties of GGBFS Containing Mortar in Accelerated Carbonation Curing

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Abstract

γ-dicalcium silicate (γ-C_2S) is characterized by its strong carbonation reactivity and has the prospect to be utilized as a building material with the added benefit of CO_2 capture. This paper aims to point out the impact of γ-C_2S on the microstructure characteristics and mechanical properties of GGBFS paste, and mortar samples. The compressive strength of γ-C_2S added GGBFS cement mortar is higher compared to without γ-C_2S in accelerated carbonation (AC) up to 14 days of curing but once the curing duration is increased, there is no significant improvement in compressive strength. This study suggests that γ-C_2S can capture the atmospheric CO_2 (mostly generated from cement and metallurgy industries) and utilized in construction.

Keywords : ɣ-C_2S, GGBFS, accelerated carbonation curing, properties

1. Introduction

Since 2000s the treatment of CO_2 was deemed a crucial solution for supplementary cementitious materials. Thus, the urgent need to reducce the emissions of greenhouse gasses, an emphasis on the CO_2 curing[1)]. Numerous new eco-type γ-C_2S based cementitious systems were explored to reap the benefits of its high carbonation reactivity. Besides, GGBFS is also the key by-products of the steel sector that can substitute cement in concrete mixtures due to its possible hydraulicity. Hence, the effect of γ-C_2S on the compressive strength of GGBFS mortar cured in natural as well as accelerated carbonation is investigated in this study.

2. Materials and methods

2.1 Materials

2.1.1 Mixture proportion

The content of standard sand used in this paper based upon ASTM C109/C109M.

Table 1.Mixture proportion of mortar and paste (wt. %)

Samples	W/B	Binder		
		OPC	ɣ-C_2S	GGBFS
G0	0.55	40%	0%	60%
G5		40%	5%	55%
G10		40%	10%	50%

2.1.2 Sample preparation

The cubic molds of 50x50x50 mm followed ASTM C109/C109M for mortar and paste specimens were pre-casted. Compressive strength, and SEM are applied to identify the properties of the samples.

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The condition curing including natural CO_2 curing and accelerated CO_2 curing (5% CO_2, H=60%).

3. Results and Discussion

3.1 Compressive Strength

The compressive strength of the mortar samples is shown in Figure 1 at different curing conditions and durations. It can be seen from this Figure that the NC mortar samples exhibited lower in compressive strength compared to AC in all curing duration. In NC, there is no effect of carbonation rather than hydration. In this case, the mechanically properties are controlled by the hydration reaction because the CO_2 content is negligible. Moreover, once the 5% γ-C_2S (G5) was added in the mortar, the compressive strength increased with curing duration in NC and AC condition. However, it is decreased in 10% γ-C_2S (G10) compared to G0 in NC at 14d and 28d as well as G5 in NC and AC curing.

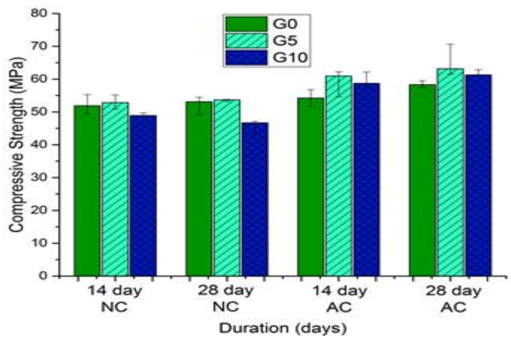

Figure 1. Compressive Strength values of all samples

3.2 SEM

The size of unreacted GGBFS in G0 (Figure 5a) is different. However, once the 5 and 10% γ-C_2S is added, the number of pores is decreased significantly. The porosity is calculated by ImageJ software and it is found to be 4.24, 0.83, and 1.76% for G0, G5 and G10, respectively. Once the amount of γ-C_2S is increased from 5 to 10%, the unreacted γ-C_2S leads to retain higher porosity. The porosity is significantly reduced in G5 samples owing to the reaction of γ-C_2S with CO_2 and leads to form the $CaCO_3$ which fill the porosity.

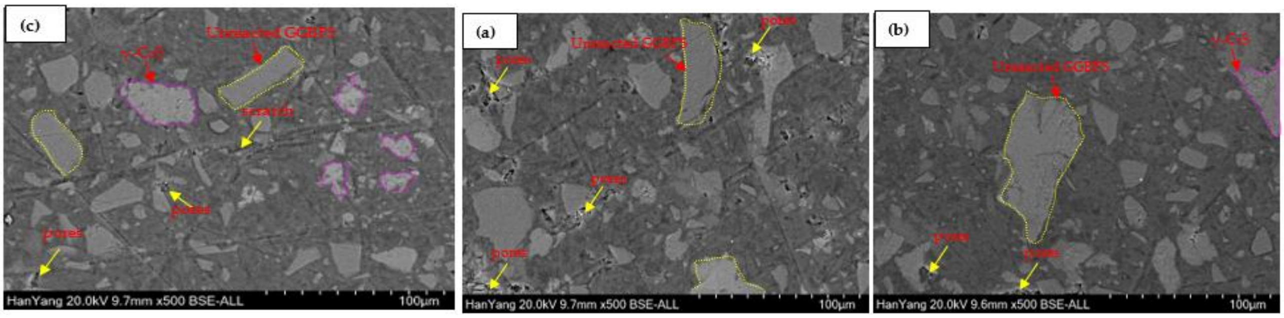

Figure 2. BSE SEM images of (a) G0, (b) G5 and, (c) G10 paste samples after 28 d of NC curing

4. Conclusion

Inspite of a relatively low hydraulic properties of γ-C_2S and high CO_2 uptake, it is expected to utilize CO_2 in the advanced construction material. The mortar sample cured in AC condition with γ-C_2S exhibited higher compressive strength compared to NC attributed that γ-C_2S react with CO_2 and form $CaCO_3$ which fill the pores of mortar matrix. SEM results show that 5% addition of γ-C_2S fill out the pore of paste matrix in AC condition and mót ò the γ-C_2S reacted and form $CaCO_3$. However, the unreacted GGBFS and γ-C_2S are seen in NC and AC conditions after 28 days of curing by SEM.

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References

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