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Thermally Activated Fly Ash Cement System with Different FA Contents

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Abstract

In this study, the effects of thermal activation on the compressive strength and water absorption of fly ash-cement systems were studied. The results show that the increase in curing temperature improves the early-age compressive strength and reduces its water absorption.

키 워 드 : 플라이 애쉬, 시멘트 페이스트, 열화성
Keywords : fly ash, cement paste, thermally activated

1. Introduction

A large amount of CO_2 is emitted during the cement production process, which greatly promotes the greenhouse effect. In order to alleviate this problem and maintain sustainable development, in recent decades, people have used fly ash as a supplementary cementitious material to replace the cement in concrete or mortar as much as possible. This is because of its pozzolanic activity and other social and economic benefits. However, due to the slow pozzolanic reaction of fly ash at room temperature, the addition of fly ash will reduce the early compressive strength, which has become one of the difficulties are facing today. Studies have shown that the pozzolanic reaction is directly related to the curing temperature, and the use of a higher curing temperature can accelerate its reaction. Therefore, in this study, the compressive strength and water absorption performance were studied under different curing temperatures.[1)]

2. Experimental methodology

The binary binders were prepared by blending OPC with FA at 8:2 and 6:4 by mass. The water to binder ratio (w/b) was fixed at 0.5 for all mixtures. The samples were sealed and cured at different curing temperatures (25℃, 35℃) until designated ages. The mix proportions of pastes are shown in Table 1.

Table 1. mix proportion of paste (wt%)

Sort of admixture	W/B (%)	Water (%)	OPC (%)	Fly Ash (%)
FA20	50	50	80	20
FA40	50	50	60	40

3. Results and Discussion

The Figure 1 shows the compressive strength of FA20 and FA40 at 1, 3, 7, 28 days at two different temperatures. On the first day, the strength of FA20 and FA40 increased by 1.9 and 1.6 times respectively with the increase of the curing temperature. It may be caused by the increase in temperature which accelerated the initial hydration rate. At 3,7,28 days, with the curing temperature increases, the compressive strength also increases to different

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degrees. This shows that the increase in temperature accelerates the hydration process of cement and the pozzolanic reaction of fly ash leads to the increase of CSH gel and improves the early compressive strength. However, it can be seen from the figure that as the number of curing time increases, during high temperature curing, the increase in strength may be limited at a later age. It can be seen from the figure that whether it is FA20 or FA40, the increase in temperature reduces the water absorption of the paste at 28d. Table 2. shows the calculated water absorption coefficient, where $\beta 1$ and $\beta 2$ represent the slope of the water absorption curve in the first (between 0 and 147s $^{1/2}$) and second (between 147s $^{1/2}$ and 838 s $^{1/2}$) stages, respectively. When the curing temperature is 20 degrees, the water absorption coefficients of FA20 and FA40 in the first stage are 9.6 $mg/mm^2*s^{1/2}$ and 17 $mg/mm^2*s^{1/2}$, which are respectively 29% and 117% higher than the water absorption coefficients under 35℃ of curing. This shows that increasing the curing temperature makes the microstructure denser and increases the density, thereby providing greater resistance to water absorption through capillary suction.

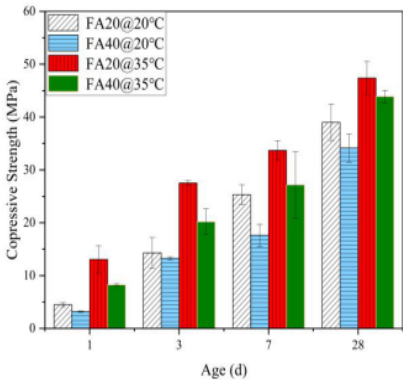

Figure 1. Compressive strength according to age

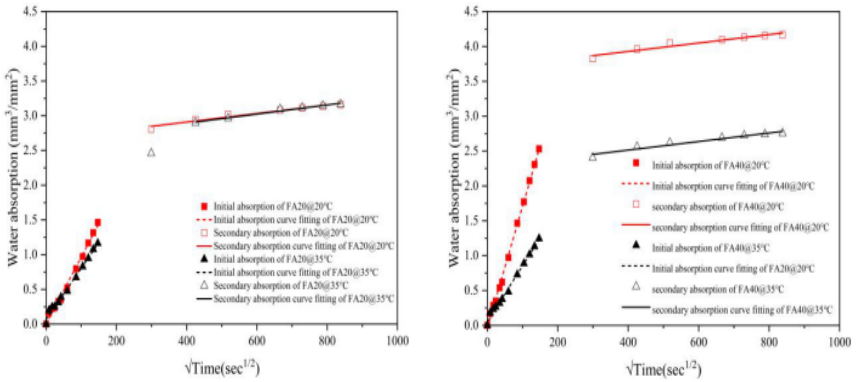

Figure 2. Cumulative water absorption of the pastes cured after 28d for (a) FA20 and (b) FA40

Table 2. Regressed results of water absorption coefficients for fly ash cement paste

Samples	20℃			35℃		
	β1	β1	R2	β1	β1	R2
FA20	9.6	6.2	0.99	7.3	6.5	0.99
FA40	17	6	0.99	8	6.1	0.99

4. Conclusion

Increasing the temperature improved the early-age compressive strength of the system, but the growth rate shows a downward trend with the curing time. In the meanwhile, thermal activation densified microstructure of the fly ash cement paste, thereby reducing the water absorption.

Acknowledgement

This research was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (No. 2015R1A5A1037548).

References

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