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EFFECT OF MIXING TIME ON HEAT EVOLUTION PATTERN OF CEMENT PASTES

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ABSTRACT

This study reports the effect of mixing time on the heat evolution pattern of Portland cement/silica fume/superplasticizer (Aalborg cement). An isothermal conduction calorimeter was used to evaluate the rate of heat evolution and total heat hydration for a period of 72 hours at 20.0°C with a water/solid ratio of 0.25. The mixing period varied from 2 minutes to 30 minutes. The results are compared with Portland cement (PC) and Portland cement/ superplasticizer (PCS)

INTRODUCTION

Silica fume is a byproduct from the reduction of high purity quartz with coal in an electric arc furnace. The fume consists of very fine spherical particles. It is reported that the strength of Portland cement/silica fume/superplasticizer depends on the nature of mixing (Ref.3). This study reports the effect of mixing time on the rate of heat evolution and total heat of hydration.

MATERIALS

Aalborg Portland (Densit) Composition was Portland cement (70%)/silica fume (30%)/Irgament Mighty (superplasticizer) (as noted in experimental) from Aalborg Portland, Denmark.

Ordinary Portland Cement Composition was C_3S: 62.98; C_2S: 11.69; C_3A: 9.91; C_4AF: 8.40; surface area 3.50 m^2Kg^{-1} Superplasticer used was Irgament Mighty 150 (a sodium salt of naphthalene sulphonated formaldehyde condensate (powder form).

EXPERIMENTAL

The details of the mixes are as follows: a). OPC 100g, w/s = 0.25; b).Densit 100g, w/s = 0.25; c). OPC + superplasticizer (100g OPC + 4g superplasticizer) w/s = 0.25.

Appropriate amounts of solid and water were mixed over a period of 2 minutes. Other mixes were prepared over different periods of time using a Gallenkamp handilab stirrer. Thirty g. of sample in a polythene bag (sealed) were placed

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in the calorimeter at 20^{o}C. The calorimeter used was a modified version of that described by Forrester (Ref.4) developed by Wexham Developments Ltd. (Ref.5) Details of the operation of this unit are to be found in Refs. 4 and 6. The cement paste was hydrated for 72 hours.

RESULTS and DISCUSSION

Typical results plotted as heat evolution against time are shown in Figure I. An hydrating cement gives two hydrating exothermic process seperated by a dormant period (Ref. 4,6,7,8). An initial fast hydrating process follows upon mixing the cement with water, producing an exothermic peak due to the heat of wetting, the hydration of free lime, and the early formation of ettringite. The dormant or induction time then occurs followed by an increase in the rate of heat evolution due to the slower hydration of alite and further ettringite formation. Figure I shows the rate of heat evolution for PC and PCS. In this and other plots the second hydration process is recorded. The rate of heat evolution is decreased by addition of superplasticizer, whilst the mechanical mixing causes an advance in the position of the hydration peak with increased time of mixing. These results can be attributed to better mixing. The results show that addition of silica fume and superplasticizer to the PC reduces the rate of heat evolution, increases the induction period and there is retardation in the position of the second peak, compared to PC. As the period of mechanical mixing is increased the induction period decreases, the position of the second peak advances and the rate of heat evolution is not significantly altered. It must be further reported that a low heat of hydration is produced with PCS and Densit at 72 hours compared with PC. As the mixing period is increased then the total heat of hydration increases at an early age due to the mechanical mixing.

CONCLUSION

It is concluded that the effect of mixing is to decrease the induction period, advance the 2nd peak, increase the rate of heat evolution and decrease the total heat of hydration (except for PCS which was hand mixed). The addition of silica fume and superplasticizer decreases the rate of heat evolution, decreases the total heat of hydration, increases the induction period and retards the 2nd peak. The mixing periods in this system do not significantly influence the rate of heat evolution. The increase of mixing time in the Densit system does however decrease the induction period and advance the 2nd peak. The significance of these results is that they show that mechanical mixing can influence the rate of heat evolution and the total heat of hydration and this will consequently also affect setting times and

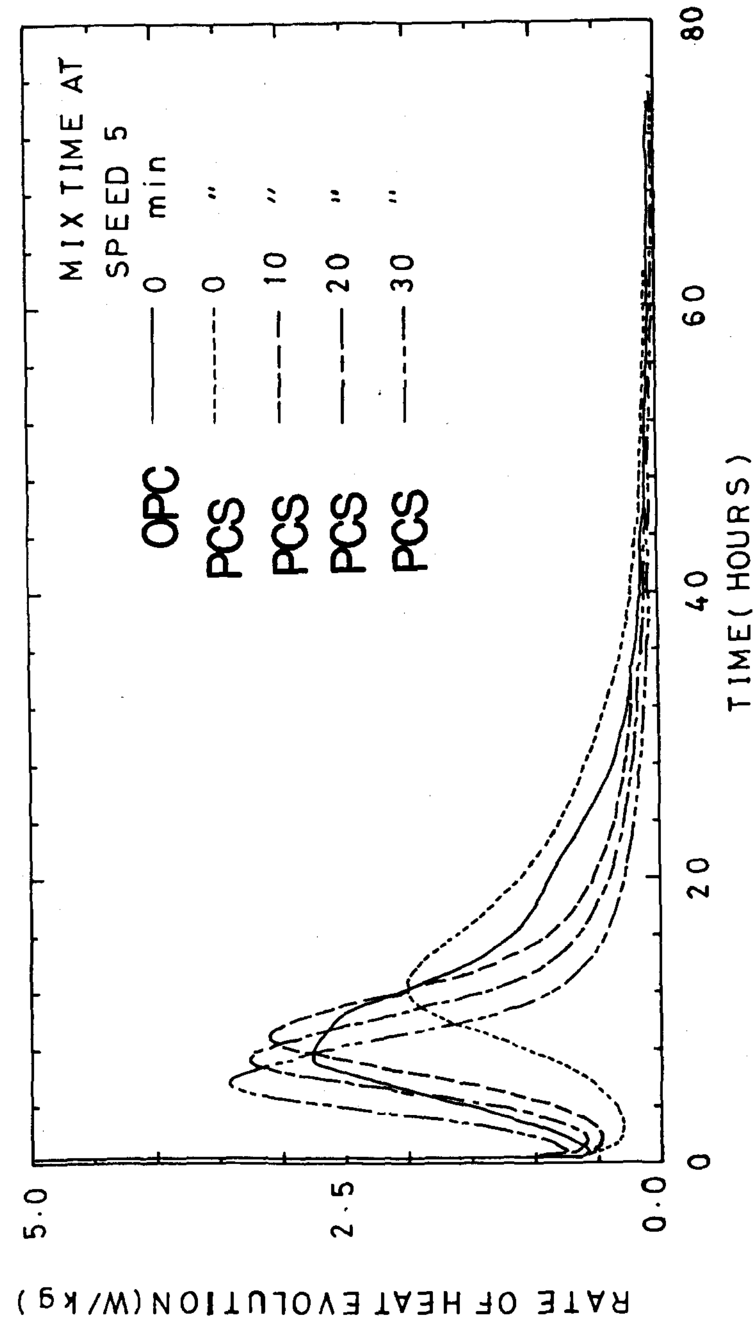

Figure I. Rate of Heat Evolution Against Time for PC and PCS.

the strength development in these systems.

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