



Hydration and microstructure of cement-based materials under microwave curing



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HIGHLIGHTS

- Microwave curing improves the early strength when compared to steam curing.
- Microwave curing reduces the pores in the range of >100 nm.
- Microwave curing forms short-rod AFt and diminishes the particle size of CH.
- Microwave curing increases the absorption of S, Mg and K by C-S-H gel.

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ABSTRACT

By reducing the curing time, microwave curing can enhance the productivity, save the capital and decrease the plant areas for precast concrete when compared with the steam curing. Based on the results of 6-h and 24-h compressive strength tests the optimum curing regime was selected. The sample microwave cured using the selected curing regime was then compared against samples cured using (a) normal curing (b) steam curing at 40 °C for 10 h and (c) steam curing at 80 °C for 4 h by performing the compressive strength, XRD, TG-DSC, SEM-EDS and MIP. The results indicate that, compared with the steam curing at 80 °C, microwave curing improves the compressive strength of mortar before the age of 28 days, increases the porosity of mortar slightly, while reduces the pores in the range of >100 nm greatly, forms short-rod AFt and smaller particle size of calcium hydroxide, and increases the adsorption of K, S and Mg by C-S-H gel.

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1. Introduction

There are many advantages when the curing period is reduced, such as productivity improvement, capital saving, and the reduction of workshop area, et al. Thermal curing technique has been used in the precast concrete for a long time. However, as a poor heat conductor, it takes >10 h to complete one curing cycle before demoulding [1]. In addition, concrete strength after 28 days is lower than that under standard curing because the fast early hydration of cement under such a high temperature, which results in the formation of large amounts of very fine C-S-H gel surrounding the unhydrates, and hence causing hindrance of diffusion and further development of strength [2].

High-frequency electromagnetic heating, such as microwave enhanced heating, is able to reduce such heterogeneity due to its

superior penetration depth. Microwave energy is attenuated by the vibration of polar molecules and dipoles and the resulting friction between the molecules generates heats rapidly throughout the concrete. Research by Watson [3] showed that 28-day compressive strength of microwave cured specimens displayed only half the strength compared to normally cured specimens. However, by optimizing the microwave curing parameters, strength can be improved effectively [4–6], making microwave curing a potential alternative method for accelerating cements hydration. Research by Xuequan et al. [2] found an increase in early strength under microwave curing, without any detrimental effect at later ages. Results of the permeability revealed that the specimens under microwave curing were denser than the reference specimens, inferring a reduction in porosity and the action of plastic shrinkage. Studied by Leung et al. showed that type III Portland cement concrete with microwave curing can develop early-age strength (at 4.5 h) and later-age strength (7 day) that compare very favorably with commercially available rapid hardening concrete as

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