



## Experimental Studies of Controlling Thermal Cracks in Mass Concrete Foundation by Circulating Water

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### Abstract

This paper summarizes an engineering experience of solving the problem of thermal cracking in mass concrete by using a large project, Zhongguancun No.1 (Beijing, China), as an example. A new method is presented for controlling temperature cracks in the mass concrete of a foundation. The method involves controlled cycles of water circulating between the surface of mass concrete foundation and the atmospheric environment. The temperature gradient between the surface and the core of the mass concrete is controlled at a relatively stable state. Water collected from the well-points used for dewatering and from rainfall is used as the source for circulating water. Mass concrete of a foundation slab is experimentally investigated through field temperature monitoring. The temperature field of the mass concrete during the entire process of heat of hydration are analyzed in detail. The proposed method provides an alternative practical basis for preventing thermal cracks in mass concrete.

**Keywords:** circulating water; mass concrete; temperature field; temperature monitoring.

### 1 Introduction

With the continuous development of high-rise buildings, the height of buildings is constantly increasing, thus posing increasing challenges to the foundation of buildings. Generally, a deeper foundation can provide a better safety factor for the whole building [1]. Thus, in the future, the depth of the building foundation can be predicted to increase. However, increased foundation depth can cause several problems. One such problem is associated with the construction of mass concrete, which is receiving growing research interest [2–6]. In particular, heat of hydration is a major problem of mass concrete. When the internal temperature of concrete exceeds a certain limit, it will produce large thermal stress, which will lead to internal premature cracks in concrete [7–9]. Such cracks are known as thermal cracks in construction. The main principle of controlling the thermal cracks in a construction is

either to reduce the production of heat of hydration or to dissipate the heat so as not to accumulate it inside concrete.

At present, the three main methods for controlling construction temperature cracks include:

(i) installing a pre-buried cooling water pipe, (ii) covering with a thermal insulation material, and (iii) adding a new material (PCM- Phase Change Material) in concrete. Seo et al. [10] developed a vertical pipe cooling method and tested it in a wall-type mass concrete specimen to validate the method. The experimental result showed that the temperature of the concrete specimen with the vertical pipe cooling system was 8–14 °C lower than that of the control specimen without the vertical pipe cooling system. Some construction measures [11,12] have adopted thermal insulation material to cover mass concrete in order to control thermal cracks in mass concrete. Some other studies [13–15] have investigated the use of phase change materials (PCM) to limit the rise in