Electric Curing of Conductive Concrete for Cold Weather

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Abstract

This paper presents electric curing of concrete as an effective thermal application method, facilitating the continuous construction of concrete structures during cold weather. Concrete specimens were cast and cured at -15°C for 48 hours, followed by air curing at 20°C. Voltage was applied to the specimens at an early stage to maintain their temperature above the freezing point for the initial 48 hours after mixing while stored at -15°C. The compressive strength of specimens was measured at a 7-day age. Results show that electric curing can linearly increase the temperature of conductive concrete. Additionally, it is demonstrated that a temperature controller can be used to maintain the concrete temperature at a desired level (target temperature) throughout the curing period. The study concludes that electric curing effectively prevents frost damage in conductive concrete, even at temperatures as low as -15°C.

Keywords: Conductive concrete, frost damage, electric curing, cold weather concrete

1 Introduction

Concrete is cured by maintaining specific moisture and temperature conditions to develop the desired mechanical and durability properties [1]. One key factor in this process is the ambient conditions. The weather greatly affects the curing process; the preferred temperature is between 10°C to 30°C [2]. In addition, curing slows down and nearly stops when the temperature is below 0°C. Cold weather condition is defined when the average daily temperature for more than three consecutive days drops below 5°C, according to the American Concrete Institute (ACI) [3]. For cold regions, concrete curing requires extra caution since it is prone to frost damage. If water in the fresh concrete mixture freezes prior to the development of adequate strength, cracks form and lead to long-term mechanical and durability issues. Using cold-weather admixtures, external heating, or insulated blankets are common measures to prevent frost damage. It is also important to monitor the concrete at an early age to check for deformations or any signs of freezing [4]. One way to prevent frost damage to fresh concrete is to accelerate curing or maintain the temperature of concrete above 5°C through thermal applications until concrete achieves sufficient strength.

Electrical resistivity of concrete ranges between 10^5 (for wet concrete) to 10^{12} ohm-mm for dry concrete. This led to dry concrete to act as an insulator [5]. Innovations have led to the development of electrically conductive concrete (ECC) where conductive materials are added so a continuous current flow network is formed [6]. Some common applications of ECC include de-icing

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