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TechNote

Internal Curing Using Prewetted Fine Lightweight Aggregate—TechNote

Keywords: autogenous volume change; curing; drying shrinkage; early age; fine aggregate; hydration; internal curing; lightweight aggregate; shrinkage; shrinkage cracking.

Question

What conditions suggest the application of internally cured concrete? What are the expected benefits of internal curing using prewetted fine lightweight aggregate?

Answer

Suggested applications for internally cured concrete include high performance concrete with high cementitious materials content, concrete with low w/cm ratios and projects with constraints to conventional external curing methods. Expected benefits include improved hydration of cementitious materials, reduced shrinkage and cracking and increased durability.

Introduction

This TechNote describes the application of prewetted fine lightweight aggregate in internal curing. Discussions review conditions that suggest the use of internally cured concrete and the associated benefits concerning economy, sustainability, and resilience.

Discussion

Cement paste has substantial influence on the properties of fresh and hardened concrete. The high content of cementitious materials in modern concrete mixtures increases these influences. The hydration of cementitious materials and the resulting chemical bond between cementitious materials and water determines the quality of the cement paste and, hence, the quality of the concrete. As some of the mixing water lost to drying, the cement paste volume is reduced (Neville 1996; Freiesleben Hansen 2009), leading to drying shrinkage. The hydration process that results in the formation of hydration products such as calcium-silicate-hydrate (C-S-H) gel is associated with volume changes due to chemical reactions, known as chemical shrinkage (PCA EB001). In mixtures with low water-cementitious materials ratio (*w*/*cm*), self-desiccation can occur, reducing the internal relative humidity of the hydrating cementitious paste and increasing autogenous shrinkage stresses, which can contribute to cracking.

The *w*/*cm* is a significant parameter that influences the chemical, physical, and mechanical properties of concrete, including workability, volume change, strength, and durability. Early-age deficiencies in the cement paste and fresh concrete, such as unmitigated volume change and resulting cracking, are responsible for durability and permeability problems throughout the service life of hardened concrete. (PCA EB001; ACI PRC-231; ACI PRC-308; Schindler and McCullough 2002).

Internal curing using prewetted fine lightweight aggregate (ASTM C330/C330M) is an effective and reliable method to contribute to mitigation of early-age shrinkage and the thermal cracking of concrete (ACI PRC-213). Lightweight aggregates have absorption and desorption properties that enable the particles to store water in their pores and release the water after the concrete sets (Byard and Schindler 2010; Castro et al. 2011). While it is difficult to completely “saturate” the particles, their effectiveness for internal curing depends on their degree of saturation. Therefore, it is important to prewet the lightweight aggregate to its 72-hour absorption to provide adequate moisture for hydration of the cementitious materials throughout the body of the concrete. It is a practical method of curing when external curing is proven to be challenging, such as for vertical surfacesand condensed construction schedules, or when high cementitious material volume, low *w*/*cm* and thick sections prevent external curing effectively providing sufficient curing water to hydrate cementitious materials, prevent self-desiccation and mitigate autogenous shrinkage (ACI PRC-308-213; ASTM C1761/C1761M; Bentz 2000; ESCSI 2021).

Standard specifications (ACI PRC-308-213), analytical models (Bentz 2000) and spreadsheet tools (Barrett et al. 2015) are available for proportioning internally cured concrete mixtures. The absolute volume of fine lightweight aggregates in an internally cured mixture, varying between 8 and 12% of concrete volume for conventional mixtures, is a function of cementitious volume, required internal moisture, and absorption and desorption degrees of aggregates. (ACI PRC-308-213; ASTM C1761/C1761M; Bentz 2000; ESCSI 2021).