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Analysis on plastic shrinkage crack with improved bleeding and evaporation evaluation

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ABSTRACT

Plastic shrinkage crack is an early-stage plastic crack in concrete, arising from the rapid loss of moisture and subsequent tensile pressure in fresh concrete. These cracks not only negatively impact the exterior aesthetics but also pose a long-term threat to the concrete structure by letting harmful acid in. Despite the crucial importance of preventing plastic shrinkage cracks for maintenance purposes, there is a notable lack of comprehensive numerical research and preventative measures for controlling these cracks. This study is dedicated to a numerical analysis of bleeding and evaporation, two critical factors in plastic shrinkage crack formation. It proposes a quantification of the influence of various factors, including a representative concrete curing method specific to plastic shrinkage cracks, such as the use of a windscreen. To achieve this, bleeding was modelled using large consolidation theory, and the bleeding properties of concrete were determined by regression analysis on concrete mix variables. This included the derivation of normalized bleeding coefficients and the bleeding coefficient of a reference concrete mix. For evaluating evaporation, an approach incorporating the diminishing effect of the evaporation rate and a concentration-weighed characteristic velocity, derived from a wind profile analyzed using Computational Fluid Dynamics (CFD), was adopted. This method aims to provide a more accurate estimation of evaporation than existing ACI nomographs. Ultimately, the proposed quantification of each influencing factor on surface dry time is expected to be effectively applied for mitigating plastic shrinkage cracks on construction sites.

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