

PLASTIC SHRINKAGE IN CONCRETE STRUCTURES WITH BLENDED CEMENT VS ORDINARY PORTLAND CEMENT

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Plastic shrinkage cracking is a critical early-age problem in concrete structures that poses a direct threat to long-term durability, serviceability, and aesthetics. These cracks typically emerge within the first few hours after casting, as the surface moisture evaporates faster than it is replenished by bleeding. When restrained, this leads to tensile stresses that exceed the tensile strain capacity of the plastic concrete. The presence of such early-age cracks can result in increased permeability, accelerated corrosion of reinforcement, and compromised structural performance. Ordinary Portland Cement (OPC), due to its rapid hydration characteristics and relatively high bleeding rates, is known to be more susceptible to plastic shrinkage cracking. In contrast, Blended Hydraulic Cement (BHC), which contains supplementary cementitious materials (SCMs) such as fly ash and slag, is thought to enhance cohesion and reduce the rate of water loss, potentially offering better resistance against plastic shrinkage.

This study aims to evaluate and compare the plastic shrinkage behaviour of concrete produced using OPC and BHC, with a special focus on tensile strain capacity. The primary objective is to measure and analyse the development of tensile strains in the plastic stage of concrete using Digital Image Correlation (DIC), a non-contact optical technique capable of capturing full-field surface strain data with high precision. Concrete mixes of grade 30 were prepared using both OPC and BHC. For each mix design, mechanical tests including compressive strength and splitting tensile strength were conducted at 7 days and 28 days. A specially designed test apparatus was used to simulate restrained conditions in fresh concrete and to evaluate plastic shrinkage behaviour. DIC was employed to monitor and quantify strain development at 2, 3, and 4 hours after casting.

The results of the study indicate that concrete made with BHC exhibited a higher tensile strain capacity and demonstrated improved resistance to plastic shrinkage cracking compared to OPC. The difference in behaviour is attributed to the refined microstructure and reduced evaporation rates achieved using SCMs in BHC. The study further validates the reliability and effectiveness of DIC for early-age strain analysis, offering greater accuracy than traditional techniques. In addition, the comparative analysis revealed that while OPC mixes performed well in terms of early strength gain, they were consistently more prone to early cracking than BHC mixes under identical environmental conditions.

In conclusion, this research highlights the significance of cement type and strain monitoring technology in addressing the problem of plastic shrinkage in concrete structures. By adopting blended cements and modern strain measurement methods, the risk of early cracking can be mitigated, leading to more durable and sustainable construction practices. These findings have practical implications for material selection and construction planning, especially in environments prone to rapid moisture loss.

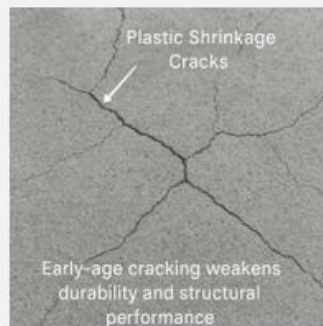
Keywords: Digital image correlation, Durability, Early-age cracking, Tensile strain capacity

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Plastic Shrinkage Behaviour and Tensile Strain Capacity of OPC and BHC Concrete

Problem Statement

Plastic shrinkage cracks are a common issue in concrete structures, compromising durability and structural integrity.

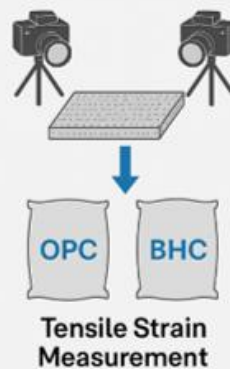


Objective

To evaluate and compare the plastic shrinkage behaviour of concrete produced using OPC and BHC, with a special focus on tensile strain capacity.

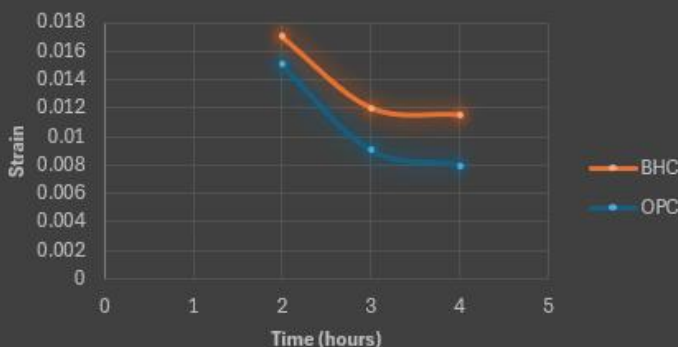
Methodology

Concrete specimens were tested for plastic shrinkage cracking using a digital image correlation (DIC) technique.

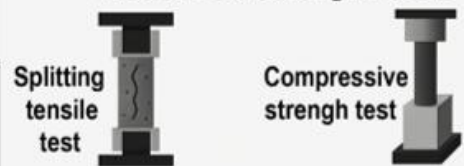


Results

Tensile strain capacity for OPC vs BHC



Mechanical Strength Tests



Conclusions

BHC concrete exhibited a higher tensile strain capacity and reduced plastic shrinkage cracking compared to OPC concrete.