INVESTIGATION OF DRYING SHRINKAGE BEHAVIOUR OF CONCRETE WITH COMPOSITE CEMENTS

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Understanding and investigating the drying shrinkage behaviour of concrete is of paramount importance for maintaining the overall performance and long-term durability of concrete structures. The occurrence of shrinkage-induced cracking can result in aesthetic concerns and functional limitations. Drying shrinkage is influenced by multiple factors, among them the type of cement plays a major role in governing the drying shrinkage behaviour. Therefore, investigating the drying shrinkage behaviour of concrete with a specific focus on composite cement becomes crucial. This study investigates the drying shrinkage behaviour of grade 30 concrete made out of two different cement types, Ordinary Portland Cement (OPC) and fly ash blended cement and checks the validity of the shrinkage model specified in Euro Code 2 (EC2) for local materials and conditions. To obtain the grade 30 mix proportions, a BRE mix design was carried out. Slump tests and compressive strength tests were done to check the suitability of the concrete mix. The required slump through the mix was 100 mm and the obtained slump value was also in the range of 100 ± 25 mm. From each cement type, 3 cubes were prepared and tested after 7 days and 28 days. The measured average 28 days compressive strength of OPC and fly ash blended cement contained concrete was 40.5 MPa and 47.2 MPa respectively. For the drying shrinkage test, moulds with 75 mm × 75 mm × 280 mm were used. After curing for 3 days and 7 days all the specimens were dried in normal room temperature and relative humidity conditions. A laser transducer was used to obtain the shrinkage values each day after letting them dry. Drying was continued up to about 45 days.

According to the obtained results, corresponding drying shrinkage in concrete with fly ash blended cement showed low values compared to that of concrete containing 100% OPC in both 3 days and 7 days of cured samples. In the first 15 days, it showed little difference between the two cement types, but when the days continued the difference became higher. Therefore, by incorporating fly ash blended cement in concrete mixes, low values for drying shrinkage can be obtained. When the effect of curing is considered, the 7 days of cured samples showed lower values for drying shrinkage than 3 days of cured samples, despite the type of cement used in concrete. When comparing the values obtained from the drying shrinkage equation in EC2 with experimental values, up to about 17 days equation values underestimated the drying shrinkage in concrete and after 17 days equation values tend to overestimate the drying shrinkage in concrete. Since the EC2 equation is not applicable under local scenarios, suitable modifications need to be done for the equations before using it.

Keywords: Drying Shrinkage, Composite Cement, Fly ash blended cement, Ordinary Portland Cement (OPC)

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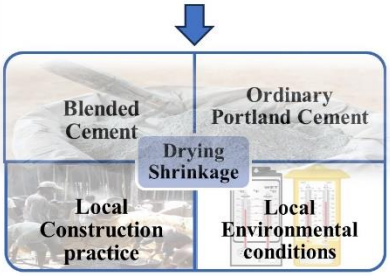
Investigating the Drying Shrinkage behavior of concrete with composite cement

Drying Shrinkage

Occurs due to the continuous loss of capillary moisture from hardened concrete to the surrounding environment.

Considerable volume reduction → Possibility of cracking → Crack control to achieve structural integrity and durability

This study investigates,



Experimental Works

PERPARATION OF MOULDS

Size: 75 mm ×75 mm × 280 mm

BRE MIX DESIGN

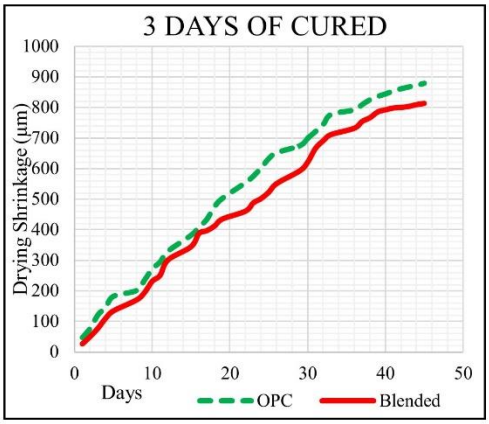
Grade 30 Concrete (For 0.02 m^3)	Cement (kg)	Fine aggregates (kg)	Coarse aggregates (kg) 10mm – 20mm	Water (kg)	Admixtures
	8.0	16.0	22.0	3.6	8 ml

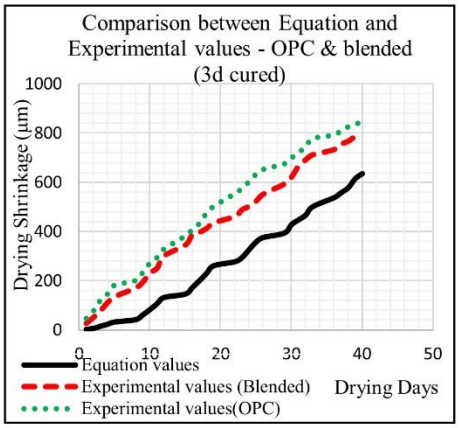
SLUMP TEST

COMPRESSIVE STRENGTH TEST

DRYING SHRINKAGE TEST

Results and Analysis





Conclusions

- Incorporating fly ash blended cement in concrete mixes reduces drying shrinkage compared to concrete made solely with Ordinary Portland Cement
- Drying shrinkage equations provided in Eurocode 2, are not suitable for accurately estimating drying shrinkage in the Sri Lankan context