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Experimental and Numerical Study of Plastic Shrinkage Cracking in Fiber Reinforced Concretes

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Abstract Plastic shrinkage cracking is a major concern in concrete structures specially where hot or windy conditions are experienced. In addition to being unsightly, these cracks can facilitate the ingress of water and aggressive agents leading to extensive deterioration by carbonation and reinforcement corrosion. Reinforcing of concrete with fibers has been known as an effective measure to reduce shrinkage cracking. Nowadays, the use of fibers is becoming increasingly common in the concrete industry; hence research is needed to better understand the plastic shrinkage behavior of fiber reinforced concretes.

In this thesis, the performance of different fibers including polypropylene, polyolefin, steel, and glass fibers in controlling plastic shrinkage cracking are investigated. In order to achieve this purpose, the present thesis is organized in two parts: experimental investigation and numerical modeling. In the first part, the effect of fibers on time of setting, bleeding, and plastic shrinkage of concrete are studied experimentally. The second part deals with modeling of drying process in plain and fiber reinforced concretes as the main cause of plastic shrinkage occurrence. Moreover, a parametric study is carried out to calculate the shrinkage strains.

Based on the experimental results, crack width and area are significantly reduced by fiber addition, and steel and glass fibers have the best performance among different fibers investigated. The results obtained from modeling indicate that the evaporation rate during first hours of drying and moisture diffusivities of fiber reinforced concretes are less than the values corresponding to plain concrete. Also, fibers do not considerably affect the pressure acting on solid skeleton, so the lower shrinkage strain of fiber reinforced concretes is probably due to their higher modulus of elasticity compared to plain concrete.