

Abstract

The aim of this research is to investigate expansion and shrinkage mechanisms of expansive concrete, which is used to prevent cracking of concrete structures due to shrinkage. The effects of amount of hyper expansive additive (HEA), fly ash content on properties of expansive concrete such as compressive strength in free and restrained condition, tensile strength and cracking strain were also studied. The results indicated that the expansion in both free and restrained conditions increased, while tensile and compressive strength under free and restrained conditions decreased with increase of the amount of expansive additive or fly ash. On the other hand, the amount of fly ash and expansive additive just slightly affected cracking strain.

This research also investigated the effects of normal expansive additive (EA) on compensation of shrinkage of ultra high strength fiber reinforced mortar (UHSFRM). The results show that 10% EA was able to produce net expansion for UHSFRM and maintain at that level after 14 days.

In addition, based on experimental data, this study proposed the method for prediction of net expansion under restraint which could be used to compute the compensating strain to prevent shrinkage cracking.

Furthermore, in this research, net expansion under 2D and 3D restraint were also tested. The results showed that the net expansion along main direction was not affected by restraint in other directions. This allows the application of the model obtained from the results of 1D restraint for prediction of the net expansion of 2D and 3D restraint such as in case of 2-way reinforced slabs and beams with stirrup, respectively.

Moreover, this research proposes a cracking age prediction method for restrained shrinkage cracking which is useful for obtaining mix proportion to prevent cracking. Parameters including restrained expansion, free shrinkage, tensile creep and cracking strain were taken into account in the calculation. The model was verified by test results of expansive concrete mixtures (with normal expansive additive (EA) and hyper expansive additive (HEA) as well as concrete mixtures with and without fly ash, with 3 levels of 1D restraint (22.04%, 31.35% and 52.15% restraining steel ratio). The results indicated that the model is qualitatively satisfactorily for both conventional concrete and expansive concrete. However, the predicted cracking ages were slightly shorter than the actual ages because of the ignorance of tensile creep in the calculation. Furthermore, despite the enhancement of early age net expansion of expansive concrete with fly ash, fly ash also increased subsequent shrinkage. Under testing conditions, it was noticed that expansive concrete with higher fly ash replacement cracked earlier.