ABSTRACT

This study is aimed to propose a model for predicting autogenous shrinkage of concrete with and without fly ash. Effects of chemical composition of cement and fly ash, fineness of cement and fly ash, water to binder ratio, curing temperature, and volume concentration of aggregate on autogenous shrinkage of concrete were experimentally investigated. A two-phase model proposed by Sudsangiam (1993) is adopted and modified in this study to create the autogenous shrinkage model. The micro models of free shrinkage of paste without restraint from aggregate, and stiffness of aggregate are needed to complete the shrinkage model. The free shrinkage model is simulated from the consideration of autogenous shrinkage mechanisms. A two-dimensional constitutive model, which was proposed by Deeesawangnade (1994) is improved for a more accurate computation of the aggregate phase stiffness of concrete. The more rational consideration of friction among aggregate particles, contact area of aggregates, and stiffness of binary mixture of aggregates are derived in this study.

The proposed model of free shrinkage was verified by comparing the autogenous shrinkage of paste obtained from experiments with those predicted values. From the test and analytical results, autogenous shrinkage increases with the decreasing of water to binder ratio, and the increasing of C_3A and C_3S content and fineness of cement. A large amount of autogenous shrinkage was observed in paste with high curing temperature, especially for early age. Fly ash was proved to reduce the autogenous shrinkage by its chemical composition. Verification tests on aggregate stiffness were performed by comparing the results from the back analysis stiffness from the two-phase material shrinkage model and analytical results from the proposed aggregate stiffness model. It was found from both the tests and the model that aggregate stiffness increases with the increasing of volume concentration of aggregate. The stiffness of coarse aggregate is larger than the stiffness of fine aggregate at the same volume concentration. The shrinkage of concrete was found to decrease when the stiffness of aggregate phase increases and also the volume concentration of total aggregates increases. As a result, the shrinkage will be small. The verification indicated that the model is effective for deriving the free shrinkage of paste and the stiffness of aggregate phase, and predicting the shrinkage of concrete as well.