ABSTRACT

Many reinforced concrete (RC) structures in inland environment deteriorate early due to carbonation-induced corrosion of their reinforcement. In some cases, the deterioration is visible within a few years of construction in the form of cover concrete cracking. This is widely accepted as one of the limit state indicators in defining the end of functional service life for existing RC structures undergoing corrosion. Many of the currently available service life prediction models are incapable of providing realistic service life estimates of RC structures beyond the corrosion initiation stage. Therefore, the need to incorporate the corrosion initiation and propagation stages in a comprehensive durability prediction approach has been receiving much research attention.

In this research, empirical models were developed for predicting carbonation rate and the amount of steel radius loss required to initiate a first visible crack in concretes exposed to Johannesburg environment. The experimental data for the models were obtained from investigations of carbonation-induced reinforcement corrosion, which were explored in three phases; (i) concrete early-age durability and strength characteristics (ii) carbonation rate of different concrete mixes exposed to the natural inland environment (iii) amount of steel radius loss required to initiate the first visible crack on the pre-carbonated cover concretes exposed to an unsheltered environment. The experimental variables for the early-age durability and strength tests were; water/binder ratio (w/b) and binder type; w/b, binder type, initial moist curing duration and exposure conditions are the experimental variables for the carbonation rate test. Cover depth, reinforcement diameter, binder type and w/b variables were considered for the corrosion cracking test.

The results showed that an improvement in concrete quality (binder type, w/b ratio and extending the initial moist curing duration) and increment in cover thickness improved the durability of the RC structures exposed to the natural inland environment. Based on the trends in the observed experimental results, models to predict carbonation rate and the amount of steel radius loss required to initiate cover cracking in concrete were developed. The proposed models' predictions are more closer to the measured values and compared well with the predictions of some previous models which indicate their respective predictive applications. They provide a general basis for durability analysis of RC structures in inland environment and can serve as basis for condition assessment of existing structures in the inland environment. Engineers can appreciate the consequences of design options on the service life of RC structures, while owners of RC structures can have information about how long their RC structures may last before any repair is envisaged.