Abstract

The alkali-carbonate reaction (ACR) in concrete is a combination of chemical reactions, which occur mainly at the phase boundary of dolomitic aggregates and binding paste. The appearance of new phases in concrete due to the progressing ACR affects the microstructure of the concrete, its mechanical properties and its durability, which spurred interest in thoroughly understanding the process and its long-term effects on concrete behavior. In this work, we studied the evolution of the phase composition and microstructure, the dynamics of secondary reaction product formation, their chemical composition and possible structure, and the effect on the mechanical properties of various dolomite-containing mortars with respect to the aggregate and binder types, and ageing conditions. Twelve types of mortar mixtures were prepared using ordinary Portland cement, blastfurnace cement or lime and two types of dolomitic aggregates. Raw materials and dolomite-containing mortars were characterised by X-ray diffraction in combination with Rietveld analysis, thermogravimetric analysis and scanning electron microscopy with X-ray microanalysis.

The results showed that the dedolomitisation degree depended on the alkaline environment of binder paste, the amount and mobility of the available hydroxide ions, and the characteristics of the initial dolomitic aggregates (calcium content, structure ordering, the presence of admixture phases). The interaction of dolomite with Al- and Si-containing components of the cement paste resulted in the formation of secondary reaction products such as the hydrotalcite-like phase and further Mg-Si-Al-containing clinochlore-like phase. The dedolomitisation process was found to promote the dissolution of Si and Ca from the slag, accelerating its hydration and leading to the formation of the multi-rim structure of hydration products. The processes of dissolution/reprecipitation of Ca/Mg and carbonate ions diffusion in lime-dolomite aggregate mortars resulted in the formation of secondary calcite, hydromagnesite or eitelite during ageing under various conditions. The formation of secondary reaction products during the ACR reduced the differences between the initially dense dolomite aggregates or slag grains and the less dense cement paste and densified the microstructure, thereby increasing the compressive and flexural strengths of the mortars.