HR-355 The Role of Magnesium in Concrete Deterioration

Key Words: Magnesium, PCC, Aggregate Durability, Alkali-Dolomite Reaction

ABSTRACT

Concretes with service lives of less than 15 years and those with lives greater than 40 years were studied with petrographic microscope, scanning electron microscope, and electron microprobe to determine why these two groups of concrete exhibit such different degrees of durability under highway conditions. Coarse aggregate used in both types of concrete were from dolomite rock, but investigation revealed that that dolomite aggregate in the two groups of concretes were much different in several respects. The poorly -performing aggregate is fine grained, has numerous euhedral and subhedral dolomite rhombohedra, and relatively high porosity. Aggregate from durable concrete is coarse- grained, tightly interlocked crystal fabric, anhedral dolomite boundaries, and low porosity. Aggregate in short service life concrete was found to have undergone pervasive chemical reactions with the cement which produced reaction rims on the boundaries of coarse aggregate particles and in the cement region adjacent to aggregate boundaries. Textural and porosity differences are believed to be chiefly responsible for different service lives of the two groups of concrete.

The basic reaction that has occurred in the short service life concretes is between coarse aggregate and cement is an alkali-dolomite reaction. In the reaction, dolomite from the aggregate reacts with hydroxide ions from the cement to free magnesium ions and carbonate ions, and the magnesium ions precipitate as brucite, $Mg(OH)_2$. Simultaneously with this reaction, a second reaction occurs in which product carbonate ions react with portlandite from the cement to form calcite and hydroxide ions. Crystal growth pressures of newly formed brucite and calcite together with other processes, e.g. hydration state changes of magnesium chloride hydrates, lead to expansion of the concretes with resultant rapid deterioration.

According to this model, magnesium from any source, either from reacting dolomite or from magnesium road deicers, has a major role in highway concrete deterioration. Consequently, magnesium deicers should be used with caution, and long -term testing of the effects of magnesium deicers on highway concrete should be implemented to determine their effects on durability.