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TechNote

Managing Alkali-Aggregate Reaction Expansion in Mass Concrete

Keywords: alkali-aggregate reaction; maintenance; mass concrete; repair.

Introduction

When the alkalis in cement react with susceptible aggregate particles, a reaction rim of alkali-silica or alkali-carbonate gel is formed around the aggregate. If this gel is exposed to moisture, it expands, causing an increase in volume of the concrete mass. This expansion will develop if the relative humidity (RH) in concrete is higher than 80 to 85% and temperature is 50 to 104°F (10 to 40°C). Alkali-aggregate reaction (AAR) in mass concrete sections typically results in extensive cracking with crack widths that can be much wider compared with cracking caused by other types of deterioration (Fig. 1). The crack width can range from 0.004 in. (0.1 mm) to as much as 0.4 in. (10 mm) in extreme cases. The severity of cracking appears to be a function of the rate of internal expansion, ambient environmental conditions, and the degree of restraint present in a given concrete section. Cracking in large mass concrete structures can be unsightly, although structural integrity may or may not be impaired. Expansion of the concrete can cause major operation and maintenance problems, such as inoperable gates in locks and dams and misalignment of hydropower generators in dams.

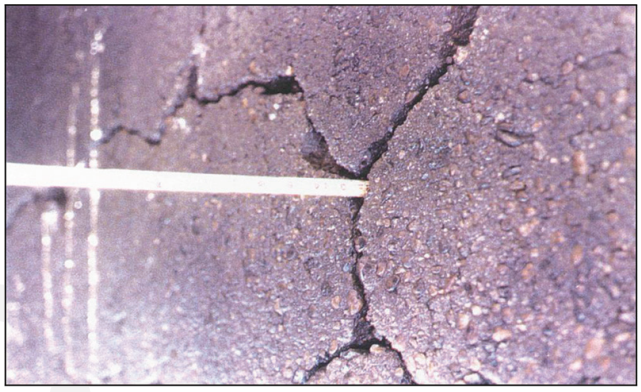

Fig. 1—Wide cracks in concrete as a result of AAR (width of the order of 1 in. [25 mm] in certain areas).

Fig. 2—Monitoring changes in crack width.

While the causes of AAR and maintenance issues may be applicable to other types of concrete structures, the discussion is often directed toward mass concrete structures. Mass concrete is the volume of concrete with dimensions large enough to require that measures be taken to cope with the generation of heat and temperature gradients from hydration of the cementitious materials and attendant volume change due to internal or external restraint.

Question

What are the maintenance and repair techniques for mass concrete structures damaged by AAR?

Answer

There is no universal approach to maintenance or repair of concrete structures affected by AAR, and problems usually are addressed on a case-by-case basis. Maintenance and repair ranges from monitoring the AAR-affected concrete (Fig. 2) to complete removal and replacement.