Development of a New Methodology Based on Conductivity Measurements to Detect the Presence of Deleterious Fine Particles in Concrete Aggregate

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ABSTRACT

Under the current Wisconsin Department of Transportation specifications, the presence of fine particles (passing the #200 sieve) in coarse and fine aggregates is limited to 1.5% and 3.5% of mass, respectively. The recent experience of technical personnel involved in field pavement operations and the latest investigations of the scientific community indicate that within some reasonable limit this is not an issue of the quantity of fine material but rather its mineralogical nature. Of special significance is the presence of certain types of clays that can alter water distribution in concrete and therefore induce changes in the aggregate-paste interface and in the hydration process. Based upon this observation, it seems that the p200 method cannot be used to distinguish between harmful or innocuous particles. At present, the California Cleanness Test (CCT) and the Methylene Blue Test (MBT) are considered to be more informative than the p200 in this regard.

However, these methods also have some significant disadvantages. The CCT cannot differentiate between large clay particles with macroscopic swelling and small non-clay particles with long sedimentation times. It should be noted that the cation exchange capacity (CEC) is a distinctive characteristic of clays, and it has been related to their potential harmfulness. While the MBT measures the CEC of the fines, the results of this test depend on operator objectivity. We have developed a new method to measure the CEC of fines, and this method also provides information on the nature of the exchangeable cations. This test is more precise than the MBT, and it does not require the separation of the fines from the aggregates. This is an important advantage, but more importantly it allows this method to be applicable to the characterization of fine aggregates.

This method is based on changes in ionic conductivity in solutions of different salts, induced upon adding a quantity of aggregates to a solution. The cations of these solutions exchange with the cations of the fines, and the magnitude of the ionic conductivity is determined by both the quantity and nature of the exchangeable cations. Equivalent conductivity, the concentration of the salts mixed with the aggregate,

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and the experimentally measured ionic conductivity of the liquid phase of the mixtures are all parameters contained in a set of equations in which the unknowns are the quantity and nature of exchangeable cations per unit mass of aggregate.

Key words: aggregate—cation exchange capacity (CEC)—clays—concrete—conductivity—deleterious—microfines