Mineral Characterization and Cataloging of Quarried Aggregate Sources Used in Michigan Highway Construction

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Problem Statement

The physical and chemical properties of quarried aggregates play an important role in determining their suitability for use in portland cement concrete (PCC). Mechanical strength, coefficient of thermal expansion, chemical reactivity, and soundness are a few of the hardened PCC properties significantly affected by the aggregate's attributes. The effect of aggregate properties on concrete durability has been, and continues to be, the topic of much research (1,2,3). Ultimately, to integrate knowledge about aggregate properties into modern construction practices, it is necessary that likely Michigan quarried aggregate sources be characterized and cataloged in a user accessible database for easy reference by engineers or technicians.

Background

An easy-to-access, graphically-based, database of commonly used aggregate sources would be an indispensable resource for use in establishing the concrete mix design for a given project. Further, this database would be of tremendous benefit to anybody involved in pavement planning, maintenance or durability research. Such a database should include information about aggregate mineralogy, grain size, porosity, pore geometry, and thermal-mechanical characteristics. In addition aggregates described in the database should be rated in terms of their reactivity in portland cement concrete. Specifically, knowledge of the susceptibility to alkali-carbonate reaction (ACR) as a result of de-icer usage is desired given the need for de-icing Michigan roads and bridges. In addition, susceptibility to alkali-silica reactivity (ASR) will also be investigated. Aggregate soundness can be qualitatively assessed by laboratory analysis and quantitatively assessed by laboratory tests such as the concrete prism test where different de-icers can be compared. Common de-icers used in Michigan result in exposure of the concrete to solutions of sodium chloride, magnesium chloride, calcium chloride, and calcium magnesium acetate (CMA).

Description of Work

It is proposed that the source characterization, establishment of the database, and investigation of aggregate soundness be performed in two phases. Phase I will characterize likely quarried sources in Michigan, Ohio, and Indiana and establish the database. This characterization will include analysis by petrographic microscopy, x-ray microscopy, scanning electron microscopy and x-ray microanalysis, as needed, and will measure mineralogy, grain size, porosity, pore geometry, and chemical composition. In addition to the computer database, the observed attributes will be compared to those same physical and chemical values measured in known reactive aggregates from other wet-freeze states. In Phase II, various tests will be performed to assess the potential susceptibility of suspected reactive aggregates. The potential ASR, ACR and deicer reactivity will be determined. The information gathered will be used to complete the database. The work outlined in this proposal constitutes Phase I.

In cooperation with MDOT, the principal quarried sources of aggregates used in Michigan will be identified. Sites will be selected based upon their potential use in Michigan concrete pavements and structures. MTU and MDOT will sample these sources as appropriate. For example, quarries and mine rock will be sampled from production stockpiles and separated into subgroups by differences in visual characteristics. The field samples will be further processed to obtain enough material for representative samples for laboratory examination.

References

(1) Cody, R.D., P.G. Spry, A.M. Cody, G.L. Gan (1994). The Role of Magnesium in Concrete Deterioration. *Final Report Iowa DOT Project HR-355*, Ames, Iowa, May 1994

(2) Mingshu, T.., D. Min, L. Xianghui, and H. Sufen, (1994). Studies on Alkali-Carbonate Reaction. *ACI Materials Journal*, V.91, No.1, January-February 1994..

(3) Spry, P.G., G.L.Gan, R.D. Cody, and A.M. Cody, (1996). The Formation of Rims on Dolomite Aggregate in Iowa Highway Concrete. *Proceedings of the Semisesquicentennial Transportation Conference Celebrating the 75th Anniversary of the Transportation Research Board*, Ames, Iowa, May 1996.