Summary Report ICAR-102-1S

The International Center for Aggregates Research is funded by the Aggregates Foundation for Technology, Research, and Education (AFTRE); the National Stone, Sand, and Gravel Association; funds from The University of Texas at Austin and Texas A&M University; and contributions from the aggregates industry.

INTERNATIONAL

ICAR

CENTER FOR AGGREGATES RESEARCH

ICAR PROJECT 102 LEADS TO HIGH-MICROFINES CONCRETE

BACKGROUND

The use of higher-microfines concrete has received considerable interest in recent years. Microfines are defined as material passing the #200 sieve, or particles smaller than 75µm. Concrete fine aggregate gradation limits in ASTM C 33 permit a maximum of 7% microfines in some applications, if the fines consist of dust-of-fracture essentially free of clay or shale. Since the production process for manufactured fine aggregate (MFA) normally generates 10 to 20% of these microfines, excess fines must be separated from the desired sizes by screening or washing.

Many countries permit much higher microfines contents based on their experiences. India permits up to 20%; Spain, 15%; and Australia, 25%. Properly used, microfines can enhance properties of the concrete.

PROJECT ORGANIZATION

This study is the most comprehensive yet undertaken on microfines in concrete. Excellent cooperation was provided by industry; aggregates were furnished, an autogenous crusher was provided along with operating personnel to crush all the aggregate sources, and some of the aggregates were characterized. After each aggregate source was processed using different crusher settings (tip speeds), each of the 63 sands from seven rock types was characterized using standard tests such as specific gravity, gradation, absorption, uncompacted void content, and tests not normally used, including laser diffraction for particle size, chemical analyses, and methylene blue.

A test series, conducted on mortar mixes containing each of the fine aggregates, featured two variables, the cement-sand ratio and the flow rate. Test results included compressive strength and drying shrinkage for each of the mortar mixes. On the basis of the mortar-test results, fine aggregates were selected for use in tests on concrete specimens. One coarse aggregate was used in all the specimens, and fixed water-cement ratio, as well as fixed-slump, test conditions were evaluated. (It should be noted that the slump test is not a good indicator of workability for high-fines concrete and can give misleading results.) Compressive strength, flexural strength, permeability, abrasion resistance, and scaling resistance were determined for the concrete specimens.

FINDINGS

1) A wide variety of rock types produced acceptable fine aggregates for concrete, to include limestone, granite, quartzite, diabase, dolomite, basalt and sandstone.

2) Aggregate processing, e.g. crusher tip speed, significantly affected the aggregate particle shape and amount of microfines produced, which, in turn, can lead to improved properties of mortar and concrete.

3) Compared to concrete made with lower-fines-content natural sand, high-fines manufactured-sand concrete generally had higher flexural strength, improved abrasion resistance, higher unit weight, and lower permeability due to filling of the pores with microfines. (Lower permeability is important for reducing corrosion).

4) Compressive strength varied but was acceptable, and shrinkage, although slightly higher, was within generally acceptable ranges.

5) Good-quality concrete could be made from nearly all of the aggregates (with microfines contents ranging from 7 to 18%) used in the test program without the use of admixtures.

Further research with standardized admixtures should provide additional improvements to the properties of high-fines concrete. Another ICAR research project is developing guidelines for maximizing the amount and type of aggregates in concrete. Admixtures will play an important role in this study.

The information in this summary is detailed in ICAR Report 102-1F, An Experimental Study on the Guidelines for Using Higher Contents of Aggregate Microfines in Portland Cement Concrete, *by Namshik Ahn and David W. Fowler.*