AGGREGATE update

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CENTER FOR AGGREGATES RESEARCH

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ICAR Technical Advisory Committee Meets

In two days of research presentations and discussions last August, the Technical Advisory Committee (TAC) identified 31 potential research topics for the Center. The following ten were selected for development into formal problem statements. When completed, the ICAR and Aggregates Foundation for Technology, Research, and Education (AFTRE) Boards will consider the problem statements for future funding.

Adapting the Virtual Cement and Concrete Testing Laboratory (VCCTL) to Optimizing the Selection of Aggregates for Concrete

Optimizing the design of complex structures is now routinely done via sophisticated computer programs. Optimizing concrete, however, involves proportioning concrete mixtures, which remains primarily an empirical procedure depending mostly on water content (water-cement ratio) and aggregate grading. These procedures provide only a first approximation of proportions that must then be checked by trial batches, a time-consuming and costly process. Aggregates can be used more effectively in concrete. Shape and texture have largely been ignored in selecting mixture proportions. Methods to evaluate a much larger range of materials rapidly and efficiently are needed. Computer-based methods appear to offer realistic, rapid solutions to these problems. Such methods can include consideration of key aggregate properties such as shape and texture, on which concrete properties like workability, strength, and durability depend.

Mitigation and New, Rapid Test Methods for D-cracking and Freeze-Thaw Susceptibility of Aggregates

D-Cracking, a freeze-thaw failure of carbonate aggregate, significantly reduces the service life of PCC pavement. Departments of transportation attempt to avoid this problem by prohibiting the use of many beds of carbonate stone in their specifications. This practice reduces the value of the ledge to the producer. ASTM C666 accurately identifies D-cracking aggregate. However, the test is expensive and very time-consuming. A rapid, new test that directly correlates with ASTM C666 is needed. In addition to identification, methods of direct mitigation of the phenomenon are needed.

Surface Energy Measurements as Indicators of Hot-Mix Asphalt (HMA) and Portland Cement Concrete Performance

The surface energies of aggregates and bitumens influence adhesive and cohesive bonds. Highly accurate surface energy measurements allow for a mixture design with improved bonding and performance. This research seeks to deliver a method that can efficiently and reliably measure the surface properties of aggregates. The ability to measure the adhesive bond between the bitumen and aggregate based on surface energy and area will provide a more accurate method to assess the benefits of surface treatments used to mitigate stripping, effects of modifying the crushing operation, and effects of stockpile age after crushing.

Reconciling Performance Data from Existing Flexible Pavements Data Bases with Aggregate Characteristics

Aggregate shape has significant, but poorly quantified, effects on the performance of hot-mix asphalt

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(HMA) mixtures. Aggregate acceptance criteria are often developed regionally and applied nationally. This study proposes to measure the characteristics of aggregates used in HMA mixtures and to relate these characteristics to HMA mixture performance. The focus will be on aggregate shape properties and surface energy and their effects on rutting and moisture susceptibility. Recent laboratory and field studies have involved evaluating the performance of asphalt mixtures under different loading conditions. These studies varied from measuring asphalt mix performance using full-scale sections (e.g., WesTrack, MnRoad, NCAT Track), APT facilities (e.g., TFHRC-ALF, TxDOT-MLS, CalTrans-HVS, Purdue, Louisiana, Kansas), or lab specimens (Yeggoni et al., 1994; Kandhal et al.; 1998; Lee et al., 1999; Chowdhury et al., 2001; Park et al., 2002). Field performance, as documented in PMS databases, should be used in conjunction with aggregate properties.

Measuring Workability of High-Fines Concrete Mixtures

Workability, an important indicator of concrete quality, is commonly measured by slump, which is actually a measure of consistency rather than workability. No accepted practical method for measuring workability of concrete exists, especially for low slump mixtures. With the increased use of microfines, we need to develop a practical, standard method for measuring workability for mixtures.

Role of Coarse Aggregate Point and Mass Strength, Particle Shape, and Texture on Resistance to Load in HMA

A new generation of HMA mixtures develops strength from stone-on-stone contact of the coarse aggregate. These types of mixes have placed demands on aggregates different from those for conventional mixtures that allowed coarse aggregates to "float" in the asphalt mastic. The contribution of the aggregate to the behavior of these mixes under loading must be understood. New methods must be developed to measure this contribution by modeling particle-to-particle contact. Specifications should ensure that aggregates possess the necessary tensile, shear, and compressive strengths to avoid degradation during handling, construction, and usage.

Evaluation of the Impact of the *AASHTO 2002 Design Guide* on the Industry

The *2002 Guide for the Design of Pavement Structures* will be based on mechanistic-empirical design principles, implemented using accepted pavement structural models and numerous additional models for material properties, pavement performance, environmental evaluation, etc. It will undoubtedly result in pavement designs with different layer thicknesses than are currently common. The producer must understand how to produce a material that will be evaluated favorably (in terms of both mechanical and cost properties) by the *Guide*.

The study will evaluate the impact of design changes on the aggregates industry in terms of potential increase or decrease in the market for various aggregate products and identify potential pavement design optimization strategies that will likely be used in the *Guide*.

Aggregate Properties Related to Degradation and Changes in HMA Volumetrics in the Plant Process

Volumetric parameters are used in design of asphalt mixtures. When these mixture proportions are used in the field, the volumetric parameters usually change due to degradation during handling and processing, possibly resulting in particle shape changes that may result in different values taken from stockpile aggregates compared to the same aggregates after processing. Prediction and minimization of such changes in advance can avoid redesign, penalties, and unnecessary delays.

Further Development of the LASS for Rapidly Determining Grain-Size Distribution

The prototype Laser-based Aggregate Scanning System (LASS) rapidly characterizes aggregate particles using laser profiling, a 3-D technology more precise than 2-D digital imaging. ICAR Project 503 studied automated techniques for rapidly measuring the grain size distribution of unbound aggregates. The true 3-D data obtained from the LASS allows both rapid and precise determination of particle shape indices. While the prototype LASS device shows tremendous potential for providing inexpensive, rapid, accurate, and detailed characterizations of aggregate samples, it needs to be developed for manufacture and use in production facilities and materials testing labs.

Creation of a Data Base of Aggregate Properties Determined through Infrared Analysis

The recently-developed portable infrared mineral analyzer (PIMA) offers potential for rapid field and laboratory determination of mineral composition of aggregates. It may offer utility for core hole analysis and for characterizing fines. This study would establish the accuracy and precision of the PIMA for a wide variety of material types, evaluate its applicability to a range of field and laboratory settings, and establish a data base of infrared spectra for mineral aggregates for future correlations and use.

The TAC consists of representatives of industry, academia, and government. These experts contribute invaluable ideas and time to ICAR's research program, for which the Center is deeply grateful.

New ICAR Research Reports

Several new reports may be ordered from ICAR on CD or paper copy. Contact the Center at 512/471-4498. In addition, they may be downloaded at no charge from ICAR's web site, www.ce.utexas.edu/org/icar.

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MANUFACTURED FINE AGGREGATES IN PCC: CONTRACTORS' EXPERIENCE

CHARACTERIZING AGGREGATE SHAPE, SIZE & SURFACE TEXTURE: PERFORMANCE IMPLICATIONS

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