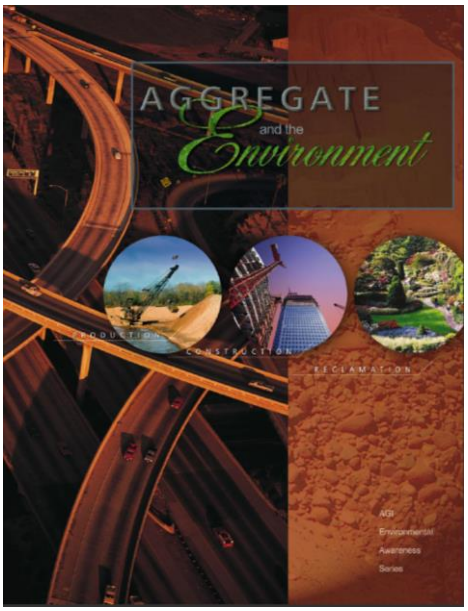
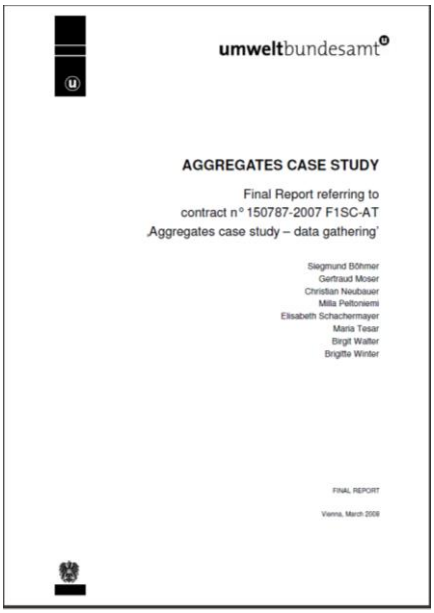


AGGREGATE AND THE ENVIRONMENT

http://www.agiweb.org/environment/publications/aggregate.pdf

Many of us tend to take natural resources for granted, especially aggregate sand, gravel and crushed stone. On one hand, aggregate resources are vital to our way of life because they are the major raw materials used in construction of roads, rail lines, bridges, hospitals, schools, airports, factories, and homes. On the other hand, the mining and processing of natural resources such as aggregate commonly raises concerns about potential environmental impacts. Nevertheless, we must have access to a readily available supply of high quality aggregate if we wish to maintain our current lifestyle. Given the right information and access to suitable resources in appropriate geologic settings, aggregate producers can meet the nations demand for aggregate without causing undue harm to the environment. We do not need to choose between aggregate development and the environment. The question is how to achieve a balance among the economic, social, and environmental aspects of aggregate resource development.

This book is designed to help you understand our aggregate resources. Their importance, where they come from, how they are processed for our use, the environmental concerns related to their mining and processing, how those concerns are addressed, and the policies and regulations designed to safeguard workers, neighbors, and the environment from the negative impacts of aggregate mining. We hope this understanding will help prepare you to be involved in decisions that need to be made.



AGGREGATES CASE STUDY

http://susproc.jrc.ec.europa.eu/activities/waste/documents/Aggregates_Case_Study_Final_Report_UBA_080331.pdf

This case study on aggregates was carried out by the Austrian Umweltbundesamt (Federal Environmental Agency) and commissioned by IPTS (Institute for Prospective Technological Studies), one of the seven scientific institutes of the European Commission's Joint Research Centre (JRC).

Covering the EU-27, the main issue of the study was to gather data on recycled and secondary aggregates, which have the potential to substitute natural aggregates. Three waste/material streams were examined: construction & demolition waste, slags from the ferrous metal production and ashes from the coal combustion.

In detail, data on the generation and on the quality of the three mentioned material streams regarding applied uses and treatment processes were assessed. In addition, the related legislations and aspects which have an influence on establishing a market for recycled and secondary aggregates and the environmental impact associated with the use of these materials were described within the study.

The Environment Ministries and Agencies of the Member States were requested to gather data on the national situation. In addition, European Associations were contacted to enable access to data already collected for the waste/material streams at European level. When interpreting and comparing the presented data it has to be taken into consideration that comparability of data is not completely ensured, e.g. due to partly different measurement methods, and some data gaps still exists.

The data on the European situation prepared in the study should provide a basis to define end-of-waste criteria for selected waste/material streams which will provide input for the definition of end-of-waste methodology.

AGGREGATE AND CONCRETE PRODUCTION

www.eco-serve.net/.../574300_Summary%20**Baseline**%20**Report**_04.pdf

This baseline report includes state-of-the art covering ongoing European and national research, as well as the economic, environmental, political and societal issues for optimum management of aggregate resources and production of concrete with limited environmental impact. The report includes input from Cluster 3 members on the current research in their national R&D projects in this field. It will serve as a consensus fundament for identifying future research needs and a link to the next report of this cluster on the Best Available Technology. The report covers aggregate and concrete production, construction and demolition waste, standardization and future research needs in these sectors.

EFFECTS OF COARSE AGGREGATE CLAY-COATINGS ON CONCRETE PERFORMANCE

www.iprf.org/.../IPRF%2001-4%202%20**Clay**%20Dispersion%20Final%20Report.pdf

Due to the fact that aggregates comprise between 60-80 % of the total volume of concrete and concrete failures have often been tied to the use of different aggregates, it would appear that one should characterize these aggregates and their surface chemistries in order to determine the roll of these materials on the final performance of concrete. Coarse aggregates often contain a layer of small particles bound strongly or weakly to the aggregate surface (a surface coating). Previous research associates the presence of some type of micro-fines on the surface of these aggregates with deleterious properties of concrete. A large fraction of micro-fine gravel coatings consist of clay minerals. Due to their small size and large surface areas as well as differing chemistries, these minerals likely can be expected to be major components of reactivity in concrete systems. It has been widely reported that presence of clays in cement reduces the compressive strength and increases shrinkage in the resulting concrete. However, the exact mechanism by which these clays affect these properties has not been established.

Our hypothesis as to how clays influence the evolution of the concrete is as follows: in the course of the mixing process, prior to the addition of cement, a fraction of the clay coating detaches from the aggregate surface and disperses into the aqueous phase. Thus, when the cement powder is added to this mixture, particles of clay will be incorporated into the matrix of the cement paste and affect hydration reactions. The other fraction of the coating will remain on the aggregate surface and influence the adhesion of the cement paste to the aggregates. The overall objective of this research project has been to establish which fraction of coating of three different types of clays (Na-montmorillonite, Ca-montmorillonite and Kaolin) detach from the surface of the aggregate, and how these detached particles of clays affect the pathway of the hydration reactions in the cement paste.

THE PETROGRAPHIC ATLAS OF POTENTIALLY ALKALI-REACTIVE ROCKS

http://vefur.honnun.is/farin/petroatlas/webindex.htm

This petrographic atlas of potentially alkali-reactive rocks has been compiled under the EU-supported project **PARTNER** (GRD1-CT-2001-40103).

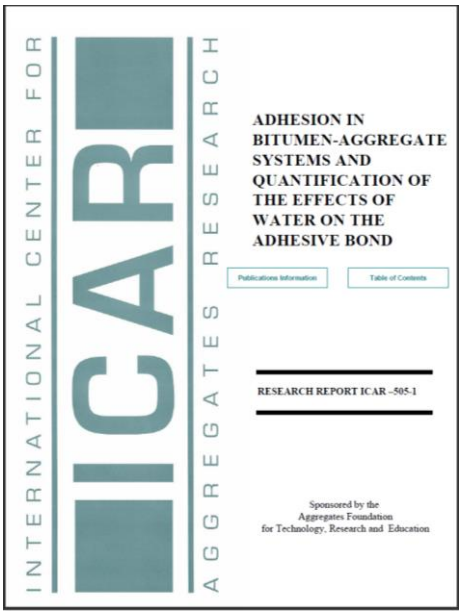
The aim of this petrographic atlas of the potentially alkali-reactive rocks in Europe is to assist geologists who work in the field of the concrete degradations and in particular in the field of the alkali-silica reactions.

It is not possible, in only one atlas, to describe every type of concrete alkali-reactive aggregate from Europe. In particular, some aggregates like the sands and the gravels, often contain several different rock types. For these reasons, this atlas has been based on the parent rocks rather than on the aggregates.

The rocks are firstly classified under their origin (sedimentary, metamorphic or igneous) using the international nomenclatures; secondly, they have been grouped under families of similar species. For each rock family, a general description is given in the header including the most particular characteristics of the different rock species from different countries. The reactive components are emphasized within the descriptions and, when possible, within the pictures which illustrate the type of aggregate. Despite the fact that this atlas is not exhaustive, it is nevertheless representative of the majority of the European alkali-reactive rocks.

Concerning the aggregates, it is important to stress additional points:

- Firstly, if some rock types are reactive, it does not necessary mean that all the rocks of the same family are reactive too.
- Secondly, some aggregate types exhibit a pessimum effect: actually, when a certain amount of reactive aggregate is reached in the concrete the expansion is at its maximum, whereas below and above this particular value less or even no expansion is observed. Because of the pessimum effect a greater proportion of a particular reactive rock type may not necessarily lead to greater reactivity.



ADHESION IN BITUMEN-AGGREGATE SYSTEMS AND QUANTIFICATION OF THE EFFECTS OF WATER ON THE ADHESIVE BOND

www.icar.utexas.edu/reports/505_1.pdf

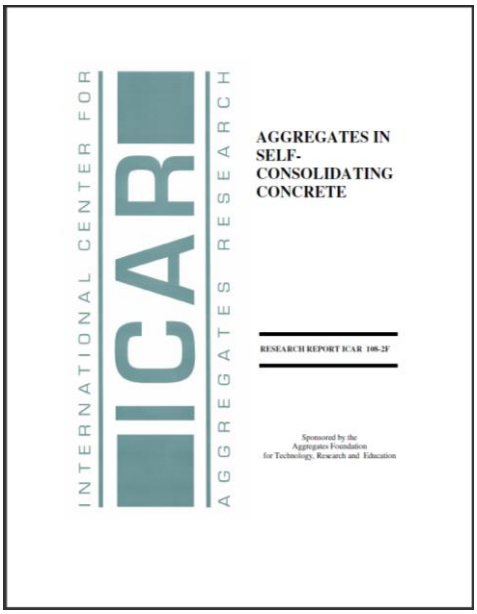
This research is intended to contribute toward the understanding, development, and implementation of a more fundamental design process for bituminous pavement materials, utilizing thermodynamic properties of the materials involved. The theory developed by van Oss, Chaudhury and Good forms the basis of this research. Optimization of techniques to characterize surface energy, as well as consideration and evaluation of additional factors that influence adhesion in the presence of water, are pursued. A synthesis of theories and mechanisms of bitumen-aggregate adhesion is presented, and existing and potential techniques for surface energy characterization are reviewed to establish firm background knowledge on this subject.

The Wilhelmy plate technique was scrutinized and improved methodologies and analysis procedures are proposed. Inverse gas chromatography (IGC) is introduced as an alternative technique. A reasonable comparison of total surface energy values form these techniques with mechanical surface tension values were found. Results suggest that bitumen surface energies do not vary substantially. Inability of these techniques to detect the effect of a liquid additive is rationalized by the 'potential' surface energy concept. Suggestions for a more realistic characterization of bitumen polar surface energy components are presented.

A static gravimetric sorption technique was employed to characterize aggregate surface energies. Dynamic vapor sorption was identified as a candidate alternative technique for aggregate surface energy characterization.

A study on the effect of pH on surface energy components of water revealed that this effect is practically negligible. Calculation of the free energy of electrostatic interaction (ΔG^{EL}) indicated that this term contributes less than 1% to the total free energy of adhesion. Despite this finding, it is shown that ΔG^{EL} alone is able to distinguish moisture sensitive mixtures. The significance of electrical phenomena at the interface is elucidated through another mechanism

following the work of M.E. Labib. The relationship between pH and electron donor-acceptor properties of aggregate surfaces is presented. The Labib approach potentially offers the solution to quantify the effect of pH on adhesion. In addition, it should be possible to resolve issues with the acid-base scale proposed by the founders of the current theory, by replacing it with a more absolute donor-acceptor scale.



AGGREGATES IN SELFCONSOLIDATING CONCRETE

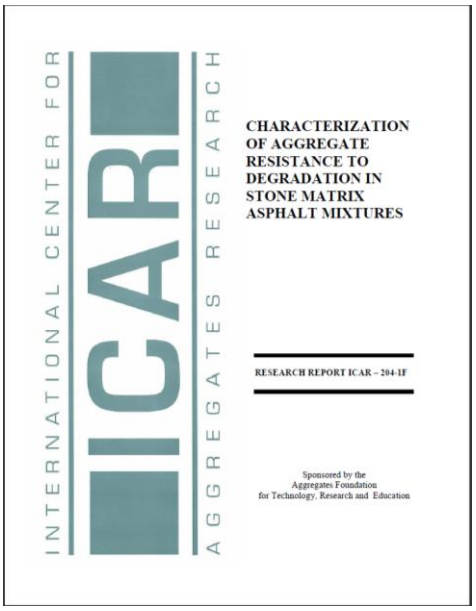
www.icar.utexas.edu/.../ICAR%20108-2F%20(Final%20Report).pdf

Self-consolidating concrete (SCC) is an advanced type of concrete that can flow through intricate geometrical configurations under its own mass without vibration or segregation. A research project was conducted to investigate the role of aggregates in SCC. Although SCC can be proportioned with a wide range of aggregates, the selection of favorable aggregate characteristics can significantly enhance the economy and performance of SCC. The objectives of the research project were to evaluate the effects of specific aggregate characteristics and mixture proportions on the workability and hardened properties of SCC, to identify favorable aggregate characteristics for SCC, and to develop guidelines for proportioning SCC with any set of aggregates.

The effects of aggregate grading; maximum size; shape, angularity, and texture; clay content; and packing density were evaluated. Separately, the effects of mixture proportions, cementitious materials, and chemical admixtures were evaluated. In total, 12 fine aggregates, 7 coarse aggregates, and 6 microfines were tested. Tests were conducted on paste, mortar, and concrete. Paste measurements were conducted to evaluate the effects of cement, fly ash, microfines, high-range water-reducing admixture (HRWRA), and viscosity modifying admixture (VMA) on rheological properties. Mortar measurements were conducted to evaluate the effects of fine aggregates, microfines, and mixture proportions on workability and hardened properties.

Concrete measurements were conducted to evaluate the effects of fine aggregates, coarse aggregates, microfines, and mixture proportions on workability and hardened properties. Target properties for SCC workability were defined as a function of the application and in terms of filling ability, passing ability, segregation resistance, and rheology. Seven workability test methods were evaluated extensively to provide sound, engineering justifications for their use and for the interpretation of their results. Specific tests for filling ability, passing ability, and segregation resistance were recommended.

Based on the results of this research and well-established principles from the literature, a mixture proportioning procedure for SCC was developed. The procedure is based on a consistent, rheology-based framework and was designed and written to be accessible and comprehensible for routine use throughout the industry. In the procedure, SCC is represented as a suspension of aggregates in paste. In order to achieve SCC workability, the paste volume must be sufficient for the given aggregate blend and the paste rheology must be selected based on the aggregate blend and paste volume. The three-step procedure consists of selecting the aggregates, paste volume, and paste composition. Detailed recommendations are provided for each step. Aggregates are selected on the basis of grading, maximum size, and shape and angularity. The paste volume is set based on the aggregate characteristics. The paste composition is established to achieve workability and hardened properties. All required testing is conducted with methods standardized by ASTM International.

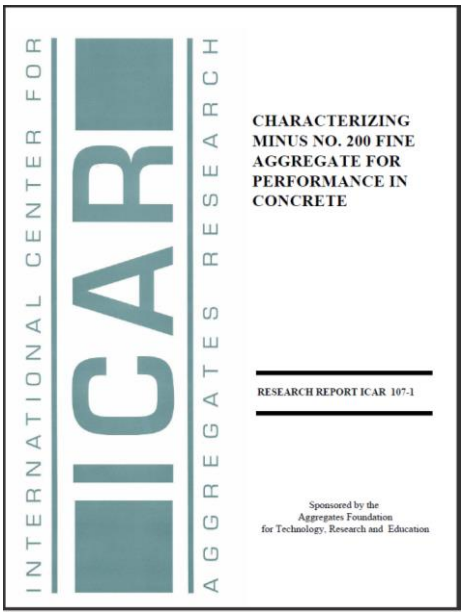


CHARACTERIZATION OF AGGREGATE RESISTANCE TO DEGRADATION IN STONE MATRIX ASPHALT MIXTURES

http://www.icar.utexas.edu/reports/204_Series/ICAR%20204%20Final%20Report.pdf

Stone matrix asphalt (SMA) mixtures rely on stone-on-stone contacts among particles to resist applied forces and permanent deformation. Aggregates in SMA should resist degradation (fracture and abrasion) under high stresses at the contact points. This study utilizes conventional techniques as well as advanced imaging techniques to evaluate aggregate characteristics and their resistance to degradation. Aggregates from different sources and types with various shape characteristics were used in this study. The Micro-Deval test was used to measure aggregate resistance to abrasion. The aggregate imaging system (AIMS) was then used to examine the changes in aggregate characteristics caused by abrasion forces in the Micro-Deval.

The resistance of aggregates to degradation in SMA was evaluated through the analysis of aggregate gradation before and after compaction using conventional mechanical sieve analysis and nondestructive Xray computed tomography (CT). The findings of this study led to the development of an approach for the evaluation of aggregate resistance to degradation in SMA. This approach measures aggregate degradation in terms of abrasion, breakage and loss of texture.



CHARACTERIZING MINUS NO. 200 FINE AGGREGATE FOR PERFORMANCE IN CONCRETE

www.icar.utexas.edu/reports/107_1.pdf

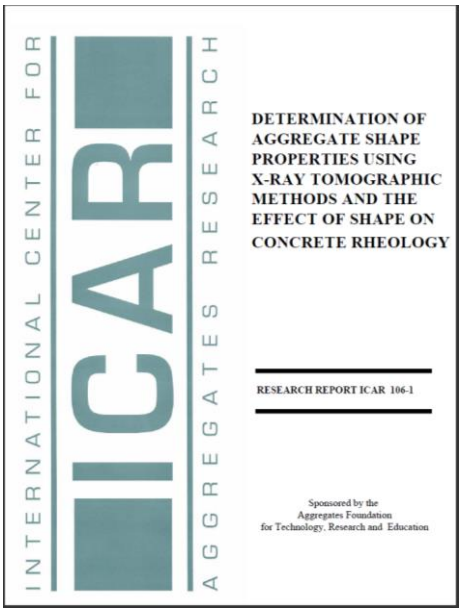
ASTM C 33 limits the amount of microfine aggregate smaller than 75 μm (No. 200 sieve) to be used in concrete. In the past, it was believed that this fraction was clay and, therefore, a poor performer. This is not necessarily the case with manufactured fine aggregates. While work continues toward altering ASTM C 33 to allow a higher percentage of microfine aggregates, there is need for a method of determining whether these microfines will have deleterious effects or not.

Fourteen aggregates were collected for evaluation in this study. Methods of characterizing the microfines to determine their effects on concrete properties were developed in this study. In addition to fully characterizing the aggregates using advanced techniques, simple tests for microfines that can be used as a criterion for their exclusion or inclusion were evaluated. For such a test to be meaningful there must be a strong correlation between its results and concrete performance. Mortar and concrete mixes incorporating microfines from fourteen different aggregates are tested in this project for a variety of performance criteria. This project fully characterizes microfines and evaluates simple tests for predicting performance in concrete.

CHARACTERIZING SURFACE PROPERTIES OF AGGREGATES USED IN HOT MIX ASPHALT

www.icar.utexas.edu/reports/505_2.pdf

Physical and chemical properties of aggregates at the micro scale strongly impact the adhesive bond (strength and durability) between bitumen and aggregate. These properties include surface free energy, chemical interaction potential, and specific surface area. This report describes testing methods developed for the Universal Sorption Device (USD), the Wilhelmy Plate (WP), and the microcalorimeter (MC) to measure these surface properties of aggregates. Test results from five different asphalt binders and nine different aggregates are presented to demonstrate how these surface properties can be used to: (1) select combinations of bitumen and aggregates that are more resistant to moisture damage, (2) select additives that can be used to improve the performance of asphalt mixtures based on the physico-chemical nature of the bitumen and aggregate, and (3) predict the resistance of the mixture to moisture-induced damage.



DETERMINATION OF AGGREGATE SHAPE PROPERTIES USING X-RAY TOMOGRAPHIC METHODS AND THE EFFECT OF SHAPE ON CONCRETE RHEOLOGY

www.nssga.org/aftre/Reports/Project-106-1.pdf

The shape of aggregate particles can significantly influence certain properties of concrete, both in its fresh and hardened states. Therefore, there is a need to be able to completely characterize the shape of aggregate particles, in three dimensions, in order to develop computational models that accurately predict properties. In the past, numerous methods have been suggested for this task. However, these methods are often only applicable to two-dimensional images of particles, they output a single or a few values, and fail to characterize the true shape of the particle.

X-ray tomographic techniques allow the capturing of the true shape of particles and have been applied to concrete aggregates. Computed tomography has been used to characterize coarse and fine aggregate particles, while X-ray microtomography has been used to characterize particles passing the 75 μm sieve. Sample preparation methods and scanning parameters applicable to concrete aggregates have been developed. The spherical harmonic method was used to efficiently store shape information, and to calculate useful parameters for individual particles, such as volume and surface area. Comparisons of the results to properties determined using other techniques were made and it was determined that the results of indirect or two-dimensional shape and size characterization methods can be misleading

.

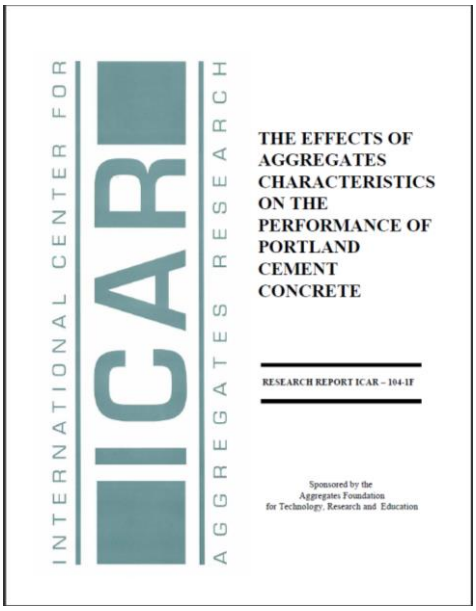
The shapes of aggregate particles particularly influence the rheological properties of concrete mixtures. However, it is not clear to what degree different-scale shape properties (the overall shape, angularity and texture) influence flow separately. Artificial aggregates were prepared in the laboratory and simplified test cases were chosen to independently investigate the effect of overall shape and surface texture on the yield stress and plastic viscosity of mixtures and to obtain a set of results that could be used to calibrate computational models. These tests revealed that the overall shape of coarse aggregate particles significantly influences the plastic viscosity of a mixture, but does not affect the yield stress visibly. Particle surface texture does not seem to noticeably influence either viscosity or yield stress for the cases tested. The

results were also used to verify the “Dissipative Particle Dynamics” model and showed good correlation with the predictions.

TEST METHODS FOR EVALUATING PREVENTIVE MEASURES FOR CONTROLLING EXPANSION DUE TO ALKALI-SILICA REACTİON IN CONCRETE

http://www.nssga.org/aftre/Reports/Project-302-1.pdf

This paper provides a critical evaluation of the various methods available for testing the efficacy of measures for preventing expansion due to alkali-silica reaction (ASR) in concrete containing deleteriously reactive aggregate. The ideal test method should be rapid, reliable and capable of determining the influence of aggregate reactivity, alkali availability and exposure conditions. None of the currently available or commonly used methods meet all of these criteria. The shortcomings of the different test methods are discussed and suggestions are made for modifying the concrete prism test and accelerated mortar bar test to make these tests more acceptable.



THE EFFECTS OF AGGREGATES CHARACTERISTICS ON THE PERFORMANCE OF PORTLAND CEMENT CONCRETE

www.icar.utexas.edu/publications/104_1F.pdf

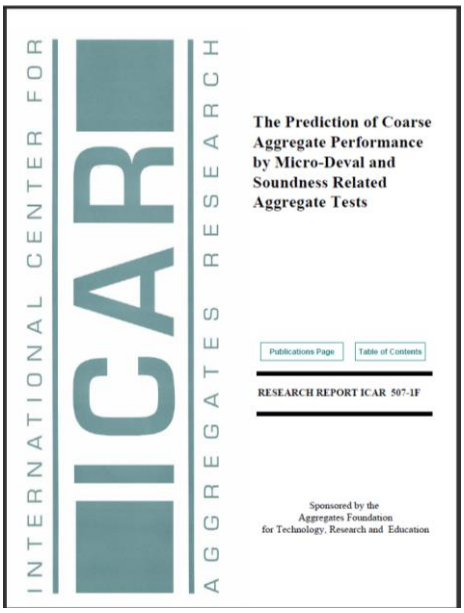
Aggregate shape, texture, and grading have a significant effect on the performance of fresh concrete. Aggregate blends with well-shaped, rounded, and smooth particles require less paste for a given slump than blends with flat, elongated, angular, and rough particles. At the same time, uniform gradings with proper amounts of each size result in aggregate blends with high packing and in concrete with low water demand. Optimized aggregate blends have high packing, requiring low amounts of paste. As a result, they are less expensive and will have less durability problems caused by the paste such as heat generation, porosity, and drying shrinkage.

Current ASTM C 33 standard limits the amount of material passing the N 200 sieve (microfines) to 7 percent. However, manufactured fine aggregate (MFA) usually has between 10 and 20 percent microfines. These limits, intended for natural sands, force MFA producers to wash aggregate incrementing costs and generating environmental issues. Research at The University of Texas and experience in other countries show that good quality concrete can be made with MFA with high-microfines content.

Many proportioning methods such as ACI 211 do not consider high amounts of microfines, considers partially the effect of shape and texture of aggregates, and do not encourage optimization of aggregate.

The effect of shape, texture and grading of aggregates on fresh concrete was evaluated experimentally, quantified by means a proportioning method based on packing density concepts, the Compressible Packing Model (CPM), and analyzed by an empirical tool suggested by Shilstone. The effect of different types and amounts of microfines was evaluated simultaneously as well as the impact of chemical admixtures and supplementary cementing materials on concrete with high microfines were also evaluated experimentally. It was concluded that chemical admixtures and some supplementary cementing materials can be

used to improve the workability of concrete with high microfines without negatively affecting hardened concrete.
Guidelines for proportioning and optimizing aggregate blends were made based on Shilstone's Coarseness Chart and the 0.45 Power Chart and CPM equations and procedures.



THE PREDICTION OF COARSE AGGREGATE PERFORMANCE BY MICRO-DEVAL AND SOUNDNESS RELATED AGGREGATE TESTS

www.icar.utexas.edu/reports/507-1F.pdf

This research project concentrated on determining whether or not a correlation existed between laboratory aggregate tests and observed aggregate field performance. For this purpose, aggregate samples were collected from the majority of the U.S. states as well as several Canadian provinces and subjected to a variety of strength, soundness, and intrinsic particle property tests. Additionally, performance data on the aggregates was obtained by contacting multiple DOTs where aggregates were in use in several categories – hot-mix asphalt, portland cement concrete, base course, and open-graded friction course. Numerical and qualitative analyses were performed to evaluate the success of separating good performers from fair and poor performers using the micro-Deval test alone as well as the micro-Deval test combined with another test. Special attention was paid to aggregate mineralogical composition. Furthermore, attempts were made to determine if a correlation exists between any two tests.

http://www.sarmaproject.eu

Aggregates (crushed stone, sand and gravel) are crucial for infrastructure and construction. SEE countries are rich in aggregates, but supply is not coordinated within or across the area.

The main objective of the project is to develop a common approach to (a) sustainable aggregate resource management (SARM) and (b) sustainable supply mix (SSM) planning, at three scales: regional, national and transnational.

The project built the foundation for a Regional Centre on sustainable aggregates management and supply.

The lead partner is the Geological Survey of Slovenia.

http://snapsee.eu

Assuring sustainable supply of aggregates is an important challenge due to their economic importance and the potential environmental and social impacts associated with their production. The SNAP-SEE project focuses on developing and disseminating tools for aggregates management planning in Southeast Europe (SEE). It builds on the results of the Sustainable Aggregates Resource Management (SARMa) project. Due to regional differences in historical development, there are diverse approaches to aggregates policies, planning and management in SEE, which is hindering resource efficiency and economic development in the region:
- differences among mineral policies;
- aggregates policies and plans are distributed among many different legal documents, making coordination and a comprehensive understanding difficult;
- authorities in SEE countries do not have the understanding of either sustainable aggregates resource management (SARM) or planning for sustainable supply mix (SSM) and;
- there is almost a complete lack of coordination on planning supply from primary and secondary aggregates sources.

MAIN OBJECTIVES

The primary objective is to develop a Toolbox for Aggregates Planning to support national/regional, primary and secondary aggregates planning in SEE countries, which will include:
- SNAP-SEE Vision for a transition to integrated, comprehensive sustainable aggregates planning in SEE;
- Handbook on Capacity Building and Stakeholder Consultation;

- Handbook on Data and Analysis Methods;
- Aggregates Planning Scheme, containing planning modules that embody the principles, approaches and action necessary to achieve the goals of the Vision.