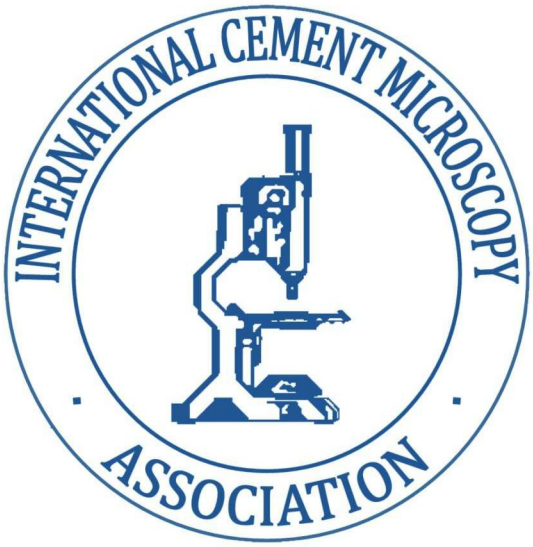
32nd INTERNATIONAL CONFERENCE ON CEMENT MICROSCOPY



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INVESTIGATIONS OF AN AESTHETIC PROBLEM ON ARTIFICIAL STONE CONCRETE BLOCKS.

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ABSTRACT

In June 1997 the author was contacted by the manufacturer of concrete 'artificial stone' blocks to help in determining the cause(s) of what appeared to be a surface degradation phenomenon which they had recently begun to experience in an intermittent manner. The customer had already confirmed that the degraded concrete block strengths were not affected, and that this surface degradation was a purely aesthetic problem.

This paper describes the investigative process which was undertaken from the initial manufacturing facility visit, site visits to affected properties, through to the petrographic examination phase. Once a mechanism of degradation was established by the petrographic examination, an investigative program was developed to firstly quantify the degree of degradation present on effected properties and then various survey methods were used to confirm that the surface degradation only occurred at a relatively young age (<18 months) and that at a later age additional degradation would not occur. The findings of these investigations were also then used in a number of potentially legal disputes between property owners affected and the manufacturer.

After close involvement in this process for four years the end result of this investigation helped the manufacturer establish the cause of the surface degradation, thus avoiding its reoccurrence in the future and also minimized the amount of remedial measures required to properties affected by the phenomenon. Twelve years after the initial investigation no further problems have been reported.

THE ROLE OF MICROSCOPY IN REGULATORY AND LEGAL APPLICATIONS: FLY ASH USE IN CEMENT AND CEMENTITIOUS PRODUCTS

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ABSTRACT

The numerous technical and scientific details relating to cement structure and strength at a microscopic level should have a tremendous impact in the environmental regulatory and civil legal system. This paper focuses on the coal combustion product fly ash in addressing present legal and environmental regulatory issues surrounding cement products and constituent elements of those products. Topics that influence regulatory and civil law include the adequacy of the cement materials used, the adequacy of the constituent product parts for the construction application, and the quality of the manufacture of the cement products. For example, fly ash introduces potentially hazardous metals when utilized in cement products. Despite the immense need to discover beneficial uses of fly ash, the presence of such metals could trigger scrutiny by governmental regulators, adjacent land owners, and environmental groups if those metals leach into groundwater or are released into the air during processing and manufacturing.

Expertise and knowledge developed through microscopic examination of materials utilized in cement and cement products should play a substantial role in both the development and implementation of government regulations as well as in the prosecution or defense of civil litigation or other lawsuits. Despite the diverse legal approaches in this field both nationally and internationally, the unification of scientific international studies will further enhance the role of microscopy in the manufacture and quality assurance of cement products. In doing so, cement microscopy should find an expanding role in the legal field despite the continuously varying legal approaches.

CORROSION OF ALUMINUM METAL IN CONCRETE – A CASE STUDY

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Abstract

Galvanic corrosion of steel-anchored aluminum nosing in outdoor portland cement concrete stairs caused debonding and cracking of the nosing, and, cracking and spalling of the adjacent concrete. Chloride-induced corrosion of embedded steel anchors in concrete has created iron oxide corrosion products and associated cracking in concrete. Chloride-induced galvanic corrosion of aluminum nosing at the locations of steel anchors has created more severe distress due to corrosion (reduction in thickness) of the nosing. Aluminum corrosion in the presence of moisture, hydroxyl and chloride ions from concrete formed a gelatinous mass of hydrated aluminum corrosion products, and associated aluminum hydroxide crystals (boehmite, bayerite, and gibbsite). A characteristic banded microstructure of sheet-like friable corrosion products of aluminum metal is detected, due to layer-by-layer advancement of corrosion, which consists of alternating layers of soft hydrated aluminum deposits and hard silicon-rich phases (the latter from silicon carbide grains embedded in nosing during manufacturing). The bottom 1 mm zone of nosing shows a corrosion microstructure where silicon-rich blades were distributed in a hydrated aluminum mass, which eventually grades into the sheet-like severely corroded metal, as described. Formation of a gelatinous mass of hydrated aluminum products and associated expansion is responsible for the nosing debonding and associated cracking of concrete, which is similar to concrete cracking by formation of alkali-silica reaction gel. Possibility of galvanic corrosion of aluminum in concrete and corrosion-related distress, especially in contact with steel and chloride, therefore, should be minimized by using a protective insulating coating on the surface of aluminum nosing in contact with concrete and embedded steel.

INVESTIGATIONS OF THE HYDRATION BEHAVIOUR OF HIGH REACTIVE PURE CEMENT PHASES

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ABSTRACT

Several high reactive pure phases of calcium silicates, calcium aluminates and other pure cement phases, such as dicalcium silicate (C_2S), tricalcium silicate (C_3S), monocalcium aluminate (CA), Mayenite ($C_{12}A_7$), tricalcium aluminate (C_3A), Brownmillerite ($C_4A_xF_{2-x}$), Gehlenite $2CaO{\cdot}Al_2O_3{\cdot}SiO_2$ (C_2AS), Ye´elimite $4CaO{\cdot}3Al_2O_3{\cdot}SO_3$ (C_4A_3s) and Pleochroite $Ca_{20}Al_{32-2x}Mg_xSi_xO_{68}$ were synthesized using different synthesis methods.
To understand and investigate phase forming of these single phases different low temperature synthesis methods (self-propagating combustion synthesis, sol-gel synthesis and polymeric precursor processes) were performed. The hydration reactions of pure cement phases at early hydration times were investigated at ambient temperatures by heat flow calorimetry, X-ray diffraction and cryo-transfer scanning electron microscopy. Due to the different synthesis procedures, different hydration reactions and microstructures can be shown and the hydration behaviour at early times can be clearly understood.

INVESTIGATIONS ON THE PUZZOLANIC REACTIVITY OF A SPECIAL GLASS MEAL IN A CEMENTITIOUS SYSTEM.

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ABSTRACT

Aim of this project was to assess the usability of the product Mikrover® in a binder system. For the investigations cement prisms of different mixtures (CEM I 42,5R and glass meal) were prepared according to EN DIN regulations. Glass meal was added in the range of 2,5 weight % to 7,5 weight %. Strength development of prisms was investigated over a time period of one year. All samples were stored in a climate chamber at 25°C under humid conditions. In addition to investigations on the binder system the raw materials were characterized. The glass meal shows a high pozzolanic reactivity according to EN DIN 196-5. Due to a determined SiO_2 excess of 443mg/l in solution, which is above a critical value of 100mg/l [BACHMANN ET AL, 2009], the product may also be described as potentially alkali sensitive. Bending tensile strength and compressive strength development of the four samples shows a clear influence of the glass meal. After one year the highest bending tensile strength was accomplished using 2,5% glass. Highest compressive strength values were observed with 5% glass content. All glass containing samples showed lower expansion and shrinkage values than the reference samples after one year of humid storage. Negative effects such as fissures and cracks were not observed. *In-situ* XRD measurements on glass containing cement samples showed the expected phase composition. The clinker phases C_2S and C_3S decreased while hydration products such as Ettringite and Portlandite increased. Differently aged and altered samples were investigated using SEM. Especially samples stored at 40°C showed perfectly shaped Ettringite and Portlandite crystals. Remaining glass particles with sharp boundaries to the adjacent cement matrix were visible in all investigated samples. These showed, depending on treatment, partially deep corroded surfaces.

KEYWORDS: Aggregates, Cement, Hydration, Pozzolanes, Strength developement

SOME CAUSES OF DEVELOPMENT OF CRACKS IN CONCRETE

AND A CASE STUDY

OF CONCRETE CONTAINING MAGNESIUM HYDROXIDE

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ABSTRACT

All concrete cracks and all types of cracks can be minimized, controlled, or avoided. Discussed are some causes of crack development in concrete and their prevention.

In a case study, a concrete core from a swimming pool of a residence in southwest USA exhibits map cracking. The core was examined petrographically and by scanning electron microscopy /SEM /. The cause of the cracking was determined to be a volume increase due to a development of magnesium hydroxide in aggregate particles.

Key words: concrete, shrinkage, cracking, corrosion, carbonation, ASR, DEF, magnesium hydroxide

The role of research in the commercial development of geopolymer concrete

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Abstract

There is a growing demand for construction materials with a low CO_2 content. The production of geopolymer or alkali activated binders and concretes from fly ash and metallurgical slag offers significant reduction (80%) in CO_2 emissions when compared to Portland cement. Contributing 5-9% of global carbon emissions, the cement industry offers much potential for emission reduction, provided that alternative supply chains are established and a new binder chemistry is adopted. The use of waste materials as precursors to geopolymer formation raises several challenges, as these materials are inherently variable from source to source. It is therefore necessary to understand and manipulate the chemistry and particle properties of ashes and slags to enable their successful use in commercial-scale geopolymer manufacture. Successful implementation of geopolymer cement and concrete technology involves understanding and controlling particle size distribution, particle packing, complex chemical reactions, and colloid and surface chemistry.

Alkali activation of solid, non-Portland cement precursors (usually high-calcium slags) was first demonstrated by Purdon in 1940, and was developed on a larger scale primarily in Eastern Europe in the succeeding decades. More recent developments have extended the range of useful raw materials to include coal fly ashes, which have become the focus of research in Australia due to their greater availability when compared to blast furnace slag. The key distinction to be made here is that the alkali activation of slags produces a fundamentally calcium silicate hydrate-based gel, with silicon present mainly in one-dimensional chains and some substitution of Al for Si and Mg for Ca, whereas the geopolymer gel is a three-dimensional alkali aluminosilicate framework structure. Dilatometry of geopolymers has recently been shown to provide a measure of fly ash reactivity under geopolymerization conditions.

Fly ash has long been used in Portland cement concretes to enhance flow and other properties and to reduce the carbon footprint of concrete. The majority of ashes which have been used in geopolymer concretes are Class F (i.e. low-calcium), although there is increasing interest in Class C (high-calcium) as the benefit of incorporating calcium into geopolymers has become clearer. These benefits are believed to be derived from the formation of a more compact microstructure due to the space-filling properties of calcium silicate hydrate gels, which when present in conjunction with the aluminosilicate geopolymer gels can lead to pore network refinement. Commercial development of geopolymer concrete in Australia is focused on both slag-rich and fly ash-rich blends, with applications ranging from pre-cast elements such as structural panels and bridge decks, to pre-mixed concrete applied in footpaths, foundations and in-situ formwork.

Geopolymer concrete will be a replacement for Portland concrete only when an efficient supply chain for raw materials and a distribution network for the products are in place. It will take time to make geopolymer cement and concrete a scalable commodity. In the meantime, it is imperative that geopolymer technology is demonstrated at a localized level. This paper discusses some of the strategic steps required to facilitate the roll out of geopolymer technology.

29 March, 2010
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ICMA Panel Discussion

Abstract Submission

Panel Section Title:
Beneficial use of coal combustion products

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KEYWORDS: Recycled, recovered, sustainable, fly ash, cement, green, concrete, CO_2 reduction

Abstract:

Coal is a relatively abundant, reliable and inexpensive energy source for world-wide power generation. However, it is also one of the main producers of Carbon Dioxide CO_2 and other noxious waste products like Mercury, Nitrogen Oxide and Sulphur Dioxide. The US alone produces approximately 1.5 billion tons of CO_2 annually; globally, coal is attributed to one third of all CO_2 emissions. Worldwide, the production of portland cement alone accounts for 6 - 8% of all human generated CO_2 greenhouse gas.

Until more economically feasible alternatives are developed for capturing and sequestrating CO_2, conventional coal-based power generation is to continue for decades to come. The construction sector could use coal combustion products in innovative manners to assist in the decrease of pollutants during a “transition” period. The use of one unit of fly ash in the cement-making process could reduce approximately one unit of CO_2 emitted by a cement kiln. For instance, fly ash (a by-product of coal burning in power generation) can be used in the fabrication of cement without posing structural changes to the end product. Durability factors are improved. Especially interesting are new, non acid-alkali reaction activated cements.

Microscopic views of the hydration of activating fly ash into hydraulic cement will be shown.

Newly developed activated fly ash products leave virtually no carbon footprint. Updated cementitious binder technology eliminates approximately 1 ton of CO_2 emitted into the atmosphere per ton of material produced. These "extreme green cement technology" engineered specifically for conventional walls and concrete block masonry, new construction and repair projects.

The extreme Green activated cement and products are comprised of up to 95% green sustainable industrial waste stream materials, primarily including fly ash. They are manufactured via a simple low energy, powder blending process. The system provides block, mortar, grout, structural and parging materials that incorporate high-performance green cement technology. The system produces structures with superior strengths, compared to traditional products made from native raw materials, and in a condensed time frame. Normal setting and hardening products also can be produced.

This green cement technology possesses excellent performance characteristics, including high early strengths and 28-day strengths near 10,000 psi. Moreover, they can be effectively placed in ambient temperatures ranging from 30 degrees F to 120 degrees F.

STABILIZATION OF VATERITE AND ARAGONITE IN CARBONATED GGBFS CEMENT PASTE BY Na-MFP

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ABSTRACT

Recent studies revealed that carbonation reduces the frost salt scaling durability of ground granulated blast-furnace slag (GGBFS) cement based materials through alteration of skin capillary porosity and strength. This phenomenon is even more detrimental for GGBFS-rich cementitious systems. It has been hypothesised that the metastable carbonates, -namely, vaterite and aragonite- are responsible for the inferior durability performance of GGBFS-rich cement systems. However, the link between metastable carbonates and the surface durability problems have not been characterised entirely. This paper presents metastable carbonates in carbonated GGBFS paste and discusses their stabilization with the help of sodium-monofluorophosphate solution treatment. Evidence was found that metastable carbonates can be stabilised by the chemical treatment into amorphous apatite-like formations which consequently renders a durable surface against frost salt scaling.

Keywords: GGBFS, carbonation, durability, microscopy, characterization.

The both sides of Ettringites (AFt) – a mineral with different properties

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Abstract

Ettringite and Thaumasite are minerals , very well known in cement chemistry, with a variety of properties. These properties lead to two distinct opinions : ettringite is mainly a mineral which occurs in products due to a failure, whereas others think about the excellent properties of these minerals and their solid solutions in optimized applications. The paper summarizes all properties of ettringites and shows optimized applications of ettringite in technological applications.
The following topics will be covered :

1. Variations in chemistry, mineralogy and crystallographic properties
2. Ettringites in application
3. Ettringites as source of failures

SURFACE ANALYSIS OF PHOTOCATALYTIC CONCRETE BY XRF ANALYTICAL MICROSCOPE

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ABSTRACT

The objective of this study is to get information relative to the surface of photocatalytic concrete using emergent technologies. Elemental chemical mapping of large surface samples of concrete, with size range from 10 cm x 10 cm to 50 cm x 50 cm is useful to get representative characterization of building material final products. The purpose of such mapping, particularly for titanium, is to correlate the density and dispersion of titanium on the surface of concrete with its photo catalytic activity.

Analyses were performed using an XRF analytical microscope (Horiba XGT). The main advantage of this technique is to provide access to basic chemical mapping of surfaces up to 50 cm x 50 cm. This equipment provides also full EDX-RF spectrum at each and every pixel of the element image, enabling various post-acquisition treatments.

Compared to other chemical surfaces analysis techniques such as SEM/EDX and GD-OES [1], the interests, of XRF analytical microscope, are: fast large sample analysis at atmospheric pressure conditions, transmission or reflection analysis. Operator can work on the same sample prepared for light microscope which allow to complete petrography and mineralogy analysis using EDX-RF for the chemical mapping at the same scale.

First results fit well and are satisfactory from a metrological point of view. The technique is very promising and can be an alternative to SEM/EDX technique for example.
The XRF analytical microscope combines the fast, non-destructive elemental analysis of Energy Dispersive X-Ray Fluorescence with the capability to pinpoint individual particles with diameters down to 10 µm in size.

RESUME

L'objectif de cette étude est de développer une technique de cartographie chimique élémentaire de surface d'échantillons de bétons photocatalytiques de dimensions allant de 10 cm x 10 cm jusqu'à 50 cm x 50 cm. Le but de ces cartographies en particulier celle du titane est de pouvoir corréler la densité et la répartition du titane présent à la surface d'un béton photocatalytique avec son activité dépolluante.

Les analyses ont été réalisées grâce à un microscope analytique à rayons X (Horiba XGT-7000WR). Le principal intérêt de cette technique est qu'elle donne accès à des cartographies chimiques élémentaires sur des surfaces allant jusqu'à 20 cm x 20 cm et permet aussi d'avoir une image X en mode transmission. Par rapport à d'autres techniques d'analyses chimiques de surfaces comme le MEB et la GD [1], l'intérêt du microscope analytique à rayons X est qu'il ne nécessite pas de métallisation ni de placer l'échantillon sous vide.

Les résultats obtenus dans le cadre de cette étude sont satisfaisants d'un point de vue métrologique et l'analyse d'échantillons de bétons photocatalytiques de grande dimension est compatible avec cette technique.

PHYSICO – MECHANICAL AND MICROSTRUCTURAL CHARACTERISTICS OF THE HARDENED POZZOLANIC CEMENT PASTES CONTAINING META-KAOLIN

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ABSTRACT

Various pozzolanic cement pastes were prepared from ordinary Portland cement (OPC) - Metakaolin (MK) blends having different MK contents by using a water/blended cement ratio of 0.45 by mass. The fresh OPC - MK pastes were hydrated for different time intervals up to 90 days. At each time interval, the hardened specimens were tested for their compressive strength, bulk density, hydration kinetics, phase composition and microstructure. The results of mechanical properties could be related to the hydraulic reactivity of metakaolin depending on its content in the different OPC – MK blends; namely, the strength increases with increasing MK content up to 25% where the rate of hydration increases as a result of activation of MK and the incase of MK content to 30% leads to the filler effect. It was found that the microstructural characteristics of the hardened OPC - MK specimens, as obtained by scanning electron microscopy (SEM), as well as the phase composition of the formed hydration products, as obtained by X-ray different (XRD), confirmed the results of mechanical properties.

FORMATION OF CALCIUM ALUMINATE HYDRATES IN CEMENT PASTES WITH DIFFERENT DOSAGES OF SBR POWDER

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ABSTRACT The formation of hydrates of calcium aluminates in cement pastes in the presence of different dosages of SBR powder was evaluated in the paper. The content of the hydrates of calcium aluminates, such as ettringite (AFt), monosulfate (AFm), C_4AH_{13} and CAH_{10} in cement pastes within 28 days was determined using X-ray diffraction (XRD). The results show that SBR powder facilitates the formation of AFt and enhances its stability in cement pastes. The enhanced formation of AFt results from the less CH formation in the SBR powder-modified pastes at early hydration age. AFm and C_4AH_{13} appear after 7 days and 28 days and both contents are decreased by addition of SBR powder. Most C_3A after the gypsum is used out reacts with CH, but little reacts with AFt. It is interesting to see that CAH_{10} presents in the cement pastes with SBR powder, and its content rises with the increase of SBR powder dosage.

KEYWORDS SBR powder; polymer-modified cement paste; hydrates of calcium aluminates; XRD

FORCE MEASUREMENTS BY AFM ON CLINKER SURFACES AND MODEL SYSTEMS IN AQUEOUS SOLUTIONS CONTAINING SUPERPLASTICIZER

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ABSTRACT

Superplasticizers are frequently used to improve the rheological properties of mortars and concrete.

The dispersion forces induced by polycarboxylate ether based superplasticizers (PCE) are studied by atomic force microscopy (AFM) applying a wet-cell facility. In such studies chemical evaluation of surface observations are maybe important and have to be considered during force measurements. Unfortunately, the reaction between cement and water occurs extremely rapidly, causing a drastic roughness change at the water-surface interface. Since AFM technique requires rather smooth substrates, cement model systems are utilized to afford direct interaction force measurements in aqueous environment.

AFM images are presented to illustrate and quantify changes of the surface roughness of model and clinker substrates treated with different ionic solutions at different times of immersion. Surface reaction increases drastically with increasing pH and in presence of calcium ions. Additional environmental scanning electron microscopy (ESEM) images are collected to describe the chemical composition of hydration products of clinker surface. It is shown which methods can be applied to reduce the negative effect of surface roughness, so that reliable force-distance results are obtained.

Keywords: atomic force microscopy, environmental scanning electron microscopy, superplasticizers, cement model system, clinker.

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ESTIMATING THE W/C RATIO OF OPC AND SLAG CONCRETE, MORTAR AND PASTE USING IMAGE PROCESSING AND ANALYSIS.

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ABSTRACT

The water cement (w/c) ratio is a typical quality parameter for concrete. The NT Build 361 Nordtest [1] method is a standard for estimating the w/c ratio in hardened concrete and is based on the relationship between the w/c ratio and the capillary porosity in the cement paste. By incorporating image processing and image analysis into the Nordtest method numerous improvements have been seen. Such as a significant reduction of the influence of aggregates and voids, as well as the ability to correct for different incident light intensities. In addition the capability to detect and quantify local variations of capillary porosity due to local differences in the w/c ratio and also to detect between poorly and properly impregnated areas of paste.

This paper extends this method from ordinary Portland cement (European CEM I) concrete to also investigate CEM I mortars and pastes as well as CEM III /B (GGBFS) concrete, mortars and pastes. Additionally the reproducibility of this method was studied by using two sets of thin sections, from the same mixes, which were prepared using two different manufacturing techniques and a different operator for each.

Keywords: w/c ratio, microscopy, image analysis, thin section, fluorescent light.

ALKALI-SILICA REACTIVITY OF AGGREGATES IN CONCRETE PAVEMENTS

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ABSTRACT

Microcracks and/or white coatings have been observed within concrete pavements on highways D1, D5, and D11 in the Czech Republic. Twenty-eight drill cores from 14 different slabs were selected for detailed investigation. Microscopic techniques (*e.g.* optical microscopy, scanning electron microscopy, and petrographic image analysis) were employed with the aim to find: (a) the micro-parameters reflecting the degree of ASR in the concrete; (b) the main rock types causing the ASR within the concrete; and (c) the cause of the different degrees of ASR.

The alkali-silica reaction (ASR) was indicated by the significant amounts of alkali-silica gels and/or microcracks in 20 out of the 28 drill cores. The other 8 drill cores show little or no signs of ASR. The ASR was attributed to three different rock types: quartz-rich volcanogenic rocks (*e.g.* tuff, tuffite, tuffitic greywacke, and tuffitic siltstone), biotitic granodiorite, and quartz aggregates. The high alkali-silica reactivity level of volcanogenic rocks is connected mainly with the very fine-grained SiO_2-rich matrix. In contrast, the alkali-silica reactivity of granodiorite and of quartz aggregates is dependent on the degree of quartz deformation and recrystallization.

INVESTIGATION OF SELF-HEALING PHENOMENA IN 'OLD' CONCRETE STRUCTURES AND HISTORICAL MASONRY MORTARS

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Abstract

This study aims to develop and apply self-healing concrete as a new method for crack control and enhanced service life in concrete structures. This concept is one of the maintenance-free methods which, apart from saving direct costs for maintenance and repair, reduces the indirect costs – a saving generally welcomed by contractors. Cementitious materials have been observed for many years to have a natural healing capability due in part to the re-hydration of previously unhydrated cement within the matrix upon re-submersion in water. In this research, the self-healing phenomenon of old concrete structures and secondary phases of newly-formed products in historical masonry mortars were investigated in a dam in Japan and old bridges in the Netherlands, respectively. Moreover, in order to understand the precipitation conditions of calcium salts in the cracks, morphology, and the shape and size of re-hydration products in the old mortar and brick, microscopy and SEM(EDS)analyses were conducted. Modified CASH phases as well as the formation of calcite were found, which increase the self-healing capability of old masonry mortar brick by both dissolution and pozzolanic reactions in cracks or pores. Furthermore, it is considered that the utilization of appropriate organic substrates for the formation of precipitated calcium carbonates is desirable as one methodology for self-healing with high strength.

Keywords: Self healing concrete, repair, historical structures, crack

DISTINGUISHING BETWEEN HYDRATED, PARTIALLY HYDRATED OR UNHYDRATED CLINKER IN HARDENED CONCRETE USING MICROSCOPY

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ABSTRACT

Hydration of clinker particles is since long a topic of interest in both designing and optimizing cement composition and its quantity used in concrete. The interest for carefully observing and also quantifying the type or stage of clinker hydration in hardened cement paste is twofold. Firstly, the characteristics of the hydration features can give useful information on the actual hydration mechanisms (e.g., diffusion versus dissolution). Secondly, considering the different hydration stages more quantitatively can help to study for example the amount of hydration or hydration rate in different types of concrete.

In this paper, it is shown that polarization and fluorescent light microscopy (PFM) and backscattered electron microscopy (BSE) can be used to quantify different clinker hydration types in hardened cement paste. Different stages or types of hydration could be distinguished in the clinker grains: (A) unhydrated clinker core without a visible hydration rim, (B) hydrated clinker 'imprint', (C) hydrated clinker core with an unhydrated clinker rim and (D) unhydrated clinker core with a clear hydration rim. These different types of clinker hydration can be quantified using point counting. In fluorescent light, the hydrated clinker zones contain more fluorescent dye compared to the unhydrated clinker parts and also to the rest of the cement paste. This suggests that the clinker may have partly or fully dissolved, creating porosity and that the hydration products have precipitated further away from the clinker particle, resulting in a less porous hardened cement paste. In other words, dissolution and precipitation processes might play a role in the hydration mechanism. Quantifying these different clinker types could also be useful for estimating for example the amount of hydration that took place, or for quantifying the 'over-capacity' of unhydrated clinker. The latter gives interesting information to possibly reduce the amount of clinker and as such lower the CO_2 footprint of concrete.

THE IMPORTANCE OF PETROGRAPHIC EXAMINATION IN COMPOSITIONAL ANALYSIS OF MORTARS

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ABSTRACT

Compositional analysis of mortar is routinely conducted to determine proportions of constituents. For modern mortars, compositional analyses are most often performed to establish mortar type, often as part of a troubleshooting investigation. For historic mortars, compositional analyses are most often performed to aid in formulating a replacement or repair mortar that is compatible with the original mortar. The compositional analyses are performed in accordance with the standard test method, ASTM C 1324, *Test Method for Examination and Analysis of Hardened Masonry Mortar*, which requires petrographic examination to complement the chemical methods of analysis.

The main functions of the petrographic examination are to determine the composition and characteristics of the aggregate and the paste/binder system, and to identify components of the mortar that would be reasonably expected to interfere with or bias the chemical analyses. The chemical analysis portion of the test method determines the amount of soluble silica, calcium compounds, magnesium compounds, insoluble material, free and combined water, and carbonates. The petrographic examination, combined with x-ray diffraction analysis of the mortar, provides the information that guides the chemist in determining how the chemically-analyzed constituents are distributed among the materials that make up the mortar.

The authors present case studies of compositional analyses of modern and historic mortars to illustrate the interdependence of the petrographic examination and the chemical analysis in producing mortar proportions.

2D-FRACTAL BASED LOGICS AND COMPUTING ARCHITECTURE FOR THE CHARACTERIZATION OF CONCRETE FINE AND ULTRAFINE PARTICLES

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ABSTRACT

The strong increase of structural and architectonic specifications, requires more and more the need to reduce construction costs, assuring at the same time manufact durability. In this perspective continuous improvement have to be made in the construction sector adopting new techniques and materials, particularly with reference to cement and concrete.
An innovative approach is proposed to detect and quantify the overall attributes of fine and ultrafine particles, currently utilized as "additives" in concrete manufacturing, and to establish possible correlations existing between the detected attributes of these particles and final concrete characteristics and behavior, strongly affecting the physical and mechanical properties of the final manufactured goods.
The work was developed with the aim to analyze fine particles resulting from different processes and characterized by different morphological and morphometrical attributes and surface characteristics. The proposed approach is based on a 2D-fractal analysis of particles population acquired as digital images. The procedure allows to perform a full measurement and control of fine particles characteristics and behavior, starting from the evaluation of statistical fractal parameters, according to particles topological assessment on a flat surface. The work was carried out to develop and implement a reliable and simple tool able to establish a correlation between fine particles characteristics, detected by the proposed logic, and those usually extracted utilizing classic methods (e.g. morphological, morphometrical, rheological analyses, etc.).

A Comparison of the Effect of Different Curing Techniques on Concrete Properties

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Abstract

This paper presents the results of a comparative study on the compressive strength of concrete tested under different curing conditions such as natural environment (ambient), water, and curing compounds. Concrete specimens in cubical and cylindrical forms are prepared and treated at various curing scenarios in order to determine their mechanical properties at 3, 7 and 28 days.

Three different types of concrete are used throughout the experimental process, namely C30, C25 and C20.

Tested specimens were cured in the UK and the Cyprus by placing them in tanks full of water, under sun exposure and under sun exposure after first being treated with a curing compound.

The results show that the effects of the curing method on the mechanical properties are highly influenced by the exposure conditions, and the different curing schemes have varying effects on the compressive and tensile strength of the concrete studied.

INFLUENCE OF DIFFERENT OPC ON THE PERFORMANCES OF A SELFLEVELLER: A CASE HISTORY.

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ABSTRACT

It is a common use when starting the production in a new plant to transfer an existing formulation in order to reach the established specification.

One of the main problem that has to be faced is to find local suitable raw materials.

Redispersible powders, retarders, superplasticizers etc, due to their “intrinsical” characteristics are usually supplied by the central headquarter, while fillers and cements have to be provided locally, to maintain a reasonable price for the final product.

The study is focused on a self-levelling compound based on a ternary binder system composed by CAC, OPC and a source of calcium sulphate.

The rheological properties of this product, normally used as underlayer for the flooring, have been strongly affected by the different characteristics of the OPC used.

In particular, a strong delay in setting time and a gel formation during the first step of the hydration have been observed.

To better understand the reasons of this behaviour, some experiments have been carried on.

Different formulations have been deeply investigated on a morphological point of view by SEM while the hydration kinetics have been followed by XRD and isothermal calorimetric tests.

FULL PATTERN CLUSTER ANALYSIS OF MULTIPLE X-RAY DIFFRACTION DATA

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ABSTRACT

Modern X-ray diffraction equipment and linear detectors allow the rapid collection of hundreds of scans in a very short time. This can be useful in application areas like mineral analysis, polymorph screening, non-ambient experiments and process and quality control. Collecting such large amounts of data it is impossible to analyze every single measurement and therefore a data reduction tool is imperative.

Cluster analysis is a method that greatly simplifies the analysis of large amounts of data by identifying the most representative scan, most different scans and outlier scans. This drastically reduces the amount of data which has to be processed because only representative scans, outliers and sometimes the most different scans have to be analyzed in more detail. Furthermore cluster analysis can be used to discover hidden patterns in the data.

This presentation will introduce cluster analysis of X-ray diffraction data and how it works. Specific examples from the cement industry will include; clinker production control, differentiation of cement compounds, cement strength indication and blended cement variability. The examples were chosen to demonstrate the benefits of this approach for various applications within the cement industry.