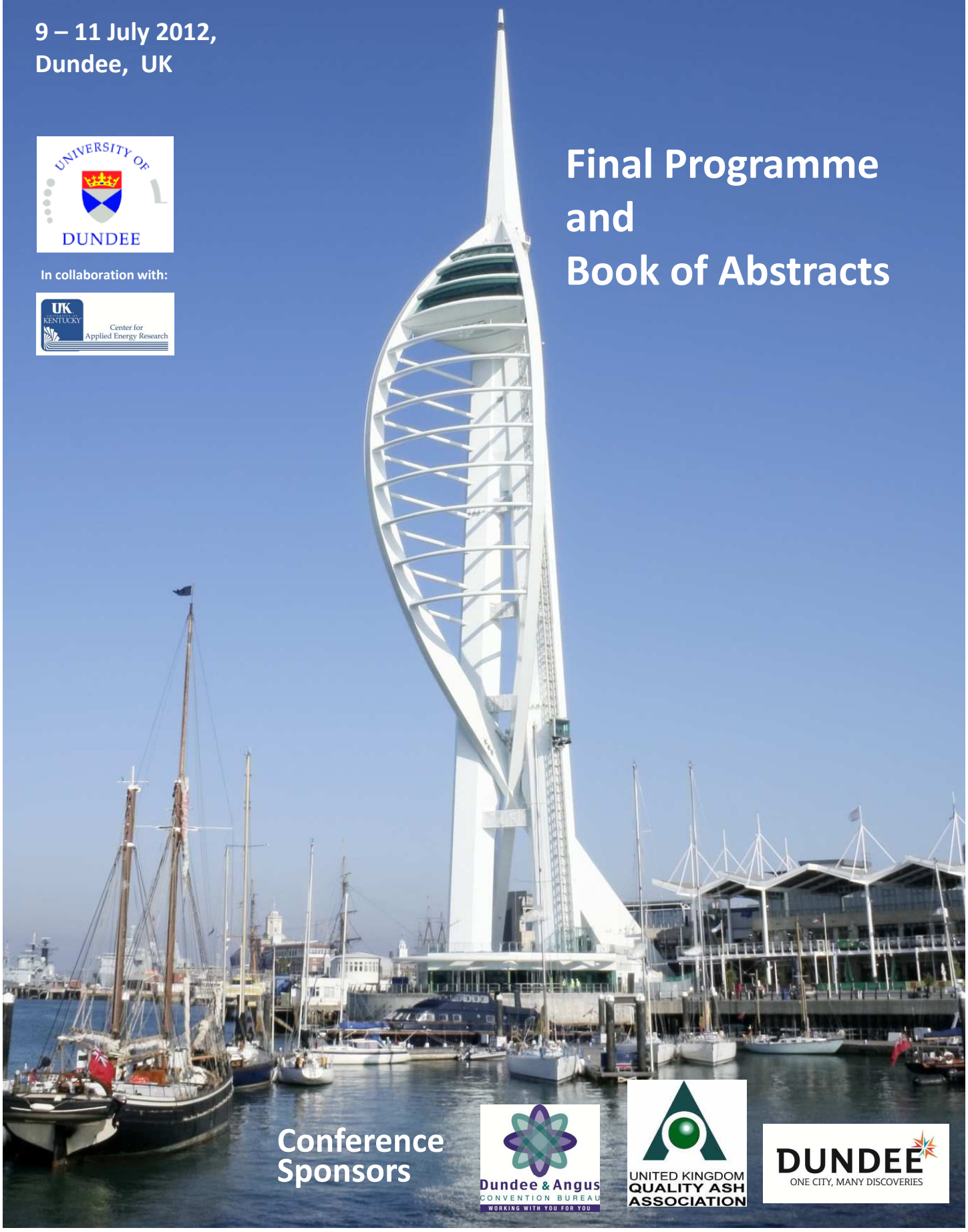
8th International Conference:

Concrete in the Low Carbon Era

9 – 11 July 2012,
Dundee, UK

In collaboration with:

Final Programme and Book of Abstracts



Conference Sponsors

Concrete is used globally and the components are widely available. The activity of construction is also global and both advanced and developing countries aspire to improve living conditions and infrastructure that consumes large quantities of energy and materials continuously. A different attitude to concrete, manufacture and use needs to be developed if we are to address, if not redress, the consequences of in-action. Concrete in some form or another is responsible for our civilised well-being. However, its manufacture and use also require substantial energy use and carbon dioxide emissions and the consequences are global. We all have a duty of care to behave responsibly and the issues of profligacy with respect to these along with related wasteful and polluting activities need to be dealt with. To do this in a committed and balanced way requires both knowledge and experience.

Dundee, over the last three decades, has provided such fora during its conferences in the field of concrete and related materials and this conference will address the causes and solutions as far as concrete and other cementitious products are concerned. Within the themes of the event, the issues of production, use, design, longevity and sustainability will be addressed. In this regard we all have to find an acceptable balance if not a solution. There would seem to be little doubt that carbon-based economies and infrastructure-driven activities will have to increasingly address these.

The University of Dundee and, specifically, the Concrete Technology Unit (CTU) has played a dominant role in exchange of information and professional interaction between all involved in concrete whatever the disciplines. This conference will be equally relevant and informative. It is an opportunity to consolidate progress and to discuss options and experience.

The CTU organised this Conference to address these challenges, continuing its established series of events, namely, Concrete: Construction's Sustainable Option, 2008, Global Construction: Ultimate Concrete Opportunities in 2005, Challenges of Concrete Construction in 2002, Creating with Concrete in 1999, Concrete in the Service of Mankind in 1996, Economic and Durable Concrete Construction Through Excellence in 1993 and Protection of Concrete in 1990.

The event was organised in collaboration with the Centre for Applied Energy, University of Kentucky from the United States of America. Under the theme of Concrete in the Low Carbon Era, the Conference consisted of six Events: *(i) Low Carbon Design of Structures and Buildings, (ii) Efficient and Sustainable Use of Resources, (iii) Infrastructure and Transportation Construction and Resilience, (iv) Structural Health Monitoring and Life Extension, (v) Security and Geohazard Engineering, (vi) Renewable Energy.* In all, a total of 150 papers were presented from 50 countries.

The Opening Addresses were given by Professor Peter Downes, Principal and Vice-Chancellor of the University of Dundee, Mr Bob Duncan, Lord Provost, City of Dundee. The Conference was formally opened by Mr David Ball, CEO of the David Ball Group and the Conference Opening Paper was presented by Mr James Aldred, Associate Director, AECOM, Australia, and the Event Keynote Papers were presented by Dr Boudewijn Piscaer, Initiator and Consultant at SUSTCON EPV, Netherlands, Professor Tom Harrison, Private Consultant, France, Dr Eng Habib Zein Alabideen, Deputy Minister, Ministry of Municipal and Rural Affairs (MOMRA), The Kingdom of Saudi Arabia, Mr Gary Lee, Fyfe (Hong Kong) Limited, China, Professor P Sukontasukkul, King Mongkut's University of Technology North Bangkok, Thailand and the Closing Paper was presented by Professor Peter Hewlett, Visiting Professor, University of Dundee and Director of Research to the David Ball Group

The support of International Professional Institutions and Sponsoring Organisations was a major contribution to the success of the Conference. The work of the Conference was an immense undertaking and all of those involved are gratefully acknowledged, in particular, the Sponsors, members of the Organising Committee for managing the event from start to finish; members of the Scientific and Technical Committees for advising on the selection and reviewing of papers; the Authors and the Chairmen of Technical Sessions for their invaluable contributions to the proceedings.

Professor Rod Jones
Conference Chairman **9 July 2012**

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VENUES, POSTER PRESENTATIONS AND EXHIBITION

The Conference is held in four parallel sessions within the Dalhousie Building of the University of Dundee. There are poster presentations in the foyer where from the venue rooms open. This is also where benchmark industrial and instrument manufacturer companies exhibit their portfolio, products and services.

LUNCHES, TEAS/COFFEES

Teas/Coffees will be served between technical sessions in the middle of mornings and afternoons in the foyer of the Dalhousie building. Lunches will be served in Room 2G11, opening from the foyer of the Dalhousie building.

CAR PARKING

A limited number of car parking spaces are available on campus (see car park locations on the campus map). If you require a permit, please ask at the Registration Desk.

CONFERENCE TIMETABLE

The Conference has a full programme of events and will be presented in parallel sessions. We ask for your co-operation in ensuring the smooth running of the Conference. Please note that it is vital that we keep to the schedule and that all sessions start promptly. On the timetable, the author who is presenting the paper is shown in bold. The session Chairman will advise of any changes to the timetable. Please note that each presentation will be for 20 minutes (15 minutes talk and 5 minutes discussion). Time will also be made available at the end of each session for further discussion. When asking questions, please state your name and affiliation.

RECEPTION AND CONFERENCE BARBECUE (by ticket only, received at registration)

Opening Ceremony (Dalhousie building)	**1045 h Monday 9 July**
Lord Provost's Civic Reception (RRS Discovery)	**1815 h Monday 9 July**
Conference Barbecue (Campus green, University of Dundee)	**1800 h Tuesday 10 July**

USEFUL INFORMATION

Taxis: 20 30 20; 50 50 50; 22 33 21; 66 93 33
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Cash dispensers (ATM) nearby: Clydesdale Bank, Nethergate (next to Queens Hotel),
Bank of Scotland, Nethergate, towards city centre
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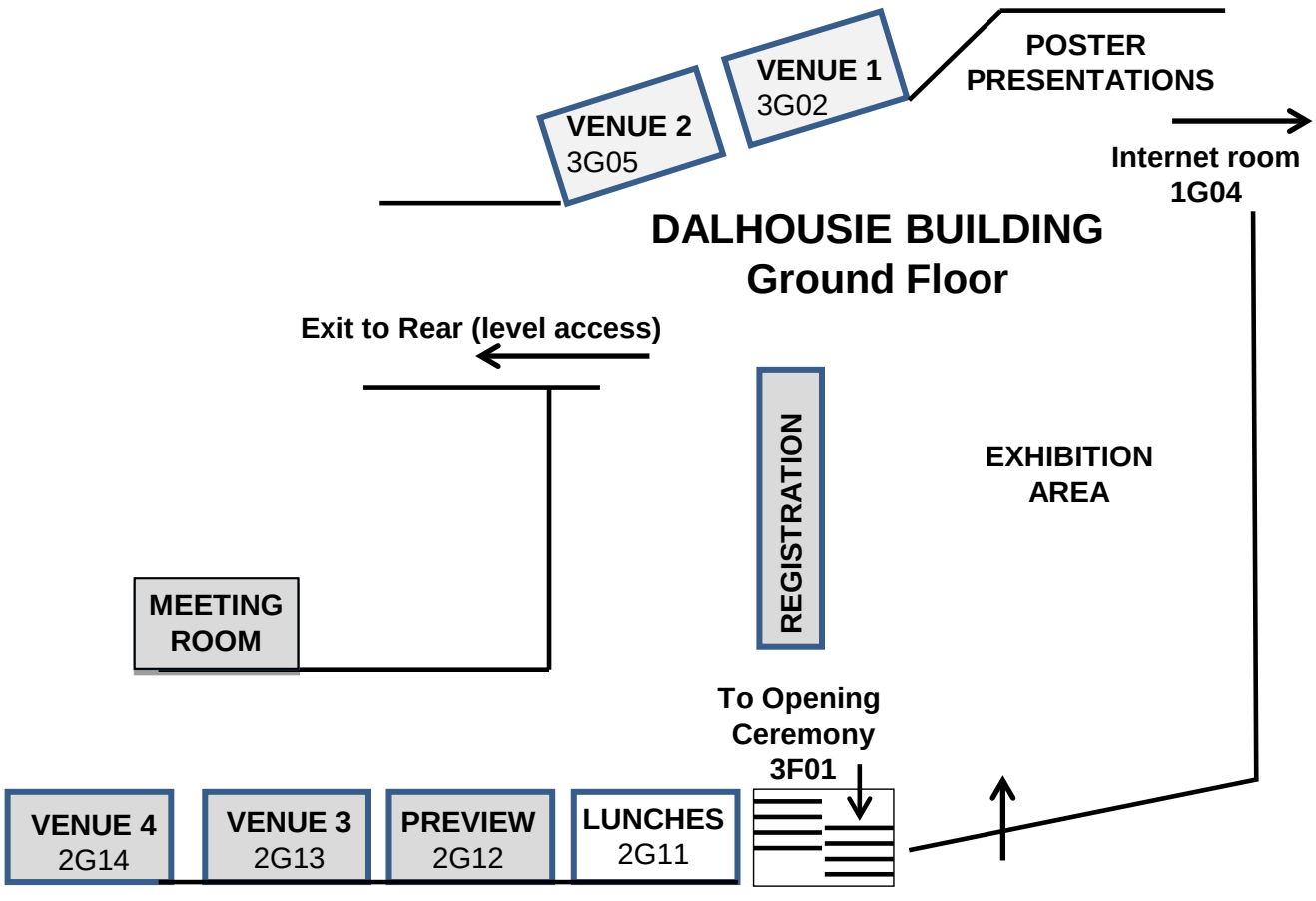
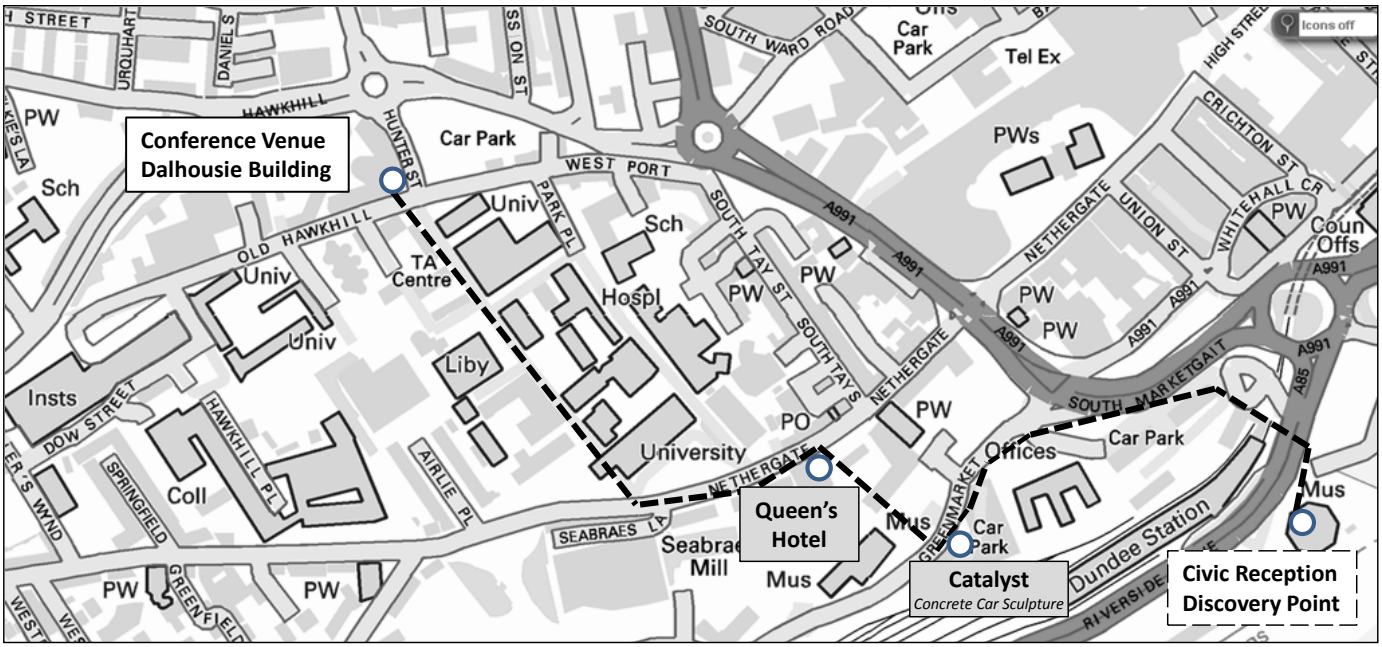
DALHOUSE BUILDING, GROUND FLOOR PLAN



ROUTE MAP TO CIVIC RECEPTION, Monday 9 July 2012, 1800 for 1830hrs

Delegates should follow the signs through the University Campus, turning right onto Nethergate until they reach the Queen's Hotel. They should then cut through the car park at the side of the Hotel, down the steps past Sensation Science Centre and head past Catalyst, the concrete car sculpture outside the Greenmarket multi-storey car park. Thereafter, head towards the Railway Station, crossing the Riverside Drive at the traffic lights and you are at Discovery Point. This is approximately 20 minutes by foot from the Conference Venue



CONFERENCE OPENING CEREMONY, Monday 9 July, 1045hrs

Chairman	*Dr Moray Newlands, Conference Secretary* *Concrete Technology Unit, University of Dundee*
1045 – 1050	**Welcoming Delegates to the Congress** ***Professor Rod Jones*** Conference Chairman, University of Dundee
1050 – 1100	**Welcoming Delegates to the University of Dundee** ***Professor Pete Downes*** Principal and Vice-Chancellor, University of Dundee
1100 – 1110	**Welcoming Delegates to the City of Dundee** ***Lord Provost Mr Bob Duncan*** City of Dundee
1110 – 1125	**Opening of the Congress** ***Mr David Ball*** David Ball Group, UK
1125-1130	**Dignitary Break**
1130 – 1200	**Conference Opening Paper** *Removing Impediments to the More Sustainable Use of Concrete* ***Dr James Aldred*** AECOM, Australia
1200	**LUNCH AND EXHIBITION**

Please note that in the following Presentation Timetable, the number below the authors refers to the page number of the abstract within this Book of Abstracts.

Conversely, below each abstract is the presentation venue and time.

Day 1:Mon 9 July		Venue 1: 3G02	Venue 2: 3G05	Venue 3: 2G13	
Slot no	1045 - 1115	Opening Ceremony			
	1115 - 1200	**Opening Paper — Removing Impediments to the More Sustainable Use of Concrete, J Aldred — 21**			
	1200 - 1300	Lunch			
		Theme 1 — Low Carbon Design of Structures and Buildings Dr Alan Richardson	**Theme 1 — Low Carbon Design of Structures and Buildings** Dr Karin Weimann	**Theme 2 — Efficient and Sustainable Use of Resources** Prof Elsabè Kearsley	
1	1300 – 1320	Reducing CO_2 by Half in Concrete B Piscaer **25 Keynote paper**	Measuring the Albedo for Different Slag Contents and Surface Finishes of Concrete Slabs A Sweeney, R P West, C O'Connor 35	Meeting the Challenge of Efficient and Sustainable Resource Use T A Harrison **57 Keynote paper**	
2	1320 – 1340	The Optimum Conditions of Steam Heat Curing Cycles on Hydration of Fly Ash Cement for the Precast Industry K Kagami, M Sato, Y Umemura 27	High Volume Slag Cement and Unwashed Crushed Rock Fine Limestone Aggregates to Produce Low Carbon Concrete for the Arabian Peninsula A S Mohammod, K A Paine, P Walker 37	The Need for Technology Transfer for Revitalized Health Safety & Environment (RHSE) in Concrete Construction: A Case of the Great Man Made River in Libya M S Tughar 58	
3	1340 – 1400	Shear Behaviour of Reinforced High Strength Concrete Beams Without Transverse Reinforcement M Hamrat, M Chemrouk, S Amziane 26	Environmental Aspects of Optimized Design of Concrete Structures P Stepanek, I Lanikova, P Simunek, F Girgle, D Horak 32	Assessment of Environmental Impact of the Addition of Photocatalytic Nanoparticles to Cementitious Materials B Y Lee, A R Jayapalan, K E Kurtis 59	
4	1400 – 1420	Effect of Water-Binder Ratio on Silicate Structures and Hydration of Silica Fume Cement M Sato, Y Umemura, K Koizumi 28	Eco-friendly Concrete with Highly Reduced Cement Content T Proske, S Hainer, H Garrecht, C-A Graubner 33	Observation of Fair-face Concrete Durability using Various Testing Methods P Reiterman, K Kolář, O Holčapek, Z Kadlecová, J Adámek 60	
5	1420 – 1440	An Experimental Study of Curing Temperatures on Workability Characteristics and Compressive Strength of Self-Compacting Geopolymer Concretes M F Nuruddin, D Samuel, N Shafiq 29	Benefits of Utilising Oil Drill Cuttings (ODC) as a Filler in PC and Ternary Cement Concrete J O Ikotun, M D Newlands, L J Csetenyi, D O Olanrewaju 38	Carbonation of Concrete: CO_2 Sequestration Potential vs Durability P Woyciechowski 61	
	1440 - 1500	Discussion	Discussion	Discussion	
	1500 - 1530	Coffee	Coffee	Coffee	
		Theme 1 — Low Carbon Design of Structures and Buildings Dr Natalie Lloyd	**Theme 1 — Low Carbon Design of Structures and Buildings** Prof Roger West	**Theme 2 — Efficient and Sustainable Use of Resources** Prof Tom Harrison	
6	1530 – 1550	To Be Sustainable: Use High Performance Concrete! R Lewis 30	Performance Evaluation of Two Types of Phase Change Materials in Cementitious Systems S Manari, N Neithalath 39	The Influence of the Surface Area of Limestone on the Physical and Mechanical Behaviour of Ternary Cements L Zeghichi, A Noui, A Lahmadi, L Belagraa 63	
7	1550 – 1610	Experimental Creep Tests on Concrete Made with Montmorillonite Nano Particles A Sprince, L Pakrastinsh, , A Korjakins 31	The Effect of Using GGBFS on Early-age Thermal Crack Control Reinforcement in Concrete K Tang, G Beattie, S Millard 40	Effects of Calcined Clay as Low Carbon Cementing Materials on the Properties of Concrete K-C Thienel, N Beuntner 65	
8	1610 – 1630	Design of Concrete Bridges for Sustainability and Durability J M Macia, S Mirza 43	Low Carbon Gound Floors for Housing: A Case Study C Shaw 42	Effects of Curing Conditions on the Durability of Slag Concrete A Bouikni, A Bali, R N Swamy, A Kasser, R Boutemeur 64	
9	1630 – 1650	Durability Performance: Models & Test Methods C A Clear 45	The Use of Concrete Filler as a Mineral Admixture in Concrete V Bilek 79	Low-carbon Calcium Sulphoaluminate Cements Synthesized from Industrial Wastes and By-products A Telesca, M Marroccoli, M L Pace, G L Valenti 67	
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1800	Civic Reception, RRS Discovery				

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Day 3:Wed 11 July		Venue 1: 3G02	Venue 2: 3G05	Venue 3: 2G13	Venue 4: 2G14
		Theme 3 — Infrastructure and Transportation Construction and Resilience Dr Diane Gardner	**Theme 2 — Efficient and Sustainable Use of Resources** Prof Peter Hewlett	**Theme 3 — Infrastructure and Transportation Construction and Resilience Theme 5 — Security and Geohazard Engineering** Prof Ian Gilbert	**Theme 5 — Security and Geohazard Engineering** Dr Laszlo Csetenyi
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Opening Paper

Removing Impediments to the More Sustainable Use of Concrete

J Aldred
AECOM, Australia

The concrete industry is keen to position itself as an integral part of the sustainable construction. Indeed, it is hard to think of sustainable development for the growing global population without thinking of concrete as the primary building material for structures and infrastructure. However, there are many impediments to the more sustainable use of concrete within projects. In fact, the contagion of excessive risk aversion and regulation sweeping the industry appears to be on a collision course with sustainably meeting the needs of the present. Sometimes even so-called “sustainable” requirements cobbled onto existing specifications may result in reduced sustainability. When asked to present the Opening Paper, I was informed that it generally sets the scene and provides a brief review of the state of the art and there is no boundary to what can be covered. I have taken this guideline seriously. This paper attempts to touch candidly on the issues facing the concrete industry in the low carbon era. As it is based on my experience and observations, it cannot help but be subjective to some extent. While I have tried to be balanced, I have also tried to avoid political correctness which so often interferes with appropriate debate about technical issues.

James has over 30 years experience in the concrete industry, working in in Australia, Asia, the Middle East, the United Kingdom and Canada. His background includes Research Scientist, Manager of the High Performance Concrete Research Group at the National University of Singapore, Technical Director and General Manager of an international building materials supplier and Technical Manager of Taywood Engineering. His responsibilities have included product development as well as technical support, training and market development, research on a range of building materials, preparation of specifications and durability plans as well as investigation of structures. James was also the Independent Verification and Testing Authority Manager for the Burj Khalifa with GHD in Dubai and currently is Associate Director in the Advanced Materials Group of AECOM based in Sydney. A Chartered Professional Engineer and a Fellow of the Institute of Engineers Australia, he is also a Fellow of the American Concrete Institute and the Institute of Concrete Technology as well as a LEED Accredited Professional

Keywords: Barriers, Concrete, Sustainability

Presentation: Opening Paper — Day 1

Theme 1 — Low Carbon Design of Structures and Buildings

Reducing CO_2 by Half in Concrete

B Piscaer
SUSTCON EPV, Netherlands

All aspects that influence the reduction of the CO_2 emissions in concrete will be mentioned briefly. Focus will however be presented on the production of the material itself in 2 main groups (i) Multiplication of "Best Practice" low clinker concrete, (ii) R & D effort towards the "State of the Art". "Best Practice" using several case studies from different geographical areas resulting in tailor made solutions will demonstrate the complexity of the subject. The interaction of all parties and academic disciplines in the ValueS Chain will be highlighted. Aspect will be dealt with such as (i) National and European regulation barriers to be resolved in order to facilitate the implementation of cross boarder Best Practice CO_2 reductions, especially in the applications of low carbon impact Supplementary Cementing Materials, (ii) human capacity development in concrete mix design such as particle size engineering and oxide engineering,(iii)supporting pillars such as developed in the European Eco-Innovation project SUSTCON EPV. The substantial CO_2 reductions from applying Best Practice will be calculated using real case stories. "R & D" will not only involve the large number of low CO_2 Non Portland Cement innovations that need to be put on the market. The demand to conduct "From Practice to Theory" R & D will be presented related with the need to bridge the gap between "Lab-Crete" and "Real-Crete". This will most likely result in more precise engineering of structures and lower the volume of concrete and rebar needed. On these efforts another figure as an objective for CO_2 reduction can be connected, justifying the ambition to half the CO_2 presently being emitted. Side effects from the ambition such as portraying concrete as an important high tech product thus attracting higher educated and motivated people will be mentioned. Finally the call will be made to improve the relation between the academic community, executive economy and policy makers.

Dr Boudewijn Piscaer is Initiator and Consultant at SUSTCON EPV, Netherlands. As an "Intrapeneur" within first German companies, he developed new markets in Europe, North America, the Caribbean and Asia. This was for high temperature resisting refractory brick. Through refractories he became familiar with the iron and steel, non ferrous metals, ceramic, glass, and especially the cement industry.

After a "Green concrete" workshop in Iceland in 1999 he combined his CO_2 reduction objectives with the application of practices from the refractory concrete. In May 2002 he organized a Green Concrete workshop and since then he presented numerous papers on Sustainable Concrete. In 2007 he discovered loopholes in the standards and a new verification methodology that could circumvent the barriers to innovations. In 2009 he initiated a European ECO-INNOVATION project proposal and united a Spanish - Dutch consortium for SUSTCON EPV (Sustainable Concrete - Environmental Performance Verified). Project previews November 2011 in Belgium and March 2012 in Madrid confirmed that substantial progress in civil concrete practice is now within reach. He consults the SUSTCON EPV project till November 2012.

Keywords: CO_2, Powder, Regulation, Sustain

Presentation: Day 1 1300 – 1320 — Venue 1: 3G02

Shear Behaviour of Reinforced High Strength Concrete Beams Without Transverse Reinforcement

M Hamrat[1], M Chemrouk[2], S Amziane[3]
1 – University Hassiba Ben Bouali, Algeria
2 – University of Science and Technology Houari Boumediene, Algeria
3 – University Blaise Pascal, France

The paper describes a study in which sixteen reinforced concrete beams without transverse stirrups were tested to failure to investigate the influences of the shear-span/depth ratio, the longitudinal steel ratio and the compressive strength of concrete on the loaded behaviour of high strength concrete in shear. Crack development and propagation were studied through continuous monitoring of the shear cracking using digital video recording. The test results show that the shear capacity depends more on the shear-span/depth ratio and the longitudinal steel ratio and relatively less so on the compressive strength in the case of high strength concrete. Among the factors that contribute to the shear resistance of high strength concrete, the aggregate interlocking contribution is found to be less than in ordinary concrete due to the nature of inclined cracking, realatively straight and transgranular in this type of concrete instead of intergranular as in ordinary concrete. Using the test results, the applicability of the different modelling approaches used in the major design codes for the contribution of high stength concrete to the shear resistance is assessed and their use as design tools for high strength concrete beams without transverse reinforcement examined.

Dr M. Hamrat is a senior lecturer at University Hassiba Ben Bouali, Chlef, Algeria. His research work concerns the structural performances of concrete with particular attention on HPC, a topic on which he has co-authored several papers recently.

Dr M. Chemrouk is a Professor at University of Science and Technology Houari Boumediene, Algiers, Algeria. His research interests include concrete deep beams, the structural properties and performances of concrete materials and the behaviour of concrete structures in seismic regions. He has published and co-authored several papers related to these topics and won a Henry Adams Award.

Dr S. Amziane is a Professor at University Blaise Pascal, Clermont Ferrand, France; formerly a senior lecturer at University of Bretagn Sud, France. His research interests cover the performances of building materials with particular reference to concrete materials and the behaviour of structures of all types. He has recently published and co-authored several papers on these topics.

Keywords: Compressive, High strength concrete, Longitudinal steel ratio, Shear span, Shear strength, strength

Presentation: Day 1 1340 – 1400 — Venue 1: 3G02

The Optimum Conditions of Steam Heat Curing Cycles on Hydration of Fly Ash Cement for the Precast Industry

K Kagami, M Sato, Y Umemura
Nihon University, Japan

This paper reports the results of an investigation of effects steam heat-curing cycles on hydration of fly ash cement for the raising efficiency of precast concrete production. The steam heat-curing conditions for the investigation were varied by changing the preset curing time (time before steam curing), temperature rise rate, maximum temperature retention time, temperature drop rate. The Compression tests were conducted on mortars made using fly ash cement under steam heating-curing conditions. The hydrate composition was measured by thermogravimetric/differential thermal analyzer (TG-DTA), selective dissolution method and X-ray diffraction (XRD) Rietveld method to clarify the influence of steam heating-curing on fly ash cement hydration. The steam heat-curing of cement incorporating fly ash accelerates the pozzolanic reaction and results in considerable increase in the one-day compressive strength. The effect of temperature drop rate predominates over other factors of steam heat-curing condition. The optimum conditions of steam heat-curing cycles that shorten the length of the precast concrete manufacturing process within the investigated range appears to be a 4 hours consisting of a preset curing time 0.5 hour, temperature rise rate 30°C/h, maximum temperature and its retention time at 65°C for 2 hours, quick cooling.

Mr K Kagami is a second-year Doctoral Course student of Civil Engineering, Graduate School of College of Science and Technology, Nihon University, Japan.

Mr M Sato is a research assistant at the Department of Civil Engineering at College of Science and Technology, Nihon University, Japan. The main fields of research are the hydration reaction analysis of cement and admixture on ultra high strength concrete.

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Keywords: Fly ash, Hydration, Precast concrete, Steam heat-curing, XRD/Rietveld

Presentation: Day 1 1320 – 1340 — Venue 1: 3G02

Effect of Water-Binder Ratio on Silicate Structures and Hydration of Silica Fume Cement

M Sato, Y Umemura, K Koizumi
Nihon University, Japan

The water-binder ratio of ultrahigh strength concrete is extremely low; therefore, the addition of low-heat Portland cement (LC), moderate-heat Portland cement (MC), and silica fume is indispensable in mixing. This research was conducted to elucidate the effects of the water-binder ratio (W/B) on the compressive strength and hydration properties concretes made with low-heat Portland cement and silica fume. The effects are discussed from the perspectives of cement hydration, investigated by powder X-ray diffraction using the Rietveld method; silica fume hydration, investigated by the selective dissolution method; and silicate-chain polymerization in calcium silicate hydrate (C-S-H), investigated by trimethylsilyl (TMS) derivatization method. When a water-binder ratio of 15% was used in the ultrahigh strength concrete, the reaction rate of SF and the amount of C-S-H generation were low, even though the compressive strength of this concrete was higher than that of concretes with water-binder ratios of 30% and 22%. The degree of polymerization of the silicate anion decreased with decreasing W/B. The addition of silica fume promoted polymerization.

M Sato is a research assistant at the Department of Civil Engineering at College of Science and Technology, Nihon University. The main fields of research are the hydration reaction analysis of cement and admixture on ultra high strength concrete.

Professor Y Umemura is a professor at the Department of Civil Engineering at College of Science and Technology, Nihon University. The main fields of research are the effect of organic and mineral admixtures on durability of concrete.

Dr K Koizumi is an assistant professor at the Department of Chemistry at College of Science and Technology, Nihon University. The main fields of research are the effect of silicate structures on hydration of cementitious materials, valuable reuse of industrial

wastes.

Keywords: C-S-H, Silica fume, Silicate anion, Ultra high strength concrete, Water-binder ratio

Presentation: Day 1 1400 – 1420 — Venue 1: 3G02

An Experimental Study of Curing Temperatures on Workability Characteristics and Compressive Strength of Self-Compacting Geopolymer Concretes

M F Nuruddin, D Samuel, N Shafiq
Universiti Teknologi PETRONAS, Malaysia

The effects of self compacting geopolymer binder systems exposed to elevated temperature are examined. Self-compacting geopolymer concrete (SCGC) is an improved way of concreting operation that does not require compaction and is made by complete elimination of ordinary Portland cement content. SCGC were synthesized from low calcium fly ash, activated by combinations of sodium hydroxide and sodium silicate solutions, and by incorporation of superplasticizer for self compactability. The present study reports the details of experimental investigation on workability and compressive strength development of SCGC. The parameters studied were water to geopolymer solids ratio, curing duration and temperature. The water to geopolymer solids ratios were 0.31, 0.33, 0.35 and 0.39. The effects of water to geopolymer solids ratio on fresh properties such as filling ability, passing ability and resistance to segregation were evaluated. The fresh properties were measured using slump flow, V-funnel, L-Box and J-ring test methods. The essential workability requirements for self-compactability according to European Federation of National Associations Representing Producers and Applicators of Specialist Building Products for Concrete (EFNARC) were satisfied. This paper also reports the effects of curing durations and temperatures on compressive strength development. The curing durations were 24, 48, 72 and 96hrs and the curing temperatures were 60, 70, 80 and 90°C. Results showed that curing duration and temperature have a significant influence on compressive strength development. The optimum curing duration and temperature for improved performance of SCGC are also reported.

M F Nuruddin is a professor and the Dean for the Faculty of Engineering at Universiti Teknologi PETRONAS. He has 28 years of teaching, research, and consultancy experience and has published more than 200 technical papers at international and national levels. Professor Nuruddin has won numerous research awards at international innovation competition and exhibition. His current interest areas are in new binders, geopolymer concrete and carbon footprint reduction initiative. He is a registered professional engineer.

D Samuel is a research assistant at the Civil Engineering Department Universiti Teknologi PETRONAS. His work in geopolymer concrete under the supervision of Professor Nuruddin has granted him an MSc degree in 2012.

N Shafiq is an Associate Professor at the Civil Engineering Department Universiti Teknologi PETRONAS. He has many years of industrial exposures in the US and Singapore dealing with designs of tall building and airport. Currently his major research interest areas are in FRP, cement replacer, and ductile concrete. He has published more than 150 technical papers and won numerous research awards at international levels.

Keywords: Compressive strength, Fly ash, Geopolymer concrete, Self-compacting concrete, Water-to-geopolymer solids ratio

Presentation: Day 1 1420 – 1440 — Venue 1: 3G02

To Be Sustainable: Use High Performance Concrete!

R Lewis
Elkem Silicon Materials, UK

This may seem like a contradiction in terms, but if we consider the design capabilities – using supplementary cementing materials to reduce cement usage; recycled aggregates and concrete; higher strengths giving reduced volume; longer lifetimes with less repairs and fewer re-builds of significant structures – then using high performance concrete is very sustainable. The paper will look at the potential of HPC – placeability, high strengths, long term durability and review a series of reference projects where its use has meant considerable savings in natural resources – including overall cost savings. The focus of the paper is to get people thinking about the value of each cubic metre – and how that can be used – rather than the simple 'cost per cubic metre'. Examples include: High Rise Towers; Parking Structures; Industrial Floors and Sprayed Concrete usage.

Robert C. Lewis is the Technical Marketing Manager at Elkem Silicon Materials. He began his career in 1978, as a field technician, for Tarmac Topmix in the UK. After 8 years and two City and Guilds exams in Concrete Technology, he was the assistant to the two Area Technical Managers for the Southern Region. In 1986 he moved to Elkem, joining the technical services of concrete operations in the UK. Currently he provides technical support to Elkem Silicon Materials' international market, covering the European and Middle Eastern Regions – and other areas as necessary. He has written, co-authored and presented numerous papers on microsilica (silica fume) and its use in concrete – including a chapter in F.M.Lea's "The Chemistry of Cement and Concrete", and has been involved in many projects world-wide. He is an ad-hoc member of a number of British Standards committees as well as the UK expert on the CEN (European Standards) committee for Silica Fume. He works on several committees of the American Concrete Institute and is currently the Chair of Committee 234 – Silica Fume. He is a Member of the Institute of Concrete Technology, an International Member of the American Concrete Institute and, in 1999 was made a Fellow of the UK Concrete Society.

Keywords: Durability, High strength, Recycled aggregates, Silica fume, Supplementary cementitious materials

Presentation: Day 1 1530 – 1550 — Venue 1: 3G02

Experimental Creep Tests on Concrete Made with Montmorillonite Nano Particles

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Riga Technical University, Latvia

The purpose of this research is to investigate and characterize the time-dependent behavior of new concrete compositions made with montmorillonite nano particles — and then comparing them with control specimens made from standard concrete. This paper presents experimental test results of the compression creep of the proposed concretes. Several concrete compositions with unconventional additives were designed and prepared. The tests were performed on both normal strength and high strength concretes. Specimens were tested in two extreme environments: in one case there was 100% humidity provided by protecting the specimens from desiccation, and in the other case specimens were air-dried and protected from any moisture. Concrete specimens were subject to load in a constant room temperature and with a constant level of moisture. The investigated properties include compression strength, modulus of elasticity, creep and creep coefficient.

Andina Sprince, Mg.sc.ing., Lecturer at RTU, Department of Structural Engineering. Acquired a Professional Master's degree in Civil Engineering, as well as a civil engineer's qualification at RTU, Department of Structural Engineering in 2009. Currently a 2nd year Phd student in the RTU Institute of Materials and Structures programme "Civil Engineering". Field of research: structural behavior of nano–modified concrete, long –term deformations.

Leonids Pakrastinsh, Dr.sc.ing., associate professor, Institute of Structural Engineering and Reconstruction, Riga Technical university, Head of Department of Structural Engineering, Convener of Technical Committee LVS/TC 30. Field of research: structural behavior of cementitious composites.

Aleksandrs Korjakins, Dr.sc.ing., professor, Institute of Materials and Structures, Riga Technical university, Head of Department of Building Materials and Units. Field of research: building materials and structures, ecological building materials, reuse of industrial waste.

Keywords: Compression strength, Creep, Creep coefficient, Modulus of elasticity, Montmorillonite nano particles

Presentation: Day 1 1550 – 1610 — Venue 1: 3G02

Environmental Aspects of Optimized Design of Concrete Structures

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The contribution describes some differences in results of practical design of a concrete structure. According to some standards for the design of concrete structures (e.g. EC2 and the original Czech standard CSN 73 1201-86) it is possible to design the structure by several methods. This paper documents the fact that even if a designed structure does not comply with the partial reliability factor method, according to EC2, it can satisfy to the reliability conditions according to the fully probabilistic approach when using the same materials, boundary conditions and the loading. The application of the fully probabilistic design approach and the verification of reliability enable the introduction of mass production with the option of control over the design procedure, and increasing quality. Individual input quantities, which are considered as random quantities with a given probability distribution (or statistical distribution parameters), can be gained by long-term monitoring and evaluation. To find the best possible design of a structure an optimising procedure (method) is appropriate to use. Economical and ecological aspects (acquisition costs, CO_2 and SO_2 emissions or embodied energy associated with concrete member production, respectively) are taken into account in objective function. The objective function has a significant influence on the obtained optimal result. Efficient design procedures can achieve not only cost savings during construction (materials and energy), erection, maintenance, disassembly and material recycling but also a more favourable environmental impact. A design example will be presented. From the example of prestressed spun concrete pole design by the partial factor method and simulation method (fully probabilistic approach according to the Eurocode) it is evident that an expert should apply a more precise (though unfortunately more complicated) design method and obtain “better” structure design.

Petr Stepanek, Prof., M.A., M.Sc, Ph.D., Head of the Department of Concrete Structures at BUT Brno. He coordinated 13 research projects and published more than 230 publications with specialisation in structural engineering, non-linear behaviour of structures, composite structures, optimization of constructions design, development of new materials and systems for building industry, programming systems for engineering tasks solution, repair, strengthening and reconstruction of constructions, identification of deterministic and stochastic systems.

Ivana Lanikova, M.Sc, Ph.D. was engaged in 5 research projects and published more than 44 publications with specialisation in optimisation of concrete structures design, integrated structure and material design, mathematical modelling of concrete structures.

Petr Simunek, M.Sc, Ph.D. cooperated on solution of 6 research projects and published more than 30 publications with specialisation in structural engineering, behaviour and design of concrete and masonry structures, management of structures risk and hazards.

Frantisek Girgle, M.Sc, Ph.D. cooperated on solution of 5 research projects and published more than 23 publications with specialisation in development of new materials and systems for building industry, composite structures, mathematical modelling of constructions and structures, design of structures.

David Horak, M.Sc, was engaged in 6 research projects and published more than 49 publications with specialisation in composite structures, development of new materials and systems for building industry (especially for load bearing structures), mathematical modelling of constructions and structures, non-linear behaviour of structures and systems.

Keywords: Concrete structures design, Environmental assessment, Optimization, Partial reliability factor, Probability based design

Presentation: Day 1 1340 – 1400 — Venue 2: 3G05

Eco-friendly Concrete with Highly Reduced Cement Content

T Proske, S Hainer, H Garrecht, C-A Graubner
TU Darmstadt, Germany

The major environmental impact of concrete is caused by the CO_2-emission during the cement production. Recent studies at the TU Darmstadt revealed that the required CO_2-emissions can be reduced significantly in ordinary concrete with normal strength. The principles of the (U)HPC design were adapted for the development of these concretes. The use of superplasticizer and high reactive cements as well as the optimisation of the particle size distribution and the reduction of the water volume allows a significant reduction of the Portland cement clinker in the mixture. Essential is the addition of mineral fillers like limestone powder to provide an optimal paste volume. In addition the already practicable substitution of the cement clinker by secondary raw materials like fly ash or furnace slag is an appropriate opportunity but limited by the availability of these resources. For the practical application of the low carbon concretes, questions must be answered regarding the workability, the strength development, the design relevant mechanical properties as well as durability aspects like carbonation of the concrete.

At the TU Darmstadt different mixtures for ordinary reinforced concrete structures were developed. It was shown that concretes with cement contents lower than 125 kg/m³ were able to meet the usual required workability, strength (app. 40 MPa) and mechanical properties. The carbonation depth of concretes with app. 150 kg/m³ was equal or lower than the depth of the DIN-standard reference concretes for exterior structures. The ecological advantages were identified, using the environmental performance evaluation. A reduction up to 50% in environmental impact compared with the DIN-Standard reference concrete mixture and a reduction of more than 65% using blast furnace cement was calculated. The application in practice was verified conducting full-scale tests in a precast concrete plant. The special requirements on workability and early strength were fulfilled with a cement content of 150 kg/m³.

Dr.-Ing. Tilo Proske is an executive employee, Institut für Massivbau, TU Darmstadt, Germany with experience as a structural engineer in Prof. Dr.-Ing. Scholz und Partner, Munich. Previously Dr Proske studied at Bauhaus-Universität Weimar.

Dipl.-Ing. Stefan Hainer, is a scientific employee, Institut für Massivbau, TU Darmstadt, Germany.

Prof. Dr.-Ing. Harald Garrecht is Chair of Construction Materials, TU Darmstadt, Germany. Previously he was chair of Construction Materials and Building Physics, Karlsruhe University of Applied Science .

Prof. Dr.-Ing. Carl-Alexander Graubner, is chair of concrete structures, Technische Universität Darmstadt, with recognition as a supervising engineer for design of massive structures - 2001, Managing Director and Associate of engineering firm König Heunisch Planungsgesellschaft mbH, Frankfurt/M. Germany

Keywords: Carbon dioxide, Carbonation, Cement reduced concrete, Durability, Green concrete

Presentation: Day 1 1400 – 1420 — Venue 2: 3G05

Analysis of Compressive Strength in Two and Three Phase Systems of Alkali Activated Composites

Radhakrishna[1], G S Manjunath[2], P S Niranjan[3]
1 – R V College of Engineering, India
2 – Gogte Institute of Technology, India
3 – MVJ College of Engineering, India

Concrete and compressed mortar blocks were prepared using alkali activated binder adopting ambient and thermal curing r without the use of conventional cement. Since concrete has solid and fluid media, it forms the two phase system. Air content makes the compressed mortar blocks a three phase system. Both the forms of materials are useful in construction industry for specific purposes. In both the cases, strength data were generated changing various parameters. It was found that compaction characteristics of the mortar are marginally affected by fluid media. The compressive strength development in compressed blocks followed a specific pattern when the degree of saturation is maintained constant. Phenomenological models were developed separately for the compressed blocks and concrete. One of the models was validated by an independent set of experimental data by the authors and another researcher. The models developed would be helpful in re-proportioning the material for the required strength at a given age.

Dr. Radhakrishna obtained his Bachelor's Degree in Civil Engineering, M.Tech in Structural Engineering and PhD in Concrete Technology. Has has 22 years of teaching expereince in various subjetcs of civil Engineering. Currently, he is the Associate Professor and Dean at Department of Civil Engineering, R V College of Engineering, Bangalore. His areas of intrest include concrete technology with particualr referecne to alternative and sustainable building materials. Presently he is guiding three research scholars. He is serving as peer reviwer for three inernatinaol journals.

Prof.G. S. Manjunath obtained his Bachelor's Degree in Civil Engineering from Bangalore University (India) and Master's Degree in Structural Engineering from Karnatak University, Dharwad (India). He has been a Faculty in the Department of Civil Engineering, KLS Gogte Institute of Technology, Belgaum, Karnataka State, India for the past 26 years. His areas of interest are Concrete Technology, Geopolymer Technology, Structural Analysis, Design of RCC Structures etc. He has served as Special Officer at Visvesvaraya Technological University, Belgaum, India. He is persuing his doctoral programme under VTU, Belgaum.

Prof. P S Niranjan obtained his bachelor's Degree in Civil Engineeering. ME in Constiurction technology. He has 24 years of teching experience in various subjects. He is an active consultant. Currently he is heading the department of Civil Engineering at MVJ College of Engineering, Bangalore. He is persuing his doctoral programme under VTU, Belgaum. His areas of intrests include concrete technology with particualr reference to FaL-G composites.

Keywords: Air content, Alkali activated binder, Compressed block, Concrete, Phenomenological model

Measuring the Albedo for Different Slag Contents and Surface Finishes of Concrete Slabs

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1 – Trinity College Dublin, Ireland
2 – Ecocem Materials, Ireland

This paper presents a review of ongoing research at Trinity College into measuring the effects of slag content and surface finish on concrete albedo, that is, the solar reflectance of concrete. There is a number of advantages to improving the albedo of surfaces which includes the reduced need for air conditioning thus reducing energy consumption, and mitigation of the urban heat island effect. The amount of light reflected back into the universe can be converted into an equivalent reduction in CO_2. The effect of the composition of concrete on the solar reflectance has been researched by others however this research is limited. The objective of this research is to quantify the improvement in albedo in concrete containing different quantities of ground granulated blast furnace slag (GGBS) (which is a cement lighter in colour) with different surface finishes. Four different percentages of GGBS and four different surface finishes representative of different applications of exposed horizontal concrete surfaces are investigated. A number of instruments is being evaluated over the course of the study as to their efficacy in measuring the albedo of the concrete samples, including a lux meter, albedometer, infrared camera and thermocouples. The surface moisture of the slabs (which affects their greyness) is being recorded using a moisture meter and the hours of sunshine using a sunshine duration sensor. Preliminary results of the lux meter, thermocouples and sunshine duration sensor indicate their sensitivity and reliability. It may be concluded that the surface finish has a measurable effect on the temperature of the specimens and that the specimens containing the higher percentages of GGBS recorded the lowest temperature increase under sunlight. It was also observed that direct sunshine is necessary to take light reflectance readings as the presence of cloud has a significant impact on the accuracy of the results.

Angharad Sweeney is a graduate of Trinity College Dublin in civil, structural and environmental engineering. She is currently a PhD researcher in TrinityHaus, the research centre for innovation and sustainability in construction. Her topic of research is the albedo effect on concrete.

R P West is an Associate Professor at The Department of Civil, Structural and Environmental Engineering at Trinity College Dublin and is currently Director of the Structural Laboratories and a former Head of Department. He is on the Examinations committee of the ICT and the Editorial Board of the Magazine of Concrete Research. His research interests lie in concrete durability and innovation and he has over 120 peer-reviewed publications

Ciara O'Connor is the Environmental Manager of Ecocem Materials; manufacturer of GGBS cement. She also manages EmissionZero, which advises Irish businesses on Carbon Reduction. Although from Dublin, Ciara has previously worked for the Carbon Trust in the UK, advising public sector organisations on strategic emissions reduction and legislative compliance issues. She is a graduate in Botany (BA) and Environmental Science (MSc) from Trinity College, Dublin

Keywords: GGBS, equivalent reduction in CO_2, heat island effect, solar reflectance, surface finish

Presentation: Day 1 1300 – 1320 — Venue 2: 3G05

Study of Environmentally Friendly High-strength Concrete

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Taisei Corporation, Japan

The spreading awareness of green issues in recent years has prompted us to develop environmentally friendly concrete: a high-strength concrete that contains high volume of by-products. Compressive strength tests were conducted using mortar and concrete specimens containing various by-products. As a result, compressive strength exceeded 100MPa even at the high cement replacement ratio of 70%. CO_2 emissions from the component materials of this environmentally friendly high-strength concrete were estimated to be 60% of the emissions for conventional high-strength concrete.

Yutaka Yoshida is a researcher in the Technology Centre of the Taisei Corporation, Japan. His reserch interests include high strength concrete, quality control of concrete, durability of concrete and environmentally friendly concrete.

K Yamamoto, H Jinnai,S Kuroiwa, K Tsujiya, are all researchers in the area of concrete durability and environmentally friendly construction in the in the Technology Centre of the Taisei Corporation, Japan.

Keywords: By-product, CO_2 emissions, Environmentally friendly, Estimation, High-strength concrete, Strength prediction model

High Volume Slag Cement and Unwashed Crushed Rock Fine Limestone Aggregates to Produce Low Carbon Concrete for the Arabian Peninsula

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1 – Xtramix Concrete Solutions, UAE
2 – University of Bath, UK
3 – BRE CICM, UK

Portland cement is the main contributor to the carbon footprint of concrete produced in the Arabian Peninsula. This study has considered a binder consisting solely of GGBS as an alternative to current cements in the production of structural grade concrete. Unwashed limestone crushed rock fine aggregate with a fines content of 10% by mass was also used in the concrete and compared with concrete made using aggregate that is currently acceptable by the local industry standards with only 5% fines content. The hardened and durability properties of concrete containing the GGBS cement and higher fines content have been found to be of an acceptable level. Implementation of the findings of this work to the production of concrete in the Arabian Peninsula will contribute greatly to a sustainable environment due to reduced use of Portland cement and elimination of the washing process for sand.

Abu Saleh Mohammod is a PhD student with the University of Bath and the Technical Manager, Xtramix Concrete Solutions, UAE. He has been working in the concrete and construction industry for last 20years. He has an MSc in concrete technology from the University of Dundee and a member of the Institute of Concrete Technology.

Dr Kevin Paine is a Senior Lecturer within the BRE Centre for Innovative Construction Materials at the University of Bath. Dr Paine specialises in the field of sustainable concrete technology and has carried out research in the use of low carbon cements, recycled and secondary aggregates and innovative concrete technologies.

Professor Pete Walker is Director of the BRE CICM. Professor Walker has gained extensive research experience in the field of structural masonry, timber engineering and sustainable building materials and technologies over the past 20 years in the UK, Australia and Zimbabwe.

Keywords: Compressive strength, Durability, GGBS, Portland cement, Unwashed sand

Presentation: Day 1 1320 – 1340 — Venue 2: 3G05

Benefits of Utilising Oil Drill Cuttings (ODC) as a Filler in PC and Ternary Cement Concrete

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1 – University of Witwatersrand, South Africa
2 – University of Dundee, UK
3 – Lagos State Polytechnics, Nigeria

This paper explores the benefits of utilizing oil drill cuttings as filler in Portland cement and ternary cement concretes. Hardened concrete properties such as compressive strength, permeation (water sorptivity and water penetration), rapid chloride permeability and carbonation were investigated. The study was conducted in two parts; 0, 5, 10 and 20% replacement of PC with oil drill cuttings (ODC) as filler and 10% ODC replacing ground granulated blast furnace slag (GGBS) and Fly Ash. All the mixes were designed with superplasticiser at fixed water/cement ratio of 0.5. Significant improvements were recorded for fresh properties for all the concretes. The influence of ODC on hardened properties of all the concretes was negligible. The investigation shows limitations and potentials in utilisation of oil drill cuttings as a cement replacement both in PC and ternary concrete.

Ikotun Jacob Olumuyiwa is a former student at Concrete Technology Unit, University of Dundee, Scotland, United Kingdom where he obtained MSc. in Concrete Engineering and Environmental Management. He is currently a doctoral Student at Civil and Environmental Engineering Department, University of the Witwatersrand, Johannesburg, South Africa and currently researching into service life modelling and durability assessment of reinforced concrete structure in Sub-Saharan Africa.

Moray Newlands is a Lecturer in the Concrete Technology Unit, University of Dundee. His research interests focus on utilising waste materials in concrete and added value applications in construction.

Laszlo Csetenyi is a research/teaching fellow at Concrete Technology Unit, University of Dundee. His main areas of interest include cement and concrete science and binder technology with emphasis on stabilisation and solidification processes as well as practical use of secondary materials in construction

Olanrewaju Deborah Olukemi obtained BSc in Building from Obafemi Awolowo University, Ile-Ife in 1997 and MSc in Construction Technology from University of Lagos, Nigeria in 2007. She is a lecturer at Building Technology Department, Lagos State Polytechnic, Nigeria.

Keywords: Concrete, Filler, Oil drill cuttings

Presentation: Day 1 1420 – 1440 — Venue 2: 3G05

Performance Evaluation of Two Types of Phase Change Materials in Cementitious Systems

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Increasing energy demand is one of the important 21st century challenges for the developing and the developed world. A significant portion of the energy used in commercial or residential buildings is spent on heating or cooling the interior space. Considerable energy savings can be realized if the heating and cooling loads in buildings can be controlled. One potential methodology to attain this objective is through the use of phase change materials (PCM) in building components. PCMs are latent heat thermal storage materials that store energy when subjected to temperatures in excess of their melting point by changing from the solid to the liquid state. The stored energy is released when the temperature drops below the melting point of the PCM. This study investigates the feasibility of using PCMs in cementitious systems to control the indoor thermal environment. Two different PCM incorporation methods – one using a microencapsulated powder, and another through impregnating porous aggregates with PCM – are evaluated. Differential scanning calorimetry (DSC) is used to understand the enthalpies associated with the pure PCM and the cement paste system incorporating the PCM. Semi-adiabatic calorimetry results are used to understand the influence of the PCM in altering the early age cement hydration reactions, which might beneficially influence early-age thermal cracking. Studies on small-scale slab systems to quantify the internal temperature reduction efficiency as a function of PCM type, dosage, and incorporation method is also reported.

Shilpa Manari is a Masters student in the Department of Civil Engineering at Clarkson University, Potsdam, NY. Her research interests are in thermally efficient concretes, characterization of the pore structure, and the beneficial effects of PCMs in concrete.

Dr. Narayanan Neithalath is an Associate Professor in the School of Sustainable Engineering and the Built Environment at Arizona State University, Tempe, AZ. His research interests are in the development and characterization of novel cementitious materials, performance evaluation and modeling of cementitious systems, computational materials science of concretes, and development of sustainable energy efficient concrete systems.

Keywords: Differential scanning calormetry, Enthalpy, Lightweight aggregate, Microencapsulation, Phase change materials

Presentation: Day 1 1530 – 1550 — Venue 2: 3G05

The Effect of Using GGBFS on Early-age Thermal Crack Control Reinforcement in Concrete

K Tang[1], G Beattie[2], S Millard[1]
1 – Xi'an Jiaotong-Liverpool University, China
2 – Arup, UK

As the biggest steel producing country, China accounted for half of the global steel production in 2009. As waste material in the steel manufacture process, over 160 million tonnes of blast furnace slag is generated in China every year. Of this total only 55% is recycled. The unwanted blast furnace slag would cover an area of 600 hectares annually if heaped 10 meters high. Blast furnace slag, ground to an appropriate fineness, can be used as a partial replacement cementitious material in concrete. In China, the major part of ground granulated blast furnace slag (GGBFS) however ends up in low-grade construction applications, including: (i)"Low heat" cementitious material in low-grade bulk concrete; (ii) Cementitious material in mortar. GGBFS has a slower reactivity than cement, which reduces the peak hydration temperature and as a result decreases the early age thermal loads experienced by concrete. The potential for using GGBFS in in-situ concrete slabs to minimise the use of more expensive supplementary thermal crack control reinforcement is being investigated at Xi'an Jiaotong-Liverpool University (XJTLU). The objective is to determine the 'optimum' GGBFS mix proportion which could result in the minimum level of crack control reinforcement.

Dr Kangkang Tang is a lecturer at Xi'an Jiaotong-Liverpool University. He has 4 year experience in China and 3 years in the UK in both design and construction, including new build and refurbishment. He got his PhD in the Department of Civil Engineering at the University of Liverpool and his research interests include cement replacement materials and the use of construction and demolition waste as aggregate in concrete.

Professor Steve Millard is Head of Department of Civil Engineering at Xi'an Jiatong Liverpool University in Suzhou, China. Previously he was a professor at the University of Liverpool, where he worked for 29 years. He has research interests in sustainable construction, in nondestructive testing of reinforced concrete structures, including corrosion assessment, and in blast and impact resistant concrete structures.

Dr Greg Beattie is an associate director at Arup (Liverpool) and he has 25 years' experience in the delivery of a wide range of engineering projects. He is an honorary fellow in the Department of Civil Engineering at the University of Liverpool and an industrial supervisor for a variety of research projects.

Keywords: GGBFS, Thermal crack control reinforcement, Thermal stresses

Presentation: Day 1 1550 – 1610 — Venue 2: 3G05

Methods to Produce Low Carbon Two Stage Concrete

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During the last decades, the concrete industry has been widely developing in many ways such as the methods of pouring concrete in order to achieve high quality concrete and low cost. Some new concretes have been produced which are completely different from the conventional concrete in the method of mixing, pouring with no need for the normal compaction methods which require more labour, tools and higher cost. This paper presents two special types of concrete: Two-Stage Concrete and Rock Filled Concrete and demonstrates the advantages and special requirements for each of the two special types of concrete and their uses. The cost of Two-Stage concrete is less than the cost of normal concrete and there is no need for compaction or vibrating the concrete. Also, the risk of having aggregate segregation is completely avoided since the coarse aggregate is placed before adding the other remaining concrete constitutes. The use Rock Filled Concrete gives many advantages that related to quality, cost and environment. The RFC gives low heat of hydration because the use of its low cement content makes it more easier to ensure temperature control and allows continuous pouring of SCC and a reduce in the construction time

Hakim S. Abdelgader is Professor of Civil Engineering Department at Tripoli University, Tripoli, Libya. He received his MSc and Ph.D. degrees in 1990 and 1996 respectively from Gdańsk University of Technology, Gdańsk, Poland. The main focus of his professional activities is on research interests concrete technology and technology of concrete elements. Has devoted his international experience with concrete to improve construction in his native Libya through the use of two-stage concrete technology (Preplaced aggregate concrete), concrete mix design, self-compacting concrete, Concrete with recycled materials and concrete casing in fabric forms. He is a voting member of American Concrete Institute (ACI) Committees 221, 304, 444 and 555. and a reviewer and contributor to ACI, Elsevier and ASCE publications.

Ali S. El-baden Assistance Professor and a senior concrete technology researcher at the Department of Civil Engineering Faculty of Engineering Tripoli University,Libya. Interested field of researchers in concrte area includes; time dependent deformations ; utilization of pozzolanic materials ; industrial wastes and recycled materials in concrete industry ; using preplaced aggregate technology in concrete.

Keywords: Mass concrete construction, Rock filled concrete, Self-compacting concrete, Two-stage concrete

Presentation: Day 2 1120 – 1140 — Venue 2: 3G05

Low Carbon Gound Floors for Housing: A Case Study

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The Paper describes the design and construction of the world's first fully integrated super insulated flexibly detailed hybrid reinforced concrete ground floor slabs for a housing development which incorporated 'underfloor heating' within the structural slab. This design provided a low cost low carbon floor which was constructed faster and easier than the previous slabs used for this type of development. The five house types were all designed using the same system. The first layer comprised super insulated carbon enriched units, which were laid on a sand blinded base of previously excavated material. The units each stand on integral legs, giving an air space under the main insulation, and interlock to give a thermal break within the thickness of the insulation. The next layer was the polythene damp proof membrane. New, specially designed soft formwork spacers were placed on the membrane and these hold a mix of flexibly detailed bar reinforcement combined with sheets of welded steel fabric reinforcement for economy. The underfloor heating pipes were fixed to the reinforcement in a specified pattern provided by the manufacturer to give individual heating control to each room on the ground floor of the house. The concrete was then poured and power floated to give the finished floor surface. The thermal mass of the concrete greatly enhances the storage capacity of the floor and reduces the thermal drift, giving a more comfortable environment. This design achieved a low cost low carbon floor.

Chris Shaw is a Chartered Civil Engineer and a Chartered Structural Engineer practising as a Consultant. He has more than 35 years experience in achieving the specified cover to the reinforcement in reinforced concrete structures, and devised the system for achieving this which was subsequently published as British Standard 7973 in 2001. He is now Chairman of the committee that prepared the Standard and gives advice, lectures, and training on the subject. He continues to carry out research and development on the products, their applications and innovative uses worldwide.

Keywords: Flexible detailing, Hybrid, Insulation, Low carbon, Spacers

Presentation: Day 1 1610 – 1630 — Venue 2: 3G05

Design of Concrete Bridges for Sustainability and Durability

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McGill University, Canada

Sustainable and durable infrastructure facilities, including bridges, require optimum use of all resources during all phases of the project with savings in energy and water consumption. These involve planning, design, construction, maintenance, operations, repair and rehabilitation, and finally decommissioning and disposal of the debris at the end of its service life. Design of a sustainable and durable bridge structure requires consideration of a few feasible alternatives to develop an optimum option to fulfill all of the relevant limit states, with the most optimum life-cycle performance and the lowest life-cycle costs. The current national standards do not account for the anticipated increases in operating loads and the increasing deterioration of bridge structures over their service life. While these standards emphasize quality control in the choice of materials, design and construction, they do not provide guidance and scientific tools to design and maintain a bridge structure for durability over its service life, and include only prescriptive tools for preventing or minimizing some deterioration modes. This research program integrates sustainability and durability requirements in the design of a conventional bridge structure in a cold climate country, subjected to the various mechanical, natural and man-made loads and an aggressive environment, and considers the performance of the various materials and structural components over the design service life. The latest available models of the relevant deterioration modes have been incorporated in the life-cycle performance and design considerations. The basic procedure adopts a multiple protection strategy for all deterioration modes, resulting from the related aggressive actions, and integrates durability considerations with structural calculations for the final design and defines maintenance strategies and any needed supplementary protection techniques. The procedure is illustrated in a worked out design example, summarized in the paper.

Juan Manuel Macia obtained his title as Civil Engineer in 2003 at the National University of Colombia. He is currently finishing his Master of Engineering Program with emphasis in Structures and Construction Materials at McGill University. His professional experience has been related to Structural Design and Bridge Engineering.

Saeed Mirza is a professor of Civil Engineering and Applied Mechanics at McGill University. His specialty is structural engineering and rehabilitation of infrastructure, with special interest is the state of public structures like ports, bridges, roads and sewer systems. He has won awards for outstanding teaching and for contributions to the field of structural engineering. He joined the Department of Civil Engineering at McGill University in 1966 after working for a consulting engineer and the Public Works Department in Pakistan.

Keywords: Aggressive environment, Bridge design, Durability, Reinforced concrete, Sustainability

Presentation: Day 1 1610 – 1630 — Venue 1: 3G02

Rheological Measurement of Fresh Portland Cement Concrete Using Direct Shear Box Tests

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2 – Government of Karnataka, India

Generally the rheological properties of fresh concrete are described by the Bingham's parameters, namely yield stress and plastic viscosity. But, there is no concurrence in the measurement of rheological properties by various rheometers, besides, the stimulus provided to concrete during testing is dynamic. Systematic study of rheological properties using specially fabricated customised direct shear box is used for fresh Portland cement concrete in this study. The uniqueness of the procedure is that after finding the peak shear stress, the shear stress at zero normal stress and at zero displacement rate was found before finally finding the rheological properties. The important characteristics of the test are the very low shear rate applied on the specimen during testing which is similar to the condition experienced by the concrete in the field and also the static condition of the test. The water was varied from 160 to 190 l/m^3 and cement content from 300 to 450 kg/m^3. Different displacement rates (5 to 25 mm/min) and normal stresses (0.015 to 0.035 N/mm^2) were used. Total numbers of trials considered were 162. The rheological properties were obtained immediately after mixing and for few mixes after a lapse of 40 minutes and 60 minutes after through mixing. The results show that fabricated customised medium size direct shear box can be used as a new tool to find the relative values of yield stress and plastic viscosity of fresh concrete effectively as a static test with low shear rate and can be an alternative in place of rheometers with high shear rate. The values are higher as compared to the values obtained by other rheometers. However the trends are very similar to the studies using rheometers i.e., significant decrease in rheological properties as the paste content increases. Also thixotropic behaviour is clearly observer with elapsed of time.

Dr. S. Girish is Professor in the Department of Civil Engineering, B.M.S College of Engineering (BMSCE), Bangalore. He has worked on Self- compacting concrete for his doctoral work. He has published research papers in various National and International Journals and in Conferences. He was the recipient of Karnataka state academic award for the best project in the year 2009 and 2011. His research interests include Fly ash characterization, Self-compacting concrete, Bacterial concrete, Pervious concrete and Geopolymer concrete

Mr. Santhosh, B. S is pursuing his doctoral work on rheological properties of fresh concrete using direct shear box. Presently he is a Assistant Professor in the Department of Civil Engineering, JSS Academy of Technology Education, Bangalore. His areas of interest include SCC, Pervious concrete and Rehabilitation of Structures.

Mrs. Shobha.L, is at present working as Assistant Engineer, Irrigation Department, Government of Karnataka,Bangalore.She completed her Master's degree from SJCE in Industrial Structures. Her areas of interest include SCC, Rheology of fresh concrete, Pervious concrete and Rehabilitation of Structures.

Mr. Vinay Kumar is a Post graduate student in Construction Technology from B.M.S. College of Engineering, Bangalore. His research interest includes SCC, Rheological properties of fresh concrete and Green building and its implementation.

Keywords: Direct shear box, Plastic viscosity, Rheology, Rheometers, Yield stress

Durability Performance: Models & Test Methods

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For reinforced concrete the environmental conditions that lead to corrosion of reinforcement, such as carbonation or chloride ingress, are recognized as well as those environmental conditions such as aggressive soil or freezing and thawing that lead to the deterioration of concrete itself. Although a complete understanding of all the deterioration mechanisms that affect concrete is some way off there are simplified models for some aspects of deterioration. The simplified models will only be useful where they can incorporate materials performance coefficients that can be obtained in a robust, repeatable and reproducible manner. For this reason it is important to continue to develop and standardize performance tests and models such that the results are both reliable and meaningful. At this time tests for chloride diffusivity, carbonation resistance and freeze thaw parameters have yet to be fully standardized at the European level, although European Technical Specifications are available and are being assessed. In some European Countries an equivalent performance concept has been adopted, a concept that formalizes testing of a proposed concrete to demonstrate performance of not less than a reference concrete of established durability. Formalised guidance for this concept at the European level is likely to be the most practical move towards performance based specification prior to the establishment of indicative performance criteria.

Chris A Clear BSc PhD CEng MICE FIMMM FICT is the Technical Director of the Mineral Products Association, UK and is a member of British and European Standardisation Committees concerned with concrete. Main subject areas of interest are concrete production, technology and all aspects of durability and performance.

Keywords: Carbonation, Chloride, Freeze-thaw, Standards, Testing

Presentation: Day 1 1630 – 1650 — Venue 1: 3G02

Performance of Self-compacting Concretes Under Acid Environments

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2 – JNTU College of Engineering Hyderabad, India

The objectives of the work described in this paper were to compare the performance of Self Compacting Concrete (SCC) and vibrated Normal Concrete (NC) of M20, M30 and M70 grades immersed in acidic solutions. Self compacting concrete was developed using Nan-Su method of mix design and normal concrete was developed using IS method of mixed design. The cured self compacting concrete and normal concrete specimens of different grades viz. M20, M30 and M70 concrete were kept exposed to 2% and 5% solutions of both sulfuric acid and hydrochloric acids respectively upto 28 days. The response of the specimens to the solutions was evaluated through change in appearance, weight, compressive strength and solid diagonals. For determining the resistance of concrete specimens to aggressive environment such as acid attack, the durability factors such as Acid Strength Loss Factor (ASLF), Acid Attacking Factor (AAF), Acid Weight Loss Factor (AWLF) and Acid Durability Loss Factor (ADLF) were proposed in this investigation. In order to normalize the concentrations (normalities), Weighted Acid Durability Loss Factor (WADLF) was evaluated. It was noted from the durability studies there is almost all the cases the loss in durability is reduced with increase in grade of concrete. Further, a comparison of SCC and NC mixes has shown a good performance of SCC specimens as against NC specimens.

S Venkateswara Rao is an Assistant Professor in the Civil Engineering department of National Institue of Technology, Warangal, A.P, India.He received his PhD from Jawaharlal Nehru Technological University, Hyderabad, India. His research interest is in the field of self compacting concrete.

M V Seshagiri Rao, Professor, Dept. of Civil Engg., J N T U College of Engg., Hyderabad, A P, India. He has 23 years of teaching experience and published 80 papers in various journals and published one text book.

D Ramaseshu, Professor, Dept. of Civil Engg. NIT Warangal, A P, India. He has 20 years of teaching experience in the field of civil engineering.

P Rathish Kumar, Associate Professor, Dept. of Civil Engg. NIT Warangal, A P, India. He has 15 years of teaching experience in many aspects of civil engineering and is a peer reviewer for several journals.

Keywords: Acid durability factor, Normal concrete, Self-compacting concrete

Special Additions in High Performance Concrete

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Exploring the relationship between concrete mix proportions and performances is a fundamental step toward a full sustainability based assessment of structures. In this context, the present paper studies the effect of using addition in laboratory made high performance concrete. The study is focused on concrete mixes based on limestone cement including fly ash and finely ggbs as addition to concrete. It is shown that using specifically selected proportions of constituent materials may help saving clinker in high performance concrete by reducing its amount to typical contents available in ordinary concrete. Some limitations are also shown taking into account mechanical performances at young ages and durability related performances.

Professor Antonio Principallo, CTG - Italcementi Group, Italy, gained a degree in Chemical Engineering from the University of Pisa in 1999 and has presented several research papers published on cement based materials in journals and conference proceedings. In 2001, he spent 6 months at TU Delft University and gained his PhD in 2002 in Engineering of Materials from Polytechnic of Milan, Italy. He is currently manager or research projects at C.T.G. and is active in CEN and UNI standardisation committees CEN/TC104 (SC1, SC1/TG17, SC1/TG19); CEN/TC51 (WG6/AHG, WG12, WG12/TG1, WG12/TG5, WG14).

Keywords: Addition, Concrete, Durability, Modeling, Sustainability

Presentation: Day 2 0920 – 0940 — Venue 2: 3G05

Effect of Mineral Additives on Hydration Heat of Concrete Mixtures

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The investigation of Portland cement with different mineral additives used for the massive concrete structures are presented in the paper. The type of cement type and ambient temperature influence on the hydration heat of concrete mixture was determined. The laboratory experiments with different additives for cement were carry out: slag up to 20% (CEM II/A-S 42,5 N), limestone up to 20% (CEM II/A-LL 42,5 R), slag from 66 to 80 % (CEM III/B 32,5 N) and without mineral additives (CEM I 42,5 R). Also the industrial experiments with designed concrete mixtures and the modeling of concrete temperature during cement hydration where carried out. The investigation of concrete mixture temperature regime during a massive concrete structure construction and curing time were performed. Cement type and mineral additives influence on the hydration heat of concrete mixture was determined. The results suggests the hydration heat of concrete mixture is highest with cement without mineral additive (CEM I 42,5 R) and the lowest with cement with the maximum amount of slag (CEM III/B 32,5 N). Modeling of heat release from hardening concrete mixture derived the use of lower activity cement with a larger amount of slag (CEM III/B 32,5 N) stands higher than the heat content of the slag with Portland cement concrete with a smaller amount of slag (CEM II/AS 42,5 N) for requiring larger quantities of cement in concrete mixture. It was found that the used retarder has not a significant effect on hydration heat of concrete mixtures with slag cement. Concrete thermal regime modeling results and temperature measurements in a concrete structure has shown that the temperature in massive concrete structure with slag cement with up to 20% slag addition reaches 61 °C. The massive concrete structures with slag additives (CEM II/A-S 42,5) can be concreted without special cooling technology in average ambient temperature under 15 °C.

Gintautas Skripkiunas, is Associate Professor at the Department of Building Materials, Vilnius Gediminas Technical University, Lithuania

Dzigita Nagrockiene is Associate Professor at the Department of Building Materials, Vilnius Gediminas Technical University, Lithuania.

Giedrius Girskas is a PhD student at the Department of Building Materials, Vilnius Gediminas Technical University, Lithuania.

Keywords: Compressive strength, Density, Hydration heat, Portland cement, Slag

Presentation: Day 2 0900 – 0920 — Venue 4: 2G14

Tests on Stub Columns of Concrete-filled CHS Sections

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Constantine University, Algeria

The behaviour of stub columns of concrete-filled circular hollow sections (CHS) subjected to axial load was investigated experimentally. A total of 13 columns were studied. The main parameters varied in the tests are: length of columns, concrete resistance and loading mode. The main objectives of these tests were threefold: firstly to describe a series of tests on composite columns; and secondly, to analyze the influence of several parameters such as loading mode and length columns on the behaviour of circular stub concrete-filled. And finally, to compare the accuracy of the predictions by using Algerian code DTR-BC, European code EC4, AIJ Japan code and Chinese code. Experimental results indicate that the length columns and loading mode have significant influence on the compressive load and the ductility of steel tube. A disparity of results is obtained with the different design codes.

Dr M Mimoune is a Professor of steel and composite structures, Civil Engineering Department, Constantine University. Algeria.

Dr F Z Mimoune is a Professor of Steel Structures, Civil Engineering Department, Constantine University. Algeria.

Keywords: Axial loading, Composite columns, Design code, Ductility, Failure mode

Contribution of precast concrete products to the good quality of indoor air

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The aim of this study is to provide experimental results on regulated dangerous substances release and information on the release mechanisms of precast concrete products. The health and environmental aspects of construction products are closely considered by the European institutions driven by the consumers' requests. The Construction Products Directive includes in the third essential requirement "Hygiene, Health and the Environment" the obligation for a construction to be design and build in order to avoid emissions from hazardous substances. Different Member States have regulations and assessment procedures that are being harmonized by the European Standardization. It concerns harmonization of measurement and testing standards and assessment procedures. In addition, a suitable labeling based on these environmental indicators is supposed to be developed and addressed to the consumers to provide information and advice on construction product performance. All of these provisions will have to maintain a well balance between the consumers' need of information and the cost increase of construction products due to the extent of assessment procedures and. It is especially the case for products made with mineral raw materials that are used in concrete. Different precast concrete products for buildings were tested according to standardized test methods. The behavior of precast concrete products regarding their emission into indoor air is discussed including the type of environmental indicator declaration. These results may support the European institutions in the description of suitable environmental indicators and procedures for these products.

P. Francisco is a chemist with CERIB (Study and Research Centre for the French Concrete Industry) since 2004, chiefly leading research on the development of concretes with innovative qualities, and has specialized in concrete durability. He has recently defended his thesis on the time-dependant deformations of UHPFRC subject to heat treatment. In addition he manages the CERIB's international cooperation since 2009.

P Rougeau is an engineer for construction materials, doctorate (PhD) in the durability of concrete in storage facilities for radioactive waste. He has a 20 years experience in the domain of R&D concerning construction materials with hydraulic binders, environmental behaviour of concrete, new types of concrete (high and ultra-high performance concrete, self compacting concrete) as well as their durability (performance approach and probabilistic modelling). He is the Head of Materials and Concrete Technology Department and in charge of the CERIB studies in the field of concrete industry.

F Jacquemot is material engineer in CERIB and leads the Materials Section since 2012. His specialist areas of research are hydration of cementitious binders, durability of concrete, low environmental footprint concrete.

C Badoz is a chemist. She has worked in CERIB for 25 years particularly on the field of concrete chemistry and concrete durability. She has developed numerous test methods in partnership with other French or European laboratories. She has specialized in the behavior of concrete regarding its impact on drinking water and indoor air.

Keywords: Air quality, Performance, Precast concrete, Products

Presentation: Day 2 0900 – 0920 — Venue 2: 3G05

Assessing the Potential for Product Stewardship for the UK Precast Concrete Industry

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1 – Loughborough University, UK
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Sustainability and climate change have now become business imperatives to governments, businesses and all stakeholders in different sectors and industries. In the UK, the UK Government has shown strong commitment for sustainable construction over the years. The UK 'Strategy for Sustainable Construction' in 2008 has clearly underlined and shown areas that need the construction industry's attention which include: Climate change mitigation, Climate change adaptation, Materials, Water, Waste, Biodiversity and Materials. As part of a four year engineering doctorate research programme aimed at improving the sustainability of the UK precast concrete industry through Product Stewardship (PS), this paper explores the possibility of implementing the principles of PS in the UK precast concrete industry. Product stewardship (PS) helps all stakeholders within the lifecycle of a product to share, own or take (full or part) responsibility for reducing, mitigating or abating the environmental impacts of the product throughout its lifecycle. Governments, countries, corporate organisations and industries globally that manufacture different products, have recognised the importance of reducing the negative environmental and social impacts of products, goods and services through the development and implementation of PS programmes and initiatives. This research paper consists of an analysis of 2006 to 2010 key performance indicators of the UK precast concrete industry and findings from 12 industry interviews. Manufacturers' understanding of PS, its potential areas of operation and implementation were investigated. Potential gaps in the sustainability management of these companies were identified and possible PS options were assessed. The paper concludes with a discussion of whether there is any synergy between PS and existing industry initiatives on sustainable construction.

Abdullahi Adamu Aliyu is a Research Engineer, British Precast Concrete Federation/ Department of Civil and Building Engineering, Loughborough University, UK. Abdullahi Adamu Aliyu is principal researcher on joint collaborative research project to improve sustainability through product stewardship in the UK precast concrete industry. He has previously worked in the construction industry and the Liveable cities design and consultancy group, UK.

Dr Jacqueline Glass is a Senior Lecturer in Architecture and Sustainable Construction, AEDM Programme Director, Department of Civil and Building Engineering, Loughborough University, Loughborough, UK. Dr. Jacqueline Glass joined the Department of Civil and Building Engineering at Loughborough University in 2003. Her teaching and research interests include architectural design, decision making, process management, sustainability and concrete construction.

Prof Andrew D.F Price is Chair of Strategic Management in the Department of Civil and Building Engineering, Loughborough University. Prof. Price has over 30 years of design, construction and industry focused research experience. His current research interest includes; strategic management, sustainability and continuous performance improvement.

Dr Hafiz K. Elhag Product Association Manager, British Precast Concrete Federation, Leicester, UK. Dr. Hafiz K. Elhag is a Product Association Manager with British Precast. He previously worked as an architect with Danish consultants COWI at the Sultanate of Oman and has completed an MSc in Construction Management and a PhD on Lifecycle Assessment of Precast Concrete Flooring from The University of Reading and Loughborough University respectively.

Keywords: Corporate Sustainability, Environmental impacts, Low carbon, Product stewardship, Sustainable construction, research

Presentation: Day 1 1650 – 1710 — Venue 1: 3G02

Shrinkage Induced Deformations of Composite Concrete Slabs with Profiled Steel Decking

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Composite concrete floor slabs with profiled steel decking as permanent formwork are commonly used in the construction of floors in buildings. The steel decking supports the wet concrete of a cast in-situ reinforced or post-tensioned concrete slab and, after the concrete sets, acts as external reinforcement. Embossments on the profiled sheeting provide the necessary shear connection to ensure composite action between the concrete and the steel deck. Despite their common usage, relatively little research has been undertaken on the time-dependent in-service deformation of such slabs and little guidance is available to practising engineers for predicting deflection and axial shortening in design. The distribution of drying shrinkage through the thickness of a slab is known to be greatly affected by the impermeable steel deck at the slab soffit, but this has not yet been quantified. This paper presents the results of both experimental and analytical studies on the effects of drying shrinkage on the in-service deformation of composite concrete slabs with steel decking. Laboratory measurements of the distribution of shrinkage through the thickness of such slabs, together with their time-dependent deflection are presented and analytical procedures for modeling this behaviour are described. Design guidance for predicting time-dependent deformations is provided. The work has been supported by the Australian Research Council, Fielders Australia and Prestressed Concrete Design Consultants.

Dr Ian Gilbert is Emeritus Professor of Civil Engineering and Deputy Director of the UNSW Centre for Infrastructure Engineering and Safety in the School of Civil and Environmental Engineering at the University of New South Wales. He has published 4 books and over 300 papers in the fields of reinforced and prestressed concrete structures. He has been actively involved in the development of the Australian Standard for Concrete Structures (AS3600) for over 25 years.

Dr Mark Bradford is Scientia Professor of Civil Engineering and Research Director of the Centre for Infrastructure Engineering and Safety at the University of New South Wales. He is a Australian Laureate Fellow.

Dr Zhen-Tian Chang is a Research Associate in the Centre for Infrastructure Engineering and Safety at the University of New South Wales, Australia.

Mr Ali Gholamhoseini is a PhD student in the School of Civil and Environmental Engineering at the University of New South Wales, Australia.

Keywords: Composite slabs, Deflection, Serviceability, Shrinkage, Steel decking

Presentation: Day 2 0940 – 1000 — Venue 2: 3G05

Cigarette Filter Material and Polypropylene Fibres in Concrete - Drying Shrinkage

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Northumbria University, UK

Due to a reduction in demand for cigarette filter material (North East UK), significant quantities have arisen that have little commercial value. The filter manufacturers have been looking for another outlet for their product and polypropylene fibre replacement in concrete was considered. The purpose of adding Type 1 polypropylene fibres (BS-EN14889) to concrete is to control plastic shrinkage and reduce bleeding. A paired comparison test was carried out to examine concrete cured under extreme conditions of heat and air flow. This micro climate would cause uneven drying due to surface evaporation and internal stresses within the concrete matrix and as a consequence of this instigate drying shrinkage cracking. Type 1 micro polypropylene fibres have known properties to control drying cracking and the performance of concrete with polypropylene fibres was compared against plain concrete and concrete with cigarette filter material. The findings showed that when cigarette filter material and Type 1 polypropylene fibres were compared together their performance was very similar and showed less drying shrinkage cracks than plain concrete.

A E Richardson, MSc, FCIOB, MInstCES is a senior lecturer within the School of the Built Environment, University of Northumbria, UK (PhD in Civil Engineering – Newcastle University. His specialist areas are polypropylene fibres in concrete with regard to durability. He has extensive publications relating to fibre concrete, particularly with heat, spalling and curing, also freeze/thaw on very early life concrete and fully cured. In addition he is ex managing director of a family run SME with a history in construction since 1850.

Keywords: Cigarette filter, Curing, Elevated temperature, Polypropylene fibres

Presentation: Day 2 1000 – 1020 — Venue 2: 3G05

Theme 2 — Efficient and Sustainable Use of Resources

Meeting the Challenge of Efficient and Sustainable Resource Use

T A Harrison
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As concrete is the most widely used construction material in the world, producing concrete from sustainable resources is essential. From a resource viewpoint the rock to make aggregates and the limestone and clay to make Portland cement are sustainable, but any fossil fuel used in their production is not sustainable nor is the use of GGBS or coal-based fly ash as they will depend upon the production of iron from iron ores and the burning of coal to produce power and the existing stockpile of fly ash. An environmental indicator is under development that measures the sustainability of the resources used over the lifecycle in terms of availability to future generations. Fossil fuel use has the biggest impact on this indicator for the material concrete and this in turn is dominated by the Portland cement clinker content of the concrete. However concrete with low PC clinker contents tend to have higher rates of carbonation. Optimization of performance can only be achieved if we develop the technical tools that allow durability to be specified by performance. Utilizing the thermal mass of concrete will save energy during the in-service phase of life and this can lead to significant savings over the lifecycle and therefore resource use must be considered over the full lifecycle.

Professor Thomas A Harrison is a Private Consultant in France, serving on numerous standards committees as well as a visiting industrial Professor to the Concrete Technology Unit, University of Dundee, UK

Keywords: Durability, Energy, Performance specification, Resource use, Sustainability

Presentation: Day 1 1300 – 1320 — Venue 3: 2G13

The Need for Technology Transfer for Revitalized Health Safety & Environment (RHSE) in Concrete Construction: A Case of the Great Man Made River in Libya

M S Tughar
Al Mergab University, Libya

The Libyan concrete construction in Water supply industry produces Million of tonnes of concrete products annually, worth an estimated cost which is roughly equivalent to the turnover of the cement and ready mix concrete industries in the country. After the wealth of experiences from concrete in Great Man Made River (GMMR) authors have developed Health Safety & Environment Management (HSEM) framework strategy and plan of action herein called as 'Revitalized' Health Safety and Environment (RHSE) to improve health safety and environment associated with concrete production, transportation, placement and compaction. The paper presents the interesting case study results to demonstrate that how new framework is capable of helping the new NTC authority in new Libya responsible for the Health Safety & Environment (HSE) management by putting an effective system, into managing health safety & environment impact and combat risks associated with climate change.

Dr. Muhieddin Saleh Tughar recently is an Associate Professor and Head of Department of Civil Engineering at Al Mergab University, Libya. He is a member of IABSE, International Association of Bridge and Structural Engineering. His area of interest is in concrete materials research, evaluation of existing structures, including investigation of structural problems, and in supervision on concrete repairs.

Keywords: Case study, Concrete products, Construction, HSEM-Revitalized Strategy, NTC of Libya, Water supply

Presentation: Day 1 1320 – 1340 — Venue 3: 2G13

Assessment of Environmental Impact of the Addition of Photocatalytic Nanoparticles to Cementitious Materials

B Y Lee, A R Jayapalan, K E Kurtis
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Use of photocatalytic titanium dioxide (TiO_2) in cementitious materials is increasing due to its novel capabilities, including smog abatement, hydrophobicity/philicity, and self-cleaning. However, the contributions of TiO_2 nanoparticles to the overall environmental impacts of photocatalytic cementitious materials have not been thoroughly considered. That is, the balance between their potential beneficial long-term use and the environmental costs associated with their production should be considered. In the first part of this study, the potential influence of TiO_2 nanoparticles on early hydration kinetics of major components in portland cement are measured and these data compared with hydration models. Results, which showed nanoparticle acceleration of calcium silicate hydration, are used to assess whether cement fractions may be reduced when nanoparticles are included, while retaining similar concrete properties. The second part of this study examined the environmental impact of the photocatalytic cement, analyzed by SimaPro Life Cycle Assessment (LCA) software. The LCA study indicates that even though the introduction of nanoparticles increases the initial environmental impact of photocatalytic cement as compared to ordinary portland cement, the long term NOx binding capabilities of TiO_2-modified cements could result in a lower environmental impact. The contributions to sustainability can be further enhanced by reductions in cement fraction, based upon the results of the first part of this investigation.

Amal R. Jayapalan is a Graduate Student in the School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, GA. He received his B. Tech from the Indian Institute of Technology (IIT), Madras, India. His research interests include durability, microstructural characterization and sustainability of cement-based materials.

Bo Yeon Lee is a Ph.D. Candidate in the School of Civil and Environmental Engineering at Georgia Institute of Technology, Atlanta, GA, where she also received her MS. She received her BS in architectural engineering from Yonsei University, Korea. Her research interests include photocatalytic cements, modeling of cement hydration, and durability of cement-based materials.

Kimberly E. Kurtis, Ph.D., FACI, FACerS is Professor in the School of Civil and Environmental Engineering at Georgia Institute of Technology, Atlanta, GA. She is Chair of ACI Committee 236: Materials Science of Concrete and an Editorial Board member at Cement and Concrete Composites.

Keywords: Acceleration, Filler, Hydration rate, LCA, TiO_2

Presentation: Day 1 1340 – 1400 — Venue 3: 2G13

Observation of Fair-face Concrete Durability using Various Testing Methods

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1 – Czech Technical University, Czech Republic
2 – Brno University of Technology, Czech Republic

An important parameter determining the durability of concrete is the quality of the surface layer, as it is directly exposed to the environment. In terms of durability properties, it is worth to monitor the parameters of the surface layers, particularly the transport processes. The paper presents the results of permeability measurements using methods Torrent Permeability Tester (TPT), Germanns Water permeation test (GWT) and the Initial Surface Absorbation Test (ISAT). These findings will serve to further optimization of the structure being created, thus ensuring its better aesthetic and functional characteristics.

Ing. Pavel Reiterman, Experimental centre, Fakulty of Civil Engineering, Czech Technical University in Prague, Prague, Czech Republic

doc. Ing. Karel Kolář, CSc., Experimental centre, Fakulty of Civil Engineering, Czech Technical University in Prague, Prague, Czech Republic

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Keywords: Fair-face concrete, Permeability, Surface layer

Presentation: Day 1 1400 – 1420 — Venue 3: 2G13

Carbonation of Concrete: CO_2 Sequestration Potential vs Durability

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The aim of the paper is to analyse the development of a theoretical model to predict the depth of carbonation in concrete. The experimentally determined model describes the depth of carbonation in function of exposure time, w/c ratio and early-age concrete curing conditions. It was assumed that the depth of carbonation as a function of the these variables is mathematically described by a hyperbolic function. According to such a model the carbonation process is self-terminating due to process of filling concrete pores with carbonation products in time. In the paper the results of tests of carbonation depth conducted in an environment with a natural concentration of CO_2 for concretes with various types of Portland cement were presented. Those results enabled the development of equations describing the relationship between depth and exposure time for each concrete. It is expected that the developed equations will provide a convenient tool for designing adequate thickness of concrete cover, sufficient to protect the reinforcement against corrosion.

Piotr Woyciechowski, Graduate at Faculty of Civil Engineering of Warsaw University of Technology (1990). Since 1991 a researcher at the Department of Building Materials Engineering at the Faculty of Civil Engineering of Warsaw University of Technology. Ph.D (1999). ACI member since 2000. Expert on building materials authorized by the Polish Society of Building Engineers.

Keywords: CO_2 sequestration, Carbonation, Modelling, Test methods

Presentation: Day 1 1420 – 1440 — Venue 3: 2G13

Development of a tool for measuring resource sustainability in construction materials and products

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1 – University of Dundee, UK
2 – Private Consultant, France

This paper reports aspects of the development of an indicator for measuring the environmental impact of the use of resources in the manufacture of construction products. This was deemed necessary on the grounds that current established indicators of resource use placed insufficient emphasis on the relative scarcity of that resource. The proposed indicator discussed in this paper compiles the residual lives of all the resources which are employed in manufacturing a product and through the application of a characterisation system generates a current scarcity score (CSS) which is used as an indicator of resource sustainability with a higher score indicting lesser sustainability. Based on comparison against a set of criteria devised to select a characterisation system which best reflects the need for sustainability, along with the uncertainty of predicting future availability of relatively plentiful resources, a hyperbolic function has been selected.

Dr Judith E Halliday is a Research/Teaching Fellow within the Concrete Technology Unit at the University of Dundee. She has been involved in numerous projects relating to sustainable and environmental issues of recycling materials in concrete construction. She has now shifted her focus on the awareness of the depletion of natural resources and the impact of their use in construction as a whole.

Dr Thomas D Dyer is a Lecturer in the Concrete Technology Unit at the University of Dundee. His research has primarily involved investigation of interactions of by-products with cement. He is also involved in applying life-cycle assessment techniques to construction. Recently his work has extended to include imprinting of biomimetic microstructures in construction materials, and interactions of brownfield contaminants with fresh concrete.

Professor M Roderick Jones is the Director of the Concrete Technology Unit at the University of Dundee. A renowned practitioner in the field of concrete technology, he is a member of numerous national and international technical committees and has published extensively on many aspects of concrete technology, cement science and sustainable construction.

Professor Thomas A Harrison is a Private Consultant in France, serving on numerous British, European and ISO standards committees as well as a visiting industrial Professor to the Concrete Technology Unit, University of Dundee, UK

Keywords: Natural resources, Residual life, Scarcity score, Sustainability

The Influence of the Surface Area of Limestone on the Physical and Mechanical Behaviour of Ternary Cements

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1 – M'sila University, Algeria
2 – Bordj Bou Arreridj University, Algeria

During cement production, a significant amount of CO_2 released into the atmosphere, it is estimated that the production of each ton of clinker free about a ton of CO_2. The use of additions as constituents of cement reduces the amount of clinker, where CO_2 emissions are reduced. The combination of additions (2 or 3) with Portland cement can develop new types of binders (ternary or quaternary) with mechanical properties and durability superior to that of Portland cement alone. The objective of this work involves the study of the effects of the surface area of limestone on the physical and mechanical properties of ternary cements containing slag (SSB1=3500, SSB2= 5500, SSB3= 11000 cm^2/g). The amount of clinker is fixed at 65% ,that of lime stone varied from 5 to 30% by weight of cement ,the remain is constituted by slag. The results show that increasing the surface area of limestone with a favorable effect on the mechanical behavior of ternary cements.

Dr L Zeghichi is a Senior Lecturer in construction materials. In civil engineering at M'sila University (Algeria). She specializes in the use of benders and durability of concrete.

A Noui, is a Senior Lecturer in the department of civil engineering at Bordj Bou Arreridj University, his research interest deals with the ternary cement formulation.

A Lahmadi is a Senior Lecturer in the department of civil engineering, M'sila University.

L Belagraa, is a senior lecturer, civil engineering department, Laboratory of Materials and Electronic Systems [LMSE], Institute of Sciences and Technology, Bordj Bou Arreridj University, Algeria.

Keywords: Addition, Limestone, Setting time, Shrinkage, Slag, Specific area

Presentation: Day 1 1530 – 1550 — Venue 3: 2G13

Effects of Curing Conditions on the Durability of Slag Concrete

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2 – Ecole Nationale Polytechnique, Algeria
3 – University of Sheffield, UK

Apart from reducing cost compared to plain Portland cement concrete, the benefits of inclusion of slag in concrete are essentially associated with the improvements it brings about to the quality and durability of concrete, and in particular, to energy savings resources conservation, and environment protection. The main objective of this study is to provide a method to get strength of 30 to 50 MPa at 28 days for a concrete having relatively high level of replacement of cement by slag of El hadjar steel factory [18] with low water binder ratio. Three curing conditions were analyzed: In air, in water and in air then water. The duration tests were: 1, 7, 28, 180 ,270, and 365 days. The method produced a slag concrete with strength comparable to ordinary Portland cement concrete from two days onwards. The compressive and flexural strength as well as elastic modulus of this concrete were highly affected by the curing conditions. High swelling strain at high slag replacement levels shows the need for longer wet curing for such concrete. The results also showed that even the condition of seven days water curing was inadequate for 50 percent replacement, and that prolonged exposure to a drying environment can have adverse effects on the long term durability of inadequately cured slag concrete.

A Bouikni is a Member of the laboratory of Geo-materials, Senior Lecturer at department of civil Engineering, Faculty of the Engineer, University of Blida with field of interests including concrete materials and concrete structures.

A Bali is Director of the Construction and Environment Laboratory, Professor at the Civil-Engineering department at the Polytechnique School of Algiers (E.N.P). His field of interests: Material including recycling, structural repairs and new materials.

R N Swamy is a Professor at the University of Sheffield, England. He has been involved in teaching, research and consultancy activities for over forty years. His research interests relate to construction technology with emphasis on concrete materials, concrete structures and their interactive performance in real environments.

A Kasser is a Member of the Laboratory of Materials Science and Engineering with research interests in bio-materials through powder metallurgies at the Polytechnique School of Algeries.

R Boutemeur is a Member of Construction and Environment Laboratory and a Lecturer at the Civil-Engineering department at the Polytechnique School of Algeries (E.N.P). His field of interest include materials, structure and construction.

Keywords: Blast furnace slag, Carbonation, Compressive strength, Concrete, Curing, Flexural strength, Modulus of elasticity, Shrinkage

Presentation: Day 1 1610 – 1630 — Venue 3: 2G13

Effects of Calcined Clay as Low Carbon Cementing Materials on the Properties of Concrete

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Lias delta clay was calcined in a rotary kiln. It was ground leading to a surface area of 5700 m²/g and a mean particle diameter of 12,5 µm. The calcined clay was tested as a Type II addition in combination with different cements (CEM I, CEM II and CEM III) and two strength classes (32,5 and 42,5). In most tests calcined clay replaced 20 % of the cement. Additionally some tests went up to a replacement of 60 %. The parameters investigated were fresh concrete properties including bleeding, compressive strength of mortar samples and concrete cubes, depth of carbonation, chloride ingress, sulphate resistance and shrinkage. The addition of the calcined clay improves the stability of the fresh mortar and concrete. Bleeding is reduced significantly. Initial strength develops at a lower rate until seven days for most mixes containing calcined clay. Beyond this age mixes with a 20 % replacement exceed the strength of the companion pure cement mixes. This holds especially for mixes containing CEM II where in some cases even a replacement of 40 % leads to higher strength values at 28 days and beyond. A comparison was made of the non-renewable energy necessary to produce the calcined clay and the energy needed to produce the different types of cement. It reveals an ecological advantage for concrete containing a binder blend of cement and calcined clay. The possible advantage depends to a large extend on the k-value which can be considered for the calcined clay and the type of cement to be substituted. The tests prove a reasonable range for the k-value between 0,6 and 1,0.

Karl-Christian Thienel is professor and head of the Institute for Building Materials, University of the German Federal Army Munich, Germany. He received his diploma and Dr.-degree in civil engineering from TU Braunschweig. He was Alexander-von-Humboldt “Feodor-Lynen” stipendiary at ACBM, Northwestern University, Evanston, IL, and head of R&D at Liapor GmbH & Co. KG. He is chairman of CEN/TC 177 and member of CEN/TC 154 SC5. His research interests include lightweight concrete, lightweight aggregate, impact and micro cracking.

Nancy Beuntner is researcher at the Institute for Building Materials, University of the German Federal Army Munich, Germany. She studied civil engineering, especially technology of building materials at Bauhaus University Weimar, Germany. She worked from 2002-2008 as product manager and sales engineer at Rohrdorfer Baustoffgruppe, Germany.

Keywords: CO_2, Calcined clay, Strength, Type II addition, Workability

Presentation: Day 1 1550 – 1610 — Venue 3: 2G13

Study on Geopolymerization of Highlime Fly Ashes

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High calcium fly ashes (HCFAs) constitute more than half of the total fly ash production in Europe, but their exploitation is very low; about 20% of their output. This leads to the rejection of huge quantities of HCFAs without any benefit of their strength capacity. HCFAs usually consist of calcium aluminates and silicates and often free lime and sulfates. In this study, HCFA samples with 8.49% free lime and ≥25% silica content are treated with water (2 parts of HCFA : 1 part of water) containing 36% of a mixture of NaOH to Na_2SiO_3 (1:1). Such mixtures were placed in (40x40x160) mm specimens and were cured in three curing regimes: 1) 65°C for 2 days, 2) 40°C for 4 days and 3) 25°C for 7 days. After the curing some of the specimens were placed into climatic chamber (95% relative humidity) and the rest were left at indoor conditions (65% relative humidity). Mechanical and elastic properties and volume deformations of the pastes were tested at 7-d, 28-d and 90-d ages. Porosity measurements were also carried out at the same ages. A microstructure analysis was made by using X-ray diffractometry, DTA-TG methodology, FTIR spectroscopy and SEM microscopy, in order to determine the mechanisms to which the cementing properties are due. The alkali-activated fly ash pastes have developed 7-d compressive strength, from 22 to 32 MPa, 28-d from 22 to 35 MPa and 90-d strength from 33 to 46 MPa. This is considered very encouraging for alkali-activation process. Volume stability measurements also have completed the study regarding the deformation of geopolymerized HCFA.

I Papayianni is currently Professor and Director of the Laboratory of Building Materials at the Civil Engineering Dept. of the Aristotle University of Thessaloniki, Greece. She is a member of ACI and RILEM Committees and the scientific responsible of many National and European Research Projects. Her specialist research fields include concrete technology, supplementary materials and repair materials.

S Konopisi is a Chemist MSc and a PhD candidate at the Laboratory of Building Materials at the Civil Engineering Dept. of the Aristotle University of Thessaloniki, Greece. She has participated in several research projects on concrete chemistry and on conservation and restoration of monuments. Her specialist areas of research include geopolymerization and construction material characterization.

Keywords: Alkaline activator, Geopolymerization, High calcium fly ash (HCFA), Mechanical strength

Presentation: Day 2 1000 – 1020 — Venue 3: 2G13

Low-carbon Calcium Sulphoaluminate Cements Synthesized from Industrial Wastes and By-products

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Compared to Portland cements, calcium sulphoaluminate (CSA) cements are energy saving and low-CO_2 hydraulic binders, due to the decrease of synthesis temperature and kiln thermal input associated with the reduced limestone requirement and carbon dioxide generation. Further enhancements in terms of environmentally friendly features can be achieved if some industrial wastes are used as partial or total substitutes for the natural materials (limestone, bauxite, gypsum) involved in the CSA cement manufacture. This paper deals with a laboratory investigation of synthetic CSA clinkers generated in an electric oven at 1150°, 1200°, 1250° and 1300°C from raw mixtures containing (i) bottom ash derived from the fluidized bed combustion (FBC) of coal (essentially a source of non-carbonated lime and calcium sulphate) and (ii) anodization mud (AM) or alumina powder (AP), Al_2O_3 rich by-products originated by the production of anodized aluminium elements and the secondary aluminium manufacture, respectively. Six bauxite-free ternary blends, containing 10-35% limestone plus 0-31% natural gypsum or 0-40% FBC bottom ash plus 0-69% AM or 0-50% AP, and four binary blends, consisting only of 37-60% FBC bottom ash and 52-63% AM or 40-45% AP, were explored. They were generally more suitable than a reference mixture composed by 42% bauxite, 33% gypsum and 25% limestone. XRD analysis showed a complete conversion of reactants and a very good selectivity towards the main CSA cement component.

A. Telesca is Researcher in Materials Science and Technology at the Department of Environmental Engineering and Physics at the University of Basilicata, Italy. His main research interests are the development of special cements and the utilization of industrial by-products as sources of raw materials.

M. Marroccoli is Professor of Materials Technology and Applied Chemistry at the Department of Environmental Engineering and Physics, University of Basilicata, Italy. Her scientific activity deals with cement technology and utilization of industrial wastes in civil engineering works and building materials industry.

M. L. Pace is PhD in Environmental Engineering at the University of Basilicata, Italy. Her research activity concerns calcium sulphoaluminate cements and their synthesis, hydration and manufacture from industrial by-products.

G. L. Valenti is Professor of Industrial Wastes and Sustainable Development at the Department of Environmental Engineering and Physics, University of Basilicata, Italy. He is mainly engaged in researches devoted to both development of special cements and utilization of industrial wastes in civil engineering works and building materials industry.

Keywords: Alumina powder, Anodization mud, Calcium sulphoaluminate cements, Fluidized bed combustion ash, Sustainable development, Waste utilization

Presentation: Day 1 1630 – 1650 — Venue 3: 2G13

Effect of a New Type of CaO Expansive Agent on the Leaching of Calcium Hydroxide from High Performance Concrete

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The hydration products of a new type of CaO expansive agent is calcium hydroxide whose solubility is relatively high, and it is necessary to determine concrete performance change due to calcium leaching when CaO expansive agent is mixed in concrete. An electrochemical acceleration test was used on the research of leaching of calcium hydroxide from high performance concrete. Tests were carried out using various amount of CaO expansive agent and water binder ratio. Experimental results showed that the quantity of dissolved Ca^{2+} of concrete mixed with 2% CaO is minimum, 94.5% of reference specimens at 42d; when the amount of CaO expansive agent is higher than 2%, the quantity of dissolved Ca^{2+} of concrete is higher than that of reference specimens. The quantity of dissolved Ca^{2+} of concrete decreased with water binder ratio; the quantity of dissolved Ca^{2+} of concrete with 4% CaO is higher than that of reference specimens when water binder ratio is 0.30,0.35,0.40 and 0.45. The shrinkage of mortar mixed with 2%CaO expansive agent was observed much lower than that of mortar without CaO expansive agent.

Jiaping Liu is currently leader of Jiangsu Bote New Materials Co.,Ltd.. Nanjing, China. He has led several research projects on concretes, and his specialist areas of research are deformation and durability of high performance concrete.

Fei Guo is currently an engineer of Jiangsu Bote New Materials Co.,Ltd.. Nanjing, China. His specialist areas of research are application of shrinkage-compensating concrete and self-compacting concrete.

Shouzhi Zhang is currently an engineer of Jiangsu Bote New Materials Co.,Ltd.. Nanjing, China. His specialist areas of research are the preparation of expensive agent and deformation of shrinkage-compensating concrete.

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Keywords: Electrochemical acceleration test, Expansive agent, Leaching, Shrinkage

Presentation: Day 1 1650 – 1710 — Venue 3: 2G13

The Engineering Properties of Alkali Activated Fly Ash Mortar

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The development of alkali activated materials has obtained increasing interest during the last decade, due to the great potential in building materials and low CO_2 emission. In order to utilize alkali activated materials in engineering applications, an evaluation of its engineering properties is essential. In this study, the engineering properties of alkali activated fly ash mortar, including setting time, mechanical strength and drying shrinkage, were studied with different amount of sodium silicate solutions. In addition, the microstructure and the interfacial transition zone (ITZ) between the paste and aggregates were examined by environmental scanning electron microscopy (ESEM). The result presents the compressive strength of around 50 MPa could be obtained after 7 days curing at 40°C of alkali activated fly ash mortar, with similar setting time and workability as Portland cement. The drying shrinkage were greatly influenced by the activating solutions (SiO2 and Na_2O content). Furthermore, the alkali activated fly ash mortar has a dense microstructure; no apparent ITZ could be identified near the aggregates.

Y Ma is an PhD candidate in Microlab, section of Materials and Environment

Faculty of Civil Engineering and Geosciences, Delft University of Technology. Her PhD research topic is ”study on alkali activated fly ash as an environmental friendly alternative to Portland cement”.

G Ye is an associate professor in Microlab, section of Materials and Environment Faculty of Civil Engineering and Geosciences, Delft University of Technology, the Netherlands. His research interests include ”Supplementary Cementitious Materials”, ”concrete material properties at early ages”,”hydration and microstructure, numerical simulation and durability of concrete”.

Keywords: Alkali activated fly ash mortar, Drying shrinkage, Engineering properties, Microstructure

Presentation: Day 2 0940 – 1000 — Venue 3: 2G13

Interfacial Bond between Reinforcing Fibres and CSA Cements: An Examination of its Influence on Fibre Pullout Characteristics

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This paper presents the results of an experimental investigation on the influence of the interfacial bond of reinforcing fibres embedded in a calcium sulfoaluminate (CSA) matrix on the fibre pullout energy. Bonding at the fibre-matrix interface plays an important role in controlling the mechanical performance of cementitious composites. In particular, composites formed from sulfate-based systems (CSA) as opposed to the silicate systems found in Portland cement. To examine the fibre-matrix bonding within the CSA and Portland cement system various types of fibres were selected, including polyvinyl-alcohol (PVA), polypropylene, and copper-coated steel. The fibres were embedded in three different matrices, two sulfate-based including one commercially available CSA cement and a CSA fabricated from coal-combustion byproducts. The thirds matrix was a silicate-based OPC. In this study, the results of the single-fibre pullout test was coupled with scanning electron microscopy to examine the interfacial bond between the fibre and CSA matrix for evidence of debonding and possible reaction products.

Robert B Jewell, Research Scientist for the Center for Applied Energy Research at the University of Kentucky, currently conducting research into the application of coal combustion by-products in the formulation low energy cement and concrete.

Kamyar C Mahboub, Dr. Mahboub has been working on mechanistic characterization of construction materials. He has also worked on pavement design, analysis, construction, and management. In addition in his journal publications, he has published two chapters in a popular civil engineering textbook: chapters on Superpave, and Pavement Management, “Pavement Analysis and Design”, with Professor Y.H. Huang. Dr. Mahboub received his BSCE from The University of Texas at Austin in 1982, and MSCE and Ph.D. from Texas A&M University in 1985 and 1988, respectively. He is the Lawson Professor of Civil Engineering at University of Kentucky, an ASCE Fellow, and a registered professional engineer (PE) in Kentucky.

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Keywords: CSA Cement, Low-energy cement, Single-fibre pullout

Presentation: Day 2 0900 – 0920 — Venue 3: 2G13

The Effect of Titanium Dioxide on the Structure and Reactivity of Ferrite

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Minor constituents can have a major impact on the structure and reactivity of Portland cement and Calcium Sulfoaluminate cement. An important example of this is the effect of titanium dioxide on the reactivity of the ferrite phase, the end member of which is brownmillerite. The effect of TiO_2 on ferrite reactivity was investigated by forming the pure end member from reagent grade materials and adding in TiO_2 at the dosages 0%, 0.5% 1.6% 2.6% and 3.6% by weight. The powders were mixed and pressed into pellets, preheated to 800 °C and then fired at 1350 °C for 30 minutes. The brownmillerite was milled for 1 hour and characterized by X-ray diffraction, energy-dispersive X-ray spectroscopy, isothermal calorimeter and thermogravimetric analysis. The addition of TiO_2 was expressed in the principle XRD peak with values of TiO_2 greater than 1.6% shifting it to higher d-spacing. For TiO_2 greater than 1.6% the hydration and subsequent set time was found to be retarded, from only a few minutes for the materials with no TiO_2 to approximately 5 to 6 hours. The addition of very low levels of TiO_2 (0.5%) appeared to slightly increase the set time of the brownmillerite over the pure end member. The rate of strength development of mortar cubes also varied significantly with the higher TiO_2 samples (i.e. 2.6 and 3.6%) having lower one-day strengths but much higher (by up to twice) at 7 and 28 days. It was demonstrated that the behavior of brownmillerite as a cementitious material was greatly affected by relatively small dosages of TiO_2 indicating the importance of even low levels of minor components in the Portland cement and Calcium Sulfoaluminate cement.

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Dr. Thomas L. Robl, University of Kentucky, Center for Applied Energy Research, 2540 Research Park Drive, Lexington, Kentucky, 40511, USA. Dr. Robl is an Associate Director of the Center for Applied Energy Research of the University of Kentucky. He is currently conducting research into the application of coal combustion and other industrial by products into low energy cement systems.

Professor Fred P. Glasser, Chemistry Department, University of Aberdeen, Aberdeen, UK. Dr. Glasser holds the position Professor Emeritus at Aberdeen University. He is currently active in investigations of CSA and other low energy cement systems. Professor Glasser is preeminent among the experts in cement chemistry.

Keywords: Brownmillerite, Ferrite, Reactivity, Titanium dioxide

Presentation: Day 2 0920 – 0940 — Venue 3: 2G13

Sustainable Low Carbon Foamed Concrete

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Universally increased concern for sustainability, reduced carbon dioxide emissions and responsible use of resources has made governments and authorities upgrade related standards and regulations. There is no doubt, the sustainability strategies agreed and the regulations set by the authorities have a vital effect on restructuring construction industry practices. Being the most widely used construction material and therefore the most resource demanding material, concrete needs to be designed and produced responsibly. So the concrete industry has shown an 18% reduction in CO_2 emissions through the use of recycled materials and alternative fuels compared to 1990 baselines only until 2010. As the rest of the concrete industry, foamed concrete also contributes to sustainable construction effectively. Research has shown that recycled and secondary aggregate (RSA) materials can effectively replace primary aggregates or high carbon materials in foamed concrete either fully or partially, whilst maintaining the performance properties. Despite a number of risky factors such as high heterogeneity and water absorption capacity of the RSA materials used in foamed concrete, the key advantage arising from the use of these materials is their 0-3 mm particle sizes, which is not a suitable range for use in normal weight concrete. Furthermore, the study concluded that, foamed concrete can easily be recycled and used in the production of new foamed concrete.

Kezban Ozlutas is a PhD student University of Dundee.

Amarnath Yerramala is a former PhD student in University of Dundee.

Kharidu Srinivasa Rao is a former PhD student in University of Dundee.

M Roderick Jones is a Professor of Civil Engineering in University of Dundee.

Keywords: Embodied carbon dioxide, Foamed concrete, RSA materials, Sustainability

Presentation: Day 2 1100 – 1120 — Venue 1: 3G02

Secondary Aluminas - A Sustainable, Low Cost Source of Alumina for Clinker Production

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Portland clinker contains calcium aluminate minerals such as C_3A and C_4AF. Alumina is a crucial ingredient of cement raw materials to form these minerals when burning the cement clinker. RVA, a French chemical reprocessing company, produces a high alumina material from the recycling of aluminium salt slags. These slags arise during melting operations from secondary aluminium refining operations. The slag is a hazardous waste the landfilling of which is prohibited in Europe. Plants such as RVA receive the slag from aluminium refiners and recover useful products from it. One of RVA's outputs is the alumina material, generically referred to as a secondary alumina but known more widely under its trade name, Valoxy. As a result of its chemical, mineral and physical properties, Valoxy has proven to be an effective alumina source in cement production. Potential benefits to the cement producer include: improved burnability of the clinker; improved sintering; reduced residence time; and improved lime saturation factor and silica ratios. Valoxy is sustainable since it derives from an industrial process and not from virgin ore. It also offers potential savings in operating costs through reduced fuel consumption and lower communition energy. Recognising the technical, economic and environmental benefits, many of Europe's leading cement producers have incorporated Valoxy into their kiln feed.

Howard Epstein graduated with a degree in chemistry from the University of Manchester, UK and then went on to complete an MBA at the London Business School. He began his professional career as an applications technologist for ICI Organics before being appointed European marketing manager with a subsidiary of Sigma Chemicals, St. Louis. In 1994 Howard joined Bernhard Metals, at that time the leading secondary aluminium smelter in the UK. He was subsequently appointed Managing Director of Bernhard Metals Group of which RVA was an associate company. Since 2006 he has been working independently as a consultant to the chemical and related industries. This work includes a long-standing consultancy relationship with RVA.

Keywords: Alumina, Cement, Clinker, Minerals, Recycling

Geopolymer Concrete with Recycled Concrete Aggregate

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Geopolymer concrete replaces cement based binder with a binder which contains no Portland cement. One type of geopolymer binder is that which contains fly-ash activated by an alkaline solution of sodium silicate and sodium hydroxide. Utilising recycled concrete waste from construction and demolition sites, that would otherwise be disposed of into landfill, as a source of aggregate offers a potential environmental and economic benefit. The term recycled concrete aggregate (RCA) is used to define aggregate produced from crushed demolition and construction waste. Research has been conducted into both recycled concrete aggregate (RCA) and geopolymer concrete; however there was limited published data on using RCA in geopolymer at the time of this research. This paper reports on the outcomes of the research into the mechanical properties of geopolymer concrete with recycled concrete aggregate as partial replacement of the natural coarse aggregate which indicate the potential of incorporating RCA in geopolymer concrete mixtures.

Benjamin Galvin was an undergraduate student at the time of this research; he graduated with honors from Curtin University in 2011.

Natalie Lloyd is a senior lecturer at Curtin University; her research interests include geopolymer concrete and sustainable structural materials, durability and structural behaviour of concrete and composites.

Keywords: Compressive strength, Construction waste, Fly ash, Geopolymer, Recycled concrete aggregate

Presentation: Day 2 1100 – 1120 — Venue 3: 2G13

Strength and Durability of High Calcium Fly Ash in High Volume Fly Ash Concrete (HVFAC)

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The performance of cement with high volume fly ash is superior to normal Portland cement in almost all aspects; there are also significant environmental benefits, i.e. the production of one tonne of Portland cement results in the release of about one tonne of CO_2 into the atmosphere. Thus, if expensive cement can be conserved by replacing around 50% of fly ash, it can make significant contributions to the green house gas emissions and reduction in the manufacturing cost. In addition to this, fly ash reduces the rise in temperature in the concrete, at the same time increasing the compressive strength and durability properties. Further using the high calcium fly ash variety in the concrete, is more reactive than low-calcium (ASTM Class F) fly ash because it contains most of the calcium in the form of reactive crystalline compounds, such as C_3A, CS, and C_4A_3S; also there is evidence that the principal constituent (i.e., non-crystalline phase) contains enough calcium ions to enhance the reactivity of the aluminosilicate glass. Hence it is decided to use the high Calcium Class C fly ash in the HVFAC with a constant binder content of 360kg/m^3. This paper reports the results from experimental studies on the compressive strength, rise in temperature and durability studies of the concrete containing the high calcium class C fly ash replaced with various proportions (20%, 40%, 60% and control) of cement.

Dr G Mohan Ganesh is Professor, Programme Manager & Division Leader, Structural and Geotechnical Engineering Division, School of mechanical and building Sciences, VIT University, Vellore. He has led three research projects on High volume fly ash concrete. His research interests include Steel Structures, Flyash Concrete, Steel – Concrete Composite structures, Artificial Neural Network (ANN), and Genetic Algorithms (GA).

Dr A S Santhi is Professor and Assistant Director in centre for Structural Engineering, Structural and Geotechnical Engineering Division, Director, School of mechanical and building Sciences, VIT University, Vellore. She has led three research projects on High volume fly ash concrete. Her research interests include Creep and Shrinkage Properties in RCC Structures, Flyash Concrete.

S B Murugan has completed M.Tech (Structural Engineering) at VIT University nad pursuing PhD. At VIT University in the area of High volume fly ash concrete. He did his under graduate studies in Civil Engineering.

Keywords: CO_2, Durability, High calcium, High volume fly ash

Presentation: Day 2 1120 – 1140 — Venue 3: 2G13

Study of the Effect of Sulfate Resistant Cement on the Mechanical Strength of a Recycled Concrete Aggregate Containing Marble Fillers

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1 – Bordj Bou Arreridj University, Algeria
2 – M'sila University, Algeria

The needs of the construction sector are still increasing for concrete. However the shortage of natural resources of aggregate could be a problem for the concrete industry, in addition to the negative impact on the environment due to the demolition wastes. In the last decade a major interest has developed for the reuse of recycled aggregates that presents more than 70 % of the concrete volume. These should fulfill the requirements of lower cost and better quality, in order to establish its role in the concrete. The aim of this study is to assess the effect of sulfate resistant cement combined with the local admixtures on the mechanical behaviour of recycled aggregate concrete (RAC). Physical and mechanical properties of RAC were investigated including the density, water absorption, water reduction and the resistance. The non destructive test methods (pulse-velocity, rebound hammer) were used to determine the concrete strength. The results obtained were compared to crushed aggregate concrete (CAC) using the normal compressive testing machine test method. Thus, the convenience of indirect tests in the case of a recycled agregate concrete were demonstrated.

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Miloud Beddar is a Lecturer in the Department of Civil Engineering, M'sila University, Algeria.

Souad Tabet is a Post graduate student in the Department of Civil Engineering, M'sila university, Algeria.

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Keywords: Demolition waste, Fillers, Mechanical strength, Non-destructive tests, Recycled concrete aggregate, Sulfate resistant cement

An Experimental Plan Method to Formulate a Resin Concrete

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2 – Ouem Elbouaghi University, Algeria

Abstract— This work is an experimental approach based on the method of experimental plans to determine a specific formulation of a resin concrete. In this study, an unsaturated polyester resin (thermosetting resin) was used with two types of mineral fillers (dune sand and crushed sand), and with the addition of a marble powder to ensure the continuity of the particle size mixing granular. The lack of the methods for developing this kind of composite materials, had led us to perform an initial experimental approach to define the experimental field, that is to say determine the mass proportions of the various compounds of mixture of our study. In the second approach, we have established and implemented fully experimental plans with three factors namely: (factor 1: sand, factor 2: resin, factor 3: marble powder). Test results being the density of polymer concrete and the mechanical resistances. Finally, multi-parameters regression allowed us to determine predictive mathematical models for the different responses of the study. Tests results showed that at three days we got a tensile strength of about 16 MPa with a resin concrete density of 1.9 g/cm^3 . This shows the advantages of this material.

M. Beddar is an associated professor in civil and hydraulic engineering department, Faculty of Technology, M'sila University, Algeria. His is the director of materials and mechanical structures Laboratory. His research interests are fibers reinforced concrete , behavior of concrete under extremes conditions and valorization of solid waste in civil engineering materials. His member of several national and international scientific associations.

Z.Boudaoud is an associated professor in civil engineering department, Faculty of Technology, Ouem elbouaghi University, Algeria. His research interests structural analysis of concrete., and valorization of waste in cimentious materials.

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H.S.M'hammedi is an engineer of civil engineering department. Graduted from M'sila University , she is now doing a research about the use of rubber waste in the concrete made from local materials.

Keywords: Experimental plans method, Index terms concrete, Mechanical resistance, Polyester resin

Influence of Recycled Aggregate in SCC Properties

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Self-compacting concrete (SCC) has emerged from the need to produce structures heavily armed or with complex geometry in which the use of vibration results in problems. On the other hand, construction and demolition wastes (CDW) are a great problem in many countries. In Brazil, as in many parts of the world, CDW are already crushed and sieved, been transforming in recycled aggregates (RA). Once RA has different properties than natural aggregates, its use in concrete modifies concrete's properties. The aim of this article is study the replacement of natural coarse aggregate in 10%, 20% and 30% of volume by recycled coarse aggregate in SCC production. The water/cement ratio was fixed in 0.35. The influence of RA in SCC fresh conditions was verified using L box, V funnel, J ring and slump flow tests. Specimens were casted to measure compressive strength, modulus of elasticity, voids content, water absorption and specific density of SCC with RA. The results show the self-compacting properties do not decrease with the increase of RA replacement. SCC hardened properties still reach values that allow it to be used in current applications.

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Keywords: Construction and demolition waste, Fresh testing, Hardened testing, Recycled aggregate, Self-compacting concrete

Presentation: Day 2 1120 – 1140 — Venue 4: 2G14

The Use of Concrete Filler as a Mineral Admixture in Concrete

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One of the most important challenges of present time concrete science is how to reduce Portland cement production and limit its use. One reason for this is a need for CO_2 emission reduction and another a need for a saving of natural resources (limestone, energy). The present paper deals with some results achieved by a replacement of natural ground limestone with ground recycled concrete. Two different concretes were used as the source of concrete filler. Both of them were ground to three specific surfaces. A limestone of similar specific surfaces was used too. Mortars were mixed with a blend of Portland cement, fly ash and concrete filler or limestone filler. The compressive strengths at the age of 24 hours and 28 days are presented in the paper. The results prove that mortars with fly ash and concrete filler show a similar workability; worse early-age strengths and better 28-day strengths than those with fly ash and limestone

Vlastimil Bilek is a Research Engineer at the ZPSV a.s., He received his MS and PhD from Brno University of Technology. His research interests include alkali activated materials, concretes with mineral admixtures and durability of concrete. He is involved in the organisation of Non-Traditional Cement and Concrete Conferences in Brno, Czech Republic (2002, 2005, 2008 and 2011).

Keywords: Concrete filler, Fly ash, Limestone, Synergy, Ternary binders

Presentation: Day 1 1630 – 1650 — Venue 2: 3G05

Fibre Reinforced Aerated Cement with Composite-based Rubber Tyre Particles

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2 – University of Badji Mokhtar, Algeria

The large demand on building material industry has resulted from the increasing population, leading to a chronic shortage of building materials. The engineers have been challenged to convert the industrial wastes to useful building and construction materials. Accumulation of unmanaged wastes is one of significant environmental concerns, especially in developing countries. Recycling of such wastes as building materials appears to be viable solution to both pollution problem and economical design of buildings. In recent years, considerable research has been conducted on the utilisation of waste like fly ash, silica fume, blast furnace slag, lightweight crushed bricks, pozolanic materials, lightweight expanded clay aggregates, and foam polystyrene in civil engineering materials. Each of these wastes has provided a specific effect on the properties of fresh and hardened cement based materials. The two main potential fields in which recycled waste materials have been successfully used are the transportation and construction industries. One of the new and popular products in this sense is modified cementitious composites with scrap tyre rubber. The accumulation of rubber can be considered non-decaying materials that disturb the surrounding environment make the disposition of tyres a relevant problem to be solved. However, a positive method for disposing of this non-decaying material, such as reuse in concrete mixes, would have a beneficial effect like lower density, increased toughness and ductility, higher impact resistance, and more efficient heat and sound insulation. The use of recycled tyre rubber in Portland cement concrete mixtures also helps alleviate disposal problems and address the growing public concern about the need to preserve natural sand and aggregates. The work presented herein focuses on the feasibility of aerated cement composite, containing rubber tyre particles, and reinforced with polymer fibres. The composite consists of mortar incorporating rubber particles and polymer fibres as replacement to the sand. The replacement levels were 0 (control specimen), 25, 50, 75, and 100% by volume. An experimental test program was conducted mainly to investigate some of the fresh and hardened properties thought to be significant in relation to composite performances. The test properties were consistency, air content, dry unit weight, and compressive and flexural strengths measured at 28 days.

Dr A Benazzouk is a lecturer in Civil Engineering at the University of Picardie Jules Verne, Amiens. His research interests the durability and physico-mechanical behaviour of cement composite based on natural and local materials.

Dr Douzane O., Is a lecturer in Civil Engineering, University of Picardie Jules Verne, Amiens. His major center of interest is thermal and mechanical behaviour of building materials.

Pr Langlet T., Is a professor in Civil Engineering, University of Picardie Jules Verne, Amiens. His major center of interest is thermal and mechanical behaviour of building materials.

Dr M Merzoud is a Lecturer in Civil Engineering Department at the University of Badji Mokhtar, Annaba, Algeria. His research interests the behavior of masonry structures, the use of natural local materials in composites.

Keywords: Aerated cement composite, Fresh and hardened properties, Polymer fibres, Rubber tyre particles

Presentation: Day 1 1650 – 1710 — Venue 2: 3G05

Reducing Sulphates in Crushed Concrete: Improving the Building Material Properties of Recycled Concrete Aggregates

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The material properties of recycled concrete aggregates (RCA) are correlated to the sorting accuracy of the former demolition waste. Impurities like wood, clay bricks or gypsum can lead to inferior building material properties. Harmful substances like heavy metals or organic pollutants should be minimised as well. Hence the non-concrete materials have to be separated from the concrete material stream. This can be done during the demolition process by using selective dismantling techniques. Alternatively a variety sorting and classifying techniques to purify the crushed concrete can be utilized.

A research project, funded by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, investigated the possibilities of gaining recycled concrete aggregates of a high quality for the reuse in the production of concrete. The work focuses especially on how gypsum respectively sulphates in the crushed concrete can be reduced. Sulphates can impair the setting behaviour of concrete and also damage set concrete by causing expansion. Therefore the content of sulphates in RCA is restricted by guidelines and standards in Germany. Generally, gypsum in construction waste originates from interior fittings like gypsum walls, floor screeds, plaster boards and also plaster. Most of these materials can be reconstructed using selective dismantling techniques. This can be achieved either by manual labour or by using mechanical equipment e.g. to remove floor screeds by milling. Depending on the specific deconstruction site it can be more effective and/or more environmentally compatible to remove sulphates by treating the crushed concrete. Applicable treatments for sulphate reduction include dry processes like manual sorting of gypsum wall blocks as well as wet treatments e.g. jigging. In addition this research project an environmental performance evaluation was undertaken to assess different techniques for reducing sulphates in recycled concrete aggregates.

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Prof. Dr. Anette Müller, senior scientist at IFF Weimar e. V., Germany

Dr. Elske Linß, Tabea Schulz are scientists at the Faculty of Civil Engineering, Bauhaus-University of Weimar, Germany

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Keywords: Building material properties, Environmental performance evaluation, Gypsum, Recycled concrete aggregates, Sulphates

Presentation: Day 2 1100 – 1120 — Venue 4: 2G14

CO_2 Sequestration by Means of High Energy Milled Asbestos-cement Containing Waste

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High Energy Milling (HEM) is a brand new technology able to destroy, at microscopic level, the fibres present in the asbestos containing materials (ACM), thus causing their complete inertisation. The obtained materials are powders with fine granulometry that can be re-used in different fields. In this work, we present some experimental results on the recycling of inertised ACM in building applications and suggest another innovative application in the field of CO_2 chemical sequestration.

Luca De Stefano graduated cum laude in Physics at University of Naples ”Federico II” and is currently a Researcher at the Italian National Council of Research

Grazia Accardo graduated cum laude in Industrial Chemistry at University of Naples ”Federico II” and is currently undertaking a PhD at the University Parthenope of Naples, Italy.

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Keywords: Asbestos, CO_2, CO_2 sequestration, High energy milling

Presentation: Day 2 1000 – 1020 — Venue 4: 2G14

A Study on Bond Strength of Self-compacting Concrete Made using Recycled Aggregates

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Reutilization of construction and demolition waste as a new construction material is becoming a primary objective for sustainable construction activities. Many waste materials have proved to be successfully utilized in the manufacturing of normal and high performance concretes. However, the utilization of Recycled Aggregates can minimize environmental impact and slowdown the huge consumption of natural resources used for concrete applications. Further in recent years, self-compacting concrete (SCC) has gained wide use for placement in congested reinforced concrete structures with difficult casting conditions. For such applications, the fresh concrete must possess high fluidity and good cohesiveness. This paper presents the experimental investigation on the bond behavior of Recycled Self Compacting concrete. A comparison of bond behavior and bond strengths in concrete grades M20 and M40 Normal and self compacting concretes with different percent replacement of recycled aggregates. The results indicated that the Self compacting concrete bond performance is better compared to normal concrete.

D Rama Seshu is currently working as Professor of Civil Engineering, National Institute of Technology, Warangal, India.

Keywords: Bond strength, Recycled aggregates, Self-compacting concrete

Concrete with Fluorescent Waste Glass Suspension

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The accumulation of non-recyclable waste glass in the plants without being used represents two major problems: a solid waste disposal and a negative impact to the environment. Borosilicate glass (DRL) and leaden silicate glass (LB) remaining after fluorescence lamp utilization is the waste which is not possible to recycle by traditional methods due to specific chemical composition. It causes a problem for glass disposal because glass is not biodegradable and landfill is not the best environment friendly solution for it. Using fluorescent waste glass as micro filler which partially substitute cement in concrete is a good way to solve these problems. In present study was investigated: the possibility to increase the fineness of fluorescent waste glass powder as micro filler by its additional grinding in water environment with water/glass (160/90 and 125/125) weight proportions and influence on concrete's compressive strength by incorporating waste glass powder suspension into the mix. Fourteen different concrete mixes with additionally ground DRL and LB waste glass powders and powder suspensions were prepared. The particle grading of waste glass suspension was determined by Laser diffraction method. The best obtained particle size was in range from 0,6 μm to 11 μm with average grain size 5 μm. The concrete specimens were tested at the age of 7, 28, 56, 84 and 112 days. The most prospective results were obtained using additionally 30 & 90 minutes DRL ground glass powder and DRL glass suspensions made within 90 minutes, especially DRL suspension with water/glass weight proportion 160/90 shown the highest result at the age of 112 days of 83,7 MPa. However, LB waste glass mixes showed lower results in comparison to control mix, there were observed improvements for mixes with additional grinding for 90 minutes of glass powder with compressive strength result of 66 MPa at the age of 112 days and suspension LB suspension with water/glass weight proportion 125/125 with compressive strength of 68,1 MPa.

P Kara is currently Scientific researcher at Professor Group of Building Materials and Products, Institute of Materials and Structures, Riga Technical University, Member of LVS STK 30 Eurocode Sub-Committee. The main fields of research are building materials and structures reuse of industrial wastes and by-products, concrete technology.

A Korjakins is currently Professor and Chair of Professor Group of Building Materials and Products, Institute of Materials and Structures, Riga Technical University. The main fields of research are building materials and structures, ecological building materials, reuse of industrial waste.

Keywords: Compressive strength, Fineness, Fluorescent waste glass powder, Micro filler, Waste glass suspension

Presentation: Day 2 0920 – 0940 — Venue 4: 2G14

Feasibility of Using Spent Printer Toner as a Colouring Additive in Concrete

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The growing demand for quality print-outs, wider availability and more economical operation of laser printers also means that more toner cartridges are made and recycled world-wide. However the toner powder removed from spent cartridges is not suitable for printers anymore and currently sent to landfill. Toner does not mix with water either and therefore cannot be used directly to colour concrete. The paper reports the development of a patented, multi-component, surfactant-based admixture, which makes toner powder compatible with concrete. Properties of such coloured concrete are investigated as a function of toner levels, including strength and permeability (ingress of water at atmospheric conditions and under pressure). Beyond its decorative values, toner coloured concrete also shows improved water tightness resulting in enhanced durability.

K Moock is Managing Director of Moock Environmental Solution Ltd, which is part of Easdale Environmental Development Ltd.

L J Csetenyi is a Research/Teaching Fellow in the Concrete Technology Unit, University of Dundee. His main areas of interest include cement and concrete science and technology with emphasis on waste stabilisation/solidification and practical use of these materials in construction.

M D Newlands is a Lecturer in the Concrete Technology Unit, Division of Civil Engineering, at the University of Dundee, UK. His research interests lie in concrete durability, sustainability and the development of test methods.

L Zheng is a Research Fellow in the Concrete Technology Unit in the Division of Civil Engineering, at the University of Dundee, UK. His research focuses mainly on Recycling of waste materials, concrete durability, mix optimisation, cement hydration and modelling.

Keywords: Colour, Concrete, Pigment, Toner

Presentation: Day 2 0940 – 1000 — Venue 4: 2G14

Comparative Study of Self-compacting Concrete with Manufactured and Dune Sand

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Sand is an inert element which essential in the composition of concrete; its use ensures granular continuity between the cement and gravel for better cohesion of concrete. This paper presents the results of a study that investigated the influence of sand quality on the properties of fresh and hardened self-compacting concrete SCC. The dune sands are very fine materials characterized by a high intergranular porosity, high surface area and low fineness modulus; on the other hand crushed (manufactured) sand has a high rate into thin, irregular shapes which are influencing the workability of Concrete. The amount of dune sand varies from (0% 50%, to 100%) by weight of fine aggregates. The results show that the rheological properties favor the use of dune sands; however the mechanical properties support the use of crushed sand.

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Keywords: Crushed sand, Dune sand, Mechanical properties, Segregation resistance, Self-compacting concrete

Influence of the Variety of Superplasticizer on the Properties of Blastfurnace Slag Concrete

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High performance cementitious materials have been developed with the use of polymer additives (superplasticizers). Superplasticizers can produce high workability of concrete and high strength, but they may produce undesirable effects on setting and hardening of concrete if used in large amounts in mixes. In this work the parameters involved are superplasticizer content and optimal percentage of mineral addition. The experimental study has been carried out using two different families of superplasticizers (Polycarboxylates and Poly-Melamine Sulfonate) and blastfurnace slag as a mineral addition. This investigation aims also to valorize an industrial waste (slag) and to incorporate it into the concrete formulations at high proportions, without altering the rheological properties of grouts and concretes with the presence of superplasticizers. The results obtained show that the type of superplasticizer used has a great influence on the variation of rheological parameters - plastic viscosity and shear stress – of grouts. Moreover, the optimum percentage of mineral addition (slag) is strongly related to the type of superplasticizer and cement.

Ahmed Laichaoui is a Lecturer and PhD student in civil engineering department at the Polytechnic National School (ENP), Algeria. His field of interest includes materials, structures, repair and cementitious materials

Ratiba Mitiche-Kettab is a lecturer in Civil Engineering and a researcher in the construction and environment laboratory of the Polytechnic National School (ENP) in Algiers. His research interests focus on the mechanical behaviour of concrete, the performance of roads and building materials, dune sand concrete, and the use of local materials and reuse of materials.

A Bali, Professor in Civil Engineering Department, is the Director of the Construction & Environment laboratory, his field of interest covers the materials, recycling of industrial and demolition wastes, structures reparing, new sustainable materials, valorisation of local materials.

Keywords: Cement grouts, Concrete properties, Slag, Superplasticizer, Viscosity

Presentation: Day 2 1440 – 1500 — Venue 4: 2G14

Rapid Pozzolanic Reactions with Silicate Solutions

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Hardened specimens of measurable compressive strength were made from mixtures of calcium hydroxide (CH) and aqueous silicate solutions through rapid pozzolanic reaction. The hydration products were assumed to be non-crystalline as there were no new crystalline phases detected by X-ray diffraction. Indeed, calcium silicate hydrates (C-S-H) have been synthesized as confirmed by the trimethylsilylation (TMS) method. However, the distribution of the various types of silicate anions in the C-S-H generated by mixing CH and water glass were different from C-S-H as cement hydration product. In addition, the pozzolanic reaction of CH with water glass was found to be very rapid, as assessed by analysing the structure of silicate anions. This technique can be widely used to appraise the potential of calcium containing construction wastes for utilisation.

Dr K Koizumi is an assistant professor at the Department of Chemistry at College of Science and Technology, Nihon University. The main fields of research are the effect of silicate structures on hydration of cementitious materials, valuable reuse of industrial wastes.

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Keywords: Calcium silicate hydrate (C-S-H), EPMA, Pozzolanic reaction, Silicate solution, Trimethylsililation

Presentation: Day 2 1420 – 1440 — Venue 4: 2G14

Manufactured Sand for a Low Carbon Era

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In 2000 the Welsh Assembly acknowledged the need to find a sustainable use for the growing stock piles of crusher fines in Wales, and commissioned research into their use as a replacement for natural sand in concrete. This study concluded that crusher fines were not a suitable replacement for natural sand in concrete due to their inconsistent grading and a lack of particles in the 0.3 to 1 mm range. New methods of manufacturing sand are now available, which can more accurately control the sand particle size, shape and gradation, including particles in the usually deficient range. Therefore a study has been launched to investigate the suitability of this manufactured sand for use in concrete applications. Concrete that incorporates sand manufactured from quarry waste is a major development in achieving a sustainable construction material. However, the characteristics of manufactured fine aggregates are different to those of natural sands and their effects on the performance of concrete are not fully understood. The most common issues associated with manufactured sands are poor shape, gradation, and the quantity and quality of filler material. To investigate the effects of these and other parameters a test programme has been undertaken. Laboratory tests have been used to evaluate the mineralogical and physical characteristics of a range of quarry waste sands. This paper describes the methodology of this study, presents the results to date and discusses the significance of the findings in the context of manufactured sand for a low carbon era. These results show that it is viable to produce workable concretes of satisfactory strength in which the natural sand has been completely replaced by manufactured sand.

Martins Pilegis graduated Cardiff University with a 1st class BEng degree in Civil Engineering in 2010. Currently he is a research student at the Cardiff School of Engineering, Cardiff University.

Dr Diane Gardner graduated from Cardiff with a 1st class MEng degree in Civil Engineering in 2002. Following this she undertook a PhD in experimental and numerical studies of the permeability of concrete. She obtained PhD in 2005 and joined Hyder Consulting UK Ltd, and spent 3 years working in their bridge/civil structures team. She took up her present academic post in January 2009 and her primary research interests are in experimental testing of sustainable cementitious materials.

Professor Bob Lark is a Chartered Engineer with over 30 years of varied Civil Engineering experience. He has been an academic at Cardiff University for 15 years and during this time has undertaken research on the design and behaviour of concrete and steel structures, bridge monitoring and assessment, and the development of life cycle analysis and asset management techniques. He has solely and jointly generated research income in excess of £1M. He has supervised 10 successful PhDs and is currently jointly supervising a further 4 PhD students and a Research Associate. He has over 60 publications in international journals and refereed conferences since 1996.

Keywords: Concrete, Manufactured sand, Sand replacement, Strength, Workability

Presentation: Day 2 1400 – 1420 — Venue 4: 2G14

Carbon Dioxide Capturing Ability of Cementitious Building Finishing Materials

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In this study, we focused on the carbon dioxide capturing ability of cementitious materials for the use of the building wall finishing. Carbon dioxide capturing tests were performed for various finishing materials by using the 10-litre Tedlar bag filled with 20% concentration carbon dioxide gas and with a finishing material. Reduction of the concentration of carbon dioxide gas in the Tedlar bag was measured by the carbon dioxide detector tube. Finishing materials such as Japanese plaster, diatomite, autoclaved aerated concrete, moisture control finishing, mortar, tile were used for the carbon dioxide capturing test. It was found that the materials including the chemical element of calcium have high carbon dioxide capturing ability.

Y Kitsutaka is a Professor in the Department of Architecture and Building Science at Tokyo Metropolitan University, Japan, Eng. Dr. from Tokyo Institute of Technology in 1986, aesthetics of building finishes, durability of building materials, new concrete material, fracture mechanics of structural materials, the 2001 paper prize of Architectural Institute of Japan.

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Keywords: Capturing ability, Carbon dioxide, Finishing materials, Greenhouse gases

Presentation: Day 2 1200 – 1220 — Venue 4: 2G14

Possible Use of Iron- and Steelmaking Slag as Replacements for Cement

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2 – Luleå University of Technology, Sweden

Steelmaking slags have mainly been used as aggregates in road construction, while only 1 % was used in cement production in Europe 2004. There are at least two good arguments to why the utilization of steelmaking slags should be increased in cement production, i.e. to decrease CO_2 emissions and to conserve natural resources which thereby reduce the amount of slags sent to landfill. In addition to a general evaluation of the possibility to use slags as replacement for cement or as a raw material in production of cement, some examples will be given. Results provided in this study show that the level of CO_2 emissions can be reduced by about 30-35 % in comparison to ordinary Portland cement production (OPC) when a major fraction of steelmaking slags are used as raw material for production of slow hardening sulphoaluminate belite cement (SAB). The formation of calcium aluminate hydrates in ladle furnace slag (LFS) results in high early strength which is why LFS is considered to be used as binder supplement for OPC in for instance metallurgical briquettes. Another application is the use of LFS in barrier constructions, as for example the liner layer in a landfill top cover. An ongoing field-study in the community of Hagfors, Sweden, shows that LFS in combination with electric arc furnace slag (EAF) can fulfill the technical and environmental requirements for a cover of a municipal solid waste landfill.

Dr D Adolfsson is a researcher with SSAB EMEA, Oxelösund, Sweden.

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Dr F Engström is a Lecturer and Professor B Björkman is a Professor, in process metallurgy at Luleå University of Technology, Sweden.

Keywords: Binder additive, Cement replacement, Liner material, SAB cement, Steelmaking slag

Presentation: Day 2 1140 – 1200 — Venue 4: 2G14

Use of Double Punching Test (Barcelona test) for Quality Control of Fibre Reinforced Concretes

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2 – Universitat Politècnica de Catalunya, Spain

Traditionally, flexural testing is used to characterize the strength and post – peak behavior of fiber – reinforced concretes (FRC). Nevertheless, these tests results exhibit a high dispersion, and therefore invalidate their use as tests for the systematic control of FRCs in works. Also, they have the disadvantage of being complex tests, which require heavy specimens and highly qualified staff. With the aim to solve these problems, an indirect tensile test based on double punching test set up, called the Barcelona test, has been proposed to control tensile behavior of FRC. This test requires smaller specimens, with a high specific surface of fracture, allowing obtain values representative of strength and toughness of materials, with considerably less dispersion than other experimental methodologies, and was recently standardized in Spain. This paper presents the results of an experimental program, which validate the use of Barcelona test as a suitable methodology to systematic characterization FRC in works.

S Carmona is currently Professor of Concrete Technology at the Universidad Tecnica Federico Santa Maria, Valparaiso, Chile. He has led several researches on concrete, and also submitted several papers about fibre reinfoced concrete, high performance concrete, and sulphur concrete.

A Aguado is Full Professor of Concrete Technology, and Concrete Structures of the Department of Construction Engineering at Universitat Politècnica de Catalunya, Barcelona, Spain. He carries out many researches on high performance concrete, fibre reinforced concretes, and structures for dams and tunnels.

C Molins is Associated Professor of the Department of Construction Engineering at Universitat Politècnica de Catalunya, Barcelona, Spain. His research interest are design and analysis of the behavior of reinforced and prestressed concrete, design and analysis of precast elements for tunnels.

Keywords: Barcelona test, Fibre reinforced concrete, Toughness

Presentation: Day 2 1620 – 1640 — Venue 4: 2G14

Properties of Mortar Reinforced with Jute Fibres

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2 – University of Picardie Jules Verne, France

Efficient utilization of natural resources is very important from the perspective of sustainability. The importance of recycling and promotion of biomass is expected to constitute a major share of the future total use of renewable energy sources in many countries. Agriculture wastes were generally used for fertiliser and fuel for energy production, but little work has been carried out to develop utilisation of these wastes in the production of building materials. Cement composite manufactured with lignocellulosic materials from different sources will have some variation in properties related to their various chemical components. The materials inhibit cement setting and reduce mechanical strengths development due to the amount of alkalis and dissolved component extracts. However, the viability of the use of lignocellulosic materials in cement depends on the appropriate chemical treatment that can be used to preventing components hindering cement harden. The main objective of this study was to investigate the potential utilisation of jute fibres as reinforcement additives in cement mortar, within the scope of providing an alternative solution to an environmental problem. The jute fibres were used as partial replacement of sand at different levels: 0% (control mortar), 0.5%, 1%, 1.5% and 2% by weight. The average length of jute fibres was less than 1 cm. The chemical compatibility of jute fibres to cement was evaluated using hydration test. The results have shown that the corresponding inhibitory effect classifies the mixture as being of ”low inhibition”. An additional experimental test program was conducted mainly to investigate the properties of fresh and hardened composite, including consistency, air-entrainment, unit weight, compressive and flexural strengths.

S Menadi, is a PhD student at the University of Badji Mokhtar, Annaba, Algeria. She is currently finalizing thesis at the « Laboratoire des Technologies Innovantes », University of Picardie, Jules Verne, Amiens, France.

Dr Benazzouk A., is a lecturer in Civil Engineering at the University of Picardie Jules Verne, Amiens. His research interests the durability and physico-mechanical behaviour of cement composite based on natural and local materials.

Dr O Douzane, is a lecturer in Civil Engineering, University of Picardie Jules Verne, Amiens. His major center of interest is thermal and mechanical behaviour of building materials.

Pr T Langlet, is a professor in Civil Engineering, University of Picardie Jules Verne, Amiens. His major center of interest is thermal and mechanical behaviour of building materials.

Pr M F Habita, Professor in civil engineering department at the University of Badji Mokhtar, Annaba Algeria. Member of civil Engineering laboratory of Annaba University. His research interests concrete behaviour and masonry structures.

Dr M Merzoud, Senior Lecturer in Civil Engineering Department at the University of Badji Mokhtar, Annaba, Algeria. Member of Civil Engineering laboratory of Annaba University. His research interests the behavior of masonry structures, the use of natural local materials in composites, structures with reinforced concrete.

Keywords: Hydration test, Inhibitory effect, Jute fibres, Mechanical properties, Reinforced cement mortar

Presentation: Day 3 1000 – 1020 — Venue 2: 3G05

Glass Fibre Reinforced Concrete as a Material for Large Hanging Ceiling Designs in Underground Station Restorations

N Shangina, A Kharitonov
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The fabrication of hanging ceiling designs for underground's platform hall by hand spray-up method is a new direction of the use glass fiber reinforced concrete. There is the demand of decisions some technological and constructive problems for ensuring required level of working and decorative features at the restoration of history ceiling to Avtovo station in Saint-Petersburg. The motivation of the background technical decisions that are adopted at the restoration and referring both to material and design as a whole has been presented in the article.

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Keywords: Glass fibre reinforced concrete, Historic structures, Restoration

Presentation: Day 2 1600 – 1620 — Venue 4: 2G14

The Influence of Polypropylene Fibres on Early Autogenous Shrinkage of Fibre Reinforced High Performance Concrete

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Polypropylene fibres have been widely used in concrete to improve its engineering properties. Many researchers have studied the mechanical properties of fibre reinforced concrete, but less data are available on its rheological properties, especially for high-strength concrete at early ages. In the proposed paper the experimental results of the early autogenous shrinkage of high performance polypropylene fibre reinforced concrete with the volume content of polypropylene fibres between 0.25% and 0.75% are presented and analysed. In order to compare the autogenous shrinkage of polypropylene fibre reinforced concrete with that of a comparable concrete without fibres, also the shrinkage of comparable plain concrete was measured. The test results show that early autogenous composite shrinkage decreases with the increase of the amount of polypropylene fibres in the composite.

Branko Bandelj, Ph.D., is Design Engineer in Primorje, Slovenia. His main research activity is fibre reinforced concrete.

Drago Saje, Ph.D., is Assistant professor at the Faculty of Civil and Geodetic Engineering, University of Ljubljana. His main research activities are the mechanical and rheological properties of high performance concrete and the design of concrete and timber structures.

Barbara Mihaela Saje, M.Sc.. Her research activities mainly concern the design and safety of concrete structures, mechanical and rheological properties of ordinary and high-performance concrete at normal and elevated temperatures, nonlinear analysis of reinforced concrete structures, as well as fire resistance of concrete structures.

Jakob Šušteršič, Ph.D., is Director of Institute for Research in Materials and Applications Ljubljana, Slovenia. His main activities are associated with fibre reinforced concrete, polymer modified concrete, high performance concrete and other special concrete.

Jože Lopatič, Ph.D., is Assistant professor at the Faculty of Civil and Geodetic Engineering, University of Ljubljana. He is a Head of the Chair of Concrete and timber Structures. His main research interests include the modelling of nonlinear creep and shrinkage of concrete, design and nonlinear time-dependent analysis of reinforced concrete structures, as well as field testing of structures.

Franc Saje, Ph.D., is Associate professor at the Faculty of Civil and Geodetic Engineering, University of Ljubljana. His research activities mainly concern the design, safety and reliability of concrete and timber structures, mechanical properties of concrete at normal and elevated temperature, nonlinear analysis of reinforced concrete structures, as well as fire resistance of concrete and timber structures

Keywords: Autogenous shrinkage, High-performance concrete, Polypropylene fibre, Silica fume, Water-binder ratio

Presentation: Day 2 1500 – 1520 — Venue 4: 2G14

Repair of Pre-loaded RC Columns Using External CFRP Sheets and Embedded Longitudinal Steel Reinforcement

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This paper presents results of an experimental investigation on the behavior of axially preloaded short circular columns that have been repaired with carbon fiber-reinforced polymer (CFRP) wrap. A total of six R.C. columns have been subjected to compression load up to three different loading levels (unloaded column "0% of ultimate load", loaded until cracking load "85% of the ultimate load", and loaded till failure 100% of ultimate load) then all the loaded column confined using CFRP wrap and subjected again to compression loading. Also a unique method has been presented in this paper for those three repaired columns using four reinforcing steel bars were embedded as near surface mounted with epoxy in grooves through the concrete cover then covered by the CFRP wrap, those additional longitudinal reinforcement could consider as replacement of any corroded existing reinforcement.

Dr. Alaa Morsy has ten years of experience in Structural engineering, practice and research. During this period he teaches more than 15 courses for under-graduate students He has a strong background in Design of Reinforced Concrete & Metallic Structures, Use Advanced Composite Materials (FRP) in Repair and Strengthening of R.C., Heat Transfer and fire Protection, and Use Finite Elements Soft wares in Modelling.

M. El-Tony is a Structural Engineering Department within the Faculty of Engineering, Alexandria University, Egypt.

Keywords: CFRP, Confinement, Preloading, Strengthening, Wrapping

Compressive Strength and Microstructure of Autoclaved Aerated Concrete Produced with Partial Replacement of Cement by Bottom Ash and Fly Ash

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This research investigated the use of coal bottom ash and fly ash from Mae Moh power plant, Lampang, Thailand, as Portland cement replacement to produce autoclaved aerated concrete. Portland cement, sand, bottom ash, fly ash, aluminium powder (added at 0.2 percent by weight) and calcium hydroxide were used. Compressive strength and physical properties tests were then carried out after the concrete were autoclaved for 6 hours and left in air for 7 days. The results show that the compressive strength and unit weight increased while the permeable of void decreased when bottom ash and fly ash was used. Therefore, both bottom and fly ashes can be seen to have the benefit in enhancing the strength of aerated concrete (11.5 MPa for 30% bottom ash concrete and 11.0 MPa for 30% fly ash concrete) when compared to the results of the control Portland cement concrete (9.5 MPa). This is due to the tobermorite ($C_5S_6H_5$) formation as shown by scanning electron micrographs which gives a denser microstructure than α-C2SH phase formed in Portland cement mix.

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Keywords: Autoclaved concrete, Bottom ash, Compressive strength, Fly ash, SEM

Presentation: Day 2 1620 – 1640 — Venue 3: 2G13

Utilising Fly Ash and Fine Tailings in Foamed Insulation Building Materials

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This paper describes an extensive laboratory-based investigation into the use of fly ash and fine tailings in one type of insulation materials of building materials-foamed concrete. Foamed concrete with apparent density from 500 to 1000 kg/m^3, compressive strength from 1 to 14.5 MPa and thermal conductivity from 0.06 to 0.145 W/(m°C) were prepared when a large volume of cement(up to 60 wt.%) have been replaced with fly ash and fine tailings. The rheologic, mechanical and heat preservation properties were investigated for the foamed concrete.The results shows that using fly ash and fine tailings can significantly enhance the rheologic property of fresh foamed concrete. In addition, up to 60% of the cement could be replaced without obvious reductions in long-term strength and thermal conductivity in relative higher density(1000kg/m^3). By using fly ash or fine tailings as fine aggregate in foamed concrete, the high volume utilization of these industrial waste becomes possible, thus providing a means of economic and safe disposal of these waste residues.

She Wei is a PhD student in Jiangsu Key laboratory for Construction Materials, Southeast University, Nanjing, China. His research interests include foamed insulation materials of building.

Zhang Yunsheng is a professor in Jiangsu Key laboratory for Construction Materials, Southeast University, Nanjing, China. He received his PhD in Structure Engineering from Southeast University in 2004. His research interests include microstructure formation process of cementitious materials, high performance concrete made with fly ash or slag, durability and service life prediction of high performance concrete.

Zhang Wenhua is a PhD student in Jiangsu Key laboratory for Construction Materials, Southeast University, Nanjing, China. His research interests include ultra-high performance cementitious materials.

Keywords: Compressive strength, Fine tailings, Fly ash, Foamed concrete, Thermal conductivity

Presentation: Day 2 1200 – 1220 — Venue 3: 2G13

Effect of Steel and Polypropylene Fibres on the Performance of Self-compacting Concrete (SCC) Incorporating Calcareous Fly Ash

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Calcareous fly ashes often increase the water demand of concrete mixtures, which is problematic in the case of SCC where the balance between fluidity robustness of the mixture and added water is very sensitive. However, by adjusting the dosages of superplasticizer and viscosity modifying agent, it was achieved to replace 30% and 50% by mass of the Portland cement in SCC mixtures with this fly ash, without modifying the water to cementitious ratio. Furthermore, in an effort to eliminate shrinkage deformations of the SCC mixtures, which typically have a high value of cementitious matrix to aggregate ratio, steel and polypropylene fibers were added at two different percentages, 0.4% and 0.7% by volume, for each type of fiber. The influence of fiber addition on the properties of fresh SCC and the mechanical and elastic characteristics of the hardened fiber-reinforced SCC at 28-d age were measured. In addition, the toughness of fiber-reinforced SCC with and without calcareous fly ash was studied by plotting flexural strength – deflection diagrams and using relevant standards. Shrinkage deformations were measured after demoulding and placing into a climatic chamber with 60% RH. It seems that the addition of fibers at the above-mentioned percentages does not influence the fluidity and robustness of the mixture significantly. By adding fibers in the SCC, strength of the same or higher level than that of the plain SCC mixtures is developed. Furthermore, fiber-reinforced SCC shows increased toughness and reduced shrinkage deformations.

I Papayianni is currently Professor and Director of the Laboratory of Building Materials at the Civil Engineering Dept. of the Aristotle University of Thessaloniki, Greece. She is a member of ACI and RILEM Committees and the scientific responsible of many National and European Research Projects. Her specialist research fields include concrete technology, supplementary materials and repair materials.

E Anastasiou is a Researcher at the Laboratory of Building Materials at the Civil Engineering Dept. of the Aristotle University of Thessaloniki, Greece. He has participated in several research projects and published several articles on concrete technology. His specialist areas of research include industrial by-products utilization in concrete, supplementary cementing materials and fiber-reinforced concrete.

M Papachristoforou is a Civil Engineer and a PhD candidate at the Laboratory of Building Materials at the Civil Engineering Dept. of the Aristotle University of Thessaloniki, Greece. He has participated in several research projects on concrete and his specialist areas of research include industrial by-products utilization in concrete, fiber-reinforced concrete and radiation shielding concrete.

Keywords: Drying shrinkage, Fibre reinforced self-compacting concrete, Fracture toughness, High calcium fly ash

Presentation: Day 2 1420 – 1440 — Venue 3: 2G13

Thermal Activation Effect on Fly Ash Based Geopolymer Concrete

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It is now well accepted that new binders are needed to replace Portland cement (OPC) to enhance the environmental and durability performance. The development of alkali-activated binders seems to be a greener alternative to OPC. The present study on geopolymer concrete has been made on low calcium fly ash with alkali activators as main binder along with Conventional river sand and 12 mm down coarse aggregates. The alkali activator fluid consists of commercial grade sodium silicate (Na_2SiO_3) pellets and sodium hydroxide (NaOH) solution. The thermal activation for geopolymer concrete in its initial stage is needed for early strength gain and thus its effect on the strength of at different ages of 3, 7, 28 days has been reported. Thermal activation was done in two distinct methods- (1) By keeping the geopolymer concrete specimens (without mould) in a microwave oven for a smaller duration (30, 45 and 60 minutes) after 3 days of casting and (2) By keeping in a hot air oven at temperatures of 600°C, 750°C and 900°C for a longer duration (48 hours) just after casting along with steel moulds. It is concluded that the compressive strength of geopolymer concrete increases with the increase of heat energy in both form cases.

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Keywords: Alkali activation, Fluid to fly ash, Fly ash, Hot air oven, Microwave oven

Presentation: Day 2 1400 – 1420 — Venue 3: 2G13

Valuation of the Residual Obtained from the Burning of Rice Husk for Use in Concrete

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In Uruguay rice production has had a dramatic increase over the past ten years, becoming the most important crop since 2001. Rice production generates large volumes of residual rice husk, fact that leads to serious accumulation issues. Rice is a plant that contains a high amount of sílica, mainly in its husk. When burnt, large quantities of ash are obtained (each ton of paddy produces aprox. 40kg of ash). A large amount of rice husk is used for the production of electricity in cogeneration systems, and as fuel in the rice milling process. In these processes the rice husk ash (RHA) obtained has different characteristics from those produced under controlled conditions: presents high-carbon content and a part of silica in crystalline state. The RHA has about 90% silica. The morphology of the silica is very dependant on the burning conditions; if it is not amorphous (crystalline), it can harm the human organism. Therefore, this paper presents the development of a pretreatment of the rice husk with HCl for the purpose of obtaining amorphous rice husk ash, and a methodology to obtain an amorphous pozzolanic mineral admixture (PRHA) for concrete from the ashes as well. Microstructure and the influence of the milling time on the pozzolanic activity index of the ash obtained are studied. Also, a part of the cement in concretes was substituted by the PRHA in order to study its influence in the compressive strength, elastic modulus, air permeability, chloride ion penetration and shrinkage. The results obtained with the PRHA are compared with those obtained without rice husk ash, proving the viability of its use in concrete when replacing part of the cement.

Dr G R de Sensale is a Full Professor in the Instituto de la Construcción and the Instituto de Ensayo de Materiales of the Faculty of Architecture and Engineering of the Universidad de la República, Montevideo, Uruguay. She has been working in the field of concrete with rice-husk ash since 1997. She is also active as a consulant to government and industry.

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Keywords: Concrete properties, Rice-husk ash, Waste utilization

Presentation: Day 2 1440 – 1500 — Venue 3: 2G13

Influence of Circulating Fluidized Bed Combustion (CFBC) Fly Ash on the Properties of Cement Pastes

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Circulating fluidized bed combustion (CFBC) technology is one of the most promising clean coal technologies. With increasing emphasis on lowering greenhouse gas emissions, CFBC boilers are widely adopted by thermal power plants in an effort to reduce NOx and SOx emissions. This paper provides the details of a systematic study tailored to understand the influence of a CFBC fly ash (high in CaO, SO_3, and LOI) as a partial cement replacement material, on the hydration behavior, and fresh and hardened properties of cement pastes. The influence of CFBC fly ash on air entrainment efficiency in cement pastes is evaluated in detail using modified foam index tests.

Hieu Cam was a Masters student in the Department of Civil Engineering at Clarkson University, Potsdam, NY. His research interests are in alternate cement replacement materials for concrete and their property evaluation.

Dr. Narayanan Neithalath is an Associate Professor in the School of Sustainable Engineering and the Built Environment at Arizona State University, Tempe, AZ. His research interests are in the development and characterization of novel cementitious materials, performance evaluation and modeling of cementitious systems, computational materials science of concretes, and development of sustainable energy efficient concrete systems.

Keywords: CFBC fly ash, Calcium hydroxide content, Compressive strength, Foam Index test, Hydration

Presentation: Day 2 1500 – 1520 — Venue 3: 2G13

Maximizing the Use of PFA in the Production of Sustainable Structural Materials

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Despite concrete having universal acceptance, approximately one tonne of CO_2 is emitted per tonne of Portland cement produced. Notwithstanding the promotion and increasing acceptance of high volume fly ash concrete (HVFAC), over 80% of PFA generated in the UK has yet to find acceptance as a cement supplement due to non-compliance to the fineness and or loss on ignition (LOI) criteria set out in EN 450. Alkali activation of higher LOI ashes reveals compressive strength inadequacy for structural application. It is believed that, like the interaction with air entrainment admixtures, unburned carbons might have a role in rendering the alkalis less effective in dissolving adequate alumino-silicate species. Fly ash with and without 20% Portland cement (OPC) in the feed material was treated with sodium silicate with 0.41 silica modulus and setting time, compressive strength and LOI assessed on activated samples. It is observed that, 20% Portland cement (OPC) in the feed material resulted in improved compressive strength compared to that which had only fly ash after curing at room temperature. Loss on ignition tests on the alkali-activated samples however revealed 3.8% mass loss compared to 9% on the un-activated PFA.

Samuel Adu-Amankwah is a researcher at the University of Wolverhampton. His research is on Maximizing the use of Fly Ash in the Production of Sustainable Construction Materials. His research actitivities include low carbon cementitious materials and correlating composition cementitious materials to performance.

Dr. Jamal M. Khatib is a Principal Lecturer at the University of Wolverhampton. Jamal is currently involved in a number of research projects on sustainable construction materials.

Dr. David Searle is a Senior Lecturer at the University. His research interests include sustainable construction materials and environmental engineering.

Dr. Lindon K.A. Sear is the Technical Director of the UK Quality Ash Association.

Keywords: Alkali-activation, Alumino-silicate, Fly ash, LOI, Portland cement

Presentation: Day 2 1640 – 1700 — Venue 3: 2G13

Towards the Development of Carbon Dioxide Neutral Renewable Cement (BioCement)

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Concrete is currently the most extensively used construction material and the global consumption of concrete increases every year. As an essential component in concrete, cement consumption also increases annually. Global cement production grew from 594 Mt in 1970 to 2770 Mt in 2007. Cement production is extremely energy-intensive and accounts for about 2% of the global primary energy consumption, or up to 5% of the total global industrial energy consumption. Between the large quantities produced and the huge energy consumption, cement is responsible for significant amounts of CO_2 being released into the atmosphere. The production of cement contributes to CO_2 emissions through two sources: the decomposition of limestone and the combustion of fossil fuel. The CO_2 emissions resulting from conversion of limestone into calcium oxide are fairly constant and equate to approximately 540 kg CO_2 per tonne of clinker produced. Since multiple factors are involved (such as the thermal efficiency of the kilns), the CO_2 emissions resulting from the combustion of fossil fuels fluctuate. In 2006 the global average gross CO_2 emissions per tonne of clinker was 866 kg. This value accounts for 5-8% of total human atmospheric CO_2 emissions. Recently many steps have been taken to combat CO_2 emissions in the cement industry including improving energy efficiency of the kilns, replacing fossil fuel with renewable energy sources and substituting part of Portland cement with other cementitious materials. While these actions have made progress in reducing CO_2 emissions they still do not provide a completely sustainable solution.

HM Jonkers is senior scientific researcher at the Sustainability unit of the Materials and Envionment group of the Delft University of Technology, The Netherlands. He is leading scientists of several currently running research projects on the development of bio-based civil engineering materials.

NN Carr is PhD student at the Sustainability unit of the Materials and Envionment group of the Delft University of Technology, The Netherlands. Her specialist area of research is application of biomass derived ashes as cement replacement.

Keywords: Biocement, Carbon dioxide, Cement, Neutral, Renewable

Presentation: Day 2 1600 – 1620 — Venue 3: 2G13

Characterisation of Alkali Activated Co-fired Fly Ash Geopolymers

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2 – University of Melbourne, Australia

Alkali-activation of waste and industrial by-products is a growing technology for the production of sustainable alternative binders for the substitution of portland cement. One of the main precursors used in the production of alkali-activated geopolymer binders is fly ash obtained from the combustion of coal. The need to reduce CO_2 emissions associated with coal combustion has promoted the development of processes involving the combined combustion of coal with other organic materials, generating a by-product referred to as 'co-fired fly ash'. The chemical composition and physical properties of co-fired fly ash can be comparable to those identified in coal fly ash, rendering it a potentially suitable option for geopolymer production, for application in the construction field as a less CO_2-intensive material. However, these ashes differ from standard fly ashes because they contain biomass ash, which has been shown to change phosphate, alkali, magnesium, and reactive silica levels in addition to altering the morphology of the resulting ash product. In this study two ashes—one commercially available coal ash and one co-fired ash produced by burning coal with wood chips—are activated with alkali silicate and hydroxide solutions, to evaluate the feasibility of using co-fired ash in the production of geopolymer binders. X-ray diffraction shows that using this co-fired ash, the formation of zeolitic phases including chabazite-Na ($NaAlSi_2O_6$•$3H_2O$) and faujasite ($Na_2Al_2Si_4O_{12}$•$8H_2O$) is favoured within an otherwise X-ray amorphous binder. Infrared spectroscopy reveals that this co-fired ash is more polymerised after alkali-activation compared to the coal ash. This paper elucidates some fundamental properties of these materials—a necessary endeavour before utilisation in future low-carbon infrastructure, and in understanding the future of geopolymer technology as the U.S., Europe and other regions move increasingly to biomass co-firing (rather than pure coal) as a fuel source for electricity generation.

Christopher R. Shearer is a Ph.D. student in the School of Civil and Environmental Engineering at Georgia Institute of Technology. His current research is on the characterisation and potential reuses of biomass and co-fired fly ash in concrete, geopolymers and fired bricks. He holds a B.S. in Civil Engineering from Ohio Northern University and a M.S. in Civil Engineering from Georgia Institute of Technology.

Susan A. Bernal holds a Bachelors degree and a Doctorate in Materials Engineering from Universidad del Valle, Colombia, and she is currently a Research Fellow in the Geopolymers and Minerals Processing Group at the University of Melbourne, Australia. She specialises in valorisation of waste and industrial by-products through alkaline activation, and the assessment and understanding of the durability properties of these materials. Her current work is developed in collaboration with the industrial partner Zeobond Pty Ltd, which focuses on the development, commercialisation and manufacturing of geopolymer technology.

John L. Provis is currently a Senior Research Fellow and leader of the Geopolymer and Minerals Processing Group in the Department of Chemical and Biomolecular Engineering, the University of Melbourne, Australia. He will commence a Professorial position in the Department of Materials Science and Engineering, University of Sheffield, UK, in June 2012. He holds BE(Hons) (2002), BSc (2002) and PhD (2006) degrees from the University of Melbourne, and is Secretary of RILEM TC 224-AAM.

Kimberly E. Kurtis, Ph.D., FACI, FACerS is Professor in the School of Civil and Environmental Engineering at Georgia Institute of Technology, Atlanta, GA. She is Chair of ACI Committee 236: Materials Science of Concrete and an Editorial Board member at Cement and Concrete Composites.

Keywords: Biomass, FTIR, Fly ash, Geopolymer, X-ray Diffraction

Presentation: Day 2 1140 – 1200 — Venue 3: 2G13

Experimental Study on the Partial Replacement of Cement by Fly Ash on Self-compacting Concrete

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This paper presents the results of an experimental investigation of fly ash based Self Compacting concrete (SCC). The results of fresh and hardened properties including rapid chloride ion permeability realized fly ash as partial replacement by replacing cement via 30%,40% and 50% in a binder content (Cement + fly ash) of 500kg. The fresh and hardened properties are influenced by all mixture factors: the compressive strength, modulus of rupture and split tensile strength decreases marginally with the increase of fly ash and reduces chloride ion permeability. The Produced SCC with water reducing admixture and without adding viscosity modifying agent both in terms of flow performance and early strength, of quality comparable or better than conventional concrete.

Dr K Nagamani graduated (B.E(Hons)Civil Engineering)in 1983 from University of Madras, Master's M.Tech(Ocean Engineering)1985 and Ph.D(Offshore structures) 1991 from Indian Institute of Technology, Madras,India. At present Professor in Civil Engineering,Division of Structural Engineering,College of Engineering, Anna University, Chennai, India

B Mahalingam graduated B.E. Civil Engineering 1987 from Bangalore University,Bangalore and M.E.(Structural Engineering)1994 from Annamalai University, Chidambaram, Tamil Nadu,India.

Keywords: Fly ash, Fresh properties, Hardened properties, Permeability, Self-compacting concrete

Presentation: Day 2 1700 – 1720 — Venue 3: 2G13

Ammonia in PFA and Cementitious Products Manufacture

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2 – Hanson Building Products, UK

In order to reduce NOx emissions, increase precipitator efficiency from coal fired power stations and to ensure compliance with the EU Large Combustion Plant Directive,ammonia will need to be injected in the furnace gases of many UK coal fired power stations. While ammonia does not have any detrimental effects on the performance of concrete, concerns have been expressed about the Health & Safety aspects of possible contamination of Pulverised Fuel Ash (PFA)/fly ash. Ammonia injection is used to convert NOx gases to nitrogen when the furnaces gases pass over Selective Catalytic Reduction (SCR) units. Ammonia may also be injected into the furnace gases to enhance the efficiency of electrostatic precipitators by increasing the ionising efficiency. Excess ammonia not converted within the SCR may thereby be found within the PFA. This ammonia will be released when used in concrete and aircrete block manufacture, due to the high pH of these products. However, this raises a number of issues such as the measurement of ammonia in PFA. With there being no recognised test method and the existence of a considerable number of techniques, what is an acceptable level of ammonia contamination and what are the possible short and long term effects on these products? This paper will review the issues associated with the use of ammonium injection, measurement of ammonia in PFA, the possible effects on concrete and aircrete block properties, experience from mainland Europe and its use in the UK. In addition it will look at the techniques for post processing PFA to remove ammonia.

Dr Lindon K A Sear, joined the newly formed UK Quality Ash Association in 1977 and has been working for the last 14 years promoting the interests of coal-fired power station operators as the UKQAA Technical Director. Lindon attends 20 different British and European Standard Committees and sub-committees and a number of research projects steering committees on behalf of the UKQAA.

Miss Jodie Guest, is Product Development Manager for Hanson Building Products, where she has worked for 9 years. Jodie provides product and process development expertise and technical support for a range of building products, particularly Thermalite autoclaved aerated blocks, which contain up to 80% PFA. Jodie also represents Hanson on the UKQAA technical commitee.

Keywords: Aircrete, Ammonia, Fly ash, Pulverised fuel ash, Selective catalytic reduction

Presentation: Day 3 0900 – 0920 — Venue 2: 3G05

Low-carbon Concrete Using Local Industrial By-products

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Micro fillers are important components in concrete mix in modern concrete technology. It improves workability of concrete mix, allows to achieve cement economy and to provide special performance of hardened concrete characteristics. The most effective micro fillers have pozzolanic action. Natural pozzolanic admixtures are not available in the most of countries (for example, in Latvia), but commercial products (such as silica fume) are quite expensive. Possibilities for use of local industrial by-products are discussed in this study. One revised direction is recycled bore silicate glass powder obtained from fluorescent lamp utilization. Based on practical experiments it is proved that roughly ground glass powder affects as passive micro-filler, but additionally ground one demonstrates properties of active micro filler which performs long-term hardening effect. Up to 20% of cement may be replaced by specially prepared glass material, providing the same mechanical strength of concrete and improving durability factor. Other revised direction is concrete sawing waste remaining in pre cast concrete plants. Sawing sludge paste contains 70% water and 30% dust concrete particles. Experimental results indicate that it is possible to find the optimum dosage of sludge, which ensures the required performance characteristics of concrete. The results of research help to select the most effective way to utilize concrete sawing waste, with due account of economical and ecological aspects. Questions of energetic effectiveness of concrete containing recycled micro fillers are discussed, taking into account cement partial replacing by waste material and environmental benefit based on waste rational application. It is proved that recycled micro fillers may be regarded as an instrument for reducing cement content and minimizing carbon dioxide emission.

G Shakhmenko is currently Docent at Professor Group of Building Materials and Products, Institute of Materials and Structures, Riga Technical University. The main fields of research are building materials and structures, reuse of industrial waste, concrete micro structural behaviour, concrete fracture, concrete technology.

A Korjakins is currently Professor and Chair of Professor Group of Building Materials and Products, Institute of Materials and Structures, Riga Technical University. The main fields of research are building materials and structures, ecological building materials, reuse of industrial waste.

P Kara is currently Scientific researcher at Professor Group of Building Materials and Products, Institute of Materials and Structures, Riga Technical University, Member of LVS STK 30 Eurocode Sub-Committee. The main fields of research are building materials and structures reuse of industrial wastes and by-products, concrete technology.

G Bumanid has recently obtained his Bachelor degree and prepares for Master studies at Professor Group of Building Materials and Products, Institute of Materials and Structures, Riga Technical University. The main fields of research are building materials and structures.

Keywords: Concrete sawing sludge, Ground glass, Micro filler

Presentation: Day 3 0920 – 0940 — Venue 2: 3G05

Concrete Mixes Made with Limestone Powder, Metakaolin and Light Fill: The Indian Scenario

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The paper reports the influence of the composition of ordinary Portland Cement (PC) and locally available materials in India such as lime stone powder (LS), metakaolin (MK) and light fill (LF) binders on the compressive strength and water permeation characteristics of concrete. Concrete mixes covering two different total cement replacement levels i.e. 20 and 35% for concrete with various LS/MK and LS/LF proportions and cured in water up to three months have been investigated. To investigate the water permeation characteristics, tests such as sorptivity and initial surface absorption have been conducted on concrete specimens. The changes in compressive strength, sorptivity and initial surface absorption with curing age at different cement replacement levels are compared with those of control concrete.

Surinder Pal Singh, is a Professor of Civil Engineering at Dr B R Ambedkar National Institute of Technology Jalandhar, India. He obtained Ph.D. from University of Roorkee in 1999 and has worked as a Commonwealth Research Fellow at the Concrete Technology Unit of the University of Dundee from October 2006 to March 2007. His research interests are fatigue behaviour of concrete composites and recycling of materials in concrete.

Bavita Bhardwaj, is a post graduate student in the Department of Civil Engineering of Dr B R Ambedkar National Institute of Technology, Jalandhar, India.

Keywords: Compressive strength, Initial surface absorption, Sorptivity, Water permeation

Properties and Performance of Alkali Activated Fly Ash and Hydrated Lime Concrete

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2 – Building Research Establishment, UK

There is still limited knowledge on the properties and performance of concrete produced using alkali activated technology. Most research has been based on either alkali activation of fly ash or ground granulated blastfurnace slag (GGBS). However, an extensive review and experimental trials has identified that the production of an alkali activated concrete with a combination of fly ash and GGBS provides further advantages in terms of setting and hardening at ambient temperature and 28 days concrete cube strength of 30 N/mm^2 can be achieved. The long-term viability of alkali activated concrete has, however been questioned due to possible limited availability of certain raw materials. This research was undertaken to investigate a promising alternative combination using fly ash and hydrated lime and assesses the impact of this formulation on strength, consistence and embodied CO_2 when compared to a combination of fly ash and ggbs. The experimental results obtained demonstrate that 5% of hydrated lime by mass of total binder could be substituted for 10% of GGBS without adversely affecting the consistence and strength of the concrete. However, it was identified that at higher hydrated lime to fly ash ratios (>5%), consistence reduced and there was also a risk of flash setting. Furthermore the results indicated that although the amount of hydrated lime used with fly ash was less than the quantity of GGBS required to give equivalent strength performance of 35 N/mm^2 at 28 days, the climate change of the concrete (kg CO_2 eq) was 8% higher with the concrete, made with hydrated lime.

Kofi Abora is a PhD student at the BRE CICM, University of Bath. His current research is on alkali activated systems with the focus on performance and durability especially the effect of alkali silica reaction on alkali activated concrete.

Kevin Paine is a Senior Lecturer in civil engineering at the BRE CICM at the University of Bath. He carries out research on low carbon and sustainable forms of concrete construction, with current focus on geopolymers, nanoparticles and the use of bacteria and mineral-precursors.

Keith Quillin is an Associate Director in BRE's Building Technology Group. He manages research and consultancy on low carbon cements, integration of assisted living measures in the built environment and the application of wireless technologies.

Andrew Dunster is a Principal Consultant in BRE's Building Technology Group. He manages research and consultancy on recycled aggregates, low carbon cements and the application of industrial by-products and wastes in construction products.

Keywords: Alkali activation, Fly ash, Ground granulated blastfurnace slag, Hydrated lime, Performance, Properties

Influence of Silica Fume on the Properties of Self-compacting Concretes

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A self-compacting concrete is the one that can be placed in the form and can go through obstructions by its own weight and without the need of vibration. Since its first development in Japan in 1988, has gained wider acceptance in Japan, Europe and USA due to its inherent distinct advantages. Although there are visible signs of its gradual acceptance in the North Africa through its limited use in construction, Libya has yet to explore the feasibility and applicability of SCC in new construction. The contributing factors to this reluctance appear to be lack of any supportive evidence of its suitability with local aggregates and the harsh environmental conditions. The primary aim of this study is to explore the feasibility of using SCC made with local aggregates of Eastern Province of Libya by examining its basic properties characteristics. This research consists of: Development of a suitable mix for SCC such as the effect of water to cement ratio, limestone and silica fume that would satisfy the requirements of the plastic state; Casting of concrete samples and testing them for compressive strength and unit weight. Local aggregates, cement, admixtures and industrial waste materials were used in this research.

Dr S K Alsanusi BSc, MSC., obtained his PhD from the School of Engineering, University of Pittsburgh, Pittsburgh, Pennsylvania, USA. He is currently a teaching staff member at the University of Benghazi, Libya, in the area of structural analysis and soil mechanics, research areas such as self compacting concrete, light weight concrete, fracture mechanics, soil structure interaction, and elastic-plastic-fracture of weak tension materials.

Keywords: Admixtures, Limestone, Self-compacting concrete, Silica fume

Presentation: Day 2 1640 – 1700 — Venue 4: 2G14

Development of Concrete Mixes with the Addition of Crushed Tyres

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The ecological problem of final disposal of used tyres has led to several technological developments in many countries. Concrete has been found to be an interesting way to recycle tyres chips. In Argentina there are two options in this respect: the crushing and classification of the metallic, textile and rubber compounds and the crushing without classification. The present paper deals with the second alternative regarding the important investment that a classification process implies. The mixes studied consisted in 0 %, 5 %, 7,5 %, 10 % and 12,5 % of aggregate replacement and two different water:cement relation. The compressive cylindrical strength was determined to calculate the decrease against the reference mix. The objective was to find the optimum percentage that causes the less significant reduction so the equation cost:benefit becomes convenient. The workability of the mixes were assessed with the Vebe consistometer (ASTM C 1170) as the mixes become dry with the tyre chips aggregates. Air content and density was also measured. Testing carried out to date has lead to select a percentage of replacement that can achieve the minimum required characteristics. Ongoing work will investigate the feasibility of producing rubberised concrete block with the required strength on a commercial basis and investigate the potential for enhanced thermal capacity and sound insulation. The ability to produce cost effective rubberised concrete products for industry depends on overcoming some of the practical production difficulties. The development of practicable concrete products with tyre chips is under research at the Center of Construction of the National Institute of Industrial Technology. In addition to meeting recycling and sustainability objectives, the aim is to produce a material with enhanced properties in specific applications. The use in pervious concrete also shows a great potential for success at present.

Alejandra Benítez, Civil Engineer, Postgraduate studies in Advanced Concrete Technology, Advanced Concrete Technology Diploma (UK), Member of the Institute of Concrete Technology (ICT-UK), Head of the Concrete Technology Area of the Construction Center at the National Institute of Industrial Technology (INTI), Postgraduate and graduate teacher at the Buenos Aires University (UBA), Technical Auditor for the Argentinian Accreditation Organism (OAA), Auditor in Construction Materials Certification, applied technological developments on innovative concretes and mortars.

Matías Polzinetti,Civil Engineer, Engineer Assistant at the Concrete Technology Area of the Construction Center at the National Institute of Concrete Technology (INTI), Auditor for Construction Materials Certification, Development of concrete and mortar mixes, Assistant Teacher at the Buenos Aires University (UBA).

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Keywords: Aggregate replacement, Compressive strength, Density, Rubber chips, Workability

Presentation: Day 3 0940 – 1000 — Venue 2: 3G05

Gigaton Analysis of the Cement Industry: The Case for Adoption of Proven Technologies

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1 – Harvest Power, USA
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The cement industry is one of the most carbon-intensive industries due in large part to the thermal energy required to produce clinker, the key component of cement. The world produced 3 billion metric tons of cement in 2009, emitting more than 2.4 gigatons (Gt) of CO_2 into the atmosphere. The industry predicts global cement production is projected to grow to 5.9 billion tons by 2020 amounting to annual CO_2 emissions from the production of cement to more than 4.8 Gt. China alone is expected to produce an extra 4 billion metric tons of cement annually by 2020. At a price of roughly $100 per metric ton, the profit margin for the industry is around 33 percent. The total size of the global cement market is more than $250 billion. Aggressive pursuit of proven carbon intensity reduction measures has the potential to reduce emissions from cement production by 0.9 Gt annually before 2020.The largest potential source of reductions with proven technology isthe accelerated use of alternative fuel (370 Mt), followed by clinker substitution with alternative materials (300 Mt), thermal energy efficiency improvements (140 Mt), and electricity efficiency improvements (90 Mt). Switching from coal to biomass for firing cement kilns requires an initial investment of $6.5 million for a 1 million metric ton capacity plant, and would yield savings of $3.8 million per year. Lowering the clinker content of cement requires additional capital expenditures of $13 million for a 1 million metric ton capacity plant for storage and handling, Using blast slag and fly ash to create a 50 percent blend would yield $11.8 million in savings annually, just from the reduced cost of clinker alone.

Carbon War Room explores the barriers preventing the implementation of these low-carbon pathways and generates market-based solutions for overcoming these impediments.

A Gupta is currently a Project Developer at Harvest Power, a leader in processing organic wastes across North America. He Holds an S.M. from the Massachusetts Institute of Technology, and a B.S./B.A. from University of California - Berkeley in Civil Engineering and Economics.

M Cullinen is currently Senior Associate for Research and Intelligence at Carbon War Room, a global non-profit focused on profitable solutions for reducing CO_2 emissions. He holds an M.A. from New York University, and a B.A. from Indiana University - Bloomington.

Keywords: Economic analysis, Efficiency, Greenhouse gas emissions, Low-carbon

Presentation: Day 2 1700 – 1720 — Venue 4: 2G14

Theme 3 — Infrastructure and Transportation Construction and Resilience

Quality Control of Concrete in Mecca Mega Projects

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Ministry of Municipal and Rural Affairs (MOMRA), The Kingdom of Saudi Arabia

Many consulting engineers consider it adequate to evaluate concrete quality through merely obtaining the mean of compressive test samples routinely collected by concrete supplier or the project contractor. However, from our long experience and exhaustive testing programs of Mega Projects, we found that these simple procedures are no guarantee for the quality and consistency desired in concrete production. The paper summarizes results obtained from a comprehensive and detailed program designed to monitor quality of ready-mix concrete in mega projects which took more than ten years to construct and 10 Million cubic meters of concrete to build. The concrete specified 28 day strength ranged between 30 to 80 MPa. One hundred thousand compression samples were tested and their results analyzed by statistical evaluation using different international standards. The research showed the importance of monitoring by a neutral external quality control agency to control quality by unscheduled surprise visits; this is carried out in parallel with the routine self monitoring conducted by supplier/contractor or his consultant. The differences in test results between self and neutral agency monitoring were large at the beginning of the construction ; however, with implementing the external monitoring program it became smaller at the end. This is in agreement with experiences of some European companies using similar procedures. The study also showed that statistical evaluation of test results makes it possible to better assess the consistence of concrete production and consequently the concrete quality by obtaining a measure for the scatter of the results. This is in agreement with European standards EN 206-1 and DIN 1045-2 as well as the American standard ACI 214R-02. The results revealed the need to adopt acceptance criteria for ACI 318 consistent with the requirements of ACI 214R-02 and EN 206-1. This is very important for countries that rely on ACI in developing their national concrete codes such as the Saudi Building Code SBC 304.

Dr Habib Zein Alabideen, obtained his B.Sc. and Ph.D. degrees from German Universities Hannover in 1970 and University of Aachen in 1975 respectively. He represents his country in several international committees. He wrote five books in material, design and construction management, he is also the author of numerous scientific papers. He supervised the construction of many project in the development of Holy sites in Makkah with budgets up to 1.8 Billion US Dollars totaling 6 Billion US $ in 15 years.

Keywords: Monitoring production, Quality control, Statistical evaluation, Strength, Testing

Presentation: Day 2 0900 – 0920 — Venue 1: 3G02

Reliable Production of Air Entrained Concrete with Sustainable Slag Cements

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Worldwide approximately 300 Mt per annum of blast furnace slag is produced. Today about 70 % is already granulated. Granulated blast furnace slag (GGBS) is commonly used as a cement main constituent or as a concrete addition for more than 100 years. While long time only technical and economical advantages of GGBS were centred, its positive effect on the carbon footprint of building materials like concrete becomes nowadays also an increasing importance since ecological aspects are of growing interest. Although many experiences of GGBS use and examples of durable concrete constructions exist, national concrete standards still restrict (e.g. Germany) its use for concrete applications in a freeze-thaw and de-icing salt exposure (XF4). The positive effect of a sufficient micro pore structure by the use of air entraining agents (AEA) is well known since the nineteen-thirties. But a sufficient formation is influenced by several parameters. However AEA's on the basis of natural substances are considered as robust in their use. But several practical experiences have shown that an unerringly production of a sufficient micro pore structure is not always possible with synthetic AEA's, for which reason the use of slag cement is often refused for such exposures. The article will present the results of a large research program, which dealt with the questions – whether the slag cement can be used for freeze-thaw and de-icing salt resistant concrete at all and which impacts are causal and important. From the results it could be clearly shown that the production of freeze-thaw and de-icing salt resistant concrete is possible with slag cements if some basics are considered. How-ever, it also appeared that the unerring production of air entrained concrete can be problematic even under the stable lab conditions, especially if plasticizer is used in addition. Effects and impacts of these interactions will be discussed in more detail and conclusions will be drawn. The results might be support to extend the ecological, economical and sustainable worthwhile utilization of GGBS in concretes exposed to severe conditions. Based on the technical data the CO_2-balance of XF4-concretes made with Portland cements and slag cements is presented.

Dr.-Ing. Volkert Feldrappe is Head of Cement Laboratory at FEhS-Institut – Building Materials Institute, Duisburg. Previously he had studied civil engineering at Technical University Braunschweig and was a Research Engineer at the Research Institute of the German Cement Association, Düsseldorf. He was recently a Quality Engineer at European Technical Centre of Lafarge Cement, Vienna.

Dr.-Ing. Andreas Ehrenberg, studied Mineral Engineering at Technical University RWTH Aachen and completed his PhD in Material Science and cat Technical University Clausthal. Since 1992 he has been Head of Building Materials Department at FEhS-Institut – Building Materials Institute, Duisburg.

Keywords: Air entrained concrete, De-icing salt resistance, Durability, Ecological footprint, Freeze-thaw, Slag cement

Presentation: Day 2 1120 – 1140 — Venue 1: 3G02

Effect of Entrained Air Voids on Salt Scaling Resistance of Concretes Containing Composite Cements

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Salt scaling is a major damage problem for concrete and concrete pavements, so the phenomenon has been the subject of an extensive research effort in the world. Replacement of cement with SCMs in the production of concrete not only improves the mechanical properties and durability of concrete but also decreases the amount of consumed cement in construction projects. In order to reduce energy consumption, CO_2 emission and increase production, cement plants produce composite cements, comprised of supplementary cementitious materials such as natural pozzolan, limestone and other SCMs. Effects of composite cement and air void on de-icer scaling resistance of concrete were investigated in this research work. Specimens with modified Portland cement (type II) and composite cement with and without air void were investigated. Mechanical properties such as compressive strength, tensile strength, and abrasion resistance were measured. Specimens were tested for freeze–thaw de-icer salt scaling resistance in accordance with ASTM C672 Standard test method. Visual examination according to ASTM C 672 and the mass of scaled material in salt scaling for every five cycles of freeze–thaw were assessed. It has been shown that the use of de-icing salt on concrete surface causes gradual deterioration from the surface into the inner section. This study shows that surface strength of concrete plays an important role in salt scaling resistance. Entrained air bubbles in the concrete reduce bleeding and will result in increased surface resistance. Therefore, entrained air bubbles improve concrete salt scaling resistance. The performance of type II Portland cement mixtures was better than that for composite cement mixtures when no air entraining admixture was used. The mixtures containing composite cement with entrained air bubbles showed the best performance in salt scaling test.

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Keywords: Composite cement, Entrained air, Freeze-thaw cycle, Salt scaling

An Experimental Study for Shrinkage Cracking Resistance of BFS Blended Cement Concrete Subjected to Different Ambient Temperature

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Applying cement blended with blast-furnace slag fine powder is an important option to achieve low carbon emission due to concrete materials in construction. However, concrete with this blended cement (BFS concrete, hereafter) has been believed vulnerable to shrinkage cracking and traditionally avoided to use in building construction except underground structural elements in Japan. To extend BFS concrete usage in building construction necessitates to quantitatively evaluate this concrete's shrinkage cracking resistance. Scope of this study is to experimentally reveal shrinkage resistance of BFS concrete, in which effects of ambient temperature are emphasized. In experiments, restraint shrinkage cracking tests were conducted with BFS concrete subjected to three levels of ambient temperatures, 10, 20, 30 °C in comparison with normal concrete. We adopted cracking age in the restraint shrinkage cracking tests as a performance index showing cracking resistance. As a result, it was demonstrated that cracking ages in BFS concrete were heavily influenced by ambient temperature, while this is not the case for normal concrete. Furthermore, free shrinkage strain in BFS concrete is larger with higher ambient temperature. These trends resulted that BFS concrete's cracking resistance is much lower than normal concrete at 30 °C while the former is better than the latter at 10 °C. This interesting result appears due to i)increased autogenous shrinkage in BFS concrete in higher temperature, ii)lower cracking strength in BFS concrete than normal concrete, and iii)comparable elastic modulus between the both types of concrete.

T. Kanda, A. Shintani, and H. Momose are research eingineers in Kajima Technical Research Institute, Tokyo Japan. Their specialized technical areas are: shrinkage, creep, restraint cracking in concrete. Their recent interest is most in application of low carbon concrete with large volume of mineral admixtures.

K. Imamoto is an associate professor at Department of Architecture, Tokyo University of Science, Tokyo, Japan. He is an active member of AIJ, JSCE, JCI, ACI, and RILEM. He has led many research projects and his research interests are: microstructure and its relation to creep and shrinkage, control of shrinkage induced cracking, nondestructive test for penetrability of concrete cover, durability design, and recycling/reuse of building materials.

A. Ogawa is a former graduate student at Tokyo University of Science and currently an employee of Takenaka corporation. Her research interests are: microstructure and its relation to creep and shrinkage, and control of shrinkage induced cracking.

Keywords: Autogenous shrinkage, Blast furnace slag, Cracking, Creep, Drying shrinkage

Presentation: Day 2 1140 – 1200 — Venue 1: 3G02

Study on Capacity of Reinforced Concrete Beams With Chloride Induced Damage

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1 – Shikoku Research Institute Inc, Japan
2 – Shikoku Electric Power Co Inc, Japan
3 – Kagawa University, Japan

It is very important for infrastructures to be maintained appropriately and utilized effectively over the long term in the low carbon era. Reinforced concrete structures received severe chloride induced damage has been observed in the coastal area of Japan. Quantitative comprehension of load-bearing capacity of deteriorated reinforced concrete members received chloride induced damage is required for appropriate maintenance. Chloride ions from sea penetrate into concrete and they reach the reinforcement. When the content of chloride ions close to reinforcement exceed the threshold, corrosion of reinforcement starts. After that, crack occurs on the concrete surface due to the pressure of expanded corrosion products. The load-bearing capacity of member depends on the ammount of corrosion of reinforcements. Corrosion induced crack on concrete surface is apparent, but ammount of corrosion of reinforcements in concrete is uncertain in the case of in-service real structure. Loading experiments were carried out. Specimens of reinforced concrete beams were prepared for the experiments. In order to be imitated real damaged structures, they were made of fresh concrete added sodium chloride, and exposed to cyclic dry and wet environment. Based on the results of experiments, the relationship between ammount of corrosion of reinforcements, corrosion induced crack width and load-bearing capacity of reinforced concrete members was researched. And the characteristics of capacity deterioration with the progress of corrosion was estimated.

Mr. Kousaku Matsuda is a senior research engineer at Shikoku Research Institute Inc., Takamatsu, Japan. He received his Master's Degree of Engineering from Kobe University in 1979. His research interests is the application of deterioration model to member received chloride induced damage. He is member of the AIJ and JCI.

Dr. Masaru Yokota is a senior research engineer at Shikoku Research Institute Inc., Takamatsu, Japan. He received his Doctor's Degree of Engineering from The University of Tokushima in 1995. His research interests include the deterioration of RC structures and the inspection model of corroded steel bar received the severe environments. He is member of the JSCE and JCI.

Mr. Kazuhiro Yonezawa is an engineer at Shikoku Electric Power Co.,Inc., Takamatsu, Japan. He received his Bachelor's Degree of Engineering from The University of Tokushima in 2003. His research interests is upgrading of maintenance of RC structures in thermal power station. He is member of JSCE and JCI.

Dr. Manabu Matsushima is a professor of Kagawa University, Takamatsu, Japan. He received his Doctor's Degree of Engineering from Tokyo Denki University in 1994. His research interest is the application of reliability theory to concrete members in RC structures. He is member of the JSCE, AIJ and JCI.

Keywords: Corrosion of reinforcement, Corrosion-induced crack, Cross-sectional loss, Load-bearing capacity, Loading experiment

Presentation: Day 2 1200 – 1220 — Venue 1: 3G02

Fundamental Research on the Freeze-thaw Resistance of Concrete with Post-added Drying-shrinkage Reducing Agent

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Hokkai-Gakuen University, Japan

The weakness of concrete with drying-shrinkage reducing agent is poor freeze-thaw resistance. Drying-shrinkage reducing agent that improves this weakness has been recently developed, and requires that the agent be added to the concrete at a later stage. This study compared the freeze-thaw resistance of concrete with post-added drying-shrinkage reducing agent against concrete with existing drying-shrinkage reducing agent. The results showed that the recently developed drying-shrinkage reducing agent was effective for improving freeze-thaw resistance.

Masashi Sugiyama is the professor of the Hokkai-Gakuen University, Department of Building Construction & Materials Engineering in Sapporo city, Japan. He received his doctorate in engineering from Hokkaido University in 1981. His doctoral dissertation was « The effect of concrete in structure of the drying on physical property ». His specialty is research into technologies which improve the durability of concrete. He received prize for research into super-high durable concrete from Japan Concrete Institute in 1988, and for research into curing concrete using new heating sheet from the Hokkaido branch of Architectural Institute of Japan in 2010.

Keywords: Drying shrinkage, Drying shrinkage reducing agent, Freeze-thaw resistance

Presentation: Day 2 1400 – 1420 — Venue 1: 3G02

Prestressed Fibre Reinforced Concrete Elements

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As a direct consequence of economic recovery and ever growing demand on the construction market in out country but also across the European Union, a race has began between large construction companies to find the most advantageous technical and economical solutions in building prefabricated buildings. This has lead to a renewed research in past studied areas, such as pre-stressed columns. Another consequence is an ever increasing skill on part of researchers in this field. There are now several domestic and foreign construction companies that have started to fund research experiments of innovative design solutions which will ultimately optimize the technological processes involved and reduce the overall cost of prefabricating construction elements.

Z. Kiss is currently Professor of Reinforced and Prestressed Concrete at the Technical University of Cluj Napoca, Romania. He is the Head of the Department of Structures, he has led several research projects on concrete, being a specialist in the areas of research for prestressed concrete, reinforced concrete, fibre reinforced concrete and he also led numerous design projects on concrete from the position of Lead Designer.

K. Bálint is currently PhD student in Prestressed Concrete with fibre reinforcement at the Technical University of Cluj Napoca, Romania. He is also a structural engineer and during his activity he design several projects on concrete and also supervised and checked the work of his team.

R. Zagon is a second year PhD student at the Technical University of Cluj Napoca at Dept. of Structures, Romania. For several years he has been working as a structural engineer, and now his main concerns are researches on prestressed concrete, reinforced concrete and fibre reinforced concrete.

Keywords: Design, Fibres, Prefabrication, Prestressed fibres

Solving Some Problems of Nonlinear Analysis of Reinforced Concrete Structures by Additional Finite Element Methods

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The work presents the ways of solving of some main problems in nonlinear design of reinforced concrete structures on the basis of the developed Additional Finite Element Method (AFEM). This method is a variant of the Finite Element Method (FEM) destined for analysis of reinforced concrete structures at limit strength state. AFEM adds to the traditional sequence of problem solving by FEM the units of design by method of ultimate equilibrium and method of additional loads.

A Ermakova, is Cand. Tech. Sc., Assistant Prof. (”dotsent”) in the Department of Building Structures of South Ural State University, Chelyabinsk, Russia.

Keywords: Additional design diagram (ADD), Additional finite element (AFE), Additional finite element method (AFEM), Ideal failure model, Limit state

Chloride Profiles of Mineral Admixture Concrete Subjected to Standard Curing

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2 – IIT Delhi, India

The paper presents the influence of silica fume and fly ash, used either as binary or ternary cementing materials along with OPC, on chloride ingress of concrete, after undergoing the realistic curing practice of 7 days of water curing regime followed by air drying till the constant strength level is reached. The chloride exposure regime consists of 48 weekly wetting and drying cycles under 5% sodium chloride and 5% calcium chloride solutions, taken separately. The chloride profiles are obtained by analysing concrete powder extracted from different depths of the surface that is exposed to chloride solution. The powder is titrated in order to obtain total chloride and free chloride contents at different depths. It is found that lowering the water-to-binder ratio reduces both total and free chloride contents at a given depth. The use of mineral admixtures increases the chloride binding capacity of concrete thus reducing the amount of chlorides available for corrosion of steel reinforcement. For both sodium chloride and calcium chloride exposures, ternary mixes are found to perform better than the binary mixes containing either silica fume or fly ash, thus leading to the conclusion that the ternary mixes are best in resisting chloride ingress in concrete.

Shweta Goyal, Ph.D., is an Assistant Professor in Civil Engineering Department, Thapar University, India.

Maneek Kumar, Ph.D., is a Professor and Head of the Civil Engineering Department, Thapar University, India.

Bishwajit Bhattacharjee, Ph.D., is a Professor in the Civil Engineering Department, Indian Institute of Technology, Delhi, India.

Keywords: Binding capacity, Chloride profile, Durability, Mineral admixtures, Total chlorides

Presentation: Day 2 1420 – 1440 — Venue 1: 3G02

Behaviour of Combined Alkali Activated Slag CNTs Exposed to Normal Temperatures

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2 – NRC Cairo, Egypt

Both carbon nanotubes (CNTs) and alkali activated slag (AAS) are the subject of two of the most areas of research in nanotechnology and green buildings. In this article, the technical feasibility of modification the properties of AAS with multi wall carbon nanotubes MWCNTs is studied. Sodium hydroxide (NaOH) was used as alkali activator. Different percentages of MWCNTs were used (0, 0.2, 0.5 and 0.7% wt.). The behaviour of the new composite materials when exposed to normal temperature was investigated. The compressive strengths before and after exposure were determined. The various decomposition phases formed were identified using X-ray diffraction (XRD), and scanning electron microscopy (SEM). The results indicated that CNTs modified and enhanced the compressive strength of specimens exposed to normal temperature.

Dr Saaid I Zaki is an Associate Professor in Strength of Material and Quality Control Research Institute, Housing and Building National Research Center, HBRC, Cairo, Egypt.

Dr A M Rashad is currently an Associate Professor in the Q.C. and Material Institute in HBRC in Cairo, Egypt. He is specialist in the area of high performance concrete.

Dr S Rawash, is currently Associate Professor in the Raw Materials Institute in HBRC in Cairo, Egypt. She is a specialist in the area of durability test methods for concrete.

Dr N Ismail is currently Associate Professor in Center of Excellency for Advanced Science and Nanomaterials in NRC, Cairo, Egypt. She is a specialist in synthesis of Carbon Nano Tubes.

Keywords: Activated slag, Carbon nanotubes, Normal temperature, Residual compressive strength, Sodium hydroxide

Presentation: Day 2 1440 – 1500 — Venue 1: 3G02

Effect of Novel Polymeric Type Shrinkage-reducing Admixture on Shrinkage of Hardened Cement Pastes

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Early plastic shrinkage, dry shrinkage, and autogenous shrinkage of concrete result in cracks without any loading, and thus seriously endanger the integrity and durability of the buildings. Shrinkage-reducing admixtures have been developed and used to lessen the shrinkage of concrete. However, conventional shrinkage-reducing admixtures with lower molecular weight (L-SRA) exhibit a reduction in strength and elasticity modulus of concrete. In order to solve those drawbacks, a novel grafted copolymer shrinkage-reducing admixture (P-SRA) was designed and synthesized. P-SRA reduced the dry shrinkage of hardened cement paste at 3 days by about 90% and by about 35% at 28 days. P-SRA also reduced the autogenous shrinkage by 70% at 28 days. And this novel polymeric P-SRA also enhanced the 28 days-compressive strengths of concrete by about 10%.

Changwen Miao is President of Jiangsu Research Institute of Building Science and Professor at the Civil Engineering Department, Southeast University, China. He has more than 30 years of experience in R&D and technology management. He has written and presented over 80 papers on his research activities related to concrete durability and chemical admixtures. He is also the recipient of several awards for his contribution to the fundamental knowledge of concrete admixtures and their use in concrete.

Qianping Ran is a Chief scientist at State Key Laboratory of High Performance Civil Engineering Materials and a Research Engineer (Prof.) in Admixture Product Technologies at Jiangsu Research Institute of Building Science, Nanjing, China. He received his MS in Material Science from Sichuan University and PhD in Polymer Chemistry and Physics from Nanjing University. He has been working in the field of concrete admixtures, focusing on the development of new polymeric superplasticizers. He is also author or co-author of over 60 papers and patents on chemical admixtures.

Jiaping Liu is a Vice-President of Jiangsu Research Institute of Building Science and General Manager of Jiangsu Bote New Material Ltd. He received his MS in Civil Engineering from Southeast University and PhD in materials science from Nanjing University of Technology. He has written and presented over 30 papers on his research activities related to high performance concrete, high performance admixture, deformation and cracking of concrete.

Nanxiao Gao is a Research Engineer in Admixture Product Technologies at Jiangsu Research Institute of Building Science, Nanjing, China. She received her MS in Polymer materials from Nanjing Normal University, Nanjing, China. She is also author or co-author of several papers on her research activities related to development of shrinkage reducing admixtures.

Qian Tian is a Professor Senior Engineer in Jiangsu Research Institute of Building Science, Nanjing, China. She received her MS and PhD in Structure Engineering from Southeast University. She has led several research projects on concrete, and her specialist areas of research are shrinkage of concrete and self-compacting concrete.

Keywords: Autogenous shrinkage, Compressive strength, Dry shrinkage, Polymeric shrinkage reducer

Presentation: Day 2 1500 – 1520 — Venue 1: 3G02

Effectiveness of Several Aminoalcohols as Corrosion Inhibitors for Steel in Simulated Concrete Pore Solutions

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Reinforcement corrosion is the most important cause of premature failure on reinforced concrete structures. Steel reinforcement in concrete, being normally in the passive condition could generally be attacked by ingress of carbon dioxide and chloride. This paper was to present inhibiting effectiveness of several aminoalcohols for carbon steel at the present of chloride ions. Concentration of chloride ion was adjusted by adding NaCl into simulated concrete pore solution. The influences of chlorides attack on the corrosion of the steel bar and the inhibition action of the studied substances were characterized by electrochemical measurements. The interaction mechanism was studied by x-ray photoelectron spectroscopy (XPS). It was indicated that when concentration of chloride ion was low, most aminoalcohols tested in this study could inhibit the corrosion of steel. However, when chloride ion content was too high, only N,N-Dimethylethanolamine (DMEA) exhibited obvious inhibition effect. Impedance of the electrode in DMEA-containing solution was increasing with time. But the transformation trend was adverse for other aminoalcohols solution. From X-Ray photoelectron spectroscopy, it was found that when DMEA existed, the exposed Fe-metal of the electrode in DMEA-containing solution was less than that of control solution. This study could make instructive contributions to the development of corrosion inhibitor for concrete.

Cuicui Chen is an engineer in State Key Labortary of High Performance Civil Engineering Materials, Jiangsu Research Institute of Building Science, China. She has attended several research projects of China, and her main research area are corrosion of steel in concrete and the responding inhibition technique.

Jingshun Cai is an engineer in State Key Labortary of High Performance Civil Engineering Materials, Jiangsu Research Institute of Building Science, China. He is major in electrochemistry and his main research is the corrosion of steel in concrete.

Jianzhong Liu is professor of State Key Labortary of High Performance Civil Engineering Materials. He has led several research projects on concrete. His specialist research area is durability of concrete and fiber reinforced concrete.

Jiaping Liu is currently Jiaping Liu is a Vice-President of Jiangsu Research Institute of Building Science, Nanjing, China. He has led several big research projects on concrete, and his specialist areas of research are deformation and durability of high performance concrete.

Keywords: Concrete, Electrochemical measurement, Inhibiting effectiveness, XPS

Presentation: Day 2 1600 – 1620 — Venue 1: 3G02

Nonlinear Analysis of Axially Loaded Columns Reinforced Longitudinally and Transversely with Glass Fibre Reinforced Polymer (GFRP) bars

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In this paper, the results of an analytical investigation on the behavior of RC columns reinforced longitudinal and transverse with glass fiber reinforced polymer bars GFRP are presented and discussed. Nonlinear finite element analysis on 16-column specimens was achieved by using ANSYS software. The nonlinear finite element analysis program ANSYS is utilized owing to its capabilities to predict either the response of reinforced concrete columns in the post elastic range or the ultimate strength of a reinforced concrete columns reinforced by GFRP bars. An extensive set of parameters is investigated including different strength of concrete, longitudinal reinforcement types (GFRP, Steel) and transverse reinforcement types (GFRP, Steel). A comparison between the experimental results and those predicted by the existing models are presented. Results and conclusions may be useful for designers, have been raised, and represented.

Khaled S. Ragab is currently Associate Professor of Concrete Constructions at Reinforced Concrete Research Institute, Housing & Building National Research Center, HBRC, Cairo, Egypt. He is a Consulting Engineer in the design of concrete structures. He is a Member of Syndicate of Egyptian Engineers, Member of the Association of Engineers of Egyptians, and Member of the reviewer team for Journal of civil engineering and construction technology. He has led several research projects on concrete, and his interesting areas of research are Fiber reinforced concrete (GFRP), High performance concrete (self compacting concrete), Nanotechnology in the field of concrete, Economic systems of construction, Nonlinear analysis by FEM for different elements of concrete construction, and Light weight concrete.

Keywords: ANSYS, Columns, FEM, GFRP stirrups, Nonlinear

Presentation: Day 2 1620 – 1640 — Venue 1: 3G02

Research on and Application of Integrated Low-carbon Environment-friendly Technology in Asphalt Pavements

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Rapid development of road construction and traffic has greater and greater impact on urban ecological system and living environment. Urban ecological environment is seriously threatened. While meeting traffic demand and promoting economic development, it is objectively required to re-examine technology for road construction, maintenance and operation from the angle of environment protection and ecology, so as to stick to the principle of sustainable development and achieve harmonious development of human being and the nature. In this research, warm-mix asphalt (WMA) technology is adopted to reduce energy consumption and pollutant emission during construction, and noise-reducing asphalt pavement added with "photo-catalyst Nanometer material" is adopted to reduce pollution by noise and vehicle exhaust on road in service. WMA technology, noise-reducing asphalt mixture technology, photo-catalysis vehicle exhaust-absorbing technology are introduced in this paper with stress, including evaluation on performance of dense gradation and open gradation WMA mixture, design for big gap and noise-reducing asphalt mixture, development of photo-catalysis test system, selection of vehicle exhaust-absorbing material, evaluation on laboratory test, addition technology and performance evaluation of asphalt mixture, application of and effect evaluation on pilot projects in Shanghai, and so on. Preliminary research and observation indicate that emission of carbon dioxide can drop by adopting WMA technology during asphalt pavement construction, and concentration of leaded compound and carbon oxide and concentration of nitrogen oxides and formaldehyde can drop by more than 50% and more than 30% respectively by adopting noise-reducing asphalt pavement added with "photo-catalyst" Nano material during operation. In addition, compared to common asphalt pavement, noise is reduced by 5 8 dB, reflecting better environmental and social benefit.

Dr Liping Liu is an Associate Professor at Tongji University, Shanghai, China. She has led several research projects on asphalt pavement, and her research interests include asphalt pavements design and maintenance, performance evaluation for warm mix asphalt, pavement recycling etc.

Haiming Xu, Jianfei Li, Hui Wang, Xiaofei Gao are graduate student.

Dr Lijun Sun is a professor at Tongji University, Shanghai, China. He has led many research projects on road pavement and traffic control area, and his specialist areas of research are asphalt pavements design, pavement management system, and intelligent traffic control.

Keywords: Asphalt pavement, Environment-friendly, Low-carbon, Nanometer material, Noise-reducing, Vehicle exhaust

Presentation: Day 3 0900 – 0920 — Venue 1: 3G02

Research on the Design and Properties of Low Carbon Semi-flexible Pavement Material

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Asphalt concrete (AC) and Portland cement concrete are two commonly used road construction materials and readily available in most locales. AC paving is a flexible pavement with the advantages like low noise, relatively low cost and disadvantages including less tensile strength than concrete. Moreover, it's produced by heating the asphalt binder to 300 °F (roughly 150 °C) for virgin asphalt and 330 °F (166 °C) for polymer modified asphalt which results in higher consumption of fossil fuels, thus releasing more carbon dioxide, aerosols and vapours. Portland cement concrete has higher mechanic strength and elastic modulus but larger brittle compare to asphalt concrete. Due to the larger cement content (300-450kg/m^3); the preparation of Portland cement concrete consumes much mineral recourse. The present study is to develop a low carbon semi-flexible composite pavement material with cement and asphalt emulsion, which can be prepared under ambient temperature and possesses the advantages of moderate resilient modulus, nice moisture stability, good low temperature crack resistance, less cement content(100-120kg/m^3), energy saving and long lasting. This new semi-flexible pavement material has been successfully applied in "Yiyang Class-A highway" of Yichang city, Hubei province for 200m and has good prospect in development and application.

Fazhou Wang is currently Professor of State Key laboratory of Silicate Materials for Architecture, Wuhan University of Technology, China. He has done much work on the concrete and advanced cement-based composite materials. His specialist areas are light-weight aggregate, cement and asphalt mortar for high-speed railway and advanced asphalt pavement.

Chunlin Yu is post graduate of State Key laboratory of Silicate Materials for Architecture, Wuhan University of Technology, China. His main research interests are advanced asphalt pavement, especially cement-asphalt emulsion concrete for semi-flexible pavement.

Yunpeng Liu is PhD candidate of State Key laboratory of Silicate Materials for Architecture, Wuhan University of Technology, China. His main research interests are cement and asphalt mortar for high-speed railway, asphalt emulsion for high-speed railway and repair materials for high-speed railway.

Jun Fu is currently Associate Professor of School of Transportation, Wuhan University of Technology, China. He his main research interests are building materials and structure engineering. His specialist areas are structure and materials for functional long life pavement, micro-mechanics analysis of pavement and bridge materials and service monitor of bridge and pavement.

Keywords: Cement emulsified asphalt concrete, Energy saving, Low carbon, Mix design, Road performances

Presentation: Day 3 0920 – 0940 — Venue 1: 3G02

Design and Development of Ultra Thin Continuously Reinforced Concrete Pavements (UTCRCP)

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University of Pretoria, South Africa

Pavement design engineers normally see concrete pavements as rigid pavements that fail in a brittle manner. The un-reinforced concrete pavements with closely spaced movement joints built in the past were rigid brittle structures, but the use of continuously reinforced concrete pavements, has resulted in both a reduction in the volume of concrete required for any given pavement, and a more flexible behaviour of the pavement. The use of modern superplasticizers has made it possible to manufacture high performance concrete with a compressive strength in excess of 100 MPa and the addition of steel fibres to this concrete can significantly enhance the flexural strength of the concrete, resulting in a more ductile failure. Optimization of the concrete mix composition can result in a significant saving in the volume of material required for a pavement designed to take a given traffic load. As part of the National Highway renewal programme currently in progress in South Africa, full-scale experimental trial sections of Ultra Thin Continuously Reinforced Concrete Pavements (UTCRCP) have been constructed. The UTCRCP consists of a 50 mm thick layer of up to 100 MPa concrete containing at least 80 kg/m^3 of steel fibre as well as a steel mesh of 5.6 mm reinforcing bars at a spacing of about 50 mm centre to centre. Since 2006 researchers at the University of Pretoria have been involved with analyzing and testing materials for use in these pavements and in this paper an overview will be given of design, construction and quality control issues encountered. This paper focuses on the development of specialized test methods that provide the input for the design of UTCRCP. The effect of bar spacing and fibre content on the flexural behaviour of the thin concrete slabs was experimentally investigated and will be discussed in this paper.

Professor E P Kearsley is currently the Head of Department Civil Engineering at the University of Pretoria. She has been involved with research into the material properties of cement and concrete materials for the last 18 years. Her recent research interests includes high strength and fibre reinforced concrete.

Mr H F Mostert is a concrete technologist with an ACT diploma. He is currently employed by the University of Pretoria where he has been conducting research on concrete materials for the last 20 years.

Keywords: High strength, Load deformation curves, Reinforced concrete pavements, Steel fibres, Ultra thin continuously reinforced concrete

Presentation: Day 2 1640 – 1700 — Venue 1: 3G02

Structural Performance of Square RC Columns Confined with Carbon Fibre Reinforced Polymer (CFRP)

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2 – University of Jijel, Algeria
3 – INSA de Rennes, France

Loading capacity and strains of square reinforced concrete (RC) columns, strengthened with external carbon fiber reinforced polymer (CFRP) sheets, were tested and evaluated. The experimental parameters include: number of wrap layers, concrete strength and the slenderness of the columns (L/a). All test specimens were loaded to failure in axial compression. Compressive stress, axial and hoop strains have been recorded to evaluate the stress-strain relationship, ultimate strength, stiffness, and ductility of the specimens. Results clearly demonstrate that composite wrapping can enhance the structural performance of RC columns in terms of both maximum strength and ductility. The effects of test parameters are evidenced and compared.

N. Chikh is Professor at the Department of Civil Engineering, Constantine University, Algeria. He is also Director of the Laboratory of materials and Durabilitry of Constructions (LMDC). His main research interests include the use of composites materials in strengthening concrete constructions as well as serviceability of concrete structurers.

R. Benzaid is assistant Professor at the Department of Geology, Jijel University, Algeria. His main research interests include the strengthening of concrete structures with FRP materials as well as risk assesement of soils.

H. Mesbah is Professor at the Department of Civil Engineering, INSA de Rennes, France. His main research interests include the strengthening of concrete structures with FRP materials as well as the study of properties of self compacted concrete.

N. Djebbar is Reader at the Department of Civil Engineering, Constantine University, Algeria. His main research interests include the strengthening of concrete structures with FRP materials as well as the study of the performance of eartquake resistant concrete structures.

Keywords: CFRP, Column, Ductility, Strength

Presentation: Day 3 1120 – 1140 — Venue 1: 3G02

Statistical Analysis of Modulus of Elasticity and Compressive Strength of C45/55 Concrete for Prestressed and Non-prestreseed Precast Beams

P Hunka, J Kolisko, K Jung, S Rehacek
Czech Technical University, Czech Republic

Random behavior of concrete C45/55 XF2 used for prefabricated pre-stressed bridge beams is described on the basis of evaluating of vast set of measurements. Detailed statistical analysis is carried out on 133 cylinders with sizes 150 x 300 mm, produced from October 2010 to November 2010. Only one worker took all specimens during the whole period and the following measuring of modulus of elasticity and compressive strength of concrete was carried out in Klokner Institute laboratories. The measuring takes place at the age of 28 days, only one testing machine with the same capping method is used. Suitable theoretical models of division are determined on the basis of tests in good congruence, with the use of Bernstein's criterion.

Petr Hunka is a PhD student at the Klokner Institute of the Czech Technical University in Prague since 2007. Graduate of Brno University of Technolog, Faculty of Civil Engineering - Building Materials Engineering. He has led several research projects on modulus of elasticity of concrete.

Doc. Jiri Kolisko is currently head of Klokner Institute of the Czech Technical University in Prague. He has led several research projects on concrete, and his specialist areas of research are special types of concrete, ultrahigh performance concrete, and mortars for reconstruction.

Karel Jung has just finished his PhD theses at the Klokner Institute of the Czech Technical University. He has led several research projects on statistical analysis of propertises of concrete.

Stanislav Rehacek is a PhD student at the Klokner Institute of the Czech Technical University in Prague since 2006. Graduate of Czech Technical University in Prague, Faculty of Civil Engineering - Building Structures. Diploma thesis: construction project of multifunctional building. His specialist areas of research are fibre concrets and diagnostic of constructions.

Keywords: Compressive strength, Concrete, Modulus of elasticity, Statistical analysis

Shear Strength of Steel Fibre Self-compacting Reinforced Concrete Beams

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The present study consists of two parts, the first one look for producing self-compacting steel fibrous concrete with reasonable flow, spread, and passing abilities, and resistance to segregation and shear. Ten percent of the cement was replaced by limestone powder with particle size less than 75μm to increase the fines fraction in the mix. The second part of the study, deals with the effect of adding steel fibres and the shear span / effective depth ratio on the shear strength of self-compacted reinforced concrete beams. Twenty four beams were cast which were 1.0 m long , 150 mm wide, and with overall depth of 200 mm. Four volume percentages of steel fibres were used, 0, 0.35, 0.7 and 1.05 together with six shear span /effective depth ratios of, 1.50, 1.74, 1.98, 2.22, 2.46, and 2.69. The test results showed that the steel fibres have adverse effect on the fresh properties and this effect was reduced by using plasticizer that increased with the fibres percentages. On the other hand, the steel fibres improved the mechanical properties of the hardened concrete in compression and tension. All the beams failed in shear, and the test results showed that the presence of steel fibres increased the cracking shear stress and the shear strength and this increase depends on the shear span / effective depth ratio and on the volume fraction of the steel fibres. The ratio of the cracking / shear strength increased from 0.4 to 0.8 as the shear span / effective depth ratio increased from 1.50 to 2.69. The strut and tie model, and some of the previously developed equations for predicting the shear strength of reinforced fibrous concrete slender beams can be used for predicting the shear strength of fibrous SCC deep and slender beams respectively.

S A AlTaan, B.Sc. Civil Engineering, is a staff member, Civil Engineering Dept., Mosul University, Mosul, Iraq. He was previously Cultural Advisor / Iraqi Embassy, Kuala Lumpur and his fields of interest, include fibre reinforced concrete. His studies were undertaken at Mosul University, and a PhD in Civil and Structural Engineering from Sheffield University, UK.

Z. S. Al Neimee, is an MSc student in Civil Engineering at Mosul University, Iraq. Mosul/IRAQ, 2005, 2005-2008, M.Sc. student, Civil Engineering, Mosul

Keywords: Beams, Cracking, Fibre concrete, Self-compacting concrete, Shear strength

Presentation: Day 3 1100 – 1120 — Venue 1: 3G02

Shear Transfer Strength between Precast Normal and Self-compacting Concrete

J R AlFeel, R S AlHadedi
Mosul University, Iraq

Repairing some parts of plain or reinforced concrete members, requires the application of relatively thin concrete sections, which should be bond the old section, but cannot be compacted in situ. The use of self-compacted concrete is a proper solution for such cases. The aim of this study is to investigate the shear transfer between precast normal and cast in place self-compacting concrete.The investigated variables were the compressive strength of the normal concrete and self-compacted concrete, and the method of treatment of the precast normal concrete surface. Four methods were used, sandblasting, chipping, shear keys, and shear connectors. The shear reinforcement (U-shaped) used were either, one 6 mm, two 6 mm, or one 10 mm diameter steel bars. Twenty-four push-off specimens were tested with or without shear connectors with the two outer sides of the push-off specimen cast with normal concrete and left in the laboratory for more than 60 days and then the middle part cast vertically with self-compacted concrete. The fresh properties of the self-compacted concrete mixes were measured using, the slump-flow to measure the spreading ability, V-funnel test to measure the separation ability, and the L-box to measure the passing ability. The load was applied gradually at the top of the middle part of the push-off specimens, and the slip was measured by using dial-gauges. The test results showed that the compressive strength of both normal and self-compacted concrete enhance the shear transfer strength. Excluding the reinforced specimens, the best method of surface treatment was the sandblasting which gave highest transfer shear strength and lowest slip, followed by the chipping and the shear keys specimens. Among the reinforced specimens, those reinforced with two 6 mm diameter bars gave the highest transfer shear strength, followed by those reinforced with one 10 mm diameter bars, and those reinforced with one 6 mm diameter bars, which gave the lowest transfer shear strength.

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Keywords: Interface, Normal concrete, Self-compacting concrete, Shear transfer, Surface treatment

Presentation: Day 3 0900 – 0920 — Venue 3: 2G13

Nano-structurization of Internal Surfaces of Oil Pipelines

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In the report results of working out of technology of modifying internal surfaces the main oil pipelines are presented. The given technology allows to lower hydraulic resistance, to level influence of a roughness on swapping parameters, to lower power expenses for transportation of hydrocarbonic raw materials, to raise operational reliability and to extend the between-repairs period. It is established that the most effective way of decrease in hydraulic resistance is modifying of an internal surface on a basis the fluorine-containing surface-active substances. As a result of nano-structural updating internal surfaces decrease in hydraulic resistance to 23-28 % is reached. The maximum decrease in hydraulic resistance is provided at a relative thickness of a molecular layer of fluorine-containing surface-active substances. It is established that the subsequent increase in a relative thickness of the adsorbed layer of fluorine-containing surface-active substances generated on an internal surface, causes increase hydraulic resistance to the certain established value. The structures modifying fluorine-containing surface-active substances are optimized. Dependences of efficiency of nano-structurization on the basic technological parameters of transportation of hydrocarbonic raw materials are investigated.

K Abdrahmanova is an Associate Professor of ”Design, construction and operation of oil pipelines” Kazakh National Technical University, Almaty, Kazakhstan.

E Bovkunov is an engineer designer of the research institute of construction materials, Almaty, Kazakhstan who conducts research in the field of resource-saving technologies of building materials and construction used for oil and gas transportation and renovation of object of oil and gas sector.

Keywords: Adsorption layer, Coefficient of hydraulic resistance, Fluorine surface active substance, Hydrophobization, Nano-structurization

Shear Behaviour of Fibre Reinforced Concrete Beams

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Most previous studies focused on studying Structural Behaviour of Beams of Reinforced Concrete in the area of bending. And, in general, the available data and information about the structural behaviour of the shear zone are not sufficient, especially for aspects that can have a relationship or a direct effect on the behaviour of shear in order to reduce the risk of cracks and prevent landslides, which is expected to occur. The aim of this study is to investigate the behaviour of shear in the beams of reinforced concrete reinforced with different types of fibres (steel, glass and polypropylene) and its impact on cases of landslides, and to study the factors that help to increase safety when we use these fibres in the area of Shear, and its impact on the properties of concrete in the shear area, and to check the width and length of cracks that appear in the early stages of loading at the bending and shear zones, and the possibility to take advantage of these data and information to evaluate the final stage of the failure of beams. We also expect from the results of this study to provide relevant information to the behaviour of shear, and the extent of its influence in fibre reinforced concrete beams in order to develop the equations of structural design and safety factors. The laboratory study conducted summarized the results in that the addition of glass and steel fibres to the concrete beams contributes to improve the final shear resistance in comparison with polypropylene fibres, which did not achieve acceptable results, and the Fibre Reinforced Concrete Beams are more stiffness compared with traditional reinforced concrete beams, and that is because of its achievement of the values of a small strain during various stages of loading.

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Keywords: Beams, Fibre, Shear behaviour

Enhancing Concrete Strength and Durability by Bacteria Mineral Precipitation

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The mineral precipitation induced by bacteria in enhancing strength and durability of concrete has been reported since in early year 2000. There are bacteria species that have been recognised in inducing precipitation namely calcium carbonate (calcite) in concrete to plug the pores and hence improve the concrete properties. In the present study, Bacillus subtilis in the different concentration cells were incorporated into the concrete mixture. The concrete mixtures were cast into cubes size 100 mm x 100 mm x 100mm for compressive strength test and in cylinder shape size 100 mm diameter and 200 mm long for rapid chloride permeability test (RCPT). The cast concrete specimens were cured in distilled water before subjected to compressive strength and RCPT at the age of 3, 7, 14, 21, 28 and 60 days. The concrete specimens were also examined under scanning electron microscope (SEM). The results show that the incorporation of bacteria does enhance the concrete strength and permeability. The concentration of 10^6 cell/ml was found to be optimum concentration of bacteria added in the concrete. The micrograph examination substantiate the presence of mineral precipitation in the concrete with the inclusion of bacteria.

H Afifudin holds Dip. Eng (Civil) and B.Eng. (Hons.) Civil from Universiti Teknologi MARA (UiTM) Malaysia. Currently, he enrolled his M.Eng (Civil) at UiTM. He has completed his Master thesis entitled “Microbial Silica Precipitation In Enhancing Concrete Properties” and expecting to graduate at the end of this year. He is awarded Young Lecturer Scheme Scholarship and will be joining Faculty of Civil Engineering, Universiti Teknologi MARA, Malaysia as a lecturer. Bioconcrete has become his research interest since enrolled as postgraduate student.

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Keywords: Calcite, Concrete strength, Microorganism, Mineral precipitation, RCPT

Presentation: Day 3 0920 – 0940 — Venue 3: 2G13

Microbial Concrete by Partly Replacing Fine Aggregate with Rice Husk Ash

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Concrete must be relatively impervious so as to enable it to withstand the service conditions for which it has been designed, without serious deterioration over the lifespan of the structure. Research has indicated that a concrete with porous nature will affect the strength and durability. In order to enhance strength and durability, pores should be filled with bonding and inert material. An advanced technique for filling the pores in concrete is by utilizing bacteria, i.e. microbiologically induced calcite ($CaCO_3$) precipitation. Microbiologically Induced Calcite Precipitation (MICP) is a technique that comes under a broader category of science called biomineralization. It is a process by which living organisms form inorganic solids. MICP is highly desirable because the calcite precipitation induced as a result of microbial activities, is pollution free and natural. Here bacillus cohnii was used for calcite ($CaCO_3$) precipitation. To enhance the growth of bacteria fine aggregate was partly replaced with rice husk. As a result, the density of concrete was reduced slightly and an increase in compressive strength and durability was observed. All the experimental details of the concrete with rice husk, preparation of bacteria and details of experimental results are presented in this paper.

Dr G Mohan Ganesh is Professor, Programme Manager & Division Leader, Structural and Geotechnical Engineering Division, School of mechanical and building Sciences, VIT University, Vellore. He has led three research projects on High volume fly ash concrete. His research interests include Steel Structures, Flyash Concrete, Steel – Concrete Composite structures, Artificial Neural Network (ANN), and Genetic Algorithms (GA).

Dr A S Santhi is Professor and Assistant Director in centre for Structural Engineering, Structural and Geotechnical Engineering Division, Director, School of mechanical and building Sciences, VIT University, Vellore. She has led three research projects on High volume fly ash concrete. Her research interests include Creep and Shrinkage Properties in RCC Structures, Flyash Concrete.

Dr Kalaichelvan Gurumurthy is a microbiologist with interests in Environmental, Industrial and Food Microbiology. He has been involved in commissioning various industrial treatment units, anaerobic treatment of solid and liquid wastes and currently he involved in developing probiotic consortia.

M Phlip, has completed M.Tech (Structural Engineering) at VIT University. He did his under graduate studies in Civil Engineering. He has presented two papers in the international conference. His research interests include Microbial concrete.

Keywords: Bacillus cohnii, Bacterial concrete, Microbial concrete, Rice husk ash

Presentation: Day 3 1140 – 1200 — Venue 1: 3G02

Estimation on Deterioration Process of Concrete Members Suffering Chloride Induced Damage Based on a Stochastic Approach

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2 – Shikoku Research, Japan

Deterioration of concrete structures has recently been affecting much attention in Japan. Severe chloride induced deterioration has been observed in the coastal area. The deterioration is mainly caused by the corrosion of reinforcement due to the action of chloride ions. Corrosion of steel material in concrete is commonly caused by electrochemical reaction and is primarily caused by the migration of airborne chloride ions. The method to predict the damage process of deteriorated structure suffered chloride induced deterioration is proposed in this paper. The deterioration process is modeled as consisting of three phases; The first is the period ts until depassivation of the reinforcement occurs after completion of the structure, and the second is the period tcr until the corrosion cracking occurs due to pressure of corrosion from corrosion of reinforcement starts. After corrosion cracking, the concrete members will be deteriorated exponentially. The deterioration phenomenon of structures in actual environment is varied widely. Therefore, the stochastic method is carried out in order to consider the actual structure with uncertainty in nature. Two parameters, Equivalent diffusion coefficient, Spacing of cover thickness is modelled as stochastic parameters. Target structure is the drainage canal passed over 35 years and deteriorated by chloride induced damage. The result calculated using proposed model is compared with actual data obtained from target structure in this paper.

Dr. Manabu Matsushima is a professor of KAGAWA University, Takamatsu, Japan. He received his Doctor of Engineering from Tokyo Denki University in1994. His research interest is the application of reliability theory to concrete members in RC structures. He is member of the JSCE, AIJ and JCI.

Mr. Kousaku Matsuda is a senior research engineer at Shikoku Research Institute Inc., Takamatsu, Japan. He received his Master Degree from Kobe University in 1979. His research interests is the application of deterioration model to member received chloride induced damage. He is member of the AIJ and JCI.

Dr. Masaru Yokota is a senior research engineer at Shikoku Research Institute Inc., Takamatsu, Japan. He received his Doctor of Engineering from Tokushima University in 1995. His research interests include the deterioration of RC structures and the inspection model of corroded steel bar received the severe environments. He is member of the JSCE and JCI.

Keywords: Chloride induced deterioration, Corrosion, Simulation, Stochastic model

Presentation: Day 3 1000 – 1020 — Venue 1: 3G02

A Navy User's Guide for Quality Assurance for New Concrete Construction

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The U.S. Navy has developed and implemented new design and quality assurance procedures including service life modeling of the concrete materials that improve the quality and durability of new marine concrete construction. The approach is delineated in the Uniform Facilities Guide Specification (UFGS) for Marine Concrete and is also referred to as the Navy's methodology. This approach allows Naval Facilities (NAVFAC) and others to specify a defined service life for concrete structures in combination with prescriptive criteria. The goal is to allow all parties involved in the design and construction process to have confidence that the completed structure will meet service life expectations. The cornerstone of this approach is a validated computer software program that can predict the time for chloride and other ions to contaminate the concrete to a degree that will result in initiation of corrosion and other chemical distress mechanisms when all other necessary conditions are met for a specific environmental condition. The use of the Navy methodology is intended to compliment the fundamental principles of good design and construction to accomplish durable concrete structures, and to supplement conventional quality assurance testing of materials. The purpose of this paper is to broaden exposure and to provide guidance on how to implement the methodology correctly and effectively for all users.

Douglas Burke, Subject Matter Expert for Concrete Materials for the U.S. Navy, Naval Facilities Engineering Service Center, Port Hueneme, CA. Mr. Burke has 38 years of experience with the U.S. Navy related to marine concrete structures, concrete durability technologies, service life modeling, and rehabilitation strategies of concrete structures. He has a MS in Test and Evaluation Engineering from California State University, Northridge

Keywords: Methodology, Modeling, Navy, Performance-based, STADIUM, Service life

Presentation: Day 3 0940 – 1000 — Venue 1: 3G02

Effect of Silica Fume in Sand Concrete for Repair Purposes

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2 – Biskra University, Algeria

The prosperity of a country in the field of construction depends on the use of local resources such as sand in southern Algeria. Sand concretes are a part of new construction materials that allow to value natural resources on sand. As its name suggests, this mixture is composed of sand as a majority element, instead of large calibre aggregates. Sand concretes therefore have the same cement contents than traditional concretes, the compactness is achieved by adding an additional thin, generally limestone filler. Repairing a concrete element usually involves two very different materials. The establishment of a green concrete supported on concrete oldest causes different types of problems related to compatibility deformational the two materials in contact. The non cracked character of sand concrete and its low module of elasticity, justified our choice to use it as a repairing material.

In this paper we present a formulation of sand concrete based on optimizing the compactness of the granular skeleton, 3 sets of concrete were prepared with 5 various mixtures to each series. Starting from a fixed choice of a Portland cement content type artificial (CPJ-CEMII/A), is varied in the amounts of sand and limestone filler type, the dosage of admixture for second series, in the end the Water/Cement in the third round. After an optimal choice of components, we introduce is the addition of silica fume in two strengths, replacing an amount of limestone filler. To study the adaptability of this material, a tensile and compressive test with measures of shrinkage were made. We were able to register a significant improvement of the mechanical characteristics so the decrease of shrinkage. An application of repair on degraded test tubes, allowed to notice a good capacity of adaptation deformational of the sand concrete with silica fume in the subtract in ordinary concrete.

K Gadri is an assistant professor in the Department of Civil Engineering of M'sila University- Algeria. She specializes in construction materials and has carried out research on the durability of repair concrete.

A Guettala is a professor in the Department of Civil Engineering and director of Research Laboratory, Biskra University- Algeria. He specializes in concrete properties and has carried out research on the durability of construction materials.

L Zeghichi is a senior lecturer in the Department of Civil Engineering of M'sila University - Algeria. She specializes in construction materials and has carried out research on the binder and cement.

Keywords: Deformational compatibility, Drying shrinkage, Sand concrete, Silica fume, Thin concrete repair

Presentation: Day 2 0920 – 0940 — Venue 1: 3G02

Performance of Polyester Resin Repair Concrete Under Wheel Tracker Tests

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During the past few years, Polyester Resin Repair Concrete (PE Concrete) has provided tremendous benefits to the Hong Kong government on the fast-track repair of concrete pavements due to their properties of fast curing and high strength development. In order to enhance the performance of the material further, reinforcements such as chicken wire mesh and steel mesh were often added. Despite the regular usage of the reinforced and unreinforced PE Concrete, the amount of contributions to the overall strength of the PE Concrete was an unknown within the highway industry. During the year 2010, the Hong Kong Road Research Laboratory (HKRRL) of the Hong Kong Polytechnic University conducted a laboratory research on investigating the behaviour of reinforced and unreinforced PE concrete slabs under repeated wheel load test. The test results indicated that with the addition of chicken wire mesh to the PE concrete, the resistance to repeated wheel loads has increased by more than 30%. Meanwhile it also enhances the ductility of the material, as clearly indicated by the failure mechanism (the gradual deformation before failure and the formation of jagged crack patterns) of the test samples with chicken mesh. The test results also show that the steel mesh D503 makes significant contribution on upholding the stability of the cracked concrete specimens after prolonged period of wheel load applications. Meanwhile the fatigue performance of Grade 40 concrete specimens under wheel tracker tests was found to be approximately 50% of the one for PE concrete specimens, which indirectly indicates that the flexural capacity of the PE concrete can be considerably higher than normal Grade 40 concrete under the condition of almost equal compressive strength.

Mr G L M Leung is currently a PhD student in Pavement Engineering at the Hong Kong Polytechnic University. He was previously a research associate within the institution as well as working with Ove Arup and Partners Hong Kong for 9 years. He obtained his BEng from Nottingham University and his MSc in Foundation Engineering from Birmingham University.

Dr W G Wong is an Associate Professor, within the Civil and Structural Engineering Department at Hong Kong Polytechnic University with over 25 years' experience in concrete design and construction.

Keywords: Mesh reinforcement, Polyester resin repair concrete, Wheel tracker test

Presentation: Day 2 0940 – 1000 — Venue 1: 3G02

Epoxy-formulations for the Coating, Repair and Structural Enhancement of Concretes

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A "tailored" series of synthetic poly-alkylene-poly-amino-methylolic (P.A.M.) curing agents for epoxide (DGEBA) resins is presented; P.A.M. products were obtained by substituting some of the hydrogen atoms of the aminic functions of an aliphatic poly-amine with methylolic groups (-CH_2OH). The viscosities of the fluid epoxy-P.A.M. formulations (before the onset of the curing reaction) were determined at room temperature. Mechanical and creep properties, permeability to carbon dioxide and water of the cured formulations were determined, as well as their adhesion to different concretes; the durability of the resin – concrete joints (U.V. irradiation, freezing-thawing) as well as their crack-bridging ability were also tested. Experimental tests were also carried out for the structural repair of fractured concrete specimens by means of a fibreglass composite with the best experimented epoxy matrix. The evaluation of the chemical structure of the cured epoxy formulations allowed the interpretation of their different behaviours as products for the protection and repair of concrete structures.

F. Medici is currently Professor of Materials Science and Technology at the "Sapienza" University of Roma, Italy. He has been and is involved in research projects on the field of the cement chemistry, concrete technology and recovery of waste materials in cement matrices.

G.Rinaldi is a Professor of Space Materials and Space Engineering and of Materials Technology and Applied Chemistry and Energetics at the "Sapienza" University of Roma.

Keywords: Coating, Composites, Cracks repair, Damaged concrete, Epoxide resins

Presentation: Day 2 1000 – 1020 — Venue 1: 3G02

Theme 4 — Structural Health Monitoring and Life Extension

Extending Concrete Structures Service Life Using FRP and Structural Health Monitoring – A Case Study

G Lee[1], J Wang[1], K Tang[2], S H Giam[2]
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2 – Greg Wong and Associates Limited, Hong Kong

Old structures often need repair and strengthening to be in a serviceable condition. This paper reports on the rehabilitation of a 30-year old pre-stressed concrete bridge to satisfy the new building regulations in Hong Kong. Because of site constraints, a combination of post-tensioning and fibre-reinforced polymeric technology was used, the latter of which formed the first project case approved by the Hong Kong building authority. Due to the pioneer nature of the project, full load-testing and several long-term monitoring techniques were designed and installed including optical fibre strain measurement. In this paper, the design basis is presented and details for implementation highlighted, including selection for materials, method of installation, fire proofing, full load testing and monitoring. Finally the test results are presented and long-term monitoring data discussed, from which some preliminary conclusions are drawn.

Gary Lee has over 12 years of engineering experience in corrosion protection, design, construction, repair and strengthening of civil infrastructures and buildings. He obtained his Bachelor's degree and Master's degree from the University of Hong Kong. Since then he has worked with Maunsell Consultants Asia Limited. He is now the Deputy General Manager of Fyfe (Hong Kong) Limited and Director of Materials Techconsult Limited. He has been involved in various significant civil engineering projects in Hong Kong such as Central Reclamation Phase III, West Rail, East Rail Extensions and Ma Wan Island Development. Gary is experienced in condition survey, defect investigation, structural strengthening and corrosion engineering of structures.

Kevin Tang has over 20 years of experience in building development and highway structure projects. He is now the Managing Director of Greg Wong and Associates Limited. His experience includes project management, preliminary engineering design, cost feasibility studies, supervision of technical and support staff, co-ordination of work with various agencies and government departments, detail design, construction supervision and contract administration. Mr. Tang's projects include high-rise building complex with transfer plate, deep excavation for basement construction, foundation design in difficult ground conditions, site formations, access viaducts and footbridges.

Mr. Siang Hai Giam is a Chartered Engineer with over 20 years of experience in general and specialist construction works. He was involved in the introduction of Tyfo Fibrwrap FRP system in Asia more than 10 years ago for civil and building works. Over the years Mr. Giam has been involved in the senior management of various general and specialist construction companies with works across Asia.

Dr. Jinsong Wang is a Chartered Civil Engineer with over 20 years of experience in the field of research and development, engineering consultancy and contracting. He obtained his Bachelor's degree from the Southeast University (China) and the Doctor's from the University of Dundee (UK). Since then he has worked with Taywood Engineering Ltd (UK), British Rail Research (UK), Harris & Sutherland Consulting Engineers (HK) and L&M Specialist Construction Ltd. Before joining Materials Techconsult Ltd. and Fyfe (Hong Kong) Ltd., he was the Chief Engineer with Maunsell Consultants Asia Ltd. as the Chief Engineer on materials technology. Dr Wang specialises in the use of materials for civil and building works, durability design, corrosion protection, repair and strengthening of concrete structures. He has published over 20 technical papers and is a Visiting Professor to the Southeast University, Nanjing. He also served in the past as the Honourary Secretary of the Materials Division of the Hong Kong Institution of Engineers.

Keywords: FRP, Optical fibre, Strengthening, Structural health monitoring

Presentation: Day 2 1100 – 1120 — Venue 2: 3G05

Impedance monitoring for assessment of corrosion

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Electrochemical impedance spectroscopy (EIS) is a powerful evaluation tool for composite materials. It is currently under utilized in practice in the area of civil engineering. The basic premise of IS is that each interface in a composite material will polarize in its own unique way when the system is subjected to an applied potential difference. A few lab studies have been reported in the literature attempting to assess corrosion of steel bars embedded in concrete utilizing EIS. In the present study, investigations were performed on steel bars embedded both in plain mortar as well as carbon fibre reinforced mortar (CFRM). Rapid macrocell tests were performed. These tests involve an anode bar encased in mortar and submerged in a salty pore solution electrically connected to two cathode bars in regular pore solution. Tests are conducted for 15 weeks. Corrosion was measured in three ways: measurement of the corrosion current across a resistor, measurement of the open-circuit corrosion potential using a saturated calomel electrode (SCE), and EIS. The frequency range of EIS was 0 – 5 MHz. Results of EIS on the bars in plain mortar proved unreliable and were not easily correlated with corrosion current or corrosion potential. Reports in the literature have indicated that carbon fibres impart a smart sensing capability to concrete. The bars encased in CFRM showed promising results. The diameters of the arcs in the Nyquist plot were sensitive to the corrosion current and potential.

Dr. Reza is associate professor in civil engineering at Minnesota State University since 2009. Prior to that, he served as assistant then associate professor at Ohio Northern University from 2001 till 2009. Dr. Reza's research interests include structural health monitoring and concrete material science. He is a member of ASCE Committee on Methods of Monitoring and Evaluating Structural Performance, and ACI.

Keywords: Impedance spectroscopy, corrosion, structural health monitoring

Acoustic Emission Criteria of the Structure of Constructional Composites

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Escalating the operational actions to construction materials demands the development of materials with improved properties. Role of the physical investigation methods during the research and development of the construction materials can't be underestimated. One of the most promising is the "acoustic emission method", which is often characterized as a method of nondestructive testing (though acoustic emission occurs – and can be measured – during the process of "destructive" testing also). The successful application of the acoustic emission method (both for forecasting the properties and during the optimization of material's composition) requires the using of scalar criteria, which are in correlation with mechanical properties of material. The procedure of derivation of such criterion is discussed in present work. The stress-strain diagrams (acquired during the load process of test sample) were divided in several regions, corresponding to the different load phases (linear and nonlinear reversible deformation, irreversible deformation, plastic yielding). Then for each region we obtain the normalized sums of primary acoustic emission criteria (amplitude, intensity, etc.). It is shown that normalized sum which is corresponding to the region immediately preceding the destruction is in strong correlation with compressive strength of material.

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Keywords: Acoustic emission, Acoustic emission equipment, Composite materials, Failure criteria

A Performance-Based Quality Control Tool for Cement Based Composites Using Modified Electrical Resistivity Measurement Techniques

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The variations in the associated conditions of in-situ-produced cement-based composites (CBC), such as curing conditions and workmanship quality, may cause considerable variations in the resulting CBC quality. Concrete for instance, as a species of CBC, usually show in-situ properties that are different from those obtained on the basis of laboratory produced test specimens. Thus, there has been an increasing focus for developing reliable nondestructive tests for CBC performance-based quality control. Such tests are performed to assess and predict CBC quality that is based on performance in order to carryout a better adjustment of both life cycle assessment and life cycle management. One of such non-destructive tests is measuring the electrical resistivity, which can be used as an indicator to assess the developing CBC properties including early stage properties, chloride diffusion, permeability, durability, etc. In this paper, a a recently proposed, cheap and reliable non-destructive technique called the Square Inner Electrical Resistivity Measurements (SIERM) technique, used to measure electrical resistivity of CBC, is introduced to study the correlations between the inner electrical resistivity measurements and the corresponding CBC strength properties including in compression, in splitting tension and in flexure. These relations are useful in conducting an actual performance based monitoring and controlling for the concrete quality and consequently have a better assessment for the constructed facility quality. These correlations can also be helpful in the construction process of concrete by controlling the right timing for formwork removal based on actual performance and expedite the time needed to proceed with subsequent construction stages. The results also show that, the electrical resistivity and strength are affected by the same factors such as age and water cement ratio. Results also show that there are strong correlations of statistical models based on regression analysis to predict strength from electrical resistivity measurements.

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Keywords: Cement-based composites, Electrical resistivity, Non-destructive testing, Quality control, Strength

Presentation: Day 2 1140 – 1200 — Venue 2: 3G05

Modeling of Fracture in Reinforced Concrete Structures with Account of Bond Degradation and Cracking Under Steel Corrosion

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The three-dimensional finite-element modeling of fracture processes in reinforced concrete structures with account of the macrocrack initiation and propagation, real geometry of reinforcing elements, discontinuity in the bond-slip behavior and nonlinear constitutive equations for concrete is considered. The concrete material is modeled including the triaxial nonlinear stress-strain behavior, tensile cracking, compression crushing and strain softening. The different models with and without account of strong discontinuity for the reinforced-concrete bond behavior are considered and compared. The finite element fracture analysis has been performed for three standard applications. The first one is the problem of pulling the reinforcing bar from the concrete block. The second presents the three-point bending concrete beam specimen. The third example is devoted to modeling of fracture process in concrete reinforced plate under steel corrosion. The comparison of obtained numerical results with experimental data is presented and discussed.

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Keywords: Corrosion, Damage, Elasto-plasticity, Finite element modeling, Fracture

Research of Column Models Strength Under Repeated Axial Impacts by Falling Weight Using Computational and Experimental Methods

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2 – Munich Technical University, Germany

Presently construction of frame buildings using shotcrete columns is widely spread. Having technological advantages, these columns of raised bearing ability perceive considerable loadings without formation of cracks under considerable deformations. Construction of high-rise buildings in aseismic areas causes studying of columns behaviour under numerous dynamic loadings. The purpose of this work has been design procedure of concrete, ferroconcrete and steel shotcrete columns durability under numerous shock loadings. A mathematical model describing behaviour of constructional materials, including concrete ones under great shock loadings has been developed. The model has been used in the program complex for problems solving of blow and explosion in full three-dimensional formulation and for dynamic problems solving by the final elements method. Analysis of the experiments results on maglio installation of concrete, ferro-concrete and steel shotcreet columns models on numerous end blow of falling cargo has been carried out using the method of computer modeling behaviour of constructional materials under great shock loadings.

Nikolai N. Belov, doctor of physics and mathematics, Professor, graduated from the Tomsk State University (specialty ”Mechanics”). Since 1996 he has worked as a professor of the department ”Higher mathematics” of the Tomsk State University of Architecture and Building (TSUAB). His research interests: behaviour of structural materials and their products under high-speed impact, explosion and influence of powerful energy flows on substance.

Dmitriy G. Kopanitsa, DSc, Professor, graduated from the Tomsk Institute of Civil Engineering (specialty ”Industrial and civil Engineering”) and since that time the professor has worked at the same university (TSUAB). In 2003 he was appointed a head of the department of metal and wooden structures. His research interests: behaviour of building structures subjected to dynamic loads.

Nikolai T., Yugov, Doctor of physics and mathematics, graduated from the Department of Physics and Mechanics of the Tomsk State University in 1980. Nowadays Yugov Nikolai T is a professor of the Department of metal and wooden structures of the Tomsk State University of Architecture and Building. He is an expert in the field of mathematical modeling structural materials under explosive and impact loading behaviour

Sergey L Kaparulin graduated from the Tomsk University of control systems ans radioelectronics in 1978. Being a candidate of science, he is a senior researcher at the department of metal and wooden structures of the Tomsk state university of Architecture and Building. His research interests: behavior of building structures subjected to dynamic loads.

Alexey A. Yugov, candidate of sciences, an Assistant Professor, graduated from the Civil Engineering Department of the Tomsk State of Architecture and Building in 2003 having got the diploma of a specialist. In 2007 he defended his thesis on construction mechanics and building structures. Presently Alexey A. Yugov is a lecturer at the department of metal and wooden structures of TSUAB and is going on his research.

Georgy Kopanitsa, PhD in technical science, graduated from the Tomsk Polytechnic University in 2011 having got the Master degree diploma. His major is artificial intelligence, business process optimization using AI techniques. Since 2007 he has worked and learned in Germany: Munich Technical University, Heidenheim quality management summer school and presently G Kopanitsa is a researcher in the Helmholtz-Zentrum (German research centre for Environmental health, Munich).

Roman S Mamtsev graduated from the Civil Engineering Department of the Tomsk State of Architecture and Building in 2007. Now he is post graduate student at the department of metal and wooden structures of this university.

Keywords: Computer modeling, Fracture, Guncrete columns, Impact

Presentation: Day 2 1200 – 1220 — Venue 2: 3G05

Efficiency of Modelling Corrosion-induced Cover Cracking in RC Structures

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Corrosion is one of the main causes of deterioration of reinforced concrete (RC) structures. Initially, it affects serviceability of a RC structure by causing excessive cracking of the cover concrete. A number of analytical models have been proposed to predict the time to corrosion-induced crack initiation. In this paper investigations on the applicability of the two main types of the analytical models based on solution of thick-walled uniform and double cylinders subjected to uniform internal pressure are described. FE analysis is employed for this purpose. Firstly, the influence of simplified formulation of the nonlinear behaviour of concrete is examined. The limits of applicability of the analytical models are established depending on c/d ratio (i.e., the ratio of the thickness of the concrete cover to the diameter of a reinforcing bar). Secondly, inability of the analytical models to account for actual boundary conditions of corroding reinforcing bars is studied. It is found that the influence of the boundary conditions on the predictive ability of the analytical models may be very significant. The FE analysis is also employed to investigate the influence of different types of concrete cover failure: cracking and delamination. The failure conditions in terms of ratios between certain geometrical parameters of a RC section have been established. The efficiency of the analytical models to describe different types of cover failure has been discussed.

L. Chernin is currently a research associate in the Institute for Infrastructure and Environment within the School of the Built Environment at Heriot-Watt University, Edinburgh. The areas of his research interests lay in the analysis of structural and material deterioration in reinforced concrete caused by corrosion of steel reinforcement, in analysis of concrete structures subjected to blast loads, and in structural and durability issues related to marine renewables.

D. Val is currently Professor in the Institute for Infrastructure and Environment within the School of the Built Environment at Heriot-Watt University, Edinburgh. His specialist areas of research are structural safety and reliability, quantitative risk assessment, performance of structures in aggressive environments, reliability of marine energy converters, adaptation of infrastructure to changing climate, and inter-infrastructure risks.

Keywords: Analytical model, Corrosion, Cracking, Finite element model, Reinforced concrete

Presentation: Day 2 1400 – 1420 — Venue 2: 3G05

A New Model for Predicting the Effective Strength in Concrete Bottle-Shaped Struts

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Strut-and-Tie Model (STM) can be used to model the flow of compression within a concrete strut. Concrete struts are formed in various shapes such as prismatic or bottle shape. Bottle-shaped struts are wider at their middle region than both ends. Due to transverse straining at the midpoint of struts, longitudinal cracks are formed parallel to applied load direction. The compression response of concrete in cracked elements differs from that of plain concrete in uniaxial compression. In this paper a new model to analysis of concrete struts was proposed based on modified compression field theory (MCFT). A database of 34 tested specimens was used to evaluate the accuracy of proposed model and approaches of both codes ACI and CSA. According to performed comparison, the results of new proposed model are accurate and can be adequate to concrete panels subjected to compression force.

A Arabzadeh is a Professor in Tarbiat Modares University, Iran.

R Aghayari is an Associate Professor in Tarbiat Modares University, Iran.

Keywords: Compressive softening, Strut-and-tie, Transverse reinforcement

Development of an Algorithm for Detecting Damage at Multiple Locations in Reinforced Concrete Structures

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2 – Kitami Institute of Technology, Japan

In recent years, there has been a renewed interest in the damage diagnosis and health monitoring of existing highway bridges using vibration based damage identification techniques. There is a growing need for built-in monitoring systems for civil engineering infrastructures, due to problems such as increasing traffic loads and rising costs of maintenance and repair. Most vibration-based damage detection theories are formulated based on the assumption that failure or deterioration would primarily affect the stiffness and therefore, affect the modal characteristics or the dynamic response of the structure. If these changes can be detected and classified, it could be further implemented for a bridge monitoring system to indicate the condition, or damage, or remaining capacity of the structures. It can be used to evaluate seismic behavior of the structures and can help take measures for rehabilitation in case of severe damages. Many damage detection schemes rely on analyzing response measurements from sensors placed on the structure. Research efforts have been made to detect structural damage directly from dynamic response measurements in the time domain, e.g. the random decrement technique, or from Frequency Response Functions (FRF). Also, some damage detection methods have been proposed to detect damage using system identification techniques. This paper deals with damage detection and localization in a reinforced concrete structure based on vibration based monitoring. The sensing system adopted in this study uses the piezoelectric accelerometer to detect, locate and estimate defects induced in the form of cracks on the beam at different locations. The piezoelectric actuator provides variable excitations in the frequency range of 0 to 800 Hz that is effective in measuring a high order mode change associated with the occurrence of damage. In this paper, a damage identification method based on changes in Transfer Function Estimate (TFE) is presented. The method can be used to accurately detect damage, predict its location and assess the extent of damage in structures.

Professor P Rathish Kumar is an Associate Professor, National Institute of Technology,Warangal, Andhra Pradesh, INDIA.

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Keywords: Damage detection, Dynamic parameters, Structural health monitoring, Transfer function, Vibration

Sliding Joints as Effective Tools for Stress Elimination Caused by Horizontal Deformation

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Sliding joint is effective method to decrease the stress in foundation structure in case of horizontal deformation of subsoil (areas afflicted with underground mining) or horizontal deformation of foundation structure (pre□stressed foundations, creep, shrinkage, temperature deformation). Convenient material for sliding joint is bitumen asphalt belt. Experiments for different types of bitumen belts passed at Faculty of Civil Engineering □ VSB TU Ostrava in 2008. Currently extended experiments are in progress and the shear resistance of slide joint is tested as a function of temperature in temperature controlled room. In the paper experiment results of temperature dependant shear resistance will be presented. The result of the experiments should be the sliding joint shear resistance as a function of deformation velocity and the temperature. Using rheological slide joint could lead to decreasing of the reinforcement amount and contribute to higher reliability of foundation structure and thus enable to design more durable and sustainable building structures.

Radim Cajka, received his civil engineering degree from the Brno university of technology, Czech Republic. He is professor and the head of the Department of Building Structures, VSB - Technical University of Ostrava, Czech Republic. His main area of research is related to foundation structures, soil - structure interaction and structural fire design.

Pavlina Mateckova,MSc.Ph.D. is a Lecturer at Department of building structures, VSB-TU Ostrava, Czech Republic.

Martina Janulikova,MSc. is a Ph.D. student, Department of building structures, VSB-TU Ostrava, Czech Republic.

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Keywords: Foundations, Sliding joint, Soil-structure interaction, Undermined area

Presentation: Day 2 1420 – 1440 — Venue 2: 3G05

Reducing the Variability of Predicting the Longevity of Reinforced Concrete Marine Structures Subjected to Physical and Chemical Degradation

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1 – University of Dundee, UK
2 – University of Leeds, UK

Modeling the longevity of marine structures is inadequate and time to ultimate failure is extremely difficult to predict. The sheer number of variables affecting the failure causes large variability in predictions. Experimental works were undertaken to further understand the rates of corrosion in submerged concrete to enhance prediction of steel section losses. This paper reports early findings from this work where CEM 1 type reinforced concrete was exposed to environments with variable oxygen concentrations. After accelerated corrosion initiation, corrosion measurements using a potentiostatic method were used to determine the average loss of steel due to corrosion. Corrosion is shown to continue to occur although the environment has a lack of oxygen. Rates are up to 50% lower exposed to oxygen concentrations of 0 to 4ppm, than in 8ppm or air exposure. These results are contradictory to common thinking suggesting that without oxygen, corrosion rates would be negligible. Further experimental works and project integration is discussed outlining future steps for the Universities of Dundee and Leeds to further reduce variability in predicting longevity off marine structures.

Professor M Roderick Jones, Director of Concrete Technology Unit and Dean of Faculty of Engineering, Physics and Mathematics, University of Dundee. His research interests lie in durability of concrete, service life prediction. use of alternative cements and foamed concrete.

Dr. John. P. Forth is a senior lecturer in the School of Civil Engineering at the University of Leeds. He was awarded his first degree, a BEng in Civil and Structural Engineering from the University of Sheffield. He received his PhD from the University of Leeds. He is on several Technical Committees (i.e. RILEM, British Standards) in the European Union. His research interests include serviceability and durability performance of reinforced concrete and masonry structures. He is a chartered member of the Institution of Structural Engineers.

Chris Thistlethwaite is a PhD research student in the Concrete Technology Unit at the University of Dundee, currently researching the longevity or concrete structures situated in aggressive marine environments.

Lee. J. Higgins is a research student in the School of Civil Engineering at the University of Leeds. He was awarded a First Class Masters (MEng) degree in Civil and Structural Engineering from the University of Leeds in 2008. His research interests include the performance of reinforced concrete structures under both sustained and fatigue load types and also the interaction between cracked reinforced concrete and hydrostatic pressures.

Keywords: Chemical degradation, Longevity, Marine structures, Physical damage

Presentation: Day 2 1440 – 1500 — Venue 2: 3G05

Stochastic Algorithm for Solving Optimal Placement of Sensors

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Fisher information matrix and MAC (modal confidence) matrix are good methods to solve optimal placement of bridge sensors problems, but both of them have their own quality. Base on them, an optimal placement of bridge sensors integer programming expected value model is found when the mode of vibration as random variables, then the advantages are presented when use of DNA genetic algorithm to solve this kind of problems, And finally the feasibility of the algorithm is showed by Siyang Bridge as an example.

Z R Feng is currently Professor of Bridge and Tunnel Engineering at Wuhan University of Technology, Wuhan, China. He has led several research projects on the process of building bridge, and his specialist areas of research are route inspection of bridge, timely monitoring during the process of bridge constructed, design of bridge and roads and research on soft basement of highway.

X Liu is currently a PhD student of Bridge Engineering at Wuhan University of Technology, Wuhan, China. His research direction is Bridge Monitoring and Evaluation.

Keywords: DNA genetic algorithm, Fisher and MAC matrix, Optimal placement of bridge sensors, Stochastic simulation

Presentation: Day 2 1500 – 1520 — Venue 2: 3G05

Deterioration of Concrete Caused by the Thaumasite Form of Sulfate Attack (TSA): A Case Study

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TU Graz, Austria

Deteriorated and un-deteriorated samples, drilling cores and needle-like efflorescence were taken from the shotcrete lining in an Austrian tunnel. Additional samples from groundwater and interstitial solutions extracted from the sampled damaged concrete materials were collected. Main elemental composition, mineralogy, and microstructure of deteriorated solids indicated that thaumasite formation was the main reason for the damage. The needle-like efflorescence was identified as the sodium sulphate mirabilite (Na_2SO_4•$10H_2O$). Based on δ13C values of dissolved inorganic carbon (DIC) in local groundwater source of carbonate for thaumasite DIC of infiltrating carbonate-rich groundwater was indicated. Analyses of δ34S of thaumasite identified that the source of sulphate in thaumasite is clearly related to the infiltrating groundwater also. SO_4^{2-} concentrations of the local ground waters were in the range of 450 to 550 mg/l, and the Na^+ concentrations were as low as 0.5-4.0 mg/l. In contrast interstitial solutions showed in the case of Na^+ up to 7400 and for SO_4^{2-} values up to 17200 mg/l. Additionally the δ2H and δ18O values (Vienna Standard Mean Ocean Water; VSMOW), of the extracted solutions display a strong enrichment of the heavy isotopes versus the local infiltrating solution. In accordance with this trend a respective enrichment of conservative (trace) elements e.g. Rb^+, K^+ and NO3- was detected. Therefore it is assumed that evaporation of the infiltrating groundwater is responsible for the enrichment of heavy isotopes and conservative elements.

Prof D Klammer is a Professor at the Institute of Applied Geosciences, with research interests in properties of inorganic binders, applied mineralogy / archeometry and inorganic binders, environmental geochemistry, and isotope signals and element cycling.

Prof J Tritthart is a Professor for “Chemistry of Civil Engineering” at the Institute of Technology and Testing of Building Materials at Graz. His research interests are mainly in the field of cement and concrete often in connection with detrimental environmental exposure conditions such as corrosion of reinforcements on chloride ingress or volume stability problems on sulfate attack, by investigating e.g. potential mapping or pore solution chemistry.

F Mittermayr is a PhD student at the Institute of Applied Geosciences, with research interest in applied mineralogy / archeometry and inorganic binders.

A Brunnsteiner is a PhD student at the Institute of Technology and Testing of Building Materials, with main research interest in assessing critical sulfate levels in concrete.

Keywords: Case study, Deterioration, Dissolved organic carbon, Isotope, Microstructure, Mirabilite, Sulfate, Thaumasite

Presentation: Day 2 1600 – 1620 — Venue 2: 3G05

Case Study of a Structural Assessment for a Building Subjected to Fire Attack

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The study describes a real fire assessment of a two story building occupied by a textile factory. It throws light upon the fire investigation tools utilized to evaluate the post fire residual strength. The paper also describes fire investigation techniques which trace the visual evidence in the fire damaged structure. The investigation also includes tools to estimate the peak temperature and duration of heating that the structure is exposed to. The factory is located in Dulail region about 100 km. east of Amman city, the capital of Jordan. It is composed of two stories. The total building area is 9500 sqm. The slabs and beams are composed of precast prestressed partially reinforced concrete units. The columns and foundations are of ordinary reinforced concrete. To assess the fire severity, the affected surfaces and the debris were inspected; the color, the state, and the condition of the material were examined. The peak temperature and duration of heating that the building has been exposed to were estimated utilizing temperature indicators tables. The assessment involved both field and laboratory work to determine the extent of damage. The investigation was initiated by visual inspection of the whole structure to trace the most damaged parts, through investigation of cracks, scale off, concrete spalling, physical and color changes. According to the severity of damage, the structure was divided into zones. Zones 1,2 were severely damaged, and the remaining parts are to be demolished. Testing was carried out only in zone 3. First nondestructive testing was carried out. It comprised both Schmidt hammer and Ultrasonic pulse velocity tests. Results were recorded. Then destructive testing was carried out in specific locations. Core samples were taken from slabs, beams and columns, to determine concrete compressive strength. This paper presents an overview of how to conduct a forensic evaluation of a fire damaged structure.

Dr. Mazen A. Musmar is currently Associate Professor of structure at the Al-ahliyya Amman University. He has worked on several research projects on reinforced concrete and steel, and his specialist areas of research are structural modeling, structural assessment of buildings and rehabilitation.

Dr. Muhammad Rjoub is currently Associate Professor of structure at the Al-ahliyya Amman University. He has worked on several research projects on reinforced concrete and structural assessment, his specialist area of research is structural assessment of buildings and rehabilitation.

Keywords: Concrete, Fire investigation, Rehabilitation, Structural assessment

Presentation: Day 2 1640 – 1700 — Venue 2: 3G05

Methods for Extending Life of Existing Bridges: A Case Study

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2 – R&S Engineering Consulting, Italy

The Italian motorway and railway networks were built about 30 to 40 years ago; they have a large number of prestressed concrete bridges and viaducts, most of these bridges must now be rehabilitated.

External post-tensioning has been found to be a powerful tool for reparation, adjustment and for increasing the life extension of existing structures. Particularly this technique of reinforcement is applied with success to bridge structures, in many countries since the 1950s and has been found to provide an efficient and economic solution for a wide range of bridge types and conditions. The technique is growing in popularity because of the speed of construction and the minimal disruption to traffic flow. In response to the demand for faster and more efficient transportation systems, there has been a steady increase in the weight and volume of traffic throughout the world. As well as increases in legal vehicle loads, the over-loading of vehicles is a common problem and it must also be considered when designing or assessing bridges. As a result, many bridges are now required to carry loads significantly greater than their original design loads. In the following, a study case of this technique will be illustrated on a railway bridge. During the construction of the railway line "Turin-Novara" (North of Italy), the Consortium Cav. TO-MI needed to utilize the bridge "Terdoppio" for the transit of the railway trains that had to serve to the placing of the equipment of the railway line. For the design of the reinforcement system, has been taken into account the presence of bonded and unbonded prestressing, also making use of some models of interaction between the different internal forces as recently proposed in literature. Today the bridge of "Terdoppio" is under service and the reinforcement has involved a substantial economy in the costs.

Antonino Recupero, Ph.D., P.E., received his BSc and PhD in structural engineering from the "Politecnico di Torino", Turin, Italy, in 1988 and 1996, respectively. He is currently Aggregate Professor of Bridge and Structural Design at the University of Messina. His research interests include shear-bending moment interaction in R.C. and in concrete prestressed members and strengthening techniques in bridge engineering .

Cosimo D. Scilipoti, P.E., received his BSc in structural engineering from the "Politecnico di Torino", Turin, Italy, in 1988. He is currently Project Manager of R&S Engineering Consulting. His research interests include bridge design and rehabilitation techniques in seismic engineering for bridges.

Nino Spinella, Ph.D., P.E., received his BSc and PhD in structural engineering from the "Università di Messina", Messina, Italy, in 2004 and 2008, respectively. His research interests include reinforcement of concrete columns with fiber-reinforced polymer, shear behavior of slightly transverse reinforced beams, fiber-reinforced concrete, and nonlinear analyses of reinforced and prestressed concrete structures.

Keywords: Bridge, Existing structures, External post-tensioning, Prestressed concrete, Rehabilitation

Influence of Mineral Fine Additions on the Durability of Reinforced Date Palm Fibre Concretes

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1 – Université Kasdi Merbah de Ouargla, Algeria
2 – Ecole Nationale Polytechnique (ENP) , Algeria
3 – INSA de Lyon, France
4 – University Amar Telidji of Laghouat, Algeria

Cement materials as like as traditional concrete or mortar resists badly to tensile strength and cracking. This brittleness is accentuated especially in the hot and dry environments, such as the Algerian Saharan climates. This region is characterised by hot temperature and low humidity. As an example of hot dry environment, between June to November, the temperature varies from a minimum of about 10°C to a maximum of 43°C, the relative humidity varies from 24% to 57% and the wind speed varies from 8 km/h to 18 km/h. The reinforcement of building materials, particularly, mortars and concretes, by natural fibres is a technique increasingly used, with an aim to improving their mechanical properties, in particular their flexural strength and cracking. However, the use of these vegetable fibres in concretes is limited by the problems of durability in alkaline cement matrix. This has been revealed in most of the research carried out on several vegetable fibres: sisal, jute and coir. This paper presents the durability of mortar reinforced by date palm fibre. This natural fibres exists in abundance in the Ouargla Oasis (south of Algeria). The durability of fibres was studded by their conservation in various cement matrixes with an addition of 20, 40 and 60 % (cement mass fraction) of natural Pozolana or Cooked broken brick powders. The durability of palm fibres is evaluated by its tensile strength and elongation, occurred over time, of fibres submitted in various cement matrixes using the tension test. The durability of the fibre-reinforced mortar is estimated by the variation of the flexural strength, in the bending test. We showed that the reinforcement of mortars and concretes by date palm fibres improves their flexural property. The durability is more improved for matrix treated by natural pozolana.

A Mokhtari is currently senior Doctor of Materials Technology and researcher of EVRNZA Laboratory at the University Kasdi Merbah of Ouargla Algeria. He has led several research projects on concrete, and his specialist areas of research are fibre reinforced concrete, and durability of concrete.

A Kriker is currently Professor of concrete Technology and Director of EVRNZA Laboratory at the University Kasdi Merbah of Ouargla Algeria . He has led several research projects on concrete, and his specialist areas of research are fibre reinforced concrete, durability of concrete and Mobilization of concrete.

A Bali is currently Professor of concrete Technology and Director of LCE Laboratory at Ecole Nationale Polytechnique (ENP) Algeria. He has led several research projects on concrete, and his specialist areas of research are fibre reinforced concrete, durability of concrete and fire-resistant concrete.

G Debicki is currently Assistant Professor of concrete Technology and Director of research at Laboratory of Civil & Environment Engineering at INSA of Lyon France. He has led several research projects on concrete, and his specialist areas of research are fibre reinforced concrete, durability and permeability of concrete.

M M Khenfer is currently Professor of concrete Technology and Director of research at Laboratory of Civil Engineering the University Amar Telidji of Laghouat Algeria . He has led several research projects on concrete, and his specialist areas of research are fibre reinforced concrete and durability of concrete.

Keywords: Cement, Date palm fibres, Durability, Flexural strength, Pozzolana

Presentation: Day 2 1620 – 1640 — Venue 2: 3G05

Theme 5 — Security and Geohazard Engineering

Bullet Resistance of Double-layer Concrete Panels Made of Rubberized and Steel Fibre Reinforced Concrete

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2 – University of British Columbia, Canada

In this study, the impact resistance of double-layer concrete panels made of rubberized and steel fiber reinforced concrete subjected to direct fire weapon (11 mm or .44 Magnum bullet size) is investigated. Concrete panels with dimensions of 400x400x50 mm are subjected to impact forces from 11 mm-diameter bullets at a distance of 10 m. Three types of concrete panels are tested: single-layer steel fiber reinforced concrete (SFRC), single-layer crumb rubber concrete (CRC) and double-layer CRC/SFRC. For a double-layer CRC/FRC, the CRC layer of 12.5 mm is added to the front surface to partially replace part of the SFRC panel. It is expected that, with its high elasticity and flexibility, the CRC layer will act as a cushion layer to absorb impact energy from the bullet and reduce the damage to the concrete panel. During the impact event, the acceleration of the plate is measured using an accelerometer. The measured acceleration is then used for calculating the force acting on the plate and also its displacement.

Professor P Sukontasukkul is an Associate Professor at King Mongkut's University of Technology North Bangkok, Department of Civil Engineering, Bangkok, Thailand. He received his doctorate education from University of British Columbia, Canada and his research interests include fibre reinforced concrete, rubberized Concrete, behaviour of concrete under impact loading and green concrete.

Manote Suppakittipakorn is currently a lecturer at King Mongkut's University of Thailand North Bangkok, Thailand. His specialist areas of research are fibre reinforced concrete, cement based sensors and corrosion in FRC.

Nemkumar Banthia is currently a professor at the University of British Columbia, Vancouver, Canada. He is a distinguished university scholar and Canada research chair in infrastructure rehabilitation and sustainability. His specialist areas of research are fibre reinforced composite, strain rate effect, shotcrete and permeability measurement.

Keywords: Bullet resistance, Fibre reinforced concrete, Multilayer concrete panel, Rubberized concrete

Presentation: Day 3 0900 – 0920 — Venue 4: 2G14

An Analysis of the Seismic Behaviour of the Grancarevo Concrete Arch Dam

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The paper first briefly describes the numerical model for the numerical simulation of the fluid-structure coupled problems. The primary intent of the applied model is to simulate the fluid-structure dynamic interaction in seismic conditions. The partition scheme of the coupled (multi-field) problem is briefly described as the most common approach for the fluid-structure dynamic analysis of large systems. The developed model includes the most important nonlinear effects in water and structure, such as concrete yielding in compression and crack opening/closing in tension, reinforcement yielding and the phenomenon of cavitation in water. Next, an analysis of the seismic behaviour of the Grancarevo concrete arch dam is performed. The complex model of the water-dam-foundation rock system is analyzed for the registered earthquake from 1986. The analysis was conducted in order to first determine the dynamic characteristics, and then to investigate the actual behaviour of the dam subjected to seismic excitation. The numerical results of the developed numerical model were compared with the registered values.

M. Smilovic is young researcher/assistant at the University of Split, Faculty of Civil Engineering, Architecture and Geodesy, where she is preparing her PhD. Her field of interest is numerical and experimental modelling of structures, and she currently work on modelling of masonry structures.

J. Radnic is currently a Professor at the University of Split, Faculty of Civil Engineering, Architecture and Geodesy. He had lead several research projects on concrete structures, and his special area of interest is modelling of concrete structures.

A. Harapin is currently a Professor at the University of Split, Faculty of Civil Engineering, Architecture and Geodesy and University of Mostar, Faculty of Civil Engineering. His field of interest is high performance concrete and numerical and experimental modelling of concrete structures.

Keywords: Arch dam, Earthquake resistance, Fluid-structure dynamic interaction, Structural analysis

Presentation: Day 3 1000 – 1020 — Venue 4: 2G14

Seismic Behaviour of Reinforced Concrete Beam-column Connections Enhanced with Steel, Polypropylene and Polyester Fibres

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2 – Indian Institute of Technology, Guwahati, India

During past devastating earthquakes, it has been noted that beam-column connections act as one of weakest links in moment resisting RC framed structures and it has been observed that exterior connections suffer more in comparison to interior ones. Since large parts of India lie in highly active seismic zones, issues relating to failure of beam-column connections due to seismic excitations are of considerable importance. IIT Guwahati is currently undertaking a major programme of tests on exterior beam-column connections and, as part of this programme, Durham University has manufactured internally strain gauged reinforcing bars for inclusion in four of the test specimens. The 2/3 scale specimens have been designed using a strong column-weak beam (weak in flexure) approach. Each specimen includes a 12 mm diameter instrumented U-bar as part of the main beam reinforcement with each bar containing 31 electric resistance strain gauges installed within a central longitudinal duct to avoid degradation of bond characteristic around the perimeter of the bar. Different combinations of steel, polypropylene and polyester fibres are used in the concrete for the four specimens to investigate ways of improving ductility under extreme displacements. Improved ductility, and hence reduced specimen damage due to seismic action, will facilitate new construction plus rehabilitation and retro-fitting of a joint after a seismic event. These four specimens have been tested using the excellent laboratory facilities available at IIT Guwahati. The paper gives details of the test programme and the influence of the fibres on joint ductility is illustrated using the considerable volume of data generated by the instrumented reinforcement. Recommendations for design engineers are made.

Dr Scott, a Reader in Engineering in the School of Engineering and Computing Sciences at Durham University, has many years experience researching into the behaviour of reinforced concrete strucural elements. He has published widely in this field and is an active participant in a number of technical committees of the American Concrete Institute.

Professor Deb is Head of the Department of Civil Engineering at IIT Guwahati. His present research is concerned with both laboratory testing and numerical modelling of seismic behaviour in a range of applications.

Professor Dutta is also involved with laboratory testing and numerical modelling of reinforced concrete structures at IIT Guwahati.

Mr Kheni is a research student at IIT Guwahati.

Keywords: Concrete, Connections, Ductility, Fibres, Seismic

Presentation: Day 3 0940 – 1000 — Venue 4: 2G14

Analysis of Seismic Vulnerability: Case Study of Buildings Within Seismic Hazard Zones

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Seismic vulnerability of an urban environment is characterized by the ability of buildings and structures to support seismic events (physical vulnerability) and by the ability of people to behave in a consistent and rational face a major event (social vulnerability). Constantine is a city with moderate seismicity but the level of risk is high because of urban concentration and topography of the site. The seismic risk reduction therefore requires assessing the physical vulnerability of its buildings. It is proposed in this paper an analysis of a group of buildings for residential use located west of the city, consisting mainly of relatively high buildings. Following a survey of a portion of the housing stock of this city, a seismic survey method was applied based on ”observations” post-seismic. Vulnerability indicators are statistically related to damage through a vulnerability index ”IVi” to establish curves of damage (or vulnerability). These are used to estimate the level of damage that is likely resulting in damage cards. The goal is to develop an initial database of some of the housing stock in the city of Constantine (knowledge of earthquake hazards, construction defects ...) to be used in the estimation of seismic risk and verification of seismic safety of existing buildings.

Guettiche Abdelheq is a second year PhD student at Mentouri University, Algerian, with research experience in seismic vulnerability and soil mechanics.

Houdheil Mimoune is a student in Masters student in the Architectural Departement at the University of Mentouri, Algeria.

Keywords: Constantine city, Damage, Earthquake hazard, Seismic vulnerability

Presentation: Day 3 0920 – 0940 — Venue 4: 2G14

Impact Resistance of Fibre Reinforced Concrete

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Fibre-reinforced composite materials are becoming important in many areas of technological application. In addition to the static load, such structures may be stressed with short-term dynamic loads or even dynamic impact loads during their lifespan. Dynamic effects can be significant especially for thin-walled shell structures and barrier constructions. Impact loading of construction components produces a complex process, where both the characteristics of the design itself and the material parameters influence the resultant behavior. It is clear that reinforced concrete with fibres has a positive impact on increasing the resistance to impact loads. However, the assessment of the increase of this resistance has not been sufficiently verified experimentally. The first part of the project: laboratory load tests, aiming not only to determine the appropriate shape of test specimens, but also to evaluate and select appropriate ways to support the test specimens can be found in paper references. The second part of the project: results of impact load tests carried out on a beams and circular specimens are presented in this paper.

Stanislav Rehacek is a PhD student at the Klokner Institute of the Czech Technical University in Prague since 2006. Graduate of Czech Technical University in Prague, Faculty of Civil Engineering - Building Structures. Diploma thesis: construction project of multifunctional building.

Petr Hunka is a PhD student at the Klokner Institute of the Czech Technical University in Prague since 2007. Graduate of Brno University of Technolog, Faculty of Civil Engineering - Building Materials Engineering . Diploma thesis: Monitoring of the growth of modulus of elasticity at high performance concrete.

I Simunek is a member of the Klokner Institute of the Czech Technical University in Prague.

Jiri Kolisko is currently head of Klokner Institute of the Czech Technical University in Prague. He has led several research projects on concrete, and his specialist areas of research are special types of concrete, ultrahigh performance concrete, and mortars for reconstruction.

Keywords: CMOD, Impact resistance, Load tests, Steel fibres

Improving Punching Shear Resistance of Slab Column Connections Using High Strength Self-compacting Concrete With Steel Fibre

K S Ragab[1], S I Zaki[1], A S Eisa[2]
1 – Housing & Building National Research Center, Egypt
2 – Zagazig University, Egypt

This paper deals with behaviour and capacity of steel fibre reinforced high strength self-compacting concrete (SFRHSCC) slabs under punching shear force. Steel fibres can significantly enhance toughness of concrete and inhibit the initiation and growth of cracks. Addition of steel fibres into concrete improves mechanical behaviour, ductility, and fatigue strength of concrete. Steel fibres change the properties of hardened concrete significantly. However, addition of fibres to fresh concrete results in a loss of workability and Self-compacting concrete (SCC) able to flow under its own weight, completely filling formwork and achieving full compaction without vibration. So, this paper studied composites of SCC and HSCC with steel fibres for further property enhancement. Previous studies have demonstrated the effectiveness of fibre reinforcement in improving the shear behaviour of reinforced concrete slabs. In this study, hooked-ends type steel fibres are tested with varying fibre dosage, ordinary concrete, self-compacting concrete and high strength self-compacting concrete. Effect of steel fibres self compacted concrete and self compacted concrete only on punching shears cracking behaviour and resistance of the slabs was investigated. The results show a significant increase of the punching shear capacity and considerable improvement of cracking behaviour as well as good integrity of column-slab connection of the slabs with fibres and self compacted concrete. The slabs without fibres failed suddenly in very brittle manner, while, the fibre reinforced ones collapsed in more ductile type. In addition, based on experimental data obtained from the author's study and literature, the paper performed an evaluation of accuracy of existing models used steel fibre reinforced high strength self-compacting concrete (SFRHSCC) and formulas in previous studies that used to predict punching shear resistance of steel fibre slabs. Keywords: self-compacting concrete; punching shear resistance; steel fibre slabs; steel fibre reinforced high strength self-compacting concrete (SFRHSCC); punching shear cracking; predict; formulas.

Khaled S. Ragab is currently Associate Professor of Concrete Constructions at Reinforced Concrete Research Institute, Housing & Building National Research Center, HBRC, Cairo, Egypt. He is a Consulting Engineer in the design of concrete structures. He is a Member of Syndicate of Egyptian Engineers, Member of the Association of Engineers of Egyptians, and Member of the reviewer team for Journal of civil engineering and construction technology. He has led several research projects on concrete, and his interesting areas of research are Fibre reinforced concrete (GFRP), High performance concrete (self compacting concrete), Nanotechnology in the field of concrete, Economic systems of construction, Nonlinear analysis by FEM for different elements of concrete construction, and Light weight concrete.

A S Eisa is currently Lecturer,Structural Engineering Department, Faculty of Engineering, Zagazig University, Zagazig, Egypt.

S I Zaki is currently Associate Professor, Building Materials Research and Quality Control Institute, Housing & Building National Research Center, HBRC, Cairo, Egypt.

Keywords: Punching shear cracking, Punching shear resistance, Self-compacting concrete, Steel fibre reinforced high strength self-compacting concrete (SFRHSCC), Steel fibre slabs

Presentation: Day 3 1100 – 1120 — Venue 3: 2G13

Successful Repair Technique of Damaged Reinforced Concrete Structures in Egypt

S I Zaki
Housing & Building National Research Centre, Egypt

During recent years, a lot of reinforced concrete structures in Egypt have severely deteriorated, mainly due to improper selection of materials, poor workmanship, absence of good quality control and supervision, and the corrosion of embedded steel in concrete subjected to aggressive environment in some cities in Egypt. The Investigation technique involved visual inspection of the structure, nondestructive testing and check of actual stresses subjected to each member. A case of study is a program of strengthening and repairing one of important buildings in 6th October city (6th of October secondary school in 6th Hay). The repair and rehabilitation program involved strengthening of R.C slabs of less thickness in 1st and 2nd floor, rebuilding of R.C columns in the center of the deflected slabs and rebuilding of R.C footing for that Columns.

Dr. Said. I. Zaki, is an Associate Professor, Housing & Building National Research, Egypt. His interests lie in the strength of construction materials with a particular emphasis on concrete construction.

Keywords: Damage level, Jacketing method, Rehabilitation program, Repair, Strengthening

Presentation: Day 3 1120 – 1140 — Venue 3: 2G13

Nonlinear Analysis of the Shear Behaviour of Concrete Beams using Glass Fibre Reinforced Polymer (GFRP) Main Reinforcement and Closed Stirrups

K S Ragab
Housing & Building National Research Centre, Egypt

This paper carried out nonlinear analysis of the shear behavior of concrete beams using main reinforced and stirrups from GFRP or steel bars based on ANSYS software. Nonlinear finite element analysis on 11-beams specimens was achieved by using ANSYS software. The nonlinear finite element analysis program ANSYS is utilized owing to its capabilities to predict either the response of reinforced concrete beams in the post elastic range or the ultimate strength of a reinforced concrete beams reinforced by GFRP bars. In this research, the effect of using GFRP or steel bars as straight shear reinforcement instead of stirrups in RC beams have been investigated. Hence, it would be helpful to reduce the reinforcement bars without reducing the shear strength of the beams. This point has never been done before and is a new idea that offers a new method to build RC beams. An extensive set of parameters is investigated under applied concentrated load on the beam at shear span equal 2.0. These parameters are investigated including the effect of dowel action without any transverse reinforcement on the shear strength, the effect of the spacing between the stirrups, the effect of changing of volumetric ratios of stirrups, the effect of type of reinforcement (GFRP or Steel) for main reinforcement or stirrups, and finally the effect of the shape of stirrups (stirrups or straight shear reinforcement). The results of finite element analysis showed that nonlinear analysis were in good accordance with the experimental results, which can well simulate the shear behavior of concrete beams reinforced by GFRP bars.

Dr Khaled S. Ragab is currently Associate Professor of Concrete Constructions at Reinforced Concrete Research Institute, Housing & Building National Research Center, HBRC, Cairo, Egypt. (kh_ragab@yahoo.com). He is a Consulting Engineer in the design of concrete structures. He is a Member of Syndicate of Egyptian Engineers, Member of the Association of Engineers of Egyptians, and Member of the reviewer team for Journal of civil engineering and construction technology. He has led several research projects on concrete, and his interesting areas of research are fibre reinforced concrete (GFRP), High performance concrete (self compacting concrete), Nanotechnology in the field of concrete, Economic systems of construction, Nonlinear analysis by FEM for different elements of concrete construction, and Light weight concrete.

Keywords: Closed stirrups, Concrete beams, Glass fibre reinforced polymer bars (GFRP), Main reinforcement, Nonlinear analysis, Shear behaviour, Shear reinforcement

Presentation: Day 3 1000 – 1020 — Venue 3: 2G13

The Use of Activated Nanoclay to Develop the Compressive Strength and Microstructure of High Performance Concrete

S I Zaki, I S Khalil
Housing and Building National Research Centre, Egypt

Concrete science is a multidisciplinary area of research where nano technology potentially offers the opportunity to enhance the understanding of concrete behavior, recent work at the area of addition of nano particles concrete has shown the potential of improving concrete properties by using nano clay as a partial replacement of cement. The purpose of this paper is to study the effect of addition of nano clay (thermally activated alumina – silicate) with percentage 0,3,5,7 and 10% by weight of cement. The results of this study indicated that the addition of nano clay to concrete mixes (as partial replacement of cement) has a potential benefits in improving the compressive strength and micro structure of concrete mixes in addition to ecological benefits in using less amounts of cement. Note: This study is a part of the National project in HBRC material institute about: Application of nanotechnology to develop the quality and performance of concrete.

Dr Saaid I Zaki is an Associate Professor in Strength of Material and Quality Control Research Institute, Housing and Building National Research Center, HBRC, Cairo, Egypt.

Eng I S Khalil is currently a laboratory engineer in HBRC Central Laboratory, Cairo, Egypt and is a specialist in the mix procedure methodologies for nanomaterial concrete mixes.

Keywords: Activated NanoClay, High performance, Micro-structure

Presentation: Day 3 0940 – 1000 — Venue 3: 2G13

Comparison of Fire Protection Lining Boards Properties and Dependence on Temperature

M Lapková, J Toman, T Korecký, R Černý
Czech Technical University, Czech Republic

Boards made of composite materials are these days used as the lining of parts of building structure to improve the object's end-use properties. For the improvement of fire protection properties the temperature stability of both thermal technical and mechanical properties of used composite material, is important. This paper describes the elasticity coefficient and heat conductivity as executed on several materials. Measured samples had been heated on specific temperature and after cooling down were gauged. After comparing the results it is possible to verify the temperature stability of mechanical and thermal technical properties of particular materials.

J Toman is currently Professor at the Faculty of Civil Engineering CTU in Prague. He has led several research projects on physical properties of building materials. His specialist areas of research are physical properties of building materials under extreme conditions (high temperatures etc.) and transport phenomena.

T Korecký is currently PhD. student at the Faculty of Civil Engineering CTU in Prague. He studies at the Department of Material Engineering and Chemistry. He has cooperated with Prof. Toman on several projects.

R Černý is currently Professor at the Faculty of Civil Engineering CTU in Prague. He is a Head of the Department of Material Engineering and Chemistry. He has led many projects of physical properties of building material. He is a member of International Association of Building Physics (IABP).

M Lapková is a PhD. student at the Faculty of Civil Engineering CTU in Prague. She studies at the Department of Material Engineering and Chemistry.

Keywords: Composite materials, High temperature, Mechanical properties, Thermal properties

Presentation: Day 3 1140 – 1200 — Venue 3: 2G13

Pavement Subgrade Stabilization: Comparative Performance of Cement and Polymers

S R Iyengar, E Masad, A K Rodriguez, H S Bazzi, D Little, H J M Hanley
Texas A&M University at Qatar, Qatar

This paper reports a preliminary laboratory investigation aimed at evaluating the potential of commercial binders for pavement subgrade stabilization in Qatar. Portland cement (PC) is one of the most commonly used binders in soil stabilization applications, and hence, the same was chosen as the standard binder for this study. However, the production of PC is not only an extremely resource and energy intensive process but also has significant negative environmental impacts. Hence, this study investigated the application of less environmentally damaging binders in the form of three commercial polymer-based soil stabilizers and their performance was compared with that of the standard, PC. The assessments were derived from measured selected physical, chemical, mechanical and micorstructural properties of natural Qatari subgrade soil when treated with a given binder over a period of 28 days of curing. Although, soil stabilization in general was found to be effective, the results demonstrate that the polymer binders modify the Qatari subgrade soils in such a manner that more favorable engineering properties are achieved than the unstabilized soils and those stabilized using PC. For example, that the compressive strengths and Toughness of the polymer stabilized soils are superior to those of the unstabilized soils and those stabilized using PC. Thus, it was demonstrated that polymers could offer a less environmentally damaging alternative in comparison to PC for pavement subgrade stabilization. While the work reported in this study was carried out with Qatari soil for subgrade stabilization, the results are relevant to other applications such as erosion control (both wind and water related) and slope stability, for similar types of soil and weather conditions experienced throughout the world.

Srinath R. Iyengar is currently an Assistant Research Scientist at Texas A&M University at Qatar. He has a Ph.D. in Engineering from the University of Cambridge and specializes in environmental goetechnics and ground improvement.

Eyad Masad is the assistant dean for research and graduate studies, and director of the Texas A&M University at Qatar division of the Texas Engineering Experiment Station. He holds the rank of a professor in the Mechanical Engineering Program at Texas A&M University at Qatar and the Zachry Department of Civil Engineering at Texas A&M.

Ana K. Rodriguez has a B.Eng in Materials Engineering from Universidad Simon Bolivar, Caracas, Venezuela. She is currently a Research Assistant at Texas A&M University at Qatar – Mechanical Engineering Department. Her research interests are materials processing and characterization, with an emphasis on polymers and lightweight alloys.

Hassan S. Bazzi is currently an Associate Professor in Chemistry and the Chair of the Science program at Texas A&M University at Qatar. He is a multiple-award winner for his academic excellence, teaches a number of courses and labs at Texas A&M University at Qatar, and has taught at Texas A&M University's main campus in College Station, Texas.

Dallas Little is Regents Professor and Snead Chair Professor at the Zachry Department of Civil Engineering and the Associate director of the Center for Aggregates Research at Texas A&M University. He is adjunct Professor of Civil Engineering at University of Saskatchewan, Canada. He has published (or has accepted for publication) approximately 160 refereed journal articles and approximately 75 refereed proceeding and has received several awards for the same.

Professor Howard J. M. Hanley was the Coordinator of Strategic Research at Texas A&M at Qatar and is now with the Australian National University, Canberra, Australia. He is a specialist on the structure and the behaviour and properties of complex materials.

Keywords: Pavement performance, Polymer stabilizer, Qatar, Soil stabilization, Subgrade

Presentation: Day 3 1100 – 1120 — Venue 4: 2G14

The Quality of Collapse Debris and Possible Reuse of this Material to Rebuild Port au Prince Haiti

D J Collery[1], M Bjerregaard[2], K A Paine[3]
1 – Environment Agency, UK
2 – Disaster Waste Recovery, UK
3 – University of Bath, UK

On the 12th January 2010 Haiti and its capital of Port au Prince were struck by a massive earthquake measuring 7.0 on the Richter scale. The earthquake and its aftershocks rendered the Haitian capital into little more than a pile of rubble and debris. The first video footage from the earthquake zone made it apparent that the rebuild of Port au Prince would involve extensive site clearance with tonnes of waste debris surplus to requirements. On making contact with Disaster Waste Recovery it was decided that research and testing on samples of the collapse debris would be undertaken to establish if this debris could be utilised as follows (i) Sub-base materials for road construction, (ii)Use of recycled fines in concrete block production, (iii) Low strength recycled aggregate concrete applications, (iv) For use in vibroflotation compaction. The results suggest that whilst use of collapse debris may reduce strength of sub-base and lower concrete strength compared to natural aggregates that in the main, positive results were obtained from this testing programme. The practical implications of recycling debris in a disaster area are discussed in relation to quality and control.

Dr David Collery is a Graduate Flood Rick Engineer for UK'S Environment Agency and was formerly a PhD student at the Concrete Technology Unit, University of Dundee. Research interests include sustainable construction, recycled aggregates and re-use of materials.

Dr Kevin Paine is a Senior Lecturer in civil engineering at the BRE CICM at the University of Bath. He carries out research on low carbon and sustainable forms of concrete construction, with current focus on geopolymers, nanoparticles and the use of bacteria and mineral-precursors.

Martin Bjerregaard has more than 20 years experience in demolition and decommissioning to provide clients with pragmatic, cost effective and safe demolition works. He is currently Director of Disaster Waste Recovery Ltd and Director of D3 Consulting Ltd. Disaster Waste Recovery is a non-for-profit organisation supporting communities with waste and debris management following disasters and conflicts.

Keywords: Debris, Disasters, Recycled aggregate, Recycling, Sustainability

Presentation: Day 3 1140 – 1200 — Venue 4: 2G14

Rapidly Deployable System Including a CSA Gunite Material for the Structural Stabilization of Shock Damaged Structures

R B Jewell[1], T L Robl[1], P S Mills[2], M R Jones[3], A Ouzounidou[3]
1 – University of Kentucky, USA
2 – Minova USA Inc, USA
3 – University of Dundee, UK

The University of Kentucky Center for Applied Energy Research (CAER), Minova USA Inc. and the University of Dundee, Scotland, have collaborated on a project to develop a rapidly deployable system to stabilize shock-damaged structures to avoid catastrophic failure. The system comprises a dry-gunned or "gunite" apparatus that sprays a mixture of rapid-hardening cement, sand and water onto a damaged surface. The cement component is based on calcium sulfoaluminate (CSA), and is capable of achieving structural strengths within 15 to 30 minutes. The project research began with a performance comparison of commercially available CSA cements. After determining which cement exhibited the best performance, an extensive research program was initiated to quantify and optimize the effects of variables including water content, aggregate content and gradation, and ratio of cement to aggregate. The experimental results produced a sprayed concrete mix that exceeded expectations in performance between 15 minutes and 24 hours after spraying. Achieving structural strengths within 15 to 30 minutes allows first responders to enter into damaged buildings with less fear of a collapsing structure.

Robert B Jewell, Research Scientist for the Center for Applied Energy Research at the University of Kentucky, currently conducting research into the application of coal combustion by-products in the formulation low energy cement and concrete.

Dr. Thomas L Robl, Associate Director of the Center for Applied Energy Research at the University of Kentucky, currently conducting research into the application of coal combustion by-products in the formulation low energy cement and concrete.

Professor M Roderick Jones, Director of Concrete Technology Unit and Dean of Faculty of Engineering, Physics and Mathematics, University of Dundee. His research interests lie in durability of concrete, service life prediction. use of alternative cements and foamed concrete.

Peter S Mills, Technology Leader for Minova, brings 34 years of experience in the mining industry to Minova's technical team; and is responsible for managing the Technical Department and all research, development, and technical support involving chemical consumables at Minova USA. During his time at Minova, Peter has patented several products, including Tekpak® P, Eclipse Bolt and Tekflex®.

Anthoula Ouzounidou is a PhD student at the University of Dundee. Her research is concerned with the utilisation of CSA cements in sprayed concrete and their potential use in rapid stablisation suituations.

Keywords: Calcium sulfoaluminate, Gunite, Rapid stabilization, Shotcrete

Presentation: Day 3 1120 – 1140 — Venue 4: 2G14

Theme 6 — Renewable Energy

Laminated Concrete and Ferrocement for the Construction of Fixed, Floating or Submerged Structures to Support Renewable Energy Devices

M Pemberton, T Tucker
Trafalgar Marine Technology Ltd, UK

”If you put steel into the ocean - then better wrap it in a quality concrete otherwise the costs of maintaining the steel will disipate your revenue and severely effect your bottom line.” Systems are being developed to construct several types of marine structure by spray and laminating techniques together with the use of high strength self compacting concretes,to produce very high quality with high strength to weight ratio material which will compete with steel structures and offer the minimum maintenance benefits of concrete. The use of laminated concrete and ferrocement in thousands of yachts in the 1970s to 1980s Joint author Tony Tucker has considerable experience in design and build of ferrocement yachts and is a recognised surveyor of these vessels. Practical evidence of no water penetration or corrosion into these yachts. There is also the reference to ferrocement boatbuilding in China and the Journal of Ferrocement special issues dealing with the marine applications of ferrocement. There are references to the work of M.E Iorns and the Fibersteel Co. of California, in the 1960‘s explaining the development of laminated ferrocement for building yachts and pontoons. There is also reference to the testing of laminated ferrocement by the United States Coast Guard for approval to build a passenger vessel. The experience of ferrocement boat builders over years has clearly demonstrated that the material is waterproof. The nominal cover to ferrocement hulls build by the traditional methods of armature And hand plastering is 3-4 mm (1/8th Inch). Reference should also be made to the several papers by M.E.Iorns. Particular reference to the test boat made by the Fibersteel Company, Sacramento, California in 1964 where different wire mesh materials and the cement ‘cover‘ to those materials was practically tested. Quality of laminated ferrocement bringing in such aspects as the impermeability and strength of the gelcoat layer and the resulting resistance to corrosion of the meshes close to the surface. The spraying and laminating process, particularly with a white cement, has been demonstrated by the building of white yacht hulls and also by the Demenil Museum Project. The previous reference relating to the Demenil Museum Project clearly demonstrates the use of the spray and laminate process to produce precision manufacturing of ferrocement to the highest possible standards. By the laminating process, any amount of steel can be laminated into a particular cross-section to satisfy any strength requirement of the cross section.

Michael Pemberton, Master Mariner, holds Patents pending relating to laminated ferrocement and laminated concrete. He previously worked with the late Mr Martin Iorns of California and with many concrete specialists/academics to promote the application of this technology. He is a member of the Concrete Society, and a past member the Renewable Power Association Ocean Energy Group.

Tony Tucker is a Naval Architiect and Marine Surveyor with many years experience of design and survey of yachts and small commercial craft in all accepted boat building materials; Ferro-Cement, GRP, Steel, Aluminium Alloy, and Timber. Many of the vessels are cruising yachts which cruise the oceans of the world, others are more specialist small commercial vessels, fishing boats, and inland passenger boats.

Keywords: Ferrocement, Floating, Laminated concrete, Renewables, Submerged structure

Presentation: Day 3 1140 – 1200 — Venue 2: 3G05

Gravitas Offshore Concrete Foundations: The Enjoyable Puzzle

H Ridgeon
Arup, UK

The UK's major programme towards sustainable, resilient, low carbon energy generation is pushing forward the next stage of offshore renewables. These deeper water sites require a new reliable approach for offshore wind turbines. This paper shall present the findings of a two year research and development project to create the ultimate offshore concrete gravity base foundation for wind turbines. Gravitas Offshore (a consortium of Costain, Hochtief and Arup) has adopted knowledge learnt in the offshore oil industry to develop a durable and sustainable concrete foundation for offshore wind structures. This concrete foundation can be deployed in upcoming wind farms around the UK coast. The solution is self-buoyant, requires no specialist onshore or offshore marine equipment to construct, lift or install and requires minimal sea bed preparation. An advantage of concrete foundations over steel is the more flexible and larger local supply chain which can aid market capacity. During the development process much effort and thought has gone into engaging with the local supply chain and developing high performance concrete specifications. These specifications have been developed to deliver high strength, lightweight, low carbon concrete. The existing offshore codes have been reviewed and compared with regard to ultimate and service limit state design.

Henrietta is a structural and civil engineer with over 15 years' experience in designing and delivering projects. After graduating with a first class degree from the University of Edinburgh she joined Arup in 1996. Since then she has worked on many different types of projects including port facilities, canal systems, water treatment plants, drainage systems, infrastructure developments, roads systems, bridge structures and offshore foundations. Through her work she has developed an interest in creating large civil engineering products from the Personal Rapid Transport system at Heathrow through to the development of offshore gravity base foundations. Her skills lie in her ability to undertake technical developments, to programme projects, to manage budgets and to advise clients on their risk management strategy, thereby saving costs and increasing project certainty.

Henrietta has spent the last few years working as technical project manager for GRAVITAS Offshore Ltd. A company formed out of Arup, Hochtief and Costain. Together they have developed a concrete gravity base foundation product, designed to be floated and towed out to Round 3 Offshore wind farms and installed without specialist marine equipment. The concrete gravity base will be mass produced in a UK port and is developed to meet the needs of round 3 wind farm developers by reducing weather risks, increasing the supply chain certainty and helping to reduce the costs of offshore turbine foundations.

Keywords: Concrete, GFS, Gravitas, Whole life

Presentation: Day 3 1120 – 1140 — Venue 2: 3G05

State of Concrete Dams in North Russia

M Sadovich, T Shlyakhtina, A Kuritsyna
Bratsk State University, Russia

It is envisaged that the interest in investigation the state of long exploitation of concrete dams will continue to grow as they age. Authentic assessments of changes in the strength and the concrete structure, the characteristics of corrosion processes, the repercussions of frost affects, combined with water saturation, and others may be considered as part of a systematic monitoring of responsible concrete structures, which certainly include dams. Given that the largest Russian northern dams were built in the 60 - 70th years of the twentieth century, the duration of operation is to date 40 - 50 years. This period is sufficient to detect the repercussions of the exploitation environment on the condition of the concrete. In accordance with the classification of interactions in the system ”concrete - environment” identifies areas of dams in relation to which were executed complex studies of the concrete.

Mark Sadovich is a Professor and a Doctor of Science. Head of the Construction Technology Department of Bratsk State University. The scope of his scientific interests includes the technology of monolithic concrete, study of hydraulic concrete, diverse study in the field of construction materials, technology of cold-weather concrete placement.

Tatyana Shlyakhtina is a Candidate of Science. The scope of her scientific interests includes the corrosion of hydraulic concrete, study of hydraulic concrete, diverse study in the field of construction materials and etc.

Anna Kuritsyna is a Candidate of Science. The scope of her scientific interests includes the corrosion of hydraulic concrete, study of hydraulic concrete, diverse study in the field of construction materials and etc.

Keywords: Concrete, Corrosion, Crack, Dam, Filtration, Strength

Presentation: Day 3 1100 – 1120 — Venue 2: 3G05

Closing Paper

Concrete : Vade Mecum II

P C Hewlett
David Ball Group and University of Dundee, UK

This paper has been written in advance of the conference and presents outcomes taken from the papers submitted but as yet not presented. In that regard the opinions expressed and direction suggested may well change as a result of the conference itself. Key items have been drawn from each of the six themes. Overall it is clear we have to achieve “more from less” notwithstanding significant efficiencies that have been made in cement and concrete production and usage as well as buildings operational efficiencies if the consequences of increased cement and concrete use are to be addressed. Some suggestions on how that may be achieved are given.

P C Hewlett is a chartered chemist and scientist. He is Visiting Industrial Professor in the Division of Civil Engineering at the University of Dundee and is an active member of the Concrete Technology Unit. In addition he is Director of Research with the David Ball Group. He is a past President of the UK Concrete Society and current President of the UK Institute of Concrete Technology. He is Chairman of the Editorial Board of the Magazine of Concrete Research. Particular interests cover durability, performance, surface and bulk characteristics of concrete modified using chemical admixtures and additions.

Keywords: Efficiency, Innovation, Magnesia, Performance, Prognosis, Sequestering, Sustainability

Presentation: Closing Paper — Day 3

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SPONSORING ORGANISATIONS
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United Kingdom Quality Ash Association, UKQAA
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The UK Quality Ash Association (UKQAA) is a trade association representing the producers and users of UK coal fired power station ash products. There are two main types of ash produced in the UK coal fired power stations - furnace bottom ash (FBA) and pulverised fuel ash (PFA) - also known as fly ash in come applications and countries. We promote members interests of an environmental, scientific, technical and educational nature associated with all applications. This is achieved by sponsoring research, promoting the range of applications for fly ash products, representation on European and UK standardisation committees, exhibitions, lunchtime presentations etc.

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Dundee & Angus Convention Bureau are proud to support the 8th International Conference: Concrete in the Low Carbon Era 2012 and would like to offer a warm welcome to all delegates to Dundee & Angus. Dundee & Angus Convention Bureau supports conferences of all sizes and offers a range of FREE services, whether you are at the bid stage or just starting the planning process.
Visit our website for more information about what there is to see and do in the area, travel information or find out more about latest offers in our Delegate Passport: www.conventiondundeeandangus.co.uk/delegates.cfm

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The Economic Development Division works towards the goals of building a strong and sustainable city economy and improving employment outcomes for the people of Dundee. The Division devises and implements strategies aimed at increasing the number of investment and employment opportunities in Dundee and enhancing the city's role as a key player in the Scottish economy, with strengths in sectors such as digital media, financial services, life sciences, retail, contact centres, and business tourism. Support is provided to new and existing businesses through the Business Gateway network and the E-Zone Project. Support for people looking to find employment is provided via Discover Opportunities.

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As the world's leading chemical company "The Chemical Company" BASF's commitment to sustainability is absolute. With diminishing mineral and finite cement resources, BASF's Glenium and X-SEED admixtures deliver sustainable concrete and it's just one example of our knowledge in action. We use our know-how, which is unique in the chemical industry in the fields of energy, product stewardship, health, safety and environment, to help the construction industry deliver a more sustainable future.

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Carbon War Room focuses on the market barriers that reinforce the status quo and prevent capital from flowing to sustainable solutions with compelling returns. Often, strong policy is a necessary but insufficient condition, and technology is not the bottleneck: Capital has to flow to solutions in a well-functioning market-place. Our vision is a world where over $1trillion invested in climate change solutions is an annual occurrence, not a historic milestone (Bloomberg New Energy Finance). In this world, market barriers will not exist in any sector where profitable carbon reduction solutions exist; and entrepreneurs who are passionate about preserving our planet's resources are simultaneously tapping in to the economic opportunity of our generation. There is no Planet B.

Elkem Silicon Materials
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Elkem Silicon Materials are the world's largest supplier of microsilica to the concrete industry. Elkem Microsilica is used in most major projects, for higher strength and significantly increased durability. Elkem Microsilica can be incorporated into all forms of concrete applications - readymix, precast, shotcrete, pumping, self-compacting, as well as being used in speciality grouts and mortars. Projects range from airports to waste transfer stations, nuclear power to bridges, tunnels to the world's tallest buildings.

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Scottish Precast Manufacturers Group was formed in April 2012 by British Precast to bring together all precast concrete product producers and their supply chain with interests in Scotland.

University of Kentucky, Center for Applied Energy Research
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The Center for Applied Energy Research (CAER) is one of the University of Kentucky's multidisciplinary research centers. Its energy research includes work on: coal, coal combustion by-products, carbon management, coal liquefaction, and renewable including algae for emissions control, and electrochemistry. CAER has a stand-alone pozzolan laboratory with capabilities to address most areas of cement and concrete quality. Facilities are available to address quality issues such as air entrainment, workability, flow, strength time of set, consistency, density and fineness. Aggregate testing capabilities include gradation, density, staining and absorption as well as 8" test block production. With these capabilities as well as the extensive analytical capabilities available at CAER, detailed evaluations can be made on cement, mortar, admixtures, concrete and concrete products at a variety of scales. By far, the majority of the beneficial uses for CCBs are related to cement, concrete and concrete products. Not surprisingly, changes in ash chemistry can have a pronounced effect on cement and concrete quality. In order to improve the fundamental understanding of the role of CCBs for these uses, CAER has developed an intensive research program focused on CCB chemistry and end-use quality considerations.

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Laser diffraction
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Particle counter technique

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