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CONCRETE SOCIETY
OF SOUTHERN AFRICA

CONCRETEBETON

GFIP: Package E

New applications for UHPFRC

Assessment of concrete with pulverised copper slag – part two

SUBWAY (C LINE), ROME, ITALY
General Contractor: METRO C Scpa, Rome Italy – Client: Rome Metropolitan s.r.l.

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COVER: The Gauteng Freeway Improvement Project – Package E1 was awarded a judges commendation in the Fulton Awards in the Sustainable Concrete category. The concrete quality and strength were recognised by the joint venture team as being of paramount importance given the durability requirements for the several bridge and ramp structures and the tunnel on this project. The team opted for a 60 MPa concrete for the permanent structures and tight control was undertaken on the quality of the concrete The testing regime included several key durability tests.

Editor's comment

Enjoy our first edition of Concrete Beton for 2015. It's going to be another tough year for everyone and not least for voluntary associations such as the Concrete Society, as we strive to remain relevant and viable in a very competitive industry. Like more than two-thirds* of all professional industry bodies, we are reliant to a large extent on members contributing to our success through voluntary work and support.

Our volunteers embark on a wide range of activities which not only provide a meaningful service to our members on a regional (branch) basis, but also enables judicious use of our limited funds.

These activities include, but are not limited to:

- Serving as Officer Bearers (President, Vice-President and Immediate Past President)
- Serving on the Board of Directors
- Chairing and serving on Branch committees
- Performing CPD accreditation functions
- Organising member events in the regions
- Promoting membership

The work of the CSSA is not, and cannot, be the volunteer's first priority. Yet we generally get the work done. But all this work and effort is meaningless unless members actively take advantage of the value proposition that we offer.

Merely joining the Society is not going to provide a member with value for money and if all he/she sees is a quarterly journal (when the postal service is working of course), then dissatisfaction will quickly set in and the perception will be that membership is a total waste of money.

The same applies to Company membership. Although the same benefits accrue to the companies' nominated members as to the individual member, the additional benefits to the company itself in terms of exposure in the marketplace, and the use of the Society logo, is immeasurable.

So I urge all members to become actively involved in the activities of the Society, even if it is only to attend more of the local events that are organised for your benefit, and expand your professional network. This can only result in a win : win situation for all…

…and to our volunteers – I salute you all! Your contribution to the success of the Concrete Society is immeasurable, and I thank you all for your dedication and commitment.

John Sheath
Editor

** As reported by a recent survey by The Centre for Association, Research & Intelligence (CARISA)*

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To be the most relevant forum for those who have an interest in concrete.

OUR MISSION
To promote excellence and innovation in the use of concrete and to provide a forum for networking and for sharing knowledge and information on concrete-related matters.

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Physical: Suite 301, The Hillside, 318 The Hillside Street, Lynnwood, 0081.

Postal: P O Box 75364, Lynnwood Ridge, 0040

Tel: +27 12 348 5305

E-mail: admin@concretesociety.co.za

Web: www.concretesociety.co.za

President's message

What a year 2014 has been for the Concrete Society as a whole and specifically for this publication being the inaugural year of the in-house publication. It has been a resounding success, far exceeding our expectations. The year 2015 is going to be a busy but exciting, with the prestigious Fulton Awards on the horizon.

This year kicked off with our first national roadshow seminar of the year, RepSem 2015, bringing together local and international industry experts (contractors, specifiers, engineers, researchers and material suppliers) to present on the critical topic of concrete repair and protection. The seminar was designed to cover and broaden the understanding of industry players on the causes of concrete deterioration, selection/design of appropriate repair methods and techniques, practical aspects of concrete repair and the latest advances in concrete repair and rehabilitation. Judging by the high turnout for this event, the topic was evidently very topical and relevant

Of course, the highlight of this year's calendar has to be the upcoming prestigious 2015 Fulton Awards weekend, that will be taking place at the Champagne Sports Resort in the Drakensberg from the 5th – 7th June. The Judging process is well underway and looking at the project entries, it is going to be yet another great event in industry calendar, showcasing the best projects in the country and the region. We have some very 'different' projects this year with the introduction of a new category - 'Innovation in Concrete'. The celebratory weekend is an event not to be missed, so be on the lookout for further details, as bookings open at the end of March..

It has now been a year since the in-house publication of the Concrete Beton commenced and we can safely say it has been very successful and continues to grow. I would like to take this opportunity to thank the Editor, his team and all contributors to this publication for their generosity and tireless efforts in consistently putting out such a high standard journal.

We are well into to the New Year now and there are still several of our members who have either not renewed their membership, or paid their membership fee. This has a serious effect on the Concrete Society's cash flow, being such a small organisation, and I urge all those that have not yet settled, to please do so straight away.

Finally, I would like to extend my gratitude and appreciation to our CEO John Sheath and the HO staff Natasja and Marike for their hard work and effort in the past year ensuring that every activity and event of the CSSA runs smoothly. Thank you to the Board for their guidance throughout the year.

Enjoy the read and God Bless!!

Yours Sincerely
Tseli Maliehe
President – Concrete Society of Southern Africa

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Gauteng Freeway Improvement Project: Package E

Gauteng, the economic heartland of South Africa, generates nearly 38% of the total value of South Africa's economic activities. As a result, development in residential, commercial, retail and industrial properties has grown significantly over the past decades, resulting in above average traffic growth. By the turn of the century it was evident that provision of road infrastructure had not kept up with the increased traffic demand, resulting in a road and freeway network that was over capacity.

The launch of the Gauteng Freeway Improvement Project (GFIP) signalled an exciting multi-billion commitment to upgrade and develop more than 500 kilometres of freeway within the province.

Involving various spheres of government in joint venture, including the Gauteng Province and the Ekurhuleni, Tshwane and Johannesburg Metros, under the guidance of the South African Roads Agency (SANRAL), the project was geared to provide an effective transport network.

Its aims included the promotion of social development, a reduction in the cost of doing business and sustainable economic growth. It was also designed to greatly improve accessibility to Gauteng's roads, while managing and reducing congestion issues.

The first phase, comprising the upgrade of 185km of the most congested freeways in the region, was divided into total of 15 work packages.

Package E

Package E comprised the substantial upgrade to three interchanges, upgrading two busy intersections, widening the highway to five lanes and the construction of three bridges using the incremental launching method, a 70 m long new bridge over the Natalspruit River at N12/N17 intersection and a cut and cover tunnel. The longest of the incrementally launched bridges was a 420 m long switch ramp. The incremental launching method has been successfully used by Group Five on long spanned bridges and in this case minimised traffic interruptions on the adjacent freeways. The new bridge was constructed using a conventional precast concrete I-beam construction method.

Structural Systems Africa, which is 50% owned by Group Five, supplied the launching equipment, including the launching girder which was manufacturing by Group Five Steel.

SANRAL's requirement was that all structures should be functional, yet aesthetically pleasing. In view of this, particular attention was paid by the consulting engineers to the design and by Group Five and the Siyavaya Joint Venture to produce fine quality off-shutter concrete throughout the project.

- Package E1 comprised a 12km section of the N3 to the southeast of Gauteng, between the Old Barn (Heidelberg) and Geldenhuys (M2) Interchanges and included widening the N3 on both sides and upgrading the Elands interchange, including the construction of the switch ramp connecting the N3 to the N12.
- Package E2 comprised a 4km section of the N12 between the Reading (R59) and Elands (N3) Interchanges. This section included the construction of two bridges over the N17 and Natalspruit River and another comprising a cut and cover tunnel at the Reading Interchange.

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The entire project involved the construction of 37 concrete structures which, as well as the above, included moving a 2,2 m diameter Rand Water pipeline to accommodate the new ramp at the Elands Interchange and the construction of two new loops at Grey Avenue, Alberton, to eliminate a right-turn against oncoming traffic.

Whilst the majority of the freeways in the GFIP were widened along the median, the entire length of Package E was also widened along the outside lanes, resulting in major earthworks either side of the busy freeways.

One of the major challenges was the safety of the public and workforce whose protection was a priority. Traffic accommodation was planned to the last detail and supported by the Metro police, whilst the site personnel were trained to comply with strict safety regulations.

CONSTRUCTION OF THE BRIDGES

Reading Interchange

The bridge at the Reading Interchange comprises an aesthetically designed and constructed cut and cover tunnel approximately 345 m long, divided into two sections measuring 162 m and 63 m respectively, and separated by an opening of approximately 38 m. The tunnel, which diverts traffic from the R59 north directly onto the N12, passes under the widened section of the R59 south. To counter the poor soil conditions the structure is founded on heavily reinforced concrete foundations up to 16,5 m deep.

Due to the extreme contours of the site, the tunnel is on a sharp horizontal and vertical curve. To accommodate the curves, the tunnel was constructed in 10 m straight segments using a movable shutter system. Moving along the base of the tunnel, the foundation of the shutter was forced to contort slightly to follow the vertical profile of the road taking the super elevation into account, thereby creating the symmetry required for the tunnel. Each joint was sealed with a waterproof bandage, while expansion joints were installed at every third joint.

The portal faces, which slope back at a gentle angle, are completed with precast concrete tiles, each one specifically designed and cast to fit the curve of the portal.

Widening the existing bridges at the Reading interchange by a lane's width of 2,6 m was done in sections to reduce lane blockages caused by the scaffolding.

Elands Interchange switch ramp

Of the three launched bridges the switch ramp, connecting the Elands Interchange over the N12 from the N3 East onto the N12 North, was the most challenging. Its purpose was the elimination of what had previously been a potentially dangerous transection between traffic from the N3 and N12 joining the M2 systems interchange.

The bridge comprises a nine-span single cell, internally post-tensioned, 3,5 m deep concrete hollow box girder, located on a 378 m radius horizontal curve and constant longitudinal grade of approximately 0,37% falling from north to south. The final span lengths varied from 29 m (span 1) to 70 m (span 7). Two temporary piers were used to reduce the maximum launching span to 45 m. The deck was launched on an uphill gradient in a southerly direction with the casting yard constructed on the high fill behind the north abutment. The bridge deck was supported on structural pot bearings on reinforced concrete spill-through abutments and coffin shaped solid piers with enlarged tapered heads, all aligned square to the bridge centre line.

Diaphragms at the abutments and anchor blocks and anchor blisters for the final post-tensioned tendons were cast monolithically with the box girder and diaphragms over the piers after completion of the final launch.

Longitudinal fixity was provided at the central piers four and five and the multi-seal modular deck expansion joints were installed at the abutments. Access to the inside of the box girder deck and the abutment expansion joints was via openings provided in the deck bottom slab and pier diaphragms.

Parapets are the standard SANRAL F-shaped, one metre high Type 2 precast parapet with matching cast in-situ end blocks. Due to the very small longitudinal grade, storm water is drained via 100 mm diameter scuppers placed at close centres to spread the discharge evenly between under-passing roadways.

Piers and abutments were founded on spread footings except for Pier 6 and the temporary launching Pier T2 which were piled using 1200 mm diameter vertical, temporarily-cased oscillator bored piles. Spread footings were founded on soft to medium hard rock sandstone in the south and medium hard to hard rock quartzite in the north. Erosion protection on the spill-through portion of the approach embankments comprises grouted stone pitching.

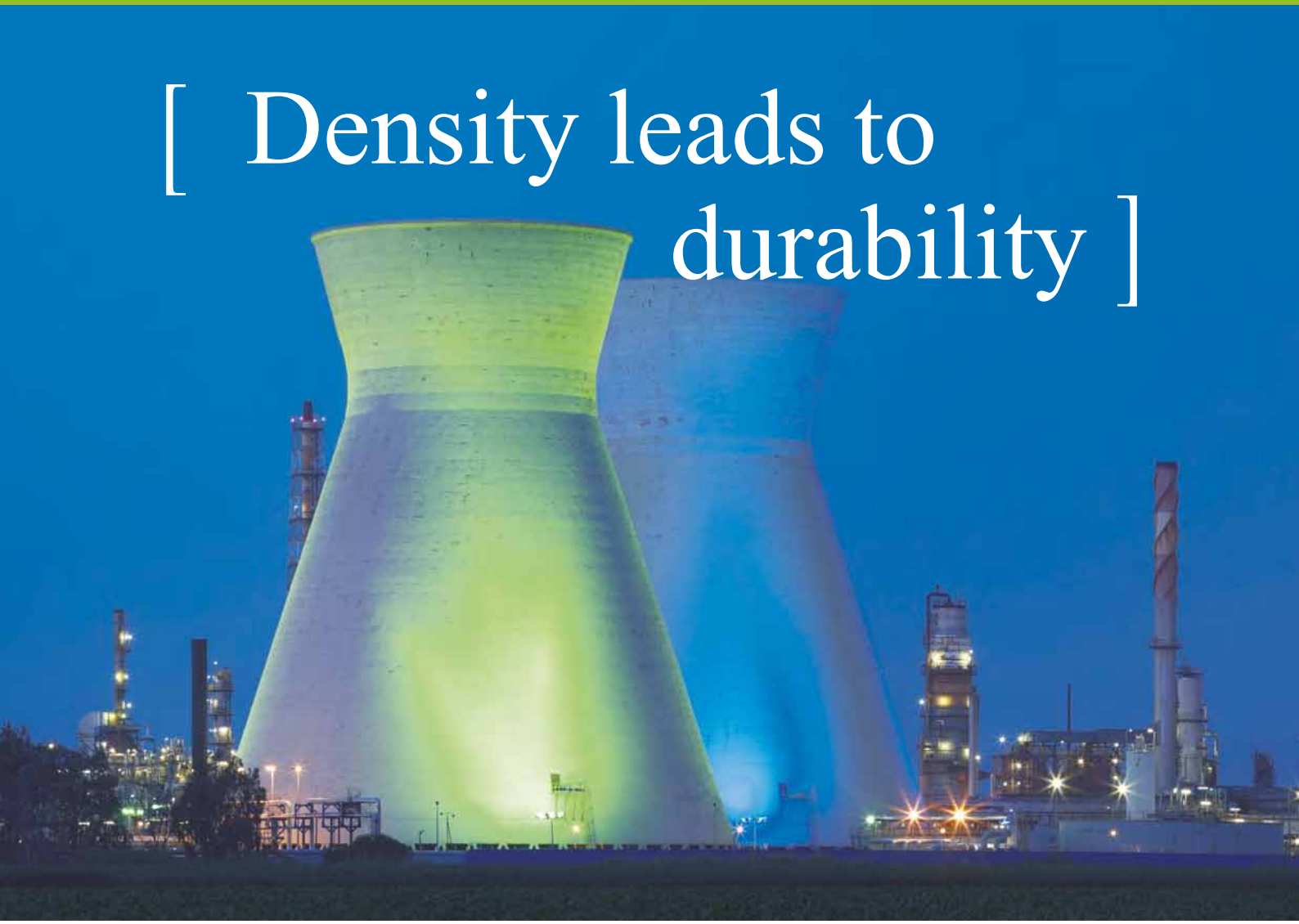
Launching Equipment

The launching equipment comprised two Eberspächer jacks, each capable of exerting 250 tons of pressure horizontally with strokes of 250 mm, as well as a lifting capability of 500t each.

The deck segment was lifted vertically a few millimetres off the brake saddles at the abutment by the jacks and then moved forward 250 mm at a time, lowered at the end of the stroke, the jacks retracted, the deck lifted again and the pushing sequence repeated. Four gripper plates each 250 mm X 300 mm, i.e. a total gripping surface of 500 mm x 600 mm at each jack provide the necessary friction for forward movement. Launching thrusts were absorbed by a sacrificial temporary pier constructed a short distance behind the abutment and tied to it by concrete beams. The launching sequence for a 25 m section averaged five hours to complete. At the final launch it was estimated that the total mass of the structure to be moved exceeded 9 400 tons. The entire bridge comprises 5 550 m³ of concrete and 560 tons of steel. Total post-tensioned stress was approximately 640 MN.

Special sliding pads were used at the temporary bearings to reduce friction between the deck and the bearing and ease the forward movement. Sliding plates were fed in from behind by hand as the deck moved forward, caught at the front and re-circulated to the back, re-oiled and reused. Side guides at the piers provided directional guidance also making use of sliding plates. Temporary bearings were positioned directly under the webs. Permanent bearings were positioned under the launched section of the bottom deck. In addition to survey control,

[Density leads to durability]



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Launching the switch ramp onto coffin-shaped piers

DESIGN PARAMETERS
Quality of Materials

Concrete

Mass concrete	Class 15/38	
Concrete	Class 15/19	
Piles	Class 30/19	8GPa
Spread footings and pile caps	Class W30/19	28GPa
Piers and pier heads	Class W30/19	28GPa
Abutment earwings and approach slabs	Class W30/19	28GPa
Bearing plinths	Class W40/13	34GPa
Deck	Class W40/19	34GPa
Concrete channelling & EJ nosings	Class W40/13	34GPa
Precast parapets	Class W40/13	34GPa
End blocks	Class W40/19	34GPa

Reinforcement (to SABS 920)

Hot rolled mild steel rounds	250 MPa }	
Hot rolled deformed high yield stress steel	450 MPa }	200GPa
High tensile welded mesh steel fabric	460 MPa }	

Founding material

- Medium to very hard rock comprising mainly quartzite on the northern end and sandstone at the southern end
- Safe net bearing capacity for spread footings 1500 kPa
- Piles socketed into medium to hard rock quartzite bedrock

Backfill material behind abutments

- Granular material with low silt/clay content
- Internal angle of friction – °≥ 30°

PROJECT TEAM

Client – South African National Roads Agency Ltd.
Principal Agent – Switchramp: KAS jv. Tunnel: UWP/Nyeleti jv
Main Contractor – Group Five Civil Engineering as Lead contractor for Siyavaya jv
Other Contractor – Afrimix

piano wire with limited movement switched automatically cut out forward movement if the perpendicular angle of any pier exceeded the allowable tolerance owing to forces exerted during a launch. The high strength of the concrete used in the deck resulted in only very minor marks with no damage of any nature.

Concrete Quality

Working to tight time lines, the concrete quality and strength was of paramount importance. Also given the durability difficulties experienced in the past with Reef Quartzite aggregate in concrete mixes, careful attention had to be given to this aspect.

The Siyavaya Joint Venture contracted with Afrimix to design and supply suitable concrete. The specification for the permanent structure called for 40 MPa at 28 days, W-type concrete, but this would not have suited the production schedule and the joint venture team opted for a 60 MPa mix.

A 19 mm dolomitic aggregate was used as coarse aggregate, with granite as an acceptable alternative. Afrimix obtained its aggregates from Zimbiwa Quarry in the south of Boksburg and cement from PPC's Jupiter factory. Admixtures were Chryso Optima 100 (water reducer) and Optima P206 (superplasticiser) to reduce water content and improve workability in order to provide the required 35 MPa compressive strength at the time of stressing.

Process and quality control was undertaken by MatroLab. The tests included compressive strength testing as well as flexural strength beam testing. The minimum flexural strength specified was 6 MPa. In addition, durability tests such as determining the Oxygen Permeability Index (OPI) and water sorbtivity were carried out, although the latter had not been specified. The minimum strengths called for mortar for grouting up cable ducts, were 20 MPa at 7 days and 30 MPa at 28 days.

N12 Spanning the N17

Two bridges widening either side of the N12 over the N17 and Natalspruit river were constructed independently and adjacent to the existing outside lanes. The bridges are 150 m long by 12.5 m wide. Through the use of the incremental launch method traffic interruptions on the N17 were minimised during construction. The piers were aesthetically designed and constructed with off-shutter concrete .

Design of the Piers

Complying with SANRAL's requirements for functionality combined with aesthetics, the piers were designed by the KAS Joint Venture. The client was presented with three designs and selected a Y shaped monolith with squared corners.

The original design, for which a 3D model was produced by Group Five, featured rounded corners, until it was noted that this design would not provide a secure surface on which to land the launching girder. The V-shape that forms the Y was also a modification to the original design. The elegant and timeless structures are a testament to the exceptional properties of concrete.

SAFETY

One of the most demanding challenges on the contract was to keep the daily average of 45 000 vehicles moving at all times.

Interior of completed cut and cover tunnel

Traffic accommodation was planned with military precision by three Siyavaya traffic safety teams who worked in partnership with the Metro Police 24 hours a day.

Blasting in this rocky area was carefully planned to take place every three days. Ten squad cars were on hand to control the traffic during blasting. A condition of the contract was that road closures were strictly limited to no more than 15 minutes putting the team under extreme pressure to do the blast and clear the debris all within this 15 minute window.

During the course of the project, over two million LTI-free hours were achieved with a work force of more than 1 000 subcontractors at peak.

TRAINING

The workforce was provided with training in first aid, fire fighting, traffic control flagmen, small plant operation, small concrete works, scaffold erection and basic finance. Regular HIV workshops were also conducted.

ENVIRONMENT

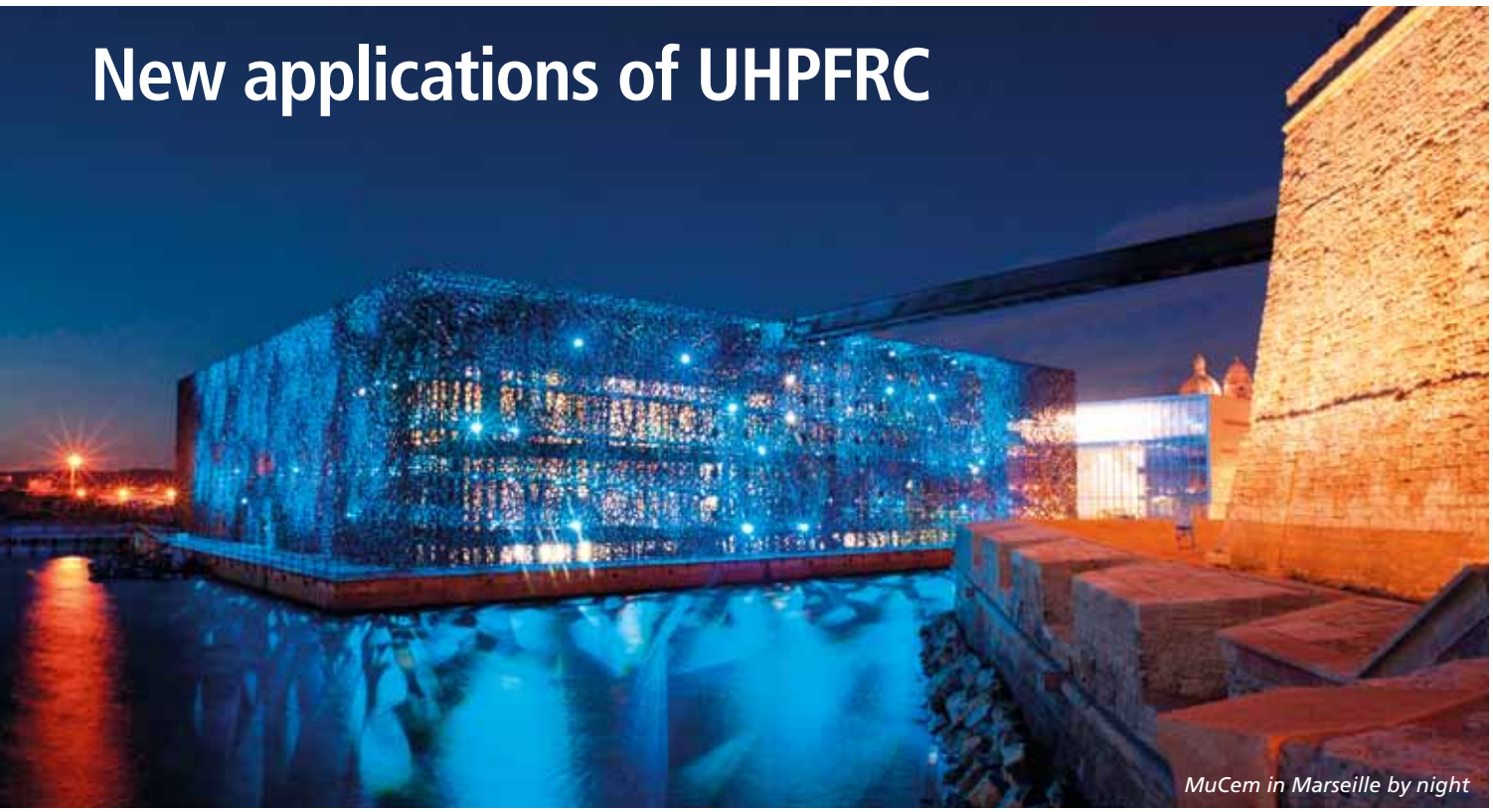
A full time environmentalist was employed and based on the site to ensure that the strict environmental controls were adhered to and that areas adjacent to the site were restored to their original state and the Natalspruit River was not polluted in any way.

Saving the Verreaux Eagles

When the Urban Raptor Conservation Project notified the Siyavaya joint venture of the plight of a pair of Verreaux eagles whose nest on an Eskom pylon adjacent to the site had been destroyed by some unscrupulous vandals, the team took immediate action by sponsoring an artificial nesting platform (ANP) on a farm across the N12 from the pylons.

The contractors, consultants and their suppliers all contributed to the 18 m high steel ANP mast which is topped with a platform onto which an expert 'nest builder' re-constructed a nest using materials salvaged from the original nest. Five days after the erection the eagles moved in and it was not many months later that they were breeding successfully. ▲

New applications of UHPFRC



MuCem in Marseille by night

Ultra-high-performance fibre-reinforced concrete (UHPFRC) – concrete with a high degree of ductility combined with a compressive strength of 150MPa or higher – was first developed in Denmark more than 25 years ago[1], as Bache developed compact reinforced composite (CRC) in 1986. Since then a number of other types of UHPFRC have been developed such as Ductal (Lafarge), BCV (Vicat) and BSI/Ceracem (Eiffage and Sika), but it is only in the past ten to 15 years that interest in these materials has really intensified.

Bendt Aarup, Hi-Con, Hjallerup, Denmark

Large UHPFRC research programmes have been initiated around the world and some of the results have been presented at a series of conferences in Kassel (2004, 2008 and 2012) and Marseille (2009 and 2013). At the same time, architects and engineers have started to design projects specifically with UHPFRC in mind[2] and the guidelines that are available for using UHPFRC are becoming more advanced[3]. UHPFRC has some limitations – often related to cost – which means that often steel, conventional concrete or other materials will be the preferred solution for a particular project. But there will still be a significant number of structural elements that can benefit from being produced in UHPFRC if there are special restrictions with regard to durability, weight, fire resistance, shape or other requirements that cannot easily or inexpensively be met with traditional materials.

New options can be opened up for designers, as UHPFRC – which to a certain extent combines the strength and ductility of steel with the formability and durability of concrete – will in some cases provide cost-effective alternatives and present new possibilities. UHPFRC will be a niche product for the foreseeable future, but as design models improve so that the materials can be used more effectively, we will see more and more applications.

Recent examples of new applications have been for façade elements, e.g. MuCem in Marseille and the Jean Bouin stadium in Paris[2], the 'Louis Vuitton Foundation for Creation' also in Paris, and projects in the Middle East, such as the proposed Louvre Abu Dhabi and the Qatar National Museum, which is currently under construction. A picture from the MuCem – a project designed by Agence Rudy Ricciotti – is shown above. In Denmark, architect CF Møller has designed a façade for a new university building in Odense – a project that was featured in the January 2011 issue of Concrete[4]. This façade will be produced in CRC by Hi-Con – a precast producer from Denmark. The first 150 façade elements have been produced and installation will start in April 2014.

Façade elements in place at the university building in Odense

PROPERTIES

UHPFRC is generally characterised by having high compressive strength, low permeability, a large ductility and typically a bending strength higher than 25 MPa. This is achieved by having a high binder content (900–1500kg/m^3), often with a large content of silica fume and glass powder, and a matrix where the largest grains are often smaller than 0.25mm. As the water/powder ratio is typically below 0.2, it is necessary to use highly effective superplasticisers, in order to ensure the necessary ductility for structural applications. Fibres (most often steel fibres) are used in quantities between 100 and 300kg/m^3.

Conventional mixing and placing equipment can be used, but as the water content is very low it is necessary to use long mixing times to achieve a homogeneous mix. As many of the UHPFRCs are used with a combination of fibres and pre-stressing, curing is often at high temperatures, which enhances the mechanical properties and ensures that most of the shrinkage has occurred before pre-stressing.

CRC is a typical UHPFRC with a compressive strength in the range 150–400MPa depending on the choice of aggregates and curing. The matrix has a large content of silica fume and water/binder ratios of typically 0.16–0.18. For most applications, local quartz sand and curing at ambient temperatures is used, giving a compressive strength around 150 MPa. With sand up to 4 mm, the binder content in CRC can be reduced compared to UHPFRC with only very fine sand, which gives a more economical mix and lower shrinkage.

Applications since 1994

One of the early applications for UHPFRC has been in pedestrian bridges, where the first of these – a small bridge in Sherbrooke, Canada – was produced in Ductal in 1997. Over the years a number of very impressive pedestrian bridges have been produced in UHPFRC and a list showing examples of applications has been included in the new AFGC guidelines[3]. For pedestrian bridges, live load is a relatively small part of the total load, so for these types of applications there is a huge advantage in making the slim and light structures that are possible with UHPFRC.

The first applications of compact reinforced composite (CRC) were as early as 1994, where a total of 43,000 drain covers were produced for the Great Belt Link in Denmark. Also, UK producers have experience with CRC, as Tarmac Precast and Ebor Concrete have both produced lining blocks for the Boulby mine in Scotland[5]. The focus for CRC has been a little different from the other UHPFRCs, as the most popular applications have been for relatively small products such as staircases and balconies, which are not included in the primary structural system, but can be used in large numbers on each project.

When Hi-Con started production in 2001, only a few staircases and balconies were produced each week but by 2003 the annual production was already at 2500 tonnes of structural elements in CRC. Since 2004 a total of 50,000 tonnes of elements – mostly staircases and balconies – have been produced in CRC. The bulk of the production has been for the Danish market, but Hi-Con has also produced elements for Sweden, Norway, Finland, Holland and England.

The CRC matrix is self-compacting but with the high fibre content (typically from 120 to 230kg/m^3) and the high viscosity of the matrix needed to ensure good fibre distribution, CRC is best suited for precast production, where vibration can be applied to improve compaction. However, in a special formulation called CRC JointCast, an in-situ concrete with up to 6% by volume of fibres (470kg of fibres per m^3) is also used – for joints between elements made in conventional concrete.

An example of a typical joint – that will have the same capacity as if the beam were continuous – is shown overleaf[6]. This product was first used in applications in 1995 and it has been tested extensively by BRE in a couple of projects[7]. Abbey Pynford has used it for a number of repair projects in the UK over the past three to four years. A version produced

Façade element produced in light CRC at Hi-Con

Joint between two concrete beams with 80 mm lap between 12 mm diameter bars

by Lafarge – called Ductal JointFill – has been very successful in North America, where more than 30 bridges have been renovated in the past few years using this jointing system[8].

Design

While most UHPFRCs are designed according to the AFGC guidelines[3], another approach has been taken with CRC design. CRC will typically combine fibre reinforcement with conventional reinforcement, and the design is basically done according to the Eurocode – but with a number of deviations.

These include allowing for a higher compressive strength and a cover to the reinforcement of 10–15 mm even in an aggressive environment, which is made possible by the large fibre content. The tensile strength of the matrix is not taken into account in the ultimate limit state design, as the fibres are used as secondary reinforcement to ensure ductility, control cracking and allow a very short anchorage length.

It has been necessary to provide extensive documentation on the properties of CRC before the material could be considered for structural applications and the material has been the subject of a number of research projects, including testing carried out at Leeds University, BRE and Imperial College.

For recent projects in the UK – which have included staircases at Sidney Stringer Academy in Coventry, with Kier as contractor and Sheppard Robson as architect and at Hotel la Tour in Birmingham, with Galliford Try and pHp Architects – Hi-Con has been responsible for the design of the staircases, while WSP has been the responsible consulting engineer on both projects overall.

Future developments

Different formulations for UHPFRC are being tested at universities around the world, but most of the mix designs that come out are very similar to the casual observer. However, as design methods are improved, there are large possibilities for finding new applications, where UHPFRC can provide significant benefits.

Hi-Con is currently involved in a number of research projects, which include looking at precast elements for wind turbine towers, elements for wave energy converters (and offshore applications in general) and columns and slabs that can survive explosive or projectile impacts.

There is certainly a huge potential, and with the new focus on UHPFRC, where projects are now being carried out all over the world in a number of different fields, more and more people will be aware of UHPFRC applications and acquire some knowledge of the strengths and weaknesses of these materials. This also means that more and more people will be getting ideas for new applications and improvements on existing products. ▲

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Assessment of concrete with pulverized copper slag as partial replacement of cement – part two

D M Boakye, H C Uzoegbo
Department of Civil and Environmental Engineering, University of the Witwatersrand

ABSTRACT

This paper presents results of an experimental research project into the effect of using pulverised copper slag (CS) as partial replacement for ordinary Portland cement (OPC). Cement was replaced in the following proportions; 2.5, 5, 10 and 15% compared to the control (0%) specimen. Tests performed included X-ray diffraction (XRD) and X-ray Fluorescence (XRF) respectively, for mineralogical and chemical oxide composition. The compressive and flexural strength developments of samples concrete were determined for up to 90 days of water curing. Oxygen permeability, water sorptivity and chloride conductivity test were performed to assess the long term durability performances.

In assessment of the hydraulic properties of slags, the hydraulic activity index of the copper slag was found to be approximately 0.5, less than the requirement for usage as constituent for cement as per SANS 55167-1:2011. The results of the strengths tests of the concrete cubes and beams showed a reduction in strength with increasing copper slag content. However, there was observed an improvement in the durability properties of the concrete samples with increase in copper slag content.

Keywords: Pozzolan, hydraulic index, compressive strength, oxygen permeability, water sorptivity, chloride conductivity index

3.0 RESULTS AND DISCUSSIONS

3.1 Mineralogical Composition of Copper Slag

The X-ray diffraction (XRD) results in Figure 3.1 shows that, the mineralogical composition of CS are quartz-(SiO_2) and augite-Ca(Mg, Fe)Si_2O_6 similar to CS used in literature which contains fayalite, magnetite and quartz Gorai et al., (2002). The glass content of the CS is approximately 99.3%, similar to Ground Granulated Blast Furnace Slag (GGBS) glass content between 85 and 90% Saddique et al., (2011). The glassy nature of a slag is responsible for its cementitious properties, with a linear relation to the late compressive strength development of concrete (Smolczyk, 1980). However, slag with completely vitreous glass may lead to strength reduction (Frigione, 1986).

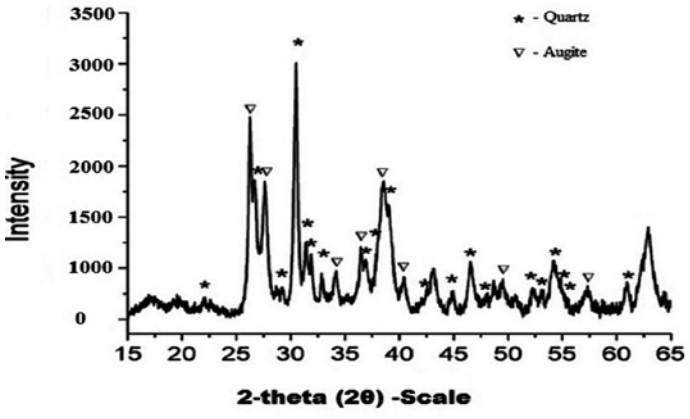

Figure 3.1: Mineralogy Composition of Copper Slag

3.2 Chemical Composition of Copper Slag

The chemical composition of the 52.5 N CEM I, procured from PPC Ltd and CS are presented in Table 3.1. It can be seen from Table 3.1 that, the calcium oxide (CaO) contribute to nearly 63% of the chemical composition of the Portland cement, whereas CS has a very low lime content of approximately 12%. This indicates that CS is not chemically a very reactive material to be used as a cementitious material since sufficient quantity of lime must be available in order to reach the required rate of hydration and to achieve the required early-age strength. On the other hand, CS has high concentrations of SiO_2 and Fe_2O_3 compared with OPC.

Table 3.1: Chemical Composition of Portland cement and Copper Slag

Components	PC%	CS%
SiO_2	19.85	38.31
Al_2O_3	4.78	7.28
Fe_2O_3	2.38	25.91
CaO	63.06	12.31
MgO	2.32	6.41
K_2O	0.94	1.08
Na_2O	0.22	0.91
TiO_2	0.25	0.61
Mn_2O_3	0.05	0.14
P_2O_5	0.26	0.20
SrO	0.3	0.02
ZnO	-	0.36
SO_3	2.48	0.42
Loss on Ignition (LOI)	2.83	2.38
$SiO_2 + Al_2O_3 + Fe_2O_3$	27.01	71.5
$(CaO + MgO)/SiO_2$	3.29	0.49

3.3 Pozzolanic Characterisation

In comparison with the chemical composition of natural pozzolans in accordance to ASTM C618-99, the summation of the three oxides (silica, alumina and iron oxide) in CS is nearly 72%, which exceeds the 70% percentile requirement for Class F fly ash and pozzolans. Therefore, the CS used is expected to have good potential to produce high quality pozzolans. Moreover, the CS has an LOI of 2.38% which falls below the maximum value of 6.0%, as per ASTM C618-99, therefore can be categorized as a Class F fly ash.

In the assessment of hydraulic properties of slag as per SANS 55167-1:2011, the slag chemical composition should consist of at least two-thirds by mass the sum of calcium oxide (CaO), magnesium oxide (MgO) and silicon dioxide (SiO_2). The remainder shall be aluminium oxide (Al_2O_3), together with small amounts of other compounds. The most popular related formulae used to indicate the hydraulic value of a slag according to SANS 55167-1:2011 is shown in equation 3.1 below.

$$\text{Hydraulic value} = \frac{CaO + MgO}{SiO_2} \qquad (3.1)$$

The result for CS is approximately 0.5, which is less than 1, the recommended requirement to be used as constituent for cement as per SANS 55167-1:2011.

3.4 Results of the Fineness Test

The minimum Blaine air surface area requirement respectively for slags and cement in accordance to SANS 55167-1:2011 are 275 m^2/kg and 300 m^2/kg. The average Blaine air surface areas determined were 4000 m^2/kg and 3968 m^2/kg respectively for the CS and OPC. The results obtained above represented below in Table 3.2, indicate that the CS used for this study is in the same range of fineness as the Portland cement and conforms to the requirement as per SANS 55167-1:2011.

Table 3.2: Surface Area results for Slag and Cement

Material	Blaine Air Surface Area (m^2/kg)	Specific Gravity
CS	4000	3.13
OPC	3968	3.14

The increased surface area of the slag may lead to pronounced strength effect at early stages of reactivity. This behaviour is typical of pozzolans and at later curing ages other factors, such as influence of pore structure and diffusion controlled processes, become more significant.

The specific gravity results for both CS and OPC are represented in Table 3.2. In general, the specific gravity varies with the iron content in the slag, from a low value of 2.8 to as high as 3.8 (Gorai et al., 2002). The results of the specific gravity shown in Table 3.2 confirm that, CS used for this research lies within the aforementioned range and slightly less than that of the Portland cement.

3.5 Setting Time

The setting time results are shown in Table 3.3. As required by SANS 55167-1:2011, the initial setting time of a combination (by mass) of 50 % of a slag with 50 % of test cement, shall not be more than twice as long as that of the test cement on its own. For all percentage replacement of Portland cement with CS, the results of the initial setting time values complies with the requirement as per SANS 55167-1:2011.

Table 3.3: Summary of the Initial and Final Setting Time Results

Mix Design	Initial Setting Time (min)	Final Setting Time (min)
Control	207	270
2.5% Replacement	333	402
5% Replacement	355	436
10% Replacement	385	480
15 % Replacement	412	512

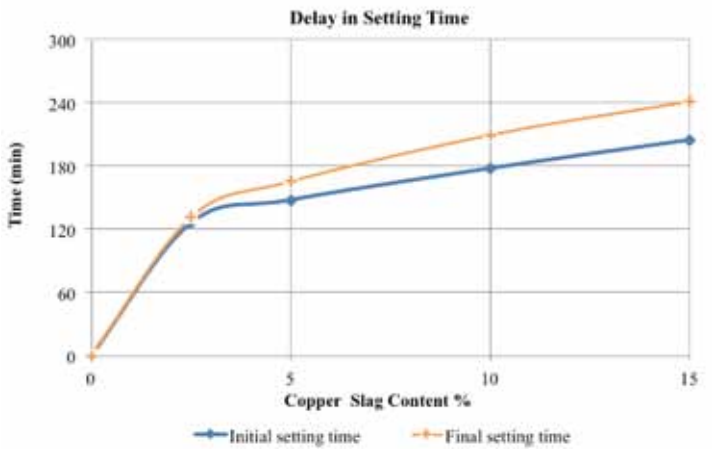

Figure 3.2: Delay Initial and Final Setting Time for Cement Paste

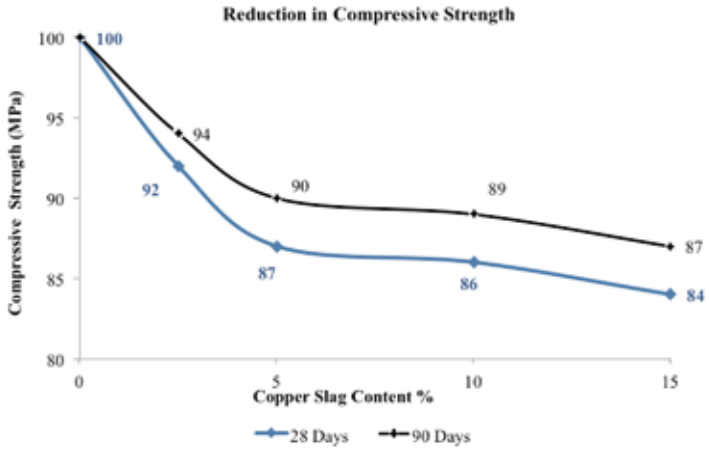

Figure 3.3: Compressive Strength Results of Copper Slag Admixed Concrete

Figure 3.2 also highlights the delay in the setting time of the cement paste as the substitution level of pulverized CS increases. This observation could be due to delayed hydration induced by the heavy ions contained in the CS. This postulation is supported by Hashem et al., (2011). According to the authors, the presence of Cu (II) ions retards cement hydration. Zain et al., (2004) were also of the opinions that, the presence of Cu, Pb and Zn compounds in CS increases cement paste setting times

3.6 Slump Test Results

Fresh concrete properties are presented in Table 3.4. The trend of the slump test results shows CS does affect concrete workability. Slumps of all samples increased significantly with an increase in the CS content.

Table 3.4: Slump Properties of Fresh Concrete

Copper slag replacement	0%	2.5%	5%	10%	15%
Slump (mm)	90	100	125	130	160

Since CS is very similar to fly ash as a less dense material compared to Portland cement and having spherical particle shape, the improvement in workability was expected (Sri Ravindrarajah and Tam, 1989). This improvement would enable the reduction of water to cement ratio leading to possible increase in the characteristics strength of concrete specimen for the same slump, as compared to the control sample.

3.7 Compressive Strength Test Results

The measured compressive strength for concrete specimens up to 15% CS replacement is shown in Figure 3.3. The compressive strengths reduction for 2.5, 5, 10 and 15% CS replacement are 92, 87, 86 and 84% respectively of the value for control specimen at 28 days of curing. Moreover at 90 days of curing, the compressive strengths reduction for 2.5, 5, 10 and 15% CS replacement are 94, 90, 89 and 87% respectively of the value for control specimen.

The overall decrease in the ultimate compressive strength for CS admixed concrete compared to control samples could be due the low hydraulic activity index of the slag. Moreover, the high glass content of the CS (99.3%) could have led to the overall reduction of the compressive strength development of the CS admixed concrete.

Demoulian et al. (1980) reported in a similar study that, slag concrete with high glass content in excess of 95% significantly reduces in compressive strength. Frigione (1986) admitted that, a low percentage of crystallization between 3–5% in mass of slag is found to be beneficial to the compressive strength development of slag concrete.

3.8 Flexural Strength Test Results

Table 3.5 shows the results of the flexural strength results up to 90 days of water curing. The flexural strength generally shows a decreasing strength trend as more CS is added to replace the cement, analogous to the trends of the compressive strength. At 90 days, the reduction in the flexural strength for 15% replacement is about 14%. However, the strength reduction is lower for the other samples with lesser replacements. The decline of the flexural strength as shown in Figure 3.4 could be due to the increased in porosity of the concrete induced by trapped excess water. The porous internal structure causes the concrete to be prone to failure in tensile cracking at the weak bonds between the concrete components.

Table 3.5: Flexural Strength Results of Prisms Up to 90 Days

	Percentage Replacement (%)				
Curing Days	0	2.5	5	10	15
3	3.36	3.10	2.86	2.65	2.46
7	4.36	4.08	3.78	3.56	3.28
14	4.62	4.37	4.00	3.68	3.60
21	5.05	4.58	4.32	4.08	3.98
28	5.41	4.88	4.64	4.45	4.30
60	5.94	5.66	5.48	5.01	4.92
90	6.25	6.10	5.86	5.59	5.40

3.9 Results of Durability Test

According to Alexander et al., (1999), the suggested ranges of index values for durability classification of concrete for three index tests namely: Oxygen permeability index (OPI), water sorptivity and chloride conductivity are shown in Table 3.6

The test results of both the oxygen permeability index (OPI) and water sorptivity are shown in Table 3.7. The results of the water sorptivity trends are more consistent than the results of the oxygen

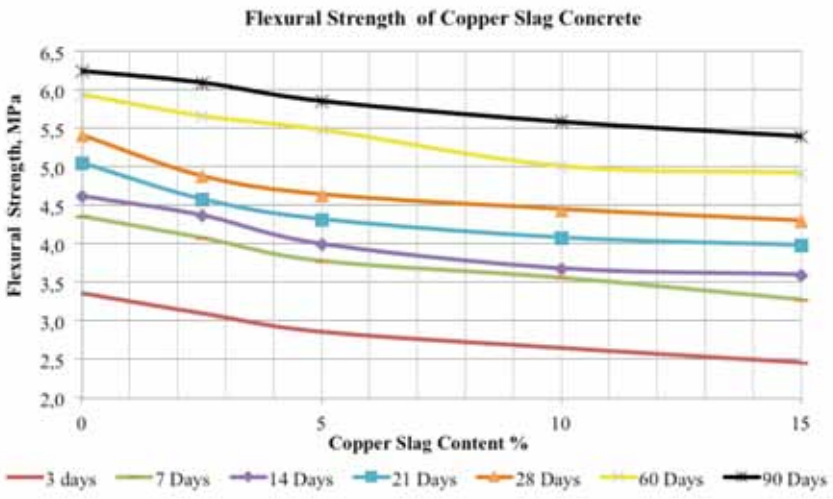

Figure 3.4: Flexural Strength of Pulverized Copper Slag Concrete Up To 90 Days of Water Curing

permeability. This observed trend could probably be due to the fact that bleed voids and other macro-defects have a smaller effect on the rate of water absorption than on air permeability. From the coefficient of oxygen permeability results shown in Figure 3.5, it is observed that, the CS can be effectively used in concrete to reduce the pore size of the concrete matrix.

As shown in Figure 3.6 the water sorptivity of the concrete sample decreases as the percentage of CS content increases. For all percentage replacement of cement with CS, the concrete samples generally performed better than the control sample; this is probably due to the pore refining effect of CS on Portland cement concrete because of its finer particle size and pozzolanic effect. Higher CS percentage replacement produced denser structure and prevents concrete from water penetration.

Moreover, the CS reacts with water in the highly alkaline environment of the concrete pore matrix and then with calcium hydroxide to form cement hydration product through pozzolanic reaction which forms extra C–S–H gel in the concrete paste and slows down the strength development at early age.

This conjecture is supported by a similar research by Daube and Bakker (1986) on the addition of Ground Granulated Blast furnace Slag (GGBS) in concrete. The Authors indicated that, the addition of GGBS modifies the products and the pore structure in a hardened cementitious material. Table 3.8 below shows the average results of chloride conductivity of two concrete discs.

Table 3.6: Suggested Ranges for Durability Classification Using Index Values

Durability Class	Oxygen Permeability Index (Log Scale)	Water Sorptivity (mm/hr0.5)	Chloride Conductivity (mS/cm)
Excellent	> 10.0	< 6.0	< 0.75
Good	9.5–10.0	6.0–10.0	0.75–1.50
Poor	9.0–9.5	10.0–15.0	1.50–2.50
Very poor	< 9.0	>15.0	> 2.50

Table 3.7: The Results of Oxygen Permeability Index and Water Sorptivity

	Durability Indexes	
Mix Design	Coefficient of Oxygen Permeability (mm/s)	Water Sorptivity Test ($mm/hr^{0.5}$)
Control	10.0	11.5
2.5% Replacement	10.0	11.0
5% Replacement	10.1	10.7
10% Replacement	10.1	10.5
15% Replacement	10.2	10.2

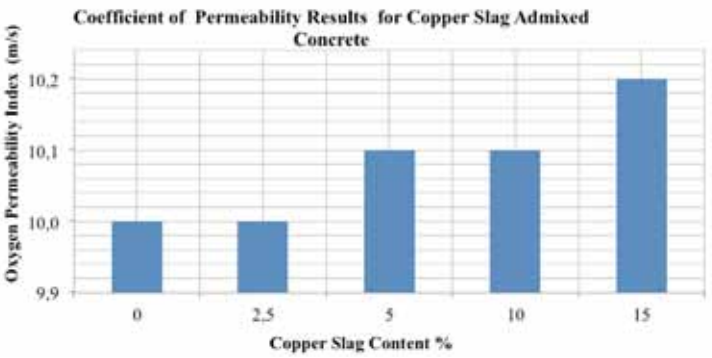

Figure 3.5: Coefficient of Oxygen Permeability Test Results

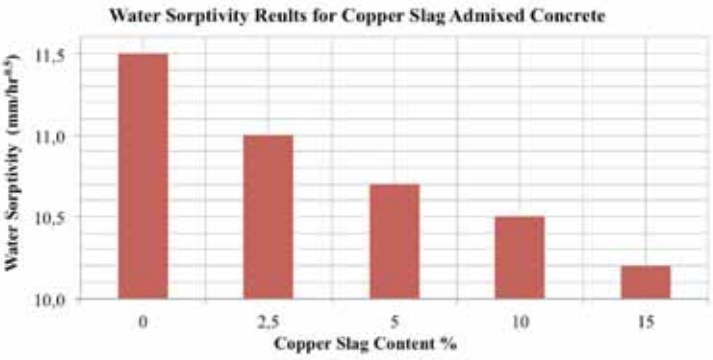

Figure 3.6: Water Sorptivity Test Results

As observed in Figure 3.7, the chloride conductivity of the concrete sample decreases with percentage increase of CS content, which could lead to reduced ingress of chlorides, and other deleterious ions responsible for concrete deterioration. The improved chloride resistance may also be the result of refinement of the pore structure, such as occurs with silica fume concretes, or may be due to increased chloride binding by aluminate phases contained in the slag (Alexander et al., 2003).

4.0 CONCLUSIONS

Based on the experimental outcome, observations and trends determined from the results of the above experimentations, the following conclusions were made:

i. The results of the X-ray diffraction (XRD) pattern signifies quartz-(SiO_2) and augite-Ca(Mg, Fe)Si_2O_6 as the major mineralogical composition of the CS, similar to those found in literature, which contains mainly fayalite, magnetite and quartz (Gorai et al., 2002)

ii. The glass content of the CS was approximately 99.3%, comparable to Ground Granulated Blast Furnace Slag (GGBS), with glass content between 85 and 90% (Saddique et al., 2011). The high glassy content of the CS could be credited to the reduction of the overall compressive strength of the concrete.

Table 3.8: Results of Chloride Conductivity Test

Mix Design	Chloride Conductivity (mS/cm)
Control	2.42
2.5% Replacement	2.02
5% Replacement	1.82
10% Replacement	1.49
15% Replacement	1.30

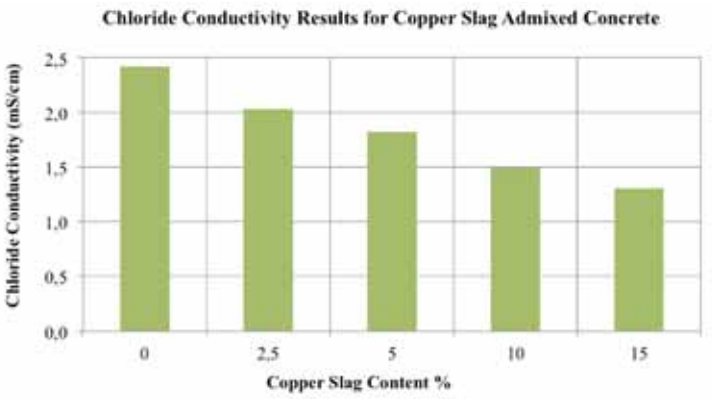

Figure 3.7: Chloride Conductivity Test Results

iii. In comparison with the chemical composition as per ASTM C618-99 natural pozzolans, the summation of the three oxides, namely, silica, alumina and iron oxides in the CS was approximately 72%, which satisfy the minimum 70% requirement for Class F pozzolans. Therefore, CS is expected to have potential to produce quality pozzolans.

iv. In assessment of the hydraulic properties of slag, The XRF chemical oxides composition result for CS was approximately 0.5% , which is less than 1, the recommended value required to be used as constituent for cement as per SANS 55167-1:2011.

v. The average Blaine air surface areas were 4000 m^2/kg and 3968 m^2/kg respectively for pulverised CS and Portland cement. The results confirmed CS used was about the same fineness as Portland cement and conforms to the requirements in accordance with SANS 55167-1:2011

vi. There was observed a delay in the setting time of the cement paste as the substitution level of pulverized CS increased. This observation could be due to delay pozzolanic action induced by the heavy ions contained in the CS

vii. The fresh concrete properties test results, show that, CS affects concrete workability; slumps of all samples increased as the proportion of the pulverized CS increases.it is therefore possible to reduce water to cement ratio and increased strength gained.

viii. For compressive strength results, there was a significant decrease as the CS content increases. The overall decrease in the ultimate strength for CS admixed concrete compared to control samples could be due to the low hydraulic activity index of the CS.

ix. The flexural strength generally shows a decreasing strength trend as more CS is added to replace cement, analogous to the trends of the compressive strength. At 90 days, the reduction in the flexural strength for 15% replacement is about 14%. However, the strength reduction is lower for the other samples.

x. The chloride conductivity and water sorptivity of the concrete sample decreases as the percentage of CS content increases. The reduction suggests an improvement in the durability performance of the slag samples compared to control, which could lead to reduce ingress of chlorides, sulphates, carbon-dioxide, moisture and other deleterious ions responsible for concrete deterioration.

xi. The results of the coefficient of oxygen permeability trends were irregular compared to those of chloride conductivity and water sorptivity. The observed trend could probably be due to the fact that, bleed voids and other macro-defects have a smaller effect on

the rate of water absorption than on air permeability than. However, the oxygen permeability results indicate that, the CS could be effectively used in concrete to reduce the pore size of the concrete matrix.

This report is based on the study of the performances of concrete with partial replacement of Portland cement with pulverised CS up to 15%. For all percentage replacement of cement with CS resulted in significant reduction in both the compressive and flexural strength. The average reduction value for both compressive and flexural strength up to 90 days of water curing for 15% CS content was approximately 15%. However, the concrete disc samples generally performed better in all the three durability tests, namely oxygen permeability, water sorptivity and chloride conductivity.

A clear observation from this study was that, pulverised CS can be used remarkably up to 15% to replace OPC to improve concrete durability properties. Notwithstanding, for mechanical strength design, CS content should be restricted below 15%. ▲

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Top marks for versatility, innovation and variety

A look at the applications of concrete in housing

By Claire Cole

Innovative uses and new applications for concrete continue to be tested as designers, engineers and product manufacturers keep pushing the boundaries of what this remarkable material can do.

In a fast-urbanising world, concrete has remained important in the provision of infrastructure in its widest sense.

As Adéle de Lange points out in her paper entitled International Concrete Trends Delivering Sustainable Social Housing (2011)[1], "Planning for sustainable human settlements begins with the provision of durable and low-maintenance infrastructure. Concrete is one of the most durable materials on earth. As an infrastructure solution – whether in-situ or pre-cast – its responsible use could result in a decreased demand for raw materials required for maintenance purposes. Concrete also lends itself to labour-intensive construction methods, creating sustainable low-skilled job opportunities. Concrete therefore makes economic, social and environmental sense for infrastructure provision."

Cement and concrete play important roles in home construction. Concrete is used for foundations, floors and lintels almost without exception, while cement is a vital ingredient in the mortar mix for masonry construction. Concrete products exist for drainage, roofing, fencing and paving. Looking a bit more broadly, the material also has multiple applications in infrastructure (such as water supply lines and reservoirs) and social amenities such as schools and clinics.

A greater move towards sustainability while meeting housing needs

The focus on sustainability and greener building methods is an inescapable part of today's construction environment – and for good reason. According to the United States Environmental Protection Agency's report entitled Inventory of U.S. Greenhouse Gases Emissions and Sinks[2], buildings contribute to some 38% of greenhouse gas emissions, of which the residential sector accounts for approximately 20%. Although concrete in itself does not have a high carbon footprint, cement production contributes approximately 7%[3] of the carbon dioxide generated by humans due to its wide use as a construction material. (Hammond, G. and Jones, C. Inventory of Carbon and Energy. University of Bath, Bath, 2011). However, concrete can be used in ways that mean it can in fact be one of the greener building materials.

In the manufacturing process, concrete can be made with supplementary cementitious materials from other industrial processes, such as fly-ash, slag and silica fume. Concrete from demolished building sites can also be crushed and re-used as part of the aggregate component in new concrete. An article in Built Magazine (De Lange: Sept/Oct 2011)[4] , points out that concrete manufacturers are looking at sourcing materials such as aggregates closer to the point of production, which reduces transport and fuel costs. The use of raw materials in the production of cement itself is also being reduced by the inclusion of extenders.

Research and development has progressed to the point where new technologies, such as the inclusion of titanium dioxide into the concrete blend, are being used to reduce air pollution by decomposing the harmful emissions released into the atmosphere by cars. Concrete made this way not only has the ability to reduce pollution, it is also self-cleaning, resulting in reduced maintenance costs (De Lange: Sept/Oct 2011).

A whole variety of new concepts exist for producing 'greener' concrete. Examples exist of discarded plastic or paper being chipped up and included in concrete mixes. Old unused tyres can be used in a similar fashion to create 'flexible' concrete. Spanish researchers have even come up with a form of organic concrete, designed with a biological layering system which allows it to absorb a certain amount of rain water and encourages plant growth directly on its surface. This could revolutionise the concept of planted walls and green roofs.

Concrete is known to be extremely durable and hard-wearing, and tends to outlast other building materials and it has a high thermal mass (the ability to absorb and retain heat). One of the key components of sustainable building is ensuring good thermal mass, as it enables buildings to stay cooler in warm conditions and retain warmth for longer in cool conditions.

Furthermore, one of the easiest ways to recycle concrete is in-situ – by taking existing structures such as unused office buildings and converting them into affordable housing or student accommodation. Successful examples of this already abound in Johannesburg and Cape Town.

A wealth of ideas and applications

In residential applications, concrete is not just for functional or affordable housing, or even just for the mundane uses. The modernists of the 1920s and 1930s started exploring its potential all those decades ago, and set a number of aesthetic trends. Today, architects, engineers,

designers and manufacturers are constantly coming up with new ideas – many of which are creative and attractive.

Daniel van der Merwe, PPC's resident architect, conducts regular research into concrete innovations and offers advice to architects, designers, contractors and anyone else interested in the applications of concrete.

Van der Merwe points out a number of different ways in which concrete can be used for high density, affordable or even emergency housing. These include established technologies such as re-using existing concrete building frames and applying new precast concrete building façades, or modular precast construction – which is good for ensuring consistent quality and is an excellent option where speed of construction is an important factor. Incremental housing models exist in which concrete 'cores' are constructed, after which home owners can build on as they are able to afford it.

Insulation panels (with concrete skins on the outside and insulation on the inside), composite sandwich panels, lightweight plastic void slabs and even insulated concrete formwork (where permanent formwork is filled with mass concrete) are all in use and are proving to be fast and cost-effective solutions for housing construction.

The aesthetics and finishes that are possible in concrete seem only to be limited by the imagination. They range from organic and natural to edgy and modern; from the minimalist, industrial chic look to the more classical and decorative styles.

Flexible formwork and textile formwork allow for wonderful organic, curvilinear and even skeletal forms to be created. The advent of three-dimensional modelling and CNC cutting makes it possible to create precise formwork out of fabrics. Textile formwork just has to be wet and draped or arranged as desired, and it dries in that position quickly. Translucent concrete or light-transmitting concrete can be created in a number of ways, most commonly by embedding optic fibres. Fibre-optic technology is also being explored in the creation of 'intelligent walls' which will be able to transmit information.

The variety of generally available ideas on the market is well summed up in an article published on the website www.concreteconstruction.net[5] which says "The popularity of decorative concrete for both interior and exterior areas of the home is growing at a tremendous rate. New concrete can be stained, stamped, stencilled, and integrally coloured to produce a variety of patterns and textures. Existing concrete can be covered with a microtopping or stamped overlay, or polished. Concrete can be made to look like other materials, such as brick, stone, or slate -in many cases at reduced costs and higher degrees of durability. Concrete countertops, both cast-in-place and precast, offer a unique customized look for kitchens and bathrooms.

The exterior of the home also is opening up to concrete possibilities. The durability and low maintenance of fibre-cement siding has led many builders to specify it for their residential projects. Concrete roof tiles continue to expand their market share as well. Genuine Portland-cement stucco and manufactured stone are other examples of cement-based products that provide superior quality as well as pleasing aesthetics for homeowners."

PPC's innovative staff support model

South Africans are all aware of the continuing challenges posed by the country's dire shortage of affordable housing. The unfortunate reality is that despite government and various public sector initiatives, the demand for adequate housing appears to be outstripping supply. Private sector organisations of all kinds make what efforts they can to help alleviate the situation.

PPC Cement, for example, has developed an innovative housing approach in its efforts to support members of its staff in acquiring homes. A large number of PPC employees live in the mining and quarrying areas of South Africa, where housing is in short supply and living conditions are less than optimal. Rather than providing a housing subsidy or giving houses to people, PPC has taken the view that people should be able to get involved and take responsibility for building, buying or extending a house. PPC provides its employees all the support necessary for these endeavours.

Rather than adopting a cookie-cutter approach, PPC works with employees to come up with individually tailored solutions to suit their needs. Yogesh Narsing, Special Projects Executive at PPC, explains that the most established and widely-used method of home building in South Africa is what is referred to as incremental housing. Because people at lower income levels are unlikely to secure bank loans or home loans, they build what they can afford to in increments, as cash becomes available. As a result, brick-and-mortar construction is by far the most common building method in these cases. "People will build over the course of years as money comes in, and in most cases, they do it without support or advice," Narsing comments.

The assistance PPC offers staff in its housing assistance programme comes in various forms. "We offer financial assistance in the sense that we will sit with individuals and look at their savings, debt and budgeting. We'll examine their individual and family balance sheets and help them work out the cash flow requirements for financing whatever it is they want to do. We also explore options such as whether it is best to buy, build or refurbish a home," says Narsing. PPC's relationship with suppliers and other role-players in the industry often means that it can source materials and supplies at favourable prices. Furthermore, the company is able to structure internal financing arrangements to assist

home owners, in the sense that it will pay builders and suppliers directly, and then make appropriate repayment arrangements with home owners. All this contributes to ensuring that PPC staff has well-built but affordable housing solutions.

The success of PPC's model has been such that many mining and manufacturing operations have embarked on similar projects, and they frequently approach PPC for advice. With over 300 projects running in various locations around the country, its benefits are clear. Aside from the purely practical aspect of addressing the issue of decent housing supply, those companies using the idea have found that the process instils a sense of pride and involvement in home owners who, as a result of this assistance, will have durable, and even bondable, assets.

Finding innovative ways to support users

Clearly, it is beneficial to manufacturers, builders and end users to optimize the results when working with cement and concrete.

An example of an industry initiative that set out to do just this is the Building Better Homes reality TV challenge, a cooperative venture between PPC Cement, Calgro M3 and Master Builders South Africa screened during 2014. Emerging builders were invited to enter, and four teams were chosen to compete in the challenge. The teams were given four construction challenges to complete – they had to plaster a wall, screed a floor, build a braai and pave a walkway. They were judged on aspects such as preparation, mixing, application, finishing, protection and curing, accuracy, project management and final appearance, and the winning team took home a new Toyota Hilux Turbo Diesel bakkie together with one ton of PPC Cement and R250 000 in cash.

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Promoting concrete by offering advice to the public

PPC's team of technical experts is able to offer advice on the correct use of concrete and concrete products to architects, builders, specifiers and anyone else that is using cement or concrete or is interested in its various applications. This advice is free to all and is intended to ensure durable fit-for-purpose structures.

Because the organisation works at the cutting edge of cement and concrete technology, the advice provided by its experts contributes to shaping a more attractive and responsibly constructed built environment. ▲

New general manager for Lafarge Aggregates

Lafarge has recently welcomed Praveen Bechoo as its general manager for aggregates. Praveen, whose appointment commenced on 1 October 2014 is based at the Lafarge head office in Longmeadow, and is a member of the country executive.

A qualified engineer, Praveen holds degrees in BSc mechanical engineering, Bachelor of Commerce and Master's in Business Administration.

Prior to joining Lafarge, he occupied various senior management roles with companies such as Eskom, Holcim and M-Web Commerce Zone. His most recent position was Business Unit Chief Executive Officer at Macsteel Coil Processing and Macsteel Special Steels where he spent thirteen (13) years.

Praveen replaces Jacques Schutte, who has been overseeing the Aggregates Product Line for the past nine (9) months. Jacques will return to his position as strategy and business development manager.

As a world leader in building materials, Lafarge employs 64,000 people in 62 countries, and posted sales of €15.2 billion in 2013. As a top-ranking player in Cement, Aggregates and Concrete, it contributes to the construction of cities around the world, through its innovative solutions providing them with more housing and making them more compact, more durable, more beautiful, and better connected. With the world's leading building materials research facility, Lafarge places innovation at the heart of its priorities in order to contribute to more sustainable construction and to better serve architectural creativity.

In South Africa, the company manufactures and supplies cement, aggregates, readymixed concrete, gypsum plasterboard and interior building fittings. It focuses on providing solutions to help the sustainable development of better cities that benefit the country's people. Through having a strong presence in all of its business lines, it is in a unique position to contribute to urban construction, while also helping to build better cities, rural towns and villages.

Lafarge South Africa also demonstrates active concern for the conservation of the country's wildlife heritage and is a major supporter of the world's first dedicated baby rhino orphanage in Limpopo Province. ▲

Concrete training: don't be fooled

Supposed top-flight, high-priced concrete training workshops that are being actively marketed to the concrete industry are often not worth the time or paper they are written on. A growing number of these workshops are being offered within the industry but contain information that is irrelevant to the local market and not recognised by any of the local industry's representative bodies. Although not illegal, the type of information being presented may be counter-productive or even harmful to the industry and can have a negative effect on the quality of concrete produced in future.

A personalised email invitation recently pricked the curiosity of, Johan van Wyk, general manager of the Southern Africa Readymix Association (SARMA), who found the terminology and several inaccuracies in the marketing material he had been sent and as a result decided to investigate further.

Johan van Wyk of SARMA

False claims

Upon closer investigation, the workshop offered by a foreign media house operating from Randburg, was found to be using the names of at least two well-known professionals who had not even heard of the workshop until then. In addition the course claimed to offer continuing professional development (CPD) points through a professional institution, which, when approached by Johan knew nothing of the workshop, nor its contents etc.

"I became suspicious when I saw the terminology being used. Some of the sample material they sent was completely incorrect while other information was clearly designed for cold climates that are completely unlike any conditions we have in southern Africa. Yet, even after confronting them with this information they still continue to market this workshop.

"We suggest that instead of spending money on seemingly impressive, well-marketed courses, we advise to first check with the industry body that represents their sector (of the concrete industry) to find out if the concrete courses on offer will be of any value. The cost of a phone call may well save thousands of Rands in useless training," says Johan.

Up-skilling the industry

In addition, professional bodies, such as SARMA provide industry specific workshops on a wide range of topics annually. Requests can also be made (where relevant) for workshops to be organised and may be hosted by either the association, or by an accredited training provider. The workshops are affordable as they are not driven by profit and attendance.

In most cases it is advisable to seek technical training (product specific) from local suppliers. Apart from the vastly differing building techniques employed in South Africa compared to places such as the USA or Europe, geological and climatic conditions are also vastly different. What works overseas may not work here and may not even be legal.

South Africa has some of the world's most accomplished concrete professionals and local industry bodies and training authorities have a wealth of expertise (and experience) to call upon when compiling local training programs and schedules. They also understand our conditions, by-laws, standards and best practices better than anyone else.

Making sure

"SARMA is 100% behind bringing new technologies and expertise from abroad to South Africa, at the same time we would also like to caution the industry against forking out money to just anybody that happens to offer a workshop.

Before doing so we would strongly suggest that anyone interested in attending a course first do some research to find out if it is legitimate. Just like you will investigate any new supplier, we suggest companies also investigate workshop and training providers," concludes Johan. ▲

SARMA, Johan van Wyk, Tel: (011) 791 3327, Fax: 086 647 8034, Email: johan@sarma.co.za, Web: www.sarma.co.za

The group of successful North West graduates from AfriSam's inaugural Enterprise Development Programme in the province.

AfriSam honours 32 north west entrepreneurs for successfully completing its enterprise development programme

AfriSam Dudfield General Manager Derick Dreyer congratulates Akanyang Mashobane, owner of AMAC Trading.

AfriSam has honoured 32 North West entrepreneurs for successfully completing its inaugural Enterprise Development Programme (EDP) in the province. The EDP is an accelerated training programme for black-owned Small, Medium and Micro Enterprises (SMMEs) to enable their inclusion in AfriSam's database of registered vendors. The entrepreneurs who were recognised own SMMEs ranging from cleaning services to catering, IT, welding, gardening and transport services.

Training was facilitated by Motswiri Consulting & Business Skills South Africa (BSSA) of Itsoseng in the Ngaka Modiri Molema District Municipality, North West Province, which has run mentoring workshops since March 2014. The training focused on equipping entrepreneurs with the necessary networking and technical skills to achieve business excellence.

"The success of the EDP is testament to AfriSam's support of local economic development. By identifying and improving black-owned SMMEs, we contribute positively towards skills development and employment," Derick Dreyer, AfriSam Dudfield General Manager, said.

"We were amazed by the level of commitment from the entrepreneurs. They saw this as an opportunity to improve their skills and set high standards for themselves so that they can become world-class service providers. We are proud of all of them," Dreyer commented.

Akanyang Mashobane, owner of AMAC Trading, expressed his gratitude to AfriSam for investing in local enterprise development. "We thank AfriSam for investing in our future by providing us with such valuable skills. These kinds of opportunities will go a long way in eradicating poverty and unemployment in our communities," Mashobane said.

To date, AfriSam's Enterprise Development team has held SMME Campaigns and Open Days in support of local communities around AfriSam's Lichtenburg, Roodekrans, Roodepoort and Eikenhof operations. More communities will be included as the programme is rolled-out to other provinces in the future. ▲

ABOUT AFRISAM (PTY) LTD

Founded as Anglovaal Portland Cement Company Limited in 1934, the AfriSam Group is today a leading black-controlled building construction materials group in Africa. With operations in South Africa, Botswana, Lesotho, Swaziland and Tanzania, the group has nearly 2 500 employees and an annual production capacity of over five million tons of cement. It has seven cement production facilities, a number of cement depots, 17 quarries and aggregate operations, 42 readymix concrete plants and a Ground Granulated Blast Furnace Slag (GGBFS) milling plant.

Fly ash products rebranded for today's market

New brands of fly ash were launched at a special industry function hosted recently by Ulula Ash (Pty) Ltd. The Editor spoke to Mark Hovy, General Manager of Ulula Ash, at the function to find out more about these rebranded products.

Hovy explained that the new fly ash specification SANS 50450 now caters for a new category of classified fly ash – Class N, which was previously an uncontrolled class that could include fly ashes of variable quality and with inconsistent properties.

"Under the new specification, Ulula Ash was the first South African producer to receive the SABS mark for Class N fly ash. This is because we have been producing a well-controlled, extremely consistent and reactive Class N fly ash since 2008. Our fly ash quality has always been controlled by ensuring that we only select the best of the best fly ash from Kriel Power Station," Hovy explained.

"The previous SANS 1491 specification only catered for a single fine grade of fly ash. The only way of achieving this was through a classification process. The new specification SANS 50450 caters for 2 grades, Class S and Class N. More than 50% of all fly ash used in South Africa falls within the Class N category which was previously an uncontrolled product which could be subject to many undesirable boiler conditions.

Due to the Ulula Ash plant design we have, since inception in 2008, produced what was then branded an unclassified ash. However, this fly ash has always been controlled by ensuring that we only select the highest quality fly ash available from Kriel Power Station.

"We are very proud to be ahead of the game with our fly ash already complying with the new specification's Class N fly ash. It is good to be the first in South Africa to carry the SABS mark for this product," concluded Hovy. ▲

More information from Ulula Ash at Tel: +27 (0) 11 708 0010 / www.ululaflyash.com

Chryso Southern Africa offers a full range of additives to optimise cement production

Chryso Southern Africa, the largest construction chemicals specialist in South Africa, offers a full range of cement additives to optimise different stages of the cement manufacturing process, explains Trevor Smith, newly appointed General Manager: Cement. Cement-mill additives comprise grinding aids and activators. Grinding aids have been developed specifically for raw meal production, as well as for the cement grinding process itself. The productivity of a raw mill can be increased by 6% to 12% and the cement mill by 10% to 25% by the use of such grinding aids.

Chryso® activators allow for increased use of supplementary cementitious materials (SCMs), which assists in reducing the percentage of clinker in the cement. Clinker production is the most energy-intensive part of the cement-making process. Reducing clinker content decreases carbon emissions as well as the costs associated with carbon taxes. The most common SCMs are slag, pozzolan, fly ash and limestone. Most Chryso® activators are designed to work with specific SCMs, contributing to significant savings associated with lower cement production costs.

"We formulate these products with a combination of activators and grinding aids. The activators effectively react with the clinker material and/or SCMs to improve the hydration reaction of the cement in the concrete. This results in the formation of calcium silicate hydrates and other crystalline structures that give concrete its strength. Some activators provide for early strength enhancement and some for late strength enhancement, while some do both," Smith says.

Clinker production is the most energy-intensive part of the cement-making process. Chryso activators help reduce clinker content, which cuts carbon emissions and carbon-tax costs.

Trevor Smith

"We have a range of formulations that allows us to select a specific product for a customer's application." The process begins with understanding a customer's cement manufacturing operation and the chemistry of his clinker and cement and what he wants to achieve in terms of cement quality and performance. For example, does he want early or late strength? Does he want improved output, which will result in improved efficiency? Or does he require a special product for a specific application? Or a combination of all three?

"We have the capability to formulate products for a specific application. Initially we will look at our broad range and then make some suggestions and follow that up with a few laboratory and plant trials. In some cases, a customer might be importing clinker from different sources where he operates a grinding facility only. He really does not want to use a different product for each type, so we will look to supply him with a more robust, broader spectrum product to cover all his requirements," Smith says.

Such close working relationships often mean that Chryso Southern Africa enters into long-term partnerships with its customers. It supplies products to the mining, precast, readymix, construction and general industrial sectors. "We have the logistical capability, in addition to three manufacturing facilities, to be able to export to most countries in Africa at present," Smith says.

"We have also developed innovative stock management systems to ensure that our clients do not run out of product. Initially developed in South Africa, we have now rolled this out into a number of Africa export countries due to the long lead times." Smith says Africa remains an important focus. "The growth and development on the continent is being lead by a requirement for cement at all levels, from bricks and blocks to roads, to major mining and oil and gas projects and to water and power infrastructure."

Latest developments from Chryso Southern Africa include a range of cement additives developed specifically for vertical roller mills to enhance stability, which leads to reduced vibration and improved output. Traditional milling circuits comprise ball mills in tandem with separators that classify the milled product to produce a cementitious product. However, vertical roller mills, with internal classification and lower specific energy consumption, are becoming increasingly common as cement producers seek to optimise their manufacturing process. ▲

Chryso Southern Africa has developed a range of cement additives specifically for vertical roller mills to enhance stability, which leads to reduced vibration and improved output.

Sika admixtures for low-cost housing project

Completed in December 2014, Sika was contracted to supply two high performance concrete admixtures to a low cost housing project in Highflats, located 50km inland from Scottburgh in KZN. Main contractors, Multicrop Construction sub-contracted Kencrete Readymix to supply the concrete. Kencrete specified Sika's high performance admixtures, Sikaplast V210, a multi-purpose water reducer and superplasticizer and SikaTard 930, developed for the control of cement hydration, for the project.

Kencrete set up a batch plant at the project location, thus easing delivery of the batched concrete to site. Multicrop Construction prepared the formwork by cutting out the base from the ground/bank and the ready batched concrete was delivered by truck and discharged into the base to form the house foundation. About 40% of the labour on site was from the local community.

The multi-purpose water reducer and superplasticizer, was added to the concrete used to construct the concrete slabs/ foundation of the houses. Its superplasticizing action provided high-slump, flowing concrete that maintained excellent workability and was placed with minimal vibration. It also provided controlled and extended slump life for periods of 45 to 90 minutes (depending on dosage) with increased set times, without significant loss in early strength development. A 0.6% dosage was used in the concrete mix and around 7 m^3 of concrete were used for each house.

SikaTard-930 was recommended for the mortar, as it was a lot coarser than the combination of plaster sand, river sand and cement. This admixture stabilised the concrete mix without setting for extended periods and without negatively influencing quality. A 0.3% dosage was used which allowed for the mortar to be workable for up to nine hours, and preventing the need for water to be added on site. If water is added on site, it causes a drop in mortar strength. Around 3,5 m^3 of mortar were used per house.

Because the project began in the rainy season, it affected construction, as contractors battled to gain access to the sites via dirt roads. Due to the isolated location of the project, the houses are vastly spread out which resulted in the need for construction of access roads off the main dirt road.

Kencrete, based in Izotsha, paid careful attention to the concrete manufacturing process which enabled them to guarantee their concrete was always up to its specified strength. Implementing a new batch plant in the project location has allowed Kencrete to expand its operations.

The Highflats project was initiated in November 2012, and the goal of constructing 2,000 houses within a 24-month period, even with the challenging rainy conditions, was successfully achieved. ▲

For further information visit www.sika.co.za

SIKA AG CORPORATE PROFILE

Sika AG, is a globally active specialty chemicals company with its South African Head Office based in Durban, and branches in all major SA cities.

Sika AG, located in Baar, Switzerland, supplies the building and construction industry as well as manufacturing industries (automotive, bus, truck, rail, solar and wind power plants, facades). Sika is a leader in processing materials used in sealing, bonding, damping, reinforcing and protecting load-bearing structures. Sika's product lines feature high-quality concrete admixtures, specialty mortars, sealants and adhesives, damping and reinforcing materials, structural strengthening systems, industrial flooring as well as roofing and waterproofing systems. Worldwide local presence in 80 countries and some 15 200 employees link customers directly to Sika and guarantee the success of all partners. Sika generated annual sales of CHF 5.14 billion in 2013.

SARMA sharpens its audit criteria

Concrete manufacturers belonging to the Southern Africa Readymix Association (SARMA) will have to pass tougher audit criteria this year in order to maintain their good standing with the association and meet tighter controls in line with international standards.

Auditors last year convened at the request of the association to review existing processes and standards, as well as propose amendments that will improve the overall standards of the industry. At the same time to simplify the process of compliance for companies and make it easier to understand.

Johan van Wyk.

Readymix plant.

Delivery of quality concrete.

"Each year we review our audit process and feedback improvements in all areas where our members are audited. This includes Safety Health, Road Traffic, Environment and Quality (Shreq) where we maintain standards that are directly comparable to ISO standards," says Johan van Wyk, general manager of SARMA.

SARMA standards

The association is a front runner in terms of introducing its own home-grown standards based on ISO requirements. For the past 9 years the association has reviewed and revised standards for the concrete readymix industry. Its accreditation process requires successful completion of an annual Safety, Health, Road and Environment Audit, as well as a full Quality audit.

Accredited members are able to bid for work wherever SARMA accreditation is a prerequisite and, in addition, ordinary buyers also have the assurance of dealing with a competent readymix supplier. "Accreditation is an acknowledgment that the readymix supplier concerned is a professional with the necessary skills and equipment to produce quality concrete in a sustainable and responsible manner," says Johan.

He explains that the association and independent auditors have reviewed and identified a number of key changes that will be made for the next round of audits. Simple yet practical initiatives will also be implemented to simplify the process for companies and auditors alike. Examples of improvements to the audit regime include starting audits of large corporate companies' audits at head offices. This will allow all relevant documentation to be scrutinised and will minimise the documents required at individual plants.

Changes to follow

"Documentation often proves to be the bain of companies seeking accreditation and without proper record keeping causes many problems with obtaining accreditation. Likewise, we will concentrate on signage on sites this year, as this required urgent attention on many sites we visit, particularly where health and safety warnings are concerned.

"Amendments will also be made to parts of the audit documents that deal with training, recycling of water, inductions for workers and visitors, labelling electrics and COF's, equipment calibration requirements, etc. Other areas of improvement may include:

- Maintenance schedules
- Staff appointment procedures and documentation
- Document correctness
- Quality controls
- Road safety

"This year we want to ensure that members have access to all the information and tools to ensure a seamless path to certification. As long as they take cognisance of statutory requirements and the requirements according to SARMA standards (and abide by these requirements) they will have no problem passing the audits," concludes Johan. ▲

SARMA, Johan van Wyk, Tel: (011) 791 3327, Fax: 086 647 8034, Email: johan@sarma.co.za, Web: www.sarma.co.za

CDP uses Echo slabs to build high-density retirement and rental accommodation

Apartment blocks at Featherbrooke Hills Retirement Village.

Reinforced slab installation at Olivedale Retirement Village.

The Echo Group has supplied precast concrete hollow-core slabs for the construction of upper-level flooring in multi-storey apartment blocks at two Gauteng retirement villages, Featherbrooke Hills Retirement Village and Olivedale Retirement Village. The villages have been brought to the market by the Central Developments Property Group and were built by its in-house building contractor, Central Development Projects (CDP).

Central Developments has completed six retirement villages during the past five years and another four are currently under construction including Olivedale, which although largely completed by the end of 2014, is due for final completion in the first quarter of 2015.

CDP operational manager, Wouter Brouwer, says hollow-core slabs have been used in all CDP retirement village projects.

"We've been working together with Echo Group projects director, Danie Esterhuizen, for the past 10 years and use hollow-core slab technology whenever we can as it shortens the overall construction time on our projects by up to 12% and saves approximately 20% in costs. Besides the retirement villages we also use slabs on our other multi-storey developments such as high-rise rental blocks in security complexes."

"All our retirement villages comprise a combination of low-density free-standing housing and high- density multi-storey apartment blocks," said Brouwer.

Both Featherbrooke Hills and Olivedale comprise six high-density blocks, one of which is a combined apartment block and service centre, the latter comprising frail-care units, dining and lounge areas, shops, doctors' consulting rooms and a multi-purpose hall. Featherbrooke Hills has 222 one and two-bedroom apartments and Olivedale 225. Floor areas on both projects vary between 40-45m² for the one-bedroom units and 61-70m² for the two-bedroom units.

The size of the apartments made them ideal for slab utilisation and Echo supplied reinforced hollow-core precast in different sizes.

Brouwer said reinforced precast slabs were the preferred option as they were more economical than the prestressed alternative for this type of short-span application.

"Another plus for reinforced precast slabs is that they are available ex-stock which makes it easy to incorporate last-minute design changes."

"To facilitate the use of reinforced slabs at Olivedale, the engineer, Wim van Straaten of Pro North Consultants, designed the internal walls of the ground floor apartments with foundations. This meant they were load-bearing and could support the weight of the upper slabs and internal walls."

CDP contracts manager, Johan Badenhorst, said that what he particularly liked about Echo's slabs was their superb finishes.

"We were able to paint them without any skimming. Moreover, Echo also cut out small sections on some of the slabs to accommodate our service ducting in the passage areas. We also liked the fact that the top sides of the slabs were cast with rough finishes which made for good bonding surfaces for our screeds."

Danie Esterhuizen manages CDP's portfolio. He says that Echo prefers to get involved with hollow-core slab projects at the design and pre-planning stages as it enables the company to offer a total slab-design installation solution.

Echo Group marketing director, Melinda Esterhuizen, advises that the success of any slab project essentially rests on pre-planning and Echo's involvement in the early stages often yields savings for the developers. "Moreover, engineers appreciate our suggestions on matters such as the introduction of columns and beams and where to construct them." ▲

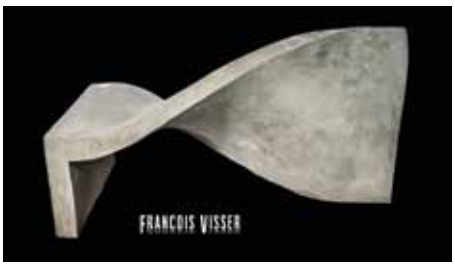
PPC sets a new creative 'bench' mark on the streets of Tshwane

Mavhungu Robert Ramavhale's bench will be placed at Viva Village in the Alaska Informal Settlement.

Mathews & Associates Architects cc in association with Sunshinegun. The bench is placed at the Pretoria Gautrain station.

Reply Mahlangu's bench is based at the TRT Station, c/o Nana Sita and Paul Kruger.

Sybrand Wiechers is located at the Café Riche, Church Square wanted to create a uniquely Pretoria which she did with her 'Moustache bench'.



Francois Visser created the public bench situated in Arcadia in the park in front of the Pretoria Art Museum.

Leading southern African cement supplier, PPC recently partnered with Cool Capital and Business and Arts South Africa (BASA) by funding 10 concrete benches to be designed and placed in public locations in and around Tshwane. This will serve as a reflection of the diversity in creative heritage that Pretoria has to offer.

The benches were commissioned by ten artists from around Pretoria to be strategically placed in public spaces around the capital city. At the same time, they create a sense of community and belonging to all who make use of these functional art pieces.

Sculptor and programme director from Dionysus Sculpture Works, and the 2003 winner of Technical Excellence at the PPC Cement Young Sculptor Awards, Francois Visser said, "Through the placement of benches, we would like to create spaces where people from different cultures and backgrounds can enter into conversation with each other, becoming spaces of cultural exchange and integration."

Visser oversaw the manufacturing and placement of the benches in the selected areas. He added that the designs vary from very simplistic and modern, to more intricate – always taking current architectural elements into account. "Other designs celebrate the 'snor city' legacy and the great impact that the Cool Capital has had in making the public more aware of their environment," said Visser.

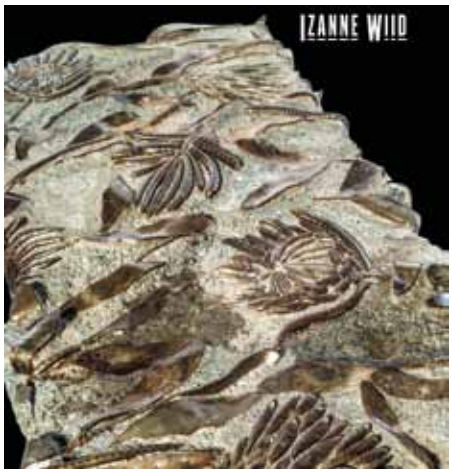
There were ten artists that contributed to this project, Mathews & Associates Architects, Reply Mahlangu, Sybrand Wiechers, Izanne Wiid, Pieter Matthews, Mavhungu Robert Ramavhale, Tsebe George Magampa, Francois Visser, Alexander von Klitzing and Tabi Tabe Takeng.

One of the artists, Izanne Wiid said, "I designed a PPC bench for the Jan Cilliers Park, also known as the Protea Park, Groenkloof. I wanted the sculpture to 'grow' out of the concrete, some areas still partly covered, others already exposed. The bench, although artificial, becomes another Protea bush, therefore blending into its natural surroundings."

Another artist Mavhungu Robert Ramavhale said recycling was the idea behind his design. "The story of recycling is a big part of our lives and became a big consideration when designing my bench. We all know that things such as tin can be used as containers to hold something, while corrugated iron can be used to build a shelter. I recycled this idea to serve my purpose, in using two tins to make the foot of the bench, and corrugated iron as a place to sit."

Through the activation of public spaces, the PPC Public Bench Project will afford the people of Pretoria an opportunity to engage with and reflect on their environment.

Architect at PPC, Daniel van der Merwe said, "PPC Ltd is proud to be the sponsor of the Cool Capital Bench initiative. This allowed designers to create several uniquely expressive benches as public art. Casting them in concrete using high performance PPC cement will ensure a lasting and enduring legacy, sprucing up public spaces for the citizens of Tshwane, and its visitors."



Izanne Wiid's bench was designed for the Jan Cilliers Park, also known as the Protea Park, Groenkloof.

"Public spaces should be places for free and creative expression and that includes art. Public spaces should also be for all parts of public life and expression. Benches in public spaces allow people to sit, eat, speak, listen, watch, read, love, think or just daydream. These benches are thus the ideal way to activate the power of public spaces. This makes it the perfect opportunity to become a public art object," he concluded.

The benches can be found at the Pretoria Arts Association, the Pretoria Art Museum, Café Riche on Church Plain, the Gautrain Station in Hatfield, Viva Village in Mamelodi East and the Protea Gardens in Groenkloof. ▲

ADVERTORIAL

DEVELOPING THE AFRICAN BUILT ENVIRONMENT OF TOMORROW

Totally Concrete and African Construction Expos take place from 12 to 14 May 2015 at the Sandton Convention Centre in Johannesburg, South Africa to address Africa's infrastructure gap and ensure sustainable infrastructure development and economic growth across the sub-Saharan region. The event covers the full spectrum of project design, management and delivery and attracts more than 6000 construction professionals from over 40 countries.

With over 170 expert speakers across the conference and workshop programmes, delegates are guaranteed to leave the African Construction and Totally Concrete Expo with dozens of ideas and hundreds of contacts to make their jobs easier and more productive.

"Reports have indicated that government infrastructure projects, which had stalled, will be rolled out faster from now on" *says John Sheath*

Totally Concrete and African Construction Expos is a timely forum for Africa while the continent is in the midst of a 20 to 30 year infrastructure development boom. Africa's growth story continues in 2015 with infrastructure development remaining at the forefront of the continent's growth trajectory.

Last year South Africa recorded an average increase of new construction work of 3.5% with every dollar spent on capital projects generating between 5% and 25% of economic returns.

"Statistics reveal that infrastructures across Africa are growing steadily, and it is estimated that infrastructure spends will grow from $70-billion in 2013 to $180-billion in 2025. Improved roll out of government infrastructure projects in South Africa is set to benefit construction sector firms in 2015, if they reposition their businesses in the correct way.

Reports have indicated that government infrastructure projects, which had stalled, will be rolled out faster from now on," says John Sheath, CEO of the Concrete Society of Southern Africa, endorsing partner of the event. "What better backdrop under which to meet stakeholders in the built environment and infrastructure sectors than at Africa's only 'all things cement and concrete' event," continues Sheath.

Supported by over 75 media and association partners, the African Construction and Totally Concrete Expos provide a crystal clear picture of where the industry is headed and what tools are needed to emerge as a leading construction industry stakeholder in the African built environment of tomorrow.

Foundation bases for tower cranes

In this regular section of Concrete Beton, we feature concrete-related, confidential reports emanating from the Structural Safety organisation* in the UK, represented in South Africa by the joint Structural Division of SAICE.

On two different contracts it was observed that the foundation base plates for tower cranes had suffered from low compaction of the concrete on which they rested. It was noticed by the reporter in one instance when ripples were seen in standing water around the base of the mast as a crane slewed. Closer inspection resulted in the detection of a small amount of 'vertical play'.

The type of anchor used for this crane depended on threaded bolts and not a steel stool. It was seen that the nuts above the base plate had not rotated so the concrete below must have moved. The bolts had lost some of their pretension, so they were re-torqued to the correct value and regular checks were made. There was no need to remove the crane or reduce its working capacity.

It would appear that the concrete team who cast the base plates onto the foundation did not take sufficient care to ensure all the air under the plate was removed and that the concrete was well compacted. Sometime later at a meeting of construction engineers, continues the reporter, the topic of tower crane foundation was discussed and it was found that another company had suffered the same type of problems, but they used a steel stool and not bolts. This meant that they were unable to re-torque the fixing and the crane had to be removed to cure the problem. Concrete teams need to take particular care when casting reinforced concrete crane bases and the engineers supervising the works should find out if the team in question has performed this type of work before, and make very clear the need for full compaction under the base plates.

CROSS comments

There are many examples of cranes failures: particularly tower cranes and mobile cranes, which tend to topple, and the importance of a stable base and sub-strate cannot be overstated. Failure of a tower crane, or indeed any crane, can be catastrophic and this type of event, and its management, is covered in the CIRIA report Guidance on catastrophic events in construction. In planning such work, any assessment of risk should identify 'safety critical' considerations and one of these would be the quality of concrete and its placing and compaction. This should be ensured by appropriate supervision and post-concreting checks. Extra care should be exercised when concreting near cast-in inserts, including anchors, and the subject should be addressed in a method statement by the contractor.

** If you found value in this material, please consider submitting issues that you have come across, such that others may, in turn, benefit from your experience. This is done through Confidential Reporting on Safety (CROSS) at www.structural-safety.co.za* ▲

A busy year for Kwa-Zulu Natal

Pumping concrete for post-tensioned floor.

The KZN Branch enjoyed a very active year in 2014, and one of the many events held was the technical meeting (MTM) on Spring Grove Dam, at which members were able to learn a lot about 'behind-the-scenes' of a Dam site. The Egg Protection Device and Cube Competition was, as always, a fun evening. Students and industry participants really enjoyed the destruction of the bridges. This evening event was sponsored by NPC and the CSSA. We ended the year with another MTM, this time on fibres by Andre Erasmus from Fibsol. The second national seminar for the year, FloorSem, was held on the 8 September 2014 in Durban. It was well attended and was as always, a great seminar with a wide array of speakers, including one from overseas.

The Garth Gamble Golf day was held on the 12 September 2014 at the Beachwood Golf Club. More than 20 teams participated and even the high winds could not blow away the enthusiasm for the game!

Everyone enjoyed the day and the evening presentation and dinner was well received by the players. Bev Reid won the Garth Gamble award for the 'Biggest Gamble' of the day and the Sika Team, led by Paul Adams, won first place. A special thanks to all the committee members who gave of their time to arrange the various functions, and to the CSSA Head Office team for their guidance and assistance.

The KZN Committee members would like to thank all their sponsors, the industry and members alike, for their valuable contribution over the year, and they look forward to ongoing support of the branch activities in the coming year. ▲

Inland Branch welcomes new Chairmen and committee members

Due to the sudden resignation of the Chairman of the Inland Branch late last year, the incumbent Vice-Chair, ***Roelof Jacobs*** *stepped in to 'take over the reigns'.*

Roelof is originally from the Free State where he was born, went to school and completed his BTech in Civil Engineering in 2007. He began his career with Lafarge Readymix as a technical controller and moved up in the company to where he is now - Manager: Products and customer support at QDSA (Quality Department Southern Africa). Roelof has completed his ACT (Advanced Concrete Technology diploma) and is currently busy with his MSc in Concrete Technology through Queens University.

His message for us: "I would like to quote from Gandhi "Live like you will die tomorrow. Learn as if you were to live forever" thus only through education and passion can we improve our industry and country"

Donovan Leach who has taken over as the new Vice–Chairman and is currently employed at PPC as Technical Marketing Manager in an area stretching as far as Rwanda. He has always been Johannesburg-based where he finished his schooling and Diplomas in Marketing and Management through RAU and IMM. He also completed the theory of his ACT diploma and is in the process of completing his research project. During his working career Donovan has also worked for Pratley Perlite, Moruo and Lafarge Readymix.

His message for us: "Concrete is a mind blowing material! It has been widely used in construction, but the potential of the material is huge. Concrete affects our lives daily and has become a stylish way to express who one is."

Kim Twiname is a newly-elected committee member and is from Johannesburg where, in 2010, she completed her Civil Engineering Degree from the University of Johannesburg. She started her career working for Sasol Technology, being the client's representative for the civil and structural phases of Sasol projects in Sasolburg, including the Sasolburg Gas Engine Power Plant Project. In 2013, she joined Royal HaskoningDHV as a Structural Engineer, in the Buildings unit, where she is responsible for the steel and concrete design of various structures. Her message for us: "I believe that concrete is a widely used material not only due to the costs associated with it, but also because of the ease at which it can be moulded into required shapes due to its fluid form when in its fresh state".

Martin Dube is also a newly-elected committee member. He is originally from KZN where he was born and went to school. He moved to Johannesburg where he completed his National Diploma at the Vaal University of Technology in 2008. Martin then joined Lafarge where he progressed to Technical Sales consultant in 2014, after spending 3 years in QDSA (Quality Department Southern Africa). His message for us: "I see and touch concrete almost every day of my life. Helping customers design concrete is a unique and special role. Concrete is so interesting, and you learn new things about it all the time"▲

Inland Branch visits Shondoni Colliery bunker project

The Inland Branch of the Concrete Society recently hosted a site visit to the Sasol Shondoni Colliery project near Secunda. More than 40 members attended this fascinating project, which features two large coal bunkers of 15 000 tons and 4 000 tons 'live' capacity and the foundation for a 22 km overland conveyor for transporting the coal to the Sasol gasification plant in Secunda.

On hand to welcome the visitors, and provide presentations, were Francois Vermeulen representing the contractors Stefanutti Stocks, Lyonell Fliss, Consulting Engineer of Lyonell Fliss & Associates, Krzystoff Szymczak Consulting Engineer of Logiman, Louw van Heerden from the client - Sasol Mining . Before proceeding to the bunker site, guests

CONSTRUCTION HIGHLIGHTS

- In-situ concrete was supplied as readymix from a plant 20Km from the project.
- The precast yard was located next to the readymix plant
- A high quality 60 MPa concrete was used for all surfaces in contact with the coal and for all precast elements
- A total of 481 precast elements were used ranging in weight from 10 – 20 tons each

were given a broad overview of the project, including such aspects as the concept, design, engineering and construction.

Concrete was chosen as the preferred construction material for the bunkers as well as for the foundations as being the most advantageous compared with other materials such as steel, and reinforced earth. It was viewed as superior in terms of cost, durability, technical performance, ease of operation and maintenance.

The precast concrete option, rather than in-situ concrete was chosen for the bunkers due to a number of advantages, all of which were realised during the construction phase, namely:

- Vastly improved constructability
- Superior durability (abrasion and corrosion resistance)
- Improved discharge flow
- Safer construction with less labour at heights
- Shorter construction duration
- Cost savings

The 15 000 ton bunker, the main focus of the visit, measures 76 metres long by 20,5 metres wide and 28 metres high. It has 10 bays, each of 7,5 metres span.

On top of the bunker is a steel beam grid which supports a feeding tripper conveyor enclosed in a structural steel house. A reclaim conveyor runs beneath the bunker, under a stockpile in a tunnel and then discharges coal into the overland conveyor.

The foundation, columns and end and internal partition walls were constructed in in-situ concrete as they were easier to shutter, reinforce and cast. The deck beams, sloped bunker slabs and beams, and vertical walls were precast, avoiding any scaffolding which is would have been required for casting in-situ of such elements.

The precast and in-situ elements are fully structurally integrated into the "composite" structure through monolithic in-situ concrete connections and in places, by pre-stressing, thus using the full structural capacity of all elements.

The overland conveyor is 22 km long, on a 3D curved route with a transport capacity of 2 000 tons per hour. The conveyor belt is supported on idlers on more than 6 000 structural steel frames at 3 metre centres which are in turn supported on sleeper foundations based on light precast sleepers and augured 'minipiles'.

This system proved to be more stable and durable than the use of conventional gravity sleepers.

During the visit to the bunker site, Roelof Jacobs, Inland Branch Chairman took the opportunity to thank all the stakeholders involved in approving and arranging the event. He also thanked Hanlie Turner, National Vice-President of the Concrete Society for initiating the concept of visiting this remarkable project.

He hoped, he expressed, that all those present had learnt a great deal from the experience and that they would continue to support the Society at similar future visits. ▲

Inland Branch

DATE	MEETING/EVENT	VENUE	CONVENOR
15 April 2015	Committee Meeting	Chryso-abe, Jet Park	Roelof Jacobs
May 2015	Technical Meeting	TBA	Hanlie Turner
20 May 2015	Committee Meeting	Lafarge, Longmeadow	Roelof Jacobs
11 June 2015	Inland Branch Fulton Awards Dinner	TBA	Roelof Jacobs/Natalie Johnson/Tina Coetzee
17 June 2015	Committee Meeting	PPC, Sandton	Roelof Jacobs
15 July 2015	Committee Meeting	Ash Resources, Longmeadow	Roelof Jacobs
July 2015	Technical Meeting	TBA	Hanlie Turner
12 August 2015	Committee Meeting	Misty Hills, Muldersdrift	Roelof Jacobs
14 August 2015	EPD Casting	Not applicable	Donovan Leach/Jannes Bester/Johan van Wyk
21 August 2015	EPD Crush-In	PPC Jupiter Works	Donovan Leach/Jannes Bester/Johan van Wyk
09 September 2015	Boat Race Sub-Committee Meeting	TBA	Roelof Jacobs/Johan van Wyk/Michelle Fick
12 September 2015	Annual Concrete Boat Race Day	Benoni Sailing Club, Homestead Lake, Benoni	Roelof Jacobs/Johan van Wyk/ Michelle Fick
16 September 2015	Committee/Planning Meeting	Sephaku, Centurion	Roelof Jacobs
14 October 2015	Committee Meeting	AfriSam, Constantia Park	Roelof Jacobs
11 November 2015	Committee Meeting	UJ, Auckland Park Campus	Roelof Jacobs
13 November 2015	Chairman's Breakfast	Blue Valley Golf Estate	Roelof Jacobs/Natalie Johnson

**Excludes Site Visits – to be announced later*

KwaZulu-Natal Branch

DATE	MEETING/EVENT	VENUE	CONVENOR
March 2015	Committee Meeting	UKZN	Theresa du Plessis
March 2015	Event: AGM/ Concrete Achiever Award	UKZN	Theresa du Plessis
April 2015	Committee Meeting	UKZN	Rod Raw
April 2015	MTM	TBC	Rod Raw
May 2015	Committee Meeting	UKZN	Rod Raw
May 2015	Site Visit	UKZN	Rod Raw
June 2015	Fulton Award – KZN Function	TBC	Rod Raw
July 2015	Committee Meeting	UKZN	Rod Raw
July 2015	MTM	UKZN	Rod Raw
August 2015	Event: EPD and Cube Competition	TBC	Andries Van Rensburg
September 2015	Event: Golf Day	Beachwood Country Club	Steve Schulte, Sub: Craig Handler
October 2015	Committee Meeting	UKZN	Rod Raw
October 2015	Site Visit	TBC	Rod Raw
November 2015	Committee Meeting	UKZN	Rod Raw
November 2015	MTM	UKZN	Rod Raw

International

DATE	MEETING/EVENT	VENUE	CONVENOR
11 – 13 May 2015	International Concrete Sustainability Conference	Miami, Florida, USA	Lionel Lemay
18 – 20 May 2015	2015 fib Symposium: "Concrete – Innovation and Design	Copenhagen, Denmark	Kaare Dahl
01 – 03 July 2015	Multi-Span Large Bridges Conference 2015	Porto, Portugal	Rui Calçada
15 – 18 September 2015	International Conference on Sustainable Structural Concrete	La Plata, Argentina	Luis Lima
15 – 17 October 2015	International Congress on Polymers in Concrete	Singapore	Lu Jin Ping

National Office

DATE	MEETING/EVENT	VENUE	CONVENOR
24 March 2015	AGM 2015	Emperor's Palace, Kempton Park	CSSA President
25 March 2015	Board Meeting	Emperor's Palace, Kempton Park	CSSA President
31 March 2015	2015 Fulton Awards Weekend Bookings Open	-	CSSA Administration
April 2015	2014/2015 Source Book	Posted to All CSSA Members	CSSA Administration
05 - 07 June 2015	2015 Fulton Awards Weekend	Champagne Sports Resort, Drakensburg	Fulton Awards Committee
June 2015	2015 Fulton Awards Concrete Beton	Posted to All CSSA Members	CSSA Administration
25 June 2015	Board Meeting	Emperor's Palace, Kempton Park	CSSA President
September 2015	Concrete Beton	Posted to All CSSA Members	CSSA Administration
07- 10 September 2015	Seminar Road Show	Cape Town, Port Elizabeth, Durban, Johannesburg	Seminar Committee
22 October 2015	Board Meeting	Emperor's Palace, Kempton park	CSSA President
31 October 2015	2016 Membership Renewals Notices	E-Mailed to All CSSA Members	CSSA Administration
November 2015	Concrete Beton	Posted to All CSSA Members	CSSA Administration

Eastern Cape

DATE	MEETING/EVENT	VENUE	CONVENOR
09 April 2015	Committee Meeting	109 Cape Road, Mill Park	Fanie Smith
April 2015	Technical Meeting	TBA	Fanie Smith
07 May 2015	Committee Meeting	109 Cape Road, Mill Park	Fanie Smith
May 2015	EPD Cube Test Competition	NMMU	Fanie Smith/Patrick Flannigan
04 June 2015	Committee Meeting	109 Cape Road, Mill Park	Fanie Smith
09 June 2015	EC Branch Fulton Awards Dinner	TBA	Fanie Smith
02 July 2015	Committee Meeting	109 Cape Road, Mill Park	Fanie Smith
06 August 2015	Committee Meeting	109 Cape Road, Mill Park	Fanie Smith
August 2015	Visit to Gas Turbine Powerstation	Coega	Fanie Smith
03 September 2015	Committee Meeting	109 Cape Road, Mill Park	Fanie Smith
08 October 2015	Committee Meeting	109 Cape Road, Mill Park	Fanie Smith
October 2015	Site Visit	TBA	Fanie Smith
05 November 2015	Committee Meeting	109 Cape Road, Mill Park	Fanie Smith

Western Cape

DATE	MEETING/EVENT	VENUE	CONVENOR
16 April 2015	Site Visit	TBC	Jan Ellis
21 May 2015	MTM – Hosted by Philemon Arito	UCT	Philemon Arito
10 June 2015	Fulton Awards Dinner	Kelvin Grove	Adrienne Taylor
16 July 2015	Site Visit	TBC	Jan Ellis
12 August 2015	Cape Construction Expo Workshop	TBC	Adrienne Taylor
17 September 2015	MTM – Proposed PhD Presentations by UCT/Stellenbosch Students	TBC	Adrienne Taylor
October 2015	Cube Crushing Competition Awards Ceremony and Prize Giving	TBC	Riaan Combrinck
November 2015	Cocktail Function	TBC	Adrienne Taylor

PLATINUM

COMPANY	CONTACT	TEL	E-MAIL
AfriSam SA (Pty) Ltd	Mr Mike McDonald	011-670-5500	mike.mcdonald@za.afrisam.com
BASF Construction Chemicals SA (Pty) Ltd	Mr Morgan Govender	011-203-2405	morgan.govender@basf.com
Lafarge Industries South Africa (Pty) Ltd	Mrs Alta Theron	011-657-1025	alta.theron@lafarge-za.lafarge.com
PPC Ltd	Mr Donovan Leach	011-386-9000	donovan.leach@ppc.co.za

GOLD

AECOM SA (Pty) Ltd	Mr Philip Ronne	021-950-7500	philip.ronne@aecom.com
Chryso Southern Africa Group	Mr Norman Seymore	011-306-9000	charne@chrysosa-abe.co.za
Sephaku Cement	Mr Graeme Smith	012-684-6328	gsmith@sephakucement.co.za
Sika South Africa (Pty) Ltd	Mr Paul Adams	031-792-6500	adams.paul@za.sika.com

SILVER

Ash Resources (Pty) Ltd	Mr David Kanguwe	011-657-2320	david.kanguwe@ashresources.co.za
The Concrete Institute	Mr Bryan Perrie	011-315-0300	bryanp@theconcreteinstitute.org.za
W.R. Grace	Mr Deon Van Den Berg	011-923-4630	deon.vandenberg@grace.com
Stoncor Africa (Pty) Ltd	Mr Ian Hague	011-254-5500	ian.hague@stoncor.com
Mapei SA (Pty) Ltd	Mr Christo Van Der Merwe	011-552-8476	c.vdmerwe@mapei.co.za
NPC Cimpor (Pty) Ltd	Mr Matthew Major	031-450-4412	majorm@intercement.com
SNA Civil & Structural Engineers (Pty) Ltd	Mr Ken Malcomson	012-842-0000	malcomson.k@sna.co.za
Twintec Limited	Mr Darryl Eddy	021-974-6136	d.eddy@twintec.co.za
Royal Haskoning DHV	Mr Alwyn Truter	012-367-5800	alwyn.truter@rhdhv.com
Department of Water and Sanitation	Mr Harry Swart	021-872-0591	swarth@dwa.gov.za

BRONZE

COMPANY	CONTACT	ADDRESS	TEL	E-MAIL
BAMR (Pty) Ltd	Mr Graham Duk	PO Box 23973 CLAREMONT Western Cape 7735	021-683-2100	sales@bamr.co.za
Bapedi Civil and Structural Consultants cc	Mr Tumi Kunutu	PO Box 412689 CRAIGHALL Gauteng 2024	011-326-3227	tumi@bapediconsult.co.za
Baseline Civil Contractors (Pty) Ltd	Mr Petrus Geldenhuys	PO Box 491 SOMERSET WEST Western Cape 7129	021-905-2545	petrus@baseline.co.za
Chris Howes Construction cck	Mr Chris Howes	PO Box 34408 NEWTON PARK Eastern Cape 6055	041-365-2711	chris@chrishowes.co.za
CLF Concrete Laser Flooring (Pty) Ltd	Mr Peter Norton	PO Box 2589 WITKOPPEN Gauteng 2068	011-704-5557	peter@concreteflooring.co.za
Concrete 4 U (Pty) Ltd	Mr Fanie Smith	PO Box 5064 WALMER Eastern Cape 6065	041-501-5400	fanie@readymix.co.za
Concrete Manufacturers Association	Mr Frans Minnaar	Postnet Suite 8612 Private Bag X32 KEMPTON PARK Gauteng 1620	011-805-6742	director@cma.org.za
Concrete Testing Equipment	Mr Marius Grassman	PO Box 77110 FONTAINEBLEAU Gauteng 2032	011-708-6141	marius@cte-labsupplies.co.za
Contest	Mr Rod Raw	PO Box 1675 HILLCREST KwaZulu-Natal 3650	031-700-9394	rodr@contest.co.za
Dick King Lab Supplies (Pty) Ltd	Mr Dick King	PO Box 82138 SOUTHDALE Gauteng 2135	011-499-9400	lanserac@iafrica.com
Doka South Africa (Pty) Ltd	Mr Matthew Kretzmann	PO Box 8337 HALFWAY HOUSE Gauteng 1684	011-310-9709	David.King@doka.com
Empa Structures cc	Mr Cameron Bain	PO Box 3846 DURBANVILLE Western Cape 7551	021-979-1129	cameron@empa.co.za
Form-Scaff	Mr Klaas Pouwels	PO Box 669 ISANDO Gauteng 1600	011-842-4000	klaasp@formscaff.com
Freyssinet-Mndeni	Mr Michael Hildyard	PO Box 1665 OLIFANTSFONTEIN Gauteng 1665	011-316-2227	mikeh@freyssinet.co.za

BRONZE

COMPANY	CONTACT	ADDRESS	TEL	E-MAIL
Group Five Civil Engineering (Pty) Ltd	Mr Nkosana Mhlophe	PO Box 1750 BEDFORDVIEW Gauteng 2008	011-922-3734	njmhlophe@groupfive.co.za
Group Five Coastal (Pty) Ltd	Mr Gareth Chambers	PO Box 201219 DURBAN NORTH KwaZulu-Natal 4016	031-569-0300	gchambers@groupfive.co.za
Hilti South Africa (Pty) Ltd	Mr Darren Chetty	PO Box 5588 HALFWAY HOUSE Gauteng 1685	011-237-3028	darren.chetty@hilti.com
Hindle Mason Projects (Pty) Ltd	Mr Benjamin De Bruyn	PO Box 2051 WITKOPPEN Gauteng 2068	011-875-9987	ben@hindlemason.co.za
Ibhayi Contracting	Mr Tseli Maliehe	PO Box 34913 NEWTON PARK Eastern Cape 6055	041-365-2871	rmaliehe@ibhayicontracting.co.za
Independent Concrete Supplies CC	Mr Darren Hoft	PO Box 1765 EAST LONDON Eastern Cape 6055	043-745-1014	dhoft@indepco.co.za
Jeffares & Green (Pty) Ltd	Mr Jacobus Burger	PO Box 794 HILTON KwaZulu-Natal 3245	033-343-6700	burgerk@jgi.co.za
Lambson's Hire	Mr Hannes Senekal	Private Bag x 3 Jeppe Town JOHANNESBURG Gauteng 2043	011-627-7700	hannes@lambsonshire.co.za
Malani Padayachee and Associates (Pty) Ltd	Mrs Malani Padayache-Saman	PO Box 3923 RANDBURG Gauteng 2125	011-781-9710	malani@mpaconsulting.co.za
Metier Mixed Concrete	Mr Kenneth Capes	Postnet Suite 546 Private Bag X4 KLOOF KwaZulu-Natal 3640	031-716-3600	kenneth@metiersa.co.za
Naidu Consulting (Pty) Ltd	Mr Josiah Padayachee	PO Box 2796 West Way Office Park WESTVILLE KwaZulu-Natal 3635	031-265-6007	padayacheej@naiduconsulting.com
Nyeleti Consulting	Mr Stephen Humphries	P.O. Box 35158 Menlopark LYNNWOOD Gauteng 0081	012-361-3629	shumphries@nyeleti.co.za
Pan Mixers South Africa (Pty) Ltd	Mr Quintin Booysen	PO Box 75098 GARDEN VIEW Gauteng 2047	011-578-8600	quintin@panmixers.co.za
Penetron SA	Ms Cassandra van der Merwe	PO Box 7467 HALFWAY HOUSE Gauteng 1685	011-314-8310	cassandra@penetron.co.za
QDS Projects	Mr Quirin Sibuyi	PO Box 2935 NELSPRUIT Mpumalanga 1200	086-722-7089	quirin@qdsprojects.co.za
Rebar, Mesh and Construction Supplies (Pty) Ltd	Mr Louis Aylward	PO Box 2225 BEDFORDVIEW Gauteng 2008	011-310-8660	louis@rmcs.com
Ruwacon	Mr Pieter Ruthven	PO Box 13596 Noordstad BLOEMFONTEIN Free State 9302	051-403-0400	pieterr@ruwacon.co.za
SARMA	Mr Johan van Wyk	PO Box 1983 RUIMSIG Gauteng 1732	011-791-3327	johan@sarma.co.za
Shukuma Flooring Systems (Pty) Ltd	Mr Meiring Ferreira	PO Box 10332 LINTON GRANGE Eastern Cape 6015	041-372-1933	meiring@shukumaflooring.co.za
Simpson Strongtie SA	Mr Francois Basson	PO Box 281 Bergvliet CAPE TOWN Western Cape 7864	087-354-0629	fbasson@strongtie.com
Simstone (Pty) Ltd	Mr Amos Masitenyane	PO Box 1113 MEYERTON Gauteng 1960	016-362-2181	amos@simstone.co.za
Spec-Con Engineering (Pty) Ltd	Mr Gordon Mowatt	PO Box 32291 KYALAMI Gauteng 1684	011-468-4265	gordon@spec-con.co.za
Stefanutti Stocks Civils	Mr Werner Jerling	PO Box 12394 ASTON MANOR Gauteng 1630	011-522-4011	werner.jerling@stefstocks.com
Strata Lab cc	Mr Elwyn Hoft	PO Box 1765 EAST LONDON Eastern Cape 5200	043-745-1014	ehoft@indepco.co.za
Structural Solutions cc	Mr Rigo Govoni	PO Box 40295 WALMER Eastern Cape 6065	041-581-3210	rigo@structuralsolutions.co.za
Topfloor Concrete Limited	Mr Peter Lord	PO Box 124 SANLAMHOF Western Cape 7532	021-951-7700	peter@awl.co.za
Uhambiso Consult (Pty) Ltd	Mr Jacques Gerber	P.O. Box 12385 CENTRAHILL Eastern Cape 6006	041-373-0180	jgerber@uhambiso.co.za
UPAT SA (Pty) Ltd	Mr Kevin Owen	PO Box 53059 TROYEVILLE Gauteng 2139	011-624-6700	kevin.owen@upat.co.za
Verni-Speciality Construction Products (Pty) Ltd	Mr Vernon Botha	PO Box 75393 GARDEN VIEW Gauteng 2047	086-118-3764	vernon@verni.co.za
VSL Construction Solutions (Pty) Ltd	Mr Andrew Richmond	PO Box 6596 HOMESTEAD Gauteng 1412	010-591-8211	andrewr@vsl.co.za
Wacker Neuson (Pty) Ltd	Mr Rainer Schmidt	PO Box 2163 FLORIDA Gauteng 1710	011-672-0847	rainer.schmidt@wackerneuson.com
Xypex Chemical Corporation	Mr Lewis Lynch	8 Leeukloof Drive Tamboerskloof CAPE TOWN Western Cape 2001	021-426-0243	llynch@xypex.co.za

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