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CONCRETEBETON

Chota Motala Incremental Launch Bridge

Effects of Cold Rebar on Fresh Concrete

Architectural Concrete Façades

CONTENTS

Editor's comment 3
President's message 4

FULTON AWARDS WINNER
Chota Motala incremental launch bridge 6

ACCREDITED TECHNICAL PAPER
How does cold reinforcing steel affect fresh concrete? 12

MATERIALS
Architectural concrete façades – the what, why & how 22

CONCRETE TIP
Some properties of concrete made with Ground Granulated Blastfurnace Slag (GGBS) from Saldanha (Part 1) 26

INDUSTRY NEWS
Rocla's Alfabloc retaining walling system 28
a.b.e. awarded global top quality management accreditation 29
The New Engineering Qualifications: Industry Implications 30
Pigmented roads for luxury Sunward Lifestyle Centre 30
Innovation differentiates Lafarge South Africa 31
Quick and efficient cement delivery provides fast turnaround times on wind farm project 32
Lafarge provides concrete solutions for new Bloemfontein reservoir 33
Master Builders Solutions® launched in South Africa 34
Lafarge assists with turning a house into a home 35

SAFETY CORNER
Balcony collapse at block of flats 36

BRANCH CHATTER
Inland Branch Heidelberg Weighbridge Station, site visit 38
Western Cape flying 39
KwaZulu-Natal update 39

EVENTS CALENDAR 40

MEMBERSHIP DETAILS 44

Cover: The Chota Motala project was commended by the Fulton Award judges in the Civil Engineering category for the special attention paid to the aesthetics of the bridge, and consideration of many aspects such as slenderness, span lengths, pier diameter, shapes of members, shadow and lighting. The result is an elegant and aesthetically pleasing civil engineering structure that showcases concrete in an excellent manner.

Editor's comment

I am delighted to announce the election of two new Directors of the Concrete Society in this issue and welcome them to the Board on behalf of the President, Office Bearers and members. They need little introduction to the industry, and they are:

Professor Mark Alexander, Department of Civil Engineering at the University Cape Town

Mark holds a BSC (Eng), MSc (Eng) and a PhD, all from WITS University and is a registered Professional Engineer (PrEng) with the Engineering Council of South Africa (ECSA).

He began his working career with the Johannesburg City Engineer's Department where he fulfilled the roles of Design Engineer, Resident Engineer on Construction, and Water Planning Engineer. He was elected a Fellow of the South African Institution of Civil Engineering (SAICE) in 2002; of UCT in 2005; of the SA Academy of Engineering in 2006, and of RILEM (The International Union of Laboratories and Experts in Construction Materials, Systems and Structures) in 2009. He is currently President of this world-renowned organisation.

Mark Alexander

Mark began his academic career when he joined WITS as a Lecturer in 1979, thereafter becoming Senior Lecturer and Associate Professor. In 1992 he moved to the University of Cape Town (UCT) as Professor. After serving as head of the Department of Civil Engineering, Deputy Dean - EBE Faculty and Assistant Dean (Academic Development), he is currently Director of the Concrete Materials & Structural Integrity Research Unit (CoMSIRU) at UCT.

Mark has been actively involved with the Concrete Society, serving on National Council for many years and serving as National President of the organisation in 1995.

Hanlie Turner

Mrs Hanlie Turner, Information Specialist, PPC Ltd

Hanlie graduated from RAU with a B.Bibl. Degree and began her career at the EMS / Murray & Roberts Library in 1981. Thereafter, she joined the consulting engineering firm, Watermeyer Legge Piésold & Uhlmann (currently Knight Piésold) in 1987. In 1993 she joined the Cement &

Concrete Institute (at that time called Portland Cement Institute) as part of their information centre team and in 1996 she was appointed Information Centre Manager. In 2008 Hanlie obtained a post-graduate diploma from the Institute of Marketing Management and was subsequently appointed Marketing Manager in June 2009, a post she held until the closure of the C&CI in 2013.

In June 2013 she took up a position with cement producer PPC as Specialist: Technical Information Services.

During 2006 she was awarded the CSSA Inland Branch Chairman's award in recognition of the overall contribution to the Concrete Industry.

Hanlie has been a member of the Concrete Society for almost 15 years and has served tirelessly as a branch committee member, Chair of the Inland Branch for 2 years, during which time she represented the branch at Board meetings, and from this year as National Vice-President.

John Sheath
Editor

President's message

The beginning of my two year term as President of the Concrete Society of Southern Africa (CSSA) for 2014 to 2016 coincides with the launch of the in-house publication of the Concrete Beton. The early feedback from members indicates that this is proving to be a resounding success. Exciting times ahead!

Firstly, as I ease into my term of office as President of the CSSA, I would like to thank Professor Billy Boshoff for his leadership during the last two years and to re-affirm my commitment to carry on with the work that has been done.

Outgoing President, Prof Billy Boshoff (r) congratulates incoming President, Tseli Maliehe.

In the last three years the Society has gone through a transition and transformation which started with the appointment of our CEO John Sheath to run the day to day activities together with the Head Office team. We welcome Marike who has joined the CSSA Head Office team in 2014. This transition continues to bear fruit, with growth in company membership and membership as a whole, much better organized successful seminars and roadshows and the general visibility of the CSSA as a relevant organisation to the industry.

As mentioned earlier, the in-house publication of the Concrete Beton has been a resounding success confirmed by the feedback we are receiving. The general "look" of the publication is fresh and I can only see this Journal growing from strength to strength.

Looking forward, in June 2014 the ConSem road-show seminar will be held in four venues around the country as we continue to "promote excellence and innovation in the use of concrete and provide a forum for networking and for sharing of knowledge and information on concrete".

In closing, I would like to thank the CSSA Board and Members for entrusting me with the responsibility to lead the Society, it is an immense honour and I intend to discharge this responsibility with the greatest pride and commitment.

Yours Sincerely
Tseli Maliehe
President – Concrete Society of Southern Africa

OUR VISION 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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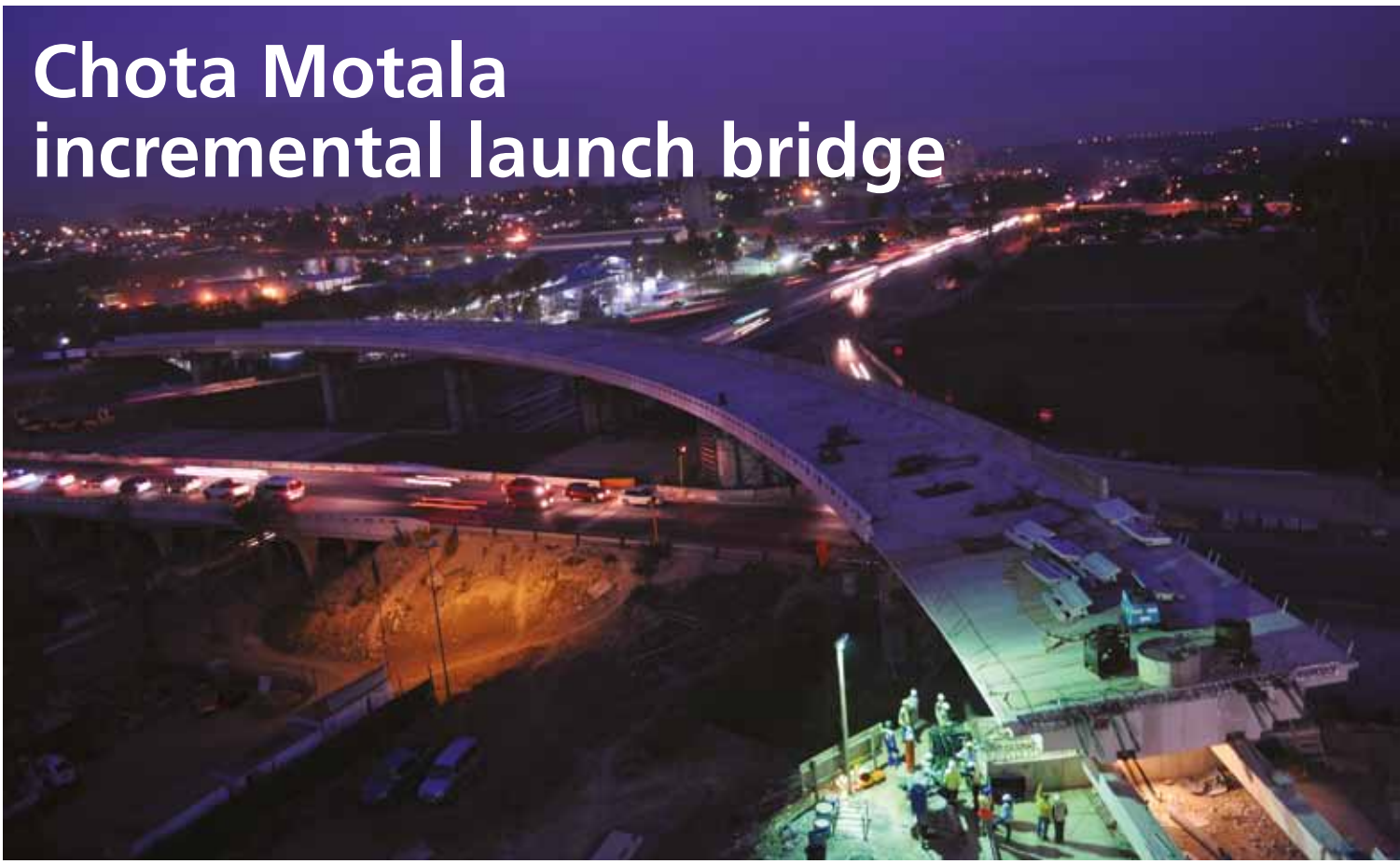
Chota Motala incremental launch bridge



The Chota Motala Incremental Launch bridge (B 0107) is a 220 m long incrementally launched bridge that forms part of a project to improve the capacity of the Chota Motala interchange on National Route 3, Section 3 in Pietermaritzburg, Kwazulu -Natal. This interchange links the N3 with Chota Motala Road (R33), which serves as a vital link to the eastern suburbs of Northdale/Woodlands and the Pietermaritzburg CBD. The bridge was awarded a judges' commendation in the Civil Engineering Structure category of the 2013 Fulton Awards.

The incrementally launched construction technique involves construction of the bridge superstructure on one side of an obstacle and then launching it into its final position. The launching is performed in a number of increments so that additional sections can be added at the rear of the superstructure prior to the subsequent launches. This technique has been in use for approximately 50 years. The first post-tensioned concrete bridge constructed by launching is believed to be over the River Caroni in Venezuela in 1963, but this type of structure remains challenging in both the design and construction.

The Chota Motala bridge has some unique design features and construction techniques, and the project team believed that this, together with the attention to detail, in both the design and construction, as well as the quality of the concrete finishes, makes this bridge a testament to excellence in the use of concrete.

Statement of Owner's need

The existing Chota Motala interchange has been operating at more than its capacity for some time. The result of this is long delays for traffic traveling both to and from the Pietermaritzburg CBD along Chota Motala road. Traffic entering the interchange from the National road N3 was also backed up on the off-ramps and into the N3. This caused a very dangerous situation for through traffic on the N3 suddenly being confronted by stationary traffic in the slow lane. The South African National Road Agency Limited (SANRAL) and the Mzunduzi Municipality investigated options for improving the capacity of this interchange, The first solution to be investigated involved the construction of a rotary interchange with a parallel service road, similar to the nearby Sanctuary road interchange.

After a tender process the Iliso/Aurecon Joint venture was appointed for the detail design of this interchange. The appointment included the review of the original traffic simulations and it was found that a rotary interchange was not feasible in this instance.

A number of alternatives were considered, among them the provision of a service road parallel to the N3, before deciding on the final solution.

Roadworks on the project included the following:

- Upgrading of Chota Motala road from a 4 lane to a 6 lane urban arterial
- Widening and minor re-alignments to ramps and construction of a new directional ramp on the Chota Motala Road Interchange over the N3.
- Upgrading of the N3 by adding an additional new fast lane in the median and rehabilitating the existing concrete pavement.
- Widening the existing Sanctuary road offramp on the eastern side.

The structural work on this project comprised the demolition and re-construction of two bridges, the construction of two new bridges, the widening of one bridge, new and lengthened culverts and a number of retaining walls and median traffic barriers.

The Chota Motala Incremental Launch Bridge is situated on a new directional ramp (ramp E of the interchange) carrying traffic traveling on Chota Motala road towards Pietermaritzburg over the N3 and Chota Motala road to merge with the westbound lane of the N3 towards Johannesburg. The bridge therefore effectively carries the third layer of traffic at the interchange.

The main determining factor in the conceptual design was that the bridge had to be constructed over the extremely busy N3 highway and the client insisted that the traffic on the N3 would not be disrupted or exposed to any danger due to construction activities. A staged construction method was investigated before finally deciding on the incremental launch method. The incremental launch method is ideal for this situation with very little risk to disrupting traffic at any stage during construction and therefore fulfills the client's requirements in every respect.

The project team

The client for this project is the South African National Roads Agency (SANRAL) together with the Mzunduzi municipality. SANRAL played the role of the implementing agent. The consultant is the Iliso/Aurecon Joint Venture. Aurecon was responsible for all the bridge work and Iliso for the roadwork and minor structures. The main contractor is the Group 5/Phambili JV who appointed Structural Systems to provide all the launching equipment and the prestressing materials and jacking. DNA Consulting Engineers and Project Managers was appointed separately as the lighting sub-contractor.

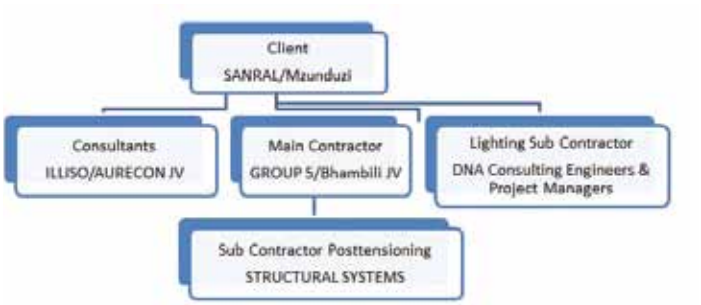


Figure 1: Organogram

Why concrete was chosen for the project

Once the decision was made to provide an incrementally launched bridge it was logical to propose prestressed concrete as the construction material. The only alternative was a launched composite deck, consisting of an open steel box-girder with a concrete slab on top. An open box-girder could have been launched over the whole length of the bridge and later a concrete slab could have been cast above it. This option was not considered further due to the following reasons:

- A composite steel bridge deck is generally more expensive than a concrete bridge deck
- The construction of the concrete top slabs would have posed a safety risk to traffic below negating the main advantage of the launch bridge
- A composite deck has much higher maintenance costs compared to a concrete bridge
- The required maintenance is difficult to undertake in the presence of heavy traffic above and below.

Reinforced concrete is the most popular choice of construction material for bridges in South Africa for the following reasons:

- It offers the lowest initial costs
- It provides the lowest maintenance costs
- It has a long lifespan if maintained properly
- It can be cast to any shape provided by the formwork

Description of the works and construction method summary

Bridge Description

The 220 m long deck consists of a single cell prestressed concrete box girder with a total of seven spans varying in length between 25.15 and 36.05 m, arranged symmetrically around the center. The deck is supported on six piers of which four are founded on piled foundations and two are founded on spread foundations. Both abutments are perched and founded on piles. The substructure is supported on shale from the Pietermaritzburg Formation at a depth of between 2 m and 5 m below natural ground level. Piles are used where the supports are constructed in existing fill conditions.

The piers, varying in height from 6.245 m to 15.913 m, start off with a 2.0 m diameter circular section and flares out over the top 6 m to a 3.6 m diameter. The pier shape reminds of a champagne flute and it provides two support points to give torsional rigidity to the deck.

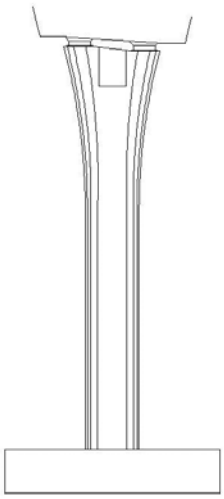


Figure 2: Permanent pier shape

Steps in construction process

a) Construct piers, temporary piers and abutments

The temporary piers are there to carry the bridge during launching by providing supports under the webs of the girder. The outer piers in Figure 3 and Photo 2 are the temporary piers with the central pier being

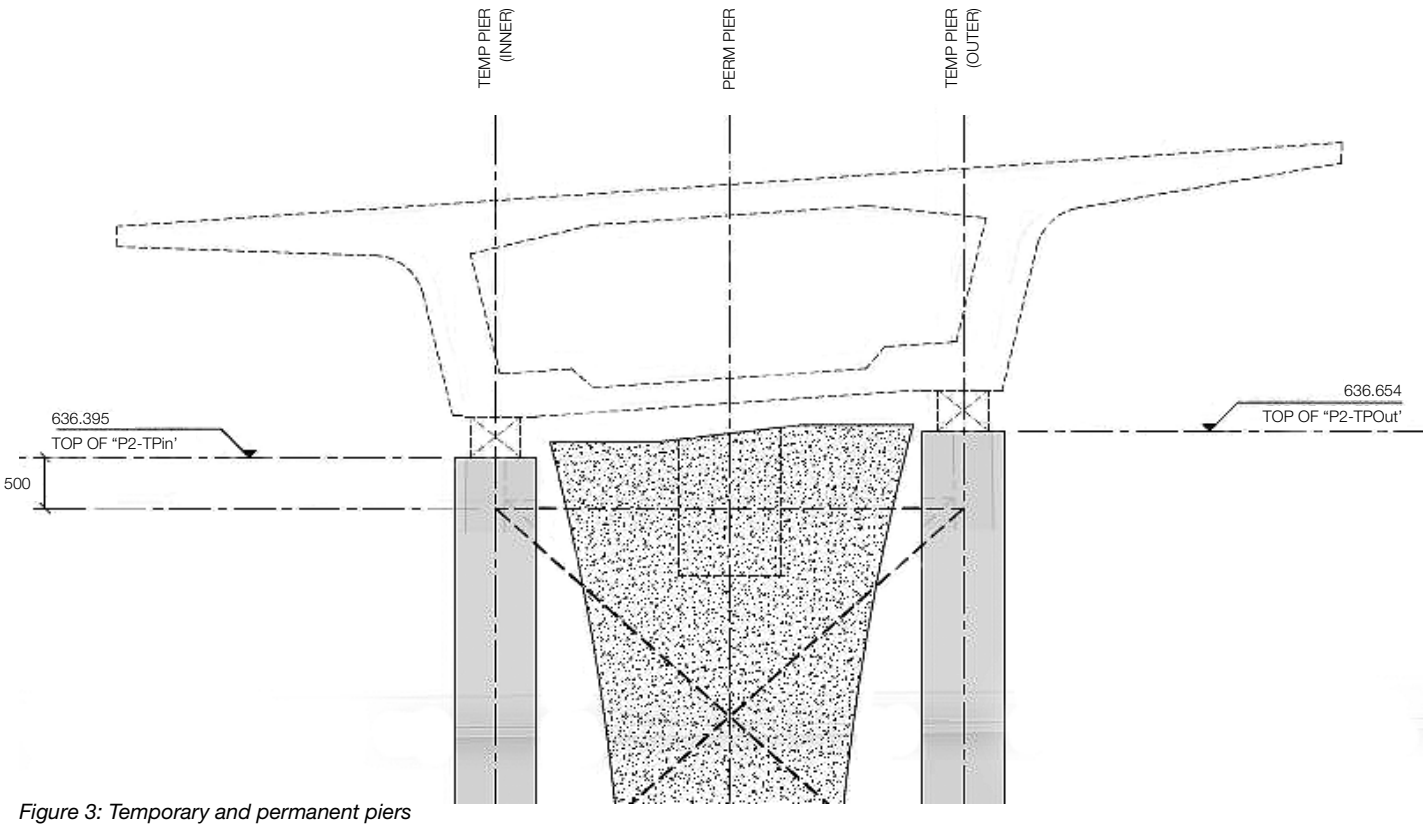


Figure 3: Temporary and permanent piers

permanent. Deck loads were transferred to the permanent piers and temporary piers were demolished upon completion of launching.

b) Construct cast bed and skid beams

The cast bed is the place where the segments of the bridge are cast. The entire bridge geometry is determined by the dimensions of the shutters and the levels of the skid beams in the casting yard. Every segment of the bridge must be cast to very accurate tolerances on the correct launch path before the segments are launched. It is extremely important that a high level of accuracy is maintained in the setting up of the cast bed as inaccuracies in this area could cause deviations in the launch path of the bridge. In order to avoid any undue settlement of the cast bed and skid beams, this structure was supported on piles.

The skid beams connect the cast bed to the abutment and are there as a platform for the jacks to pull the bridge forward from the cast bed to the abutment. Once a segment reaches the abutment, the jacks on the abutment push it forward.

c) Construct the first segment and add the nose

A launching nose is attached to the front of the first segment. The nose is lighter than the concrete girder and therefore reduces the cantilever forces during launching.

d) The subsequent segments are cast and launched

Once the previous segment has been launched the subsequent segment is cast. As soon as the concrete has attained sufficient strength, the concentric prestressing cables are stressed and the segment is ready for launching.

e) Completion of structure

After completion of the final launch, the draped prestressing cables are placed and stressed, the deck is transferred to the permanent bearings and all outstanding concrete works to the abutments and parapets are completed.

Design challenges

What made this project especially challenging was the geometry of the deck. The horizontal alignment called for a 175 m diameter circular curve, with a straight inclined vertical alignment of 0.5%. It is, however, not possible to construct an incrementally launched bridge to this exact geometry. Both the horizontal alignment and the vertical alignment must be circular, resulting in a bridge geometry which is a three dimensional circle in space, making the launching process extremely complicated.

Calculation of this launch path can be solved by means of complex mathematical equations or it can be solved visually by means of a three dimensional drafting package. For the Chota Motala Incrementally launched bridge, both these methods were used in order to check and cross-check the calculated levels. The designers used an in-house developed computer program whereas the contractor's temporary works designer used three dimensional drafting. Close correlation was found between the methods and this resulted in high confidence in the calculated levels. Tolerances on the temporary works were within 1 millimetre to ensure that the bridge reached the correct position at the other end. During the launching process the path of the bridge had to be carefully monitored to ensure that it didn't deviate from the intended path.

An important aspect of conceptual design is to make provision for access to the bridge bearings for maintenance and replacement

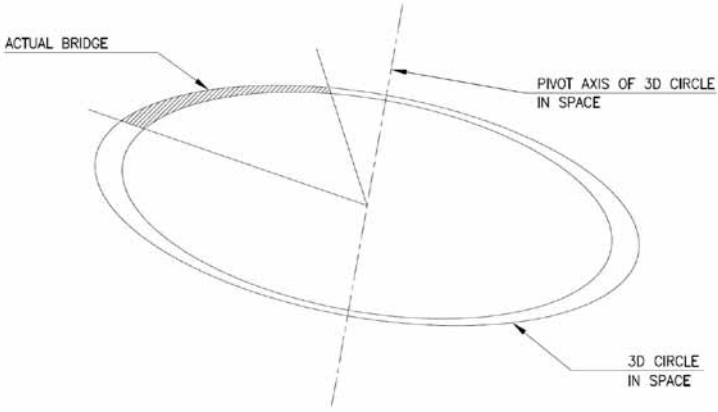


Figure 4: Circle in space

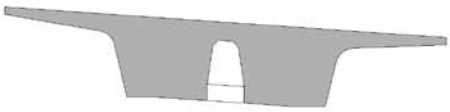


Figure 5: Recess in diaphragm for bearing access

Figure 6: Internal blisters for stressing draped cables

purposes. In what is a first for bridge design in South Africa, a recess was left in the bridge diaphragms, the deck soffit and the top of the piers. A maintenance person will gain access to the inside of the girder through one of the access hatches and then proceed to the diaphragms where he/she will climb through the recess in the deck soffit into the recess in the top of the piers. This will allow sufficient access to the bearings.

Apart from the geometric challenges, the most complicated part of the design was the design of the post tensioning elements. The bridge utilizes both concentric and draped post tensioned cables, each fulfilling a different role during and after construction.

Concentric cables fulfill the serviceability requirements during the launching of the bridge by limiting deflections and cracking of the deck. Limiting deflections is vital to ensure that the launching nose is high enough when it reaches the next pier to be able to move over the temporary bearings. The concentric cables are also used to stress the segments together as they are completed to create a continuous deck. After launching, draped cables are fed through the sleeves that have been cast in during construction. At intermediate points inside the deck there are blisters against which the draped cables are stressed (refer to Figure 6). In order to get access to the inside of the deck, voids are left in the top slab, big enough for stressing jacks to fit through. The function of the draped cables is to limit deflections and cracking during normal operation of the bridge and to provide strength during ultimate loads. Many of the concentric and draped cables overlap which required careful calculation of overlapping tendon force profiles and complicated post-tensioning loss effects.

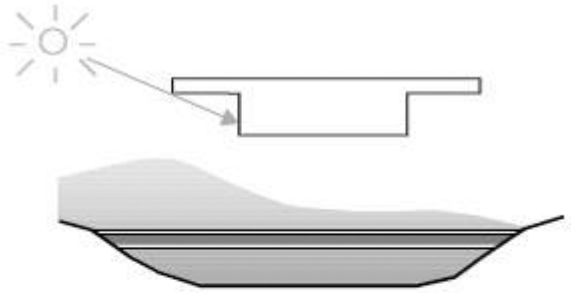
Cast bed

Skid beams

Launching nose

Launching jack in position

Maximising the overhang will increase the shadow



An angled connection will minimise this effect

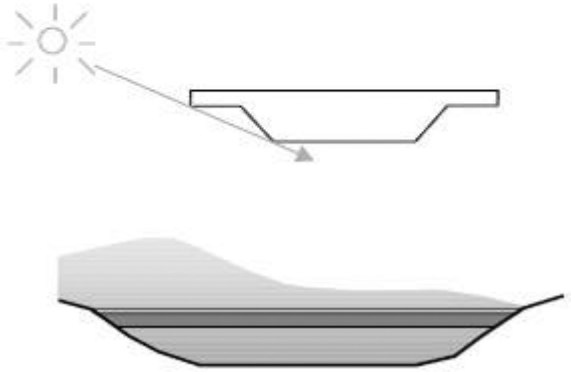


Figure 7: Shadows on the deck

Due to high jacking forces on the internal blisters, large amounts of reinforcement were needed to tie the blisters to the webs.

Pier 6 (from the Greytown side) was positioned directly on top of an existing culvert under Ramp B. Since the existing Ramp B will be discarded it was assumed that the culvert could be demolished to make way for the pier foundation. The contractor's construction sequence made this impossible and an alternative solution had to be found quickly in order to prevent delays. The position of the pier could not be revised without increasing the span lengths significantly and the proposed solution was to design a piled foundation with a pile cap spanning across the culvert. The pile cap was essentially a beam with a very high point load in the middle which resulted in a heavily reinforced pile cap. Deflections of the pile cap had to be minimized to prevent additional settlement forces on the deck above.

Aesthetics

Ramp E is the most prominent bridge of the Greytown Interchange which made aesthetics an extremely important consideration in the design. After consultation with the SANRAL bridge network manager, Edwin Kruger, it was decided that the services of an architect would not be employed, but that the consultants would consider a number of options for an aesthetically pleasing structure. After considering various pier and deck shapes the final proposal is an extremely elegant an aesthetically pleasing structure. The following aspects were considered:

- Slenderness. The slenderness ratio of Ramp E is in excess of 16, making for a streamlined design.
- Span lengths. To create an aesthetically pleasing bridge it is important that the span lengths should be similar. The span lengths of Ramp E change from 25.15 m to 33.55 m to 36.05 m, making successive spans similar in length.
- Pier diameter. In bridge design it is important that no element dominates. The deck depth should therefore not dominate the pier diameter. The deck depth is 2.15 m and the pier diameter is 2 m resulting in a ratio of very close to 1.
- It is important that lines on the deck are continuous. Ramp E has no disruptions along the length of the deck.
- The shapes of members must reflect the forces acting on them. The structural design of Ramp E was optimized to prevent any disproportionate member sizes.
- Shadows. Ramp E runs approximately in a north-south direction which means that the rays of the sun shine perpendicular on the bridge in the mornings when the sun rises and in the evenings when the sun sets. To eliminate lines on the deck caused by shadows, two methods were employed. The first was to maximize the cantilever length and the second was to make sure that the outside of the girder webs and the deck cantilever did not meet at right angles. The concept is illustrated in Figure 7.

Apart from the structural form, a lighting subcontractor (DNA Consulting Engineers & Project Managers) was appointed for the street and architectural lighting of the bridge. Ramp E is a milestone in the street lighting industry having the first major LED street lighting installation on a national road in South Africa. The entire interchange is fitted with an energy efficient and aesthetically pleasing lighting solution. Ramp E is decorated with blue high output-low energy LED ribbons and spotlights. The street lights are high output-low energy LED fittings replacing the standard 250 W & 400 W HPS (High Pressure Sodium) with an energy efficient 170 W & 270 W respectively. Ramp E is a pioneer in the energy saving industry for bridge lighting systems and sets an example for others to follow.

Ingenuity in construction techniques

Launching Equipment

For the launching of Ramp E the Eberspächer AH124 system was used. This system made a conventional launch possible even though the bridge was launched on a slight downhill slope of 0.5%.

For the first 10 m of the launch, the bridge had to be pulled from the casting yard until the first segment reached the launching jacks.

The jacks operate on a lift and slide cycle. The jack lifts the deck up off the temporary bearings and, through friction between the jack and the deck, the deck is moved forward as the jack moves forward. The jack then lowers, placing the deck on the temporary bearings and then retracts to its starting position and the cycle is repeated.

Once the deck reaches a pier there are side guides which help steer the bridge in the right direction. Rubber pads are fed through

between the deck and the side guide to protect the deck from any damage should it come into direct contact with the side guides.

Deck Formwork and Construction

The Formwork used for the Ramp E Incremental launch bridge was designed by Formscaff and was made out of steel to obtain a smooth F3 off shutter finish. The deck formwork consisted of the deck soffit panels, external web wall panels and the internal web wall panels. These panels were fabricated in three metre pieces so as to maintain the radius of the bridge. The wedge soffit formwork panels were placed between the skid beams and were supported by a super beam jacking system. The outside web wall shutters were fixed against the outside edge of the skid beams and was also supported by the super beam frame and secured to skid beams with tie rods. The internal web wall shutters were fixed into the outer web wall shutters.

The jacks supporting the super beams were used to raise and lower the deck shutter. This had to be done simultaneously to ensure that the shutter did not twist. The top slab shutter consisted of a scaffold platform with economy panels. The levels of this shutter were adjusted by raising and lowering the base jacks.

The bridge deck was cast in two stages. The soffit and web walls were cast in the first pour and the top slab in the second pour. The concrete for the bridge deck was placed using concrete buckets.

In order to reduce the cycle time of each launch, a higher strength concrete was used that allowed the required strength gain for stressing after three days.

The casting yard for the launch bridge was 60 m in length. It allowed for a 20 metre platform to prefix the reinforcing for the following segment. This reduced the fixing time for the next segment. A mobile shed was erected that allowed for the continuation of work during inclement weather.

Survey and communication

The survey equipment that was used to monitor the launching of the bridge was a Leica TS 15i with Leica geo-office 3D monitoring software. The alignment of the bridge was monitored by using a fixed point that was established in the first segment which was a metre away from the girder. Using live readings to this point, the bridge was monitored against the designed alignment. If the live readings differed from the designed alignment values, sliding pads were added or subtracted at the temporary pier bearing side guides to guide the bridge into its designed alignment. Two-way radios were used to communicate with the supervisors at each pier during the launching process.

For the monitoring of the temporary pier deflections, a survey system was used whereby a pillar beacon was built next to the launch equipment. This allowed for easy communication between the surveyor and the launching jack operator. Retro targets were glued onto all temporary piers and the deflection of the piers was monitored regularly during the launch process.

Social Upliftment and Health and Safety

One third of the labour force on the Ramp E Bridge team consisted of workers that were employed from the local community. These labourers were equipped with basic training on power tools, the use and maintenance of hand tools, erecting scaffolding, basic concrete skills and banksmen training. A total of 320 people were trained and 226 certificates were awarded.

The contractor also has reason to be proud of an excellent safety record on the project. Out of approximately 1,8 million man hours worked, only one incident leading to lost time occurred. The safety culture was very evident to anybody visiting the site with labourers quick to point out any unsafe behaviour.

Economic considerations

Tenders were called for the construction of this project towards the end of all the soccer World Cup projects and competitive prices were therefore expected. This was indeed the case with the tender for the Chota Motala bridge coming in at approximately R 26 million excluding P&G's and escalation. This equated to a cost per square metre of deck area of R 9,700, which compared extremely favorably with similar bridges recently constructed.

When considering the expected low maintenance cost during the lifetime of this bridge, it is believed that the client received extremely good value for their investment.

Conclusions

A combination of innovation in design and construction together with extreme care taken with details and concrete finishes resulted in an aesthetically pleasing structure that will be a landmark on the Pietermaritzburg horizon for years to come. ▲

How does cold reinforcing steel affect fresh concrete?

A new study evaluates the effects of placing 55°F concrete in contact with -5°F reinforcing steel.

by Ronald L. Kozikowski, W. Calvin McCall, and Bruce A. Suprenant

Documents produced by ACI Committee 306, Cold Weather Concreting, have long cautioned engineers and contractors about the effects of cold surfaces on fresh concrete. In this article, we discuss how some of those recommendations have changed through the years. We also present data obtained during placements of warm, fresh concrete around initially cold reinforcing bars, showing that many of these recommendations may be unnecessary.

ACI Cold Weather Concreting Recommendations

Two sections that have been published in different editions of ACI 306R (as far back as 1966 and up to 2010) are addressed in this study. These sections cover: Preparation of surfaces in contract with fresh concrete; and Identifying and heating massive metallic embedments.

Surfaces in contact with fresh concrete

Through the decades, ACI Committee 306 has published many different recommendations for surfaces in contact with fresh concrete. These have included:

In a chapter on preparation before concreting, "Recommended Practice for Cold Weather Concreting (ACI 306-66)"[1] suggested that "all surfaces to be in contact with the new concrete should be raised to as close as may be practical to the temperature of the new concrete that is to be placed thereon." "Cold Weather Concreting (ACI 306R-78)"[2] provided more explicit recommendations, stating that "Preparation… consists primarily in ensuring that all surfaces to be in contact with newly-placed concrete are at a temperature that cannot cause early freezing or seriously prolong hardening" [emphasis added]. It further stated that "Ordinarily, the temperature of these contact surfaces… need not be higher than a few degrees above freezing, say 35°F (2°C), and preferably not higher than the minimum temperature of concrete to be placed, as shown in Table 1.4.1, Line 1" [emphasis added]. The minimum temperatures recommended in Table 1.4.1 ranged from 55 to 40°F (13 to 4°C) for sections with minimum dimensions of less than 12 in. (300 mm) to greater than 72 in. (1800 mm).

Section 4.1 of ACI 306R-88[3] had similar language, but concluded with the statement that the temperature should be "preferably not more than 10°F (5°C) higher than the minimum placement temperatures." (It referred to a table with the same minimums published in the 1978 edition.)

The most recent edition, ACI 306R-10,[4] states in Section 6.1 that "Preparation before concrete is placed requires a temperature increase of the formwork, reinforcement, and other surfaces that will contact fresh concrete so the temperature of the freshly placed concrete will not decrease below the minimums as placed and maintained (Table 5.1)" [emphasis added]. The document further states, "There are many techniques for warming formwork and embedded items… Best practice indicates that all surfaces should be above the freezing temperature of water." This edition also cautioned to "take care to limit surface temperatures to no more than 10°F (5°C) greater or 15°F (8°C) less than that of the concrete to avoid inconsistent setting, rapid moisture loss, and plastic shrinkage cracking."

Massive metallic embedments

ACI 306R-88[3] stated in Section 4.2 that "The placement of concrete around massive metallic embedments that are at temperatures below the freezing point of the water in concrete may result in local freezing of the concrete at the interface." The document included the recommendation made by Suprenant and Basham,[5] who stated that "steel embedments having a cross-sectional area greater than 1 in.^{2} (650 mm^2) should have a temperature of at least 10°F (-12°C) immediately before being surrounded by fresh concrete at a temperature of at least 55°F (13°C)," and it recommended that "The engineer/architect should determine whether the structure contains large embedments that pose potential problems."

The Mandatory Requirement Checklist in ACI 306.1-906 requires the Specifier to identify massive metallic embedments. This checklist also states that the massive embedments "must be at a temperature above freezing prior to placement of concrete."

Section 6.2 of ACI 306R-10[4] also addresses this issue by stating "The architect/engineer should identify those portions of embedment that pose potential problems" and recommends that "Ideally, the embedment should be heated to the temperature of the concrete immediately before concrete placement."

So, the recommendations for massive metallic embedments have a curious history: ACI 306R-88[3] stated in Section 4.2 that "additional study is required before definitive recommendations can be formulated," yet ACI 306.1-90[6] requires massive embedments "to be at a temperature above freezing." And the most recent version of ACI 306R (ACI 306R-10[4], Section 6.2) recommends that the massive embedment "should be heated to the temperature of the concrete." During cold weather, the temperature of the fresh concrete could be as high as 60 to 65°F (16 to 18°C)!

Previous Analytical Studies

Since 1988, the cited ACI 306 documents have referenced work by Suprenant and Basham,[5] in which a finite element method (FEM) model was used to solve the heat flow problem of cold reinforcing steel in contact with warm concrete. Two cases were investigated: a

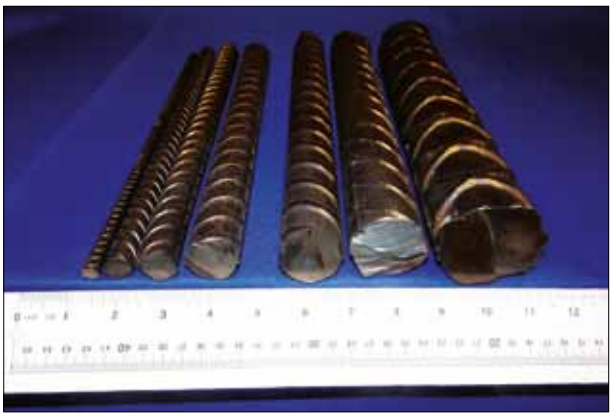


Fig. 1: Grade 60 bars conforming to ASTM A615 were used in the study. From left to right, the bars were size No. 3, 5, 7, 9, 11, 14, and 18 (the reference scale is in units of in. and mm)

Fig. 2: Molds were constructed of plywood, dimension lumber, and 1 in. (25 mm) thick extruded polystyrene (XPS) insulation boards. Fourteen molds were sized to provide steel concentrations of 1 and 5% for each of the seven bar sizes used in the study

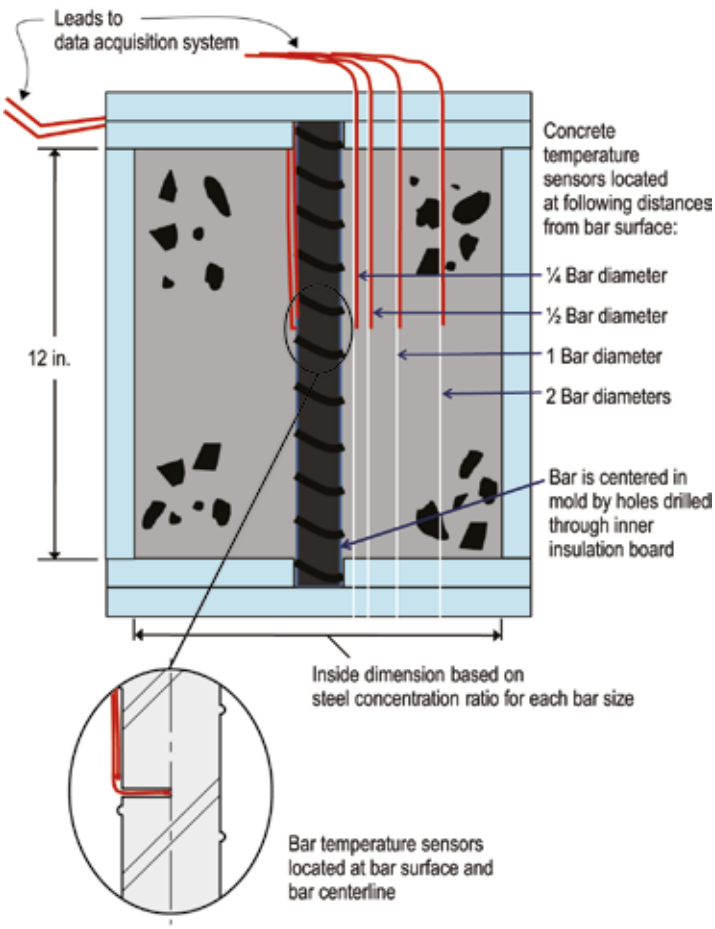


Fig. 3: In addition to the two thermistors attached to the bar, extra thermistors were installed in the mold to allow monitoring of the concrete temperature at up to four distances from the surface of the bar

No. 9 bar in a slab and a square steel tube filled with concrete. The initial concrete temperature was set at 55°F (13°C), and three initial reinforcing steel and steel tube temperatures were considered: +10, 0, and -10°F (-12, -18, and -23°C). The steel and concrete were assigned specific heat values of 0.11 and 0.22 Btu/lb·°F (460 and 924 J/kg·K) and conductivity values of 70.0 and 1.2 Btu/hr·ft·°F (120 and 2.1 W/m·K), respectively. While the models did not include convective heat transfer in the fresh concrete, they did include internal heat generation. Based on the assumption that freezing would occur when the concrete temperature reached 22°F (-6°C), the researchers suggested that steel embedments having a cross-sectional area greater than 1 in.^{2} (650 mm^2) should have a temperature of at least 10°F (-12°C) before placing fresh concrete.

Similar analytical work was later conducted by Swift et al.[7] Numerous parameters were varied, including the conductivity values and the initial temperatures for the steel and concrete. As with the earlier study,[5] the models did not include convective heat transfer between the steel and concrete but did include internal heat generation. Based on the assumption that freezing would occur when the concrete temperature reached 32°F (0°C), the researchers suggested that a thin (0.035 in. [0.89 mm]) layer of ice could form in 55°F (13°C) concrete placed against a 1.5 in. (38 mm) diameter bar at an initial temperature of 10°F (-12°C). The researchers acknowledged, however, that physical testing should be conducted to verify that freezing does actually occur.

Current Test Study

The reinforced concrete sections tested in the current study included ASTM A615 Grade 60 reinforcing bar, with sizes ranging from No. 3 to No. 18 (Fig. 1). The bars were placed in molds sized to provide steel concentrations of 1 and 5% of the gross concrete section (Fig. 2). The 1% steel concentration was selected as a conservative representation of elevated slabs or reinforced slabs-on-ground. The 5% steel concentration was selected to represent moderately reinforced concrete column sections and for comparison to the FEM study by Suprenant and Basham.[5]

Experimental setup

The concrete mixture proportions are provided in Table 1. The mixture was non-air-entrained and was designed with a slump of 7 to 9 in. (178 to 229 mm) for ease of placement and consolidation.

Concrete molds comprised wooden boxes lined with 1 in. (25 mm) extruded polystyrene (XPS) insulation boards (the R-value of the insulation was 5 hr·ft·°F/Btu [0.87 m^{2}K/W]) (Fig. 2). Each mold had a square cross section and net interior height of 12 in. (305 mm). The gross cross-sectional area of the concrete was

calculated to provide a 1 or 5% steel concentration for each reinforcing bar size. The bar and mold dimensions are listed in Tables 2 and 3 for the 1% and 5% steel concentrations, respectively.

Each reinforcing bar was cut to a length of 14 in. (356 mm) and instrumented with two thermistors: one tied to the bar surface with fishing line, and the second inserted in a hole drilled into the bar at mid-length. An instrumented bar was centered in each mold (Fig. 3), and additional probes for measuring concrete temperatures were positioned midheight in the molds at distances of ¼-, ½-, and 1-bar diameters and at ¼-, ½-, 1-, and 2-bar diameters from the bar surface, for the 1% and 5% steel concentrations, respectively. Probe spacing was based on reinforcing bar diameter to allow a relative evaluation of concrete temperature variation throughout the mold for each reinforcing bar size.

Table 1: Concrete mixture proportions

Material	Weight*, lb/yd³ (kg/m³)
Cement, Type I/II	576 (342)
Sand (siliceous)	1373 (815)
Stone (siliceous), 3/4 in. (19 mm) maximum	1900 (1127)
Water	300 (178)
Type A water reducer, fl oz/cwt (mL/100 kg)	5 (326)
Air content, %	2

*Aggregates in saturated surface dry condition

The probes were strung vertically down through the top of the mold and attached to taut strings to minimize side-to-side movement during concrete placement.

A National Instruments NI USB-6218 multifunction data acquisition module with 16-bit precision was used to collect sensor data. Sensors were Measurement Specialities thermistors with factory-applied plastic caps and lead wires. Measured resistance values were converted to temperature using the manufacturer's tabulated resistance-temperature data. Temperatures were measured at 1-second intervals from the start of placement.

Preconditioning and placement

Reinforcing bar samples were installed in the molds and stored in a chest freezer until they cooled to -5°F (-21°C). This temperature was chosen as a worst-case scenario for cold weather concreting. Molds were kept in the freezer until the concrete was mixed and ready for placement.

Concrete was mixed in an 8 ft³ (0.23 m³) rotating drum mixer in accordance with ASTM C192, "Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory." Three to four molds were filled at a time, with concrete batches ranging in volume from 3 to 5 ft³ (0.08 to 0.14 m³). Raw materials were conditioned to produce an initial concrete batch temperature of about 55°F (13°C), corresponding to a minimum concrete temperature when placed of 55°F (13°C) for concrete sections less than 12 in. (300 mm) thick, as specified in ACI 306.1-90.[6]

Table 2: Specimen mold dimensions based on bar size and 1% steel concentration

Bar size designation	Bar diameter, in. (mm)	Bar cross-sectional area, in.² (mm²)	Mold cross-sectional dimensions, in. x in. (mm x mm)	Mold volume, in.³ (mm³)
No. 3	0.375 (9.5)	0.11 (70)	3.32 x 3.32 (84.3 x 84.3)	132.3 (2,167,500)
No. 5	0.625 (15.9)	0.31 (200)	5.54 x 5.54 (141 x 141)	368.3 (6,035,300)
No. 7	0.875 (22.2)	0.60 (390)	7.75 x 7.75 (197 x 197)	720.8 (11,811,000)
No. 9	1.128 (28.7)	1.00 (650)	10.00 x 10.00 (254 x 254)	1200.0 (19,664,500)
No. 11	1.41 (35.8)	1.56 (1006)	12.50 x 12.50 (318 x 318)	1875.0 (30,725,700)
No. 14	1.693 (43.0)	2.25 (1450)	15.00 x 15.00 (381 x 381)	2700.0 (44,245,100)
No. 18	2.257 (57.3)	4.00 (2580)	20.00 x 20.00 (508 x 508)	4800.0 (78,657,900)

Table 3: Specimen mold dimensions based on bar size and 5% steel concentration

Bar size designation	Bar diameter, in. (mm)	Bar cross-sectional area, in.² (mm²)	Mold cross-sectional dimensions, in. x in. (mm x mm)	Mold volume, in.³ (mm³)
No. 3	0.375 (9.5)	0.11 (70)	1.49 x 1.49 (37.8 x 37.8)	26.6 (436,600)
No. 5	0.625 (15.9)	0.31 (200)	2.48 x 2.48 (63.0 x 63.0)	73.8 (1,209,400)
No. 7	0.875 (22.2)	0.60 (390)	3.47 x 3.47 (88.1 x 88.1)	144.5 (2,367,800)
No. 9	1.128 (28.7)	1.00 (650)	4.47 x 4.47 (114 x 114)	239.8 (3,929,100)
No. 11	1.41 (35.8)	1.56 (1006)	5.59 x 5.59 (142 x 142)	375.0 (6,144,800)
No. 14	1.693 (43.0)	2.25 (1450)	6.71 x 6.71 (170 x 170)	540.3 (8,843,800)
No. 18	2.257 (57.3)	4.00 (2580)	8.95 x 8.95 (227 x 227)	961.2 (15,751,700)

At the time of concrete placement, molds were removed one at a time from the freezer and filled with concrete as rapidly as possible. Molds were filled continuously in a single lift. The goal was to complete the process in 30 seconds or less for each mold. Concrete was discharged into larger molds directly from the mixer. Smaller molds were filled using a 5 gal. (19 L) bucket. Concrete was consolidated by thumping the sides of the molds with a rubber mallet. Molds were capped with insulation and stored inside a 4 in. (102 mm) thick insulation box while the temperatures were measured, until the reinforcing steel and concrete temperatures were nearly equal (equilibrium).

Preliminary freezing of water, paste, mortar, and concrete

Prior to testing the reinforced concrete specimens, preliminary testing was done to ensure the data acquisition and temperature probes were responding properly. Paste, mortar, and concrete samples were made, using the same raw material sources, at a constant watercement ratio (w/c) of 0.50.

Samples of water, paste, mortar, and concrete were placed in individual containers. A thermistor was set into the middle of each container and the samples were placed in a commercial-grade freezer. The freezer set points were 25°F (-4°C) and 5°F (-15°C). Typically, the compressor would turn on or off, respectively, at about 1-hour intervals. The freezer temperature varied from 25 to 5°F (-4 to -15°C), with an average temperature of about 15°F (-9°C).

All four samples show the same behavior (Fig. 4). Specifically, after the sample goes through an initial temperature drop, ice formation is indicated by the start of a constant temperature plateau. The end of ice formation is indicated when the sample temperature starts to decrease again.

The cooling curve for water shows a little super-cooling – a temperature slightly below 32°F (0°C) – as there are no initial nucleation sites for ice crystals to form. The super-cooling is not evident in the paste, mortar, and concrete samples, as they have many nucleation sites.

Note that the freezing temperature varies between the samples. The freezing point of the water sample was 32°F (0°C), while the freezing points of the paste, mortar, and concrete samples were about 30.5°F (-0.8°C) due to the dissolved ions in the mixing water. These freezing points are consistent with the values of 28.5 to 29.5°F (-1.9 to -1.4°C) measured by Korhonen[8] on four mortar samples with w/c ranging from 0.40 to 0.52.

Time-Temperature Results

Because their cross-sectional areas are 1 in.2 (650 mm²) and smaller, the No. 3, No. 5, No. 7, and No. 9 bars can be considered to correspond to ACI Committee 306 recommendations for preparation of surfaces in contact with fresh concrete. The larger bars (No. 11, No. 14, and No. 18) have cross-sectional areas that exceed 1 in.² (650 mm²) and thus can be considered to correspond to committee recommendations regarding massive metallic embedments.

Comparison with the FEM model

The FEM analyses conducted by Suprenant and Basham[5] provided time-temperature histories at the surface of an initially cold No. 9 steel bar after immersion in warm concrete. The study included an initial bar temperature of -10°F (-23°C), a concrete temperature of 55°F (13°C), and a steel concentration of 4.2%, so the analytic results can be compared to the data for a No. 9 bar at a 5% steel concentration. As shown in Fig. 5, the shapes of the temperature curves obtained in the

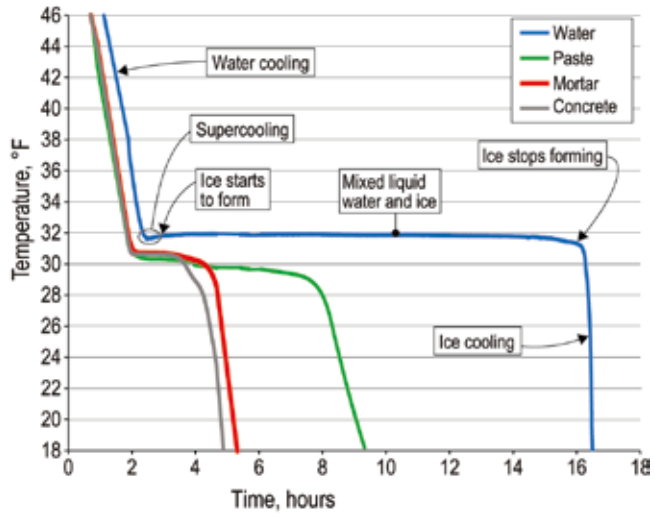


Fig. 4: The test apparatus and instrumentation were evaluated by cooling samples of water, cement paste, mortar, and concrete. The data show all samples exhibited water cooling, ice formation (starting at the beginning of the freezing point plateau), and ice cooling. The curve for water shows super-cooling as the temperature drops slightly below 32°F (0°C) at the beginning of ice formation. The curves for the paste, mortar, and concrete samples indicate that the freezing point ranged from 30.3 to 30.6°F (about -1°C). These values are higher than the 28.5 to 29.5°F (-2 to -1.5°C) range measured by Korhonen8 for the freezing point of mortar (Note: 1°F = 1.8°C + 32)

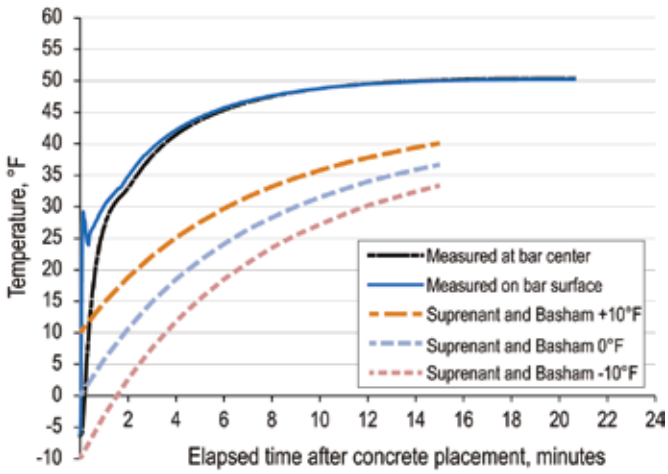


Fig. 5: A comparison of temperature readings from the current study and the FEM results obtained by Suprenant and Basham.[5] Both data sets are for a No. 9 bar with a steel concentration ratio of about 5%. While the shapes of the curves are similar, the FEM results are conservative. The FEM model did not include convective heat transfer (which would almost certainly be a factor during consolidation of the concrete), and the analyses were based on the thermal conductivity of hardened concrete (the conductivity of fresh concrete could be higher than the conductivity of hardened concrete) (Note: 1°F = 1.8°C + 32)

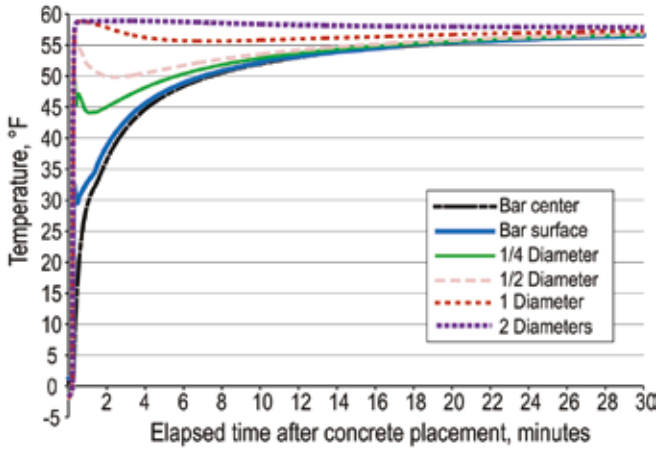


Fig. 6: Temperature readings for a No. 9 bar with a steel concentration ratio of 1%. While the bar surface readings exhibit a brief drop in temperature from 32.5 to 30°F (0.3 to -1.1°C) at 14 to 23 seconds after placement, the curve does not exhibit a freezing point plateau (Note: 1°F = 1.8°C + 32)

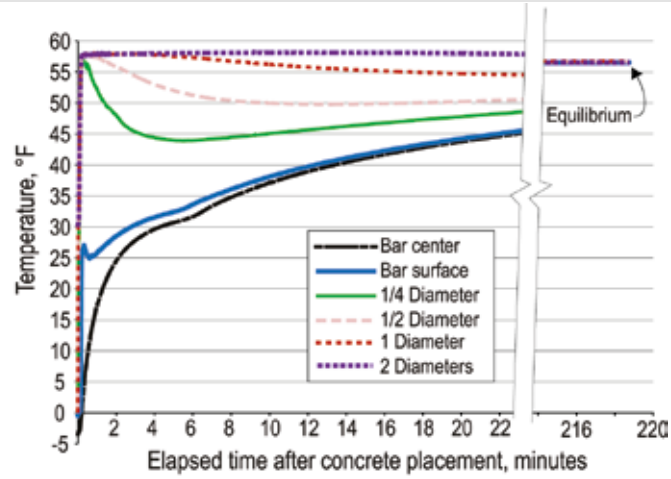


Fig. 7: Temperature readings for a No. 18 bar with a steel concentration ratio of 1%. The readings at the bar surface exhibit a slight temperature drop from 26 to 25°F (-3.3 to -3.9°C) at about 30 seconds after placement. While a very small plateau is evident and could indicate the initial formation of ice, the plateau persists for only about 20 seconds. The amount of ice would be very small and would be melted as the concrete warmed the bar surface above 32°F (0.0°C). The temperature curves converge at about 220 minutes at an equilibrium temperature of 56.6°F (13.7°C). Based on the initial bar temperature of -4.1°F (-20.1°C) and the initial concrete temperature of 58.1°F (14.5°C), the calculated equilibrium temperature was 57.0°F (13.9°C) (Note: 1°F = 1.8°C + 32)

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current study are similar to those obtained using the FEM model, but the model results do not show the very rapid early increase in the bar temperature observed in the experiment. These differences could be at least partially attributable to the fact that the FEM model did not include convective heat transfer (which almost certainly could be a factor during placement and consolidation as the concrete flows around the bar surface). In addition, the analyses were based on thermal conductivities for hardened concrete, yet the thermal conductivity of fresh concrete could be significantly higher.

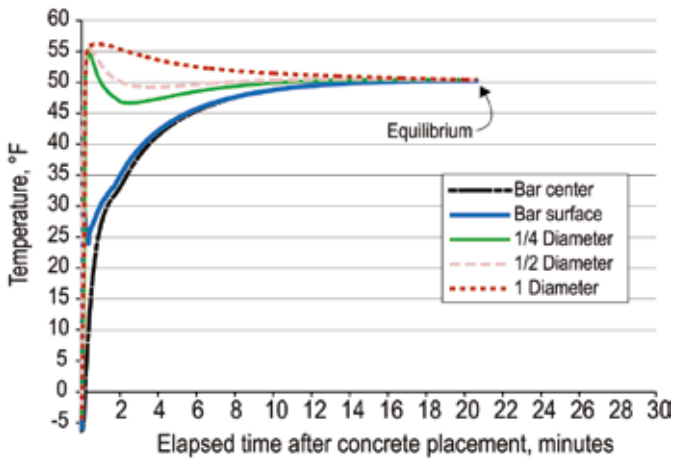

Fig. 8: Temperature readings for a No. 9 bar with a steel concentration ratio of 5%. A comparison of this No. 9 bar with the No. 9 bar with a 1% concentration ratio (Fig. 6) shows that the equilibrium temperature is lower but occurs earlier for the bar with higher concentration ratio (Note: 1°F = 1.8°C + 32)

Surfaces in contact with fresh concrete

ACI 306R-88[3] recommends heating reinforcing bars to about 35°F (2°C), whereas ACI 306R-10[4] recommends heating surfaces so the temperature of freshly placed concrete will not drop below minimum temperature protection requirements. Table 4 shows that fresh concrete at about 55°F (13°C) heats the No. 3 through No. 9 bars up to 32°F (0°C) in about 1 minute.

Because the concrete loses heat to the steel, the equilibrium temperature for the steel and concrete will be lower than the initial concrete temperature. This is an important consideration for ACI 306R-10 recommendations. As Table 4 shows, with a No. 3 bar at an initial temperature of 0°F (-18°C), the concrete temperature drops from 55.0 to 54.8°F (12.8 to 12.7°C). With a No. 18 bar at an initial temperature of -4.2°F (-20.1°C), the concrete temperature drops 1.5°F (0.8°C), from 58.1 to 56.6°F (14.5 to 13.7°C).

Figure 6 shows the temperatures as a function of time at the center and surface of a No. 9 bar as well as in the concrete. The data show that the steel bar surface warms quickly and the temperature change at the centerline lags behind that at the surface. While the temperature of the concrete located two bar diameters away from the bar surface was not affected by the cold steel, the concrete closer to the bar lost

Table 4: Temperature and time data for reinforcing steel at 1% steel concentration

1% steel	Initial steel temperature, °F (°C)	Initial concrete temperature, °F (°C)	Time for bar surface to heat to 32°F (0°C), minutes	Time for bar-concrete thermal equilibrium, minutes	Bar-concrete equilibrium temperature, °F (°C)
No. 3	0.0 (–17.8)	55.0 (12.8)	0.2	15	54.8 (12.7)
No. 5	–2.2 (–19.0)	55.0 (12.8)	0.3	—*	—*
No. 7	1.6 (–16.9)	57.8 (14.3)	0.5	—*	—*
No. 9	0.5 (–17.5)	58.8 (14.9)	1.3	—*	—*
No. 11	–2.9 (–19.4)	56.7 (13.7)	2.0	120	55.2 (12.9)
No. 14	–4.6 (–20.3)	57.8 (14.3)	2.8	—*	—*
No. 18	–4.2 (–20.1)	58.1 (14.5)	4.6	220	56.6 (13.7)

*Temperature measuring stopped

Table 5: Temperature and time data for reinforcing steel at 5% steel concentration

5% steel	Initial steel temperature, °F (°C)	Initial concrete temperature, °F (°C)	Time for bar surface to heat to 32°F (0°C), minutes	Time for bar-concrete thermal equilibrium, minutes	Bar-concrete equilibrium temperature, °F (°C)
No. 5	–0.8 (–18.2)	56.4 (13.6)	0.3	9	52.6 (11.4)
No. 7	–4.1 (–20.1)	55.0 (12.8)	0.9	12	50.5 (10.3)
No. 9	–6.3 (–21.3)	56.2 (13.4)	1.4	21	50.4 (10.2)
No. 18	–4.1 (–20.1)	56.8 (13.8)	5.1	120	50.2 (10.1)

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heat and temperature while warming the bar. Because heat flow is proportional to temperature differential and steel has a much higher conductivity than concrete, the temperature drops exhibited in the concrete lag behind the temperature drop in the steel.

Notably, Fig. 6 lacks a constant temperature plateau. A plateau would be expected if ice were forming in the concrete (refer to Fig. 4). Thus, there is no evidence that any of the concrete mixing water was frozen after coming in contact with cold reinforcing bar. On three specimens, the test time was extended so that equilibrium temperatures could be measured (Table 4). As expected, smaller bars reached equilibrium earlier than larger bars, with No. 3, No. 11, and No. 18 bars requiring 15, 120, and 220 minutes, respectively.

Massive metallic embedment

The time-temperature curves for the No. 18 bar (for purposes of this study, considered a massive metallic embedment) are shown in Fig. 7. Note that while Fig. 7 is similar to Fig. 6, the No. 18 bar took significantly longer to reach the equilibrium temperature (220 minutes) than a No. 9 bar (about 30 minutes). Measured equilibrium temperatures correlated well with calculated values, and the measured values provided valuable information on the rate at which temperature equilibrium actually occurs.

The temperature curve for the bar surface in Fig. 7 shows a slight drop from about 26 to 25°F (-3.3 to -3.9°C) at a time of about 30 seconds. At this location, a very small plateau can be seen, which could indicate that water is starting to turn to ice. This small plateau lasts for only about 20 seconds, however, so if ice did form, it would have been a very small amount that would have been melted as the surrounding concrete heated the bar past 32°F (0°C).

Effect of steel concentration

The effects of an increased steel concentration, from 1 to 5%, can be seen by comparing results in Tables 4 and 5. The data for the No. 9 bar show that while the higher steel content has no effect on the time required for the concrete to heat the bar to 32°F (0°C), the high

References

1. ACI Committee 306, "Recommended Practice for Cold Weather Concreting (ACI 306-66)," American Concrete Institute, Farmington Hills, MI, 1966, 25 pp.
2. ACI Committee 306, "Cold Weather Concreting (ACI 306R-78)," American Concrete Institute, Farmington Hills, MI, 1978, 22 pp.
3. ACI Committee 306, "Cold Weather Concreting (ACI 306R-88)," American Concrete Institute, Farmington Hills, MI, 1988, 23 pp.
4. ACI Committee 306, "Guide to Cold Weather Concreting (ACI 306R-10)," American Concrete Institute, Farmington Hills, MI, 2010, 26 pp.
5. Suprenant, B.A., and Basham, K.D., "Effects of Cold Embedments on the Temperature of Fresh Concrete," Proceedings, Third RILEM International Symposium on Winter Concreting, Technical Research Center of Finland, (VTT), Espoo, Finland, 1985.
6. ACI Committee 306, "Standard Specification for Cold Weather Concreting (ACI 306.1-90) (Reapproved 2002)," American Concrete Institute, Farmington Hills, MI, 5 pp.
7. Swift, D.P.; Puckett, J.A.; and Edgar, T.V., "Finite Element Analysis of Cold Embedments in Fresh Concrete," Journal of Cold Regions Engineering, ASCE, V. 6, No. 2, June 1992, pp. 41-57.
8. Korhonen, C.J., "Off-the-Shelf Antifreeze Admixtures," U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, ERDC/CRREL TR-02-7, Apr. 2002.

steel content does decrease the time required to reach the equilibrium temperature. The increased steel content also lowers the equilibrium temperature.

A comparison of Fig. 6 (1% steel with No. 9 bar) with Fig. 8 (5% steel with No. 9 bar) shows that the specimen with the larger steel concentration has a lower equilibrium temperature and reaches equilibrium earlier than the specimen with the lower steel concentration.

Conclusions

This experimental study presented in this article shows that:

- The shapes of the temperature curves match those determined by Suprenant and Basham[5] in their finite element heat-transfer model. However, the test curves demonstrate that the FEM model was very conservative and did not show how rapidly concrete warms large masses of steel;
- With an initial temperature of about 0°F (-18°C), No. 3 through No. 9 reinforcing bars at 1% steel concentration in contact with fresh concrete are heated by the concrete to 32°F (0°C) in about 1 minute. No temperature plateau was observed in any of the samples. That is, there was no evidence of freezing. The time to reach steel-concrete equilibrium temperatures for these reinforcing bar sizes was observed to be under 2 hours;
- It took almost 4 hours for the No. 18 bar (the massive metallic embedment) at 1% steel concentration to reach the equilibrium temperature of 56.6°F (13.7°C). (Note that the equilibrium temperature calculated from the Zero Law of Thermodynamics was 57°F [13.9°C]). It appears that little to no ice formed as the No. 18 was heated by the fresh concrete from an initial temperature of -4.2 past 32°F (-20.1 past 0°C); and
- Increasing the steel concentration ratio from 1 to 5% did not affect the time required to heat the bars to 32°F (0°C), but it did reduce the time to reach a lower equilibrium temperature. ▲

Acknowledgments

The authors would like to recognize Baker Concrete Construction for partially funding this cold weather study with Concrete Engineering Specialists.

Note: Additional information on the ASTM standards discussed in this article can be found at www.astm.org. Received and reviewed under Institute publication policies.

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Architectural concrete façades – the what, why & how

By Daniel van der Merwe, Architect, PPC Ltd

Concrete is the most commonly used construction material for load-bearing and non-load-bearing elements. Its ability to be moulded and coloured, reflects the surface qualities of its formwork and surface treatments in the hardened state, enabling it to provide a wide range of architectural finishes which eliminate the need for additional applied finishes. By utilising concrete's aesthetic potential, as well as its structural properties, cost-effective building solutions are achieved.

Fair-faced or architectural concrete is a special type of concrete that is subject to specific requirements regarding the quality and standard of smoothness or flawlessness to create a surface intended to remain on view after completion. But high-quality, off-shutter architectural finishes require special attention. They demand formwork of high quality, extreme care in the choice and production of the concrete mix and a high level of workmanship and care by all contractors involved. Client, architect, structural engineer, building contractor, formwork and concrete suppliers must all form part of a co-ordinated team so that what is created is also that which was planned beforehand.

Using in-situ, pigmented concrete is a viable option to create a no-maintenance, robust and durable finish.

Decisions must be made throughout all the project stages which will impact on the end product, and some important considerations are highlighted here. The importance of good communication between all parties involved in the building process cannot be emphasised enough, and is the key to successful execution and achievement of a desired outcome.

Design and specifications

- Designers must be aware of detailing issues that will impact on the placement of the concrete; items such as minimum wall thickness to avoid scoring the form surface during compaction, and spacing of reinforcing bars to facilitate concrete placement and avoid honeycombing.
- The principal South African national standard in which acceptance criteria for concrete are defined is SANS 2001-CCI: 2007, Construction works Part CC 1: Concrete Works. It is recommended that the Designer is especially aware of Table 1 of Clause 4.3.1.8. This however, deals only with issues of accuracy of concrete work.

When designing and specifying architectural or fair-faced concrete finishes, the architect or designer should consider the following:

- Visual standard of fair-faced concrete
- Formwork and formwork panel system
- Surface texture (formwork panels or subsequent surface treatment)
- Formation of joints between formwork elements
- Formwork ties and tie holes (position, formation and making good)
- Subdivision of the surface (dimensions of formwork elements, formwork textures, pattern of joints, arrangement of formwork tie holes etc.)
- Joints (position, direction, width and details)
- Detailing of corners and edges (e.g. keen, chamfered)
- Colouring (selected cements, aggregates, pigments, glazing, paints)
- Surface finish of areas not cast against formwork

In-situ concrete versus precast concrete

While the most appropriate approach will vary from project to project, precast concrete has some advantages over in-situ work in terms of the range and quality of off-shutter finishes that can be achieved.

The various options of architectural concrete, such as post-shutter tooling can be used as a design device, to allow for dialogue between a building façade and its surrounding context.

The main advantage of precast concrete is that elements are generally manufactured under factory-controlled conditions. The finish and quality therefore, are generally of a higher standard than concrete elements constructed on site. Other advantages are that vertical elements such as columns and wall panels are cast as horizontal elements, providing ease of manufacture, and enabling work to be inspected prior to delivery to site.

The main disadvantages of precast concrete are limitations on the size of the elements that can be manufactured, transported to site and erected by crane, and the inevitability of joints between the panels or column/beam junctions.

Off-shutter finishes

Off-shutter finishes can either be smooth or textured. Smooth finishes are typically achieved by using smooth form-face materials such as steel or plywood with a phenolic film on the surface. Textured finishes are created by either attaching materials to the formwork such as form liners or other materials, or by using profiled form-face materials. Subsequent treatments such as tooling, bush hammering and abrasive blasting can also produce textured finishes.

A new-generation concrete which is well worth considering is SCC (self-compacting concrete) which allows for superior finishes without the need for compaction and with reduced segregation.

Smooth concrete finishes

The smoothness of the surface will be determined by the surface quality of the formwork against which it is placed. SANS 2001-CC1:2007 describes a smooth surface finish to which reference could be made.

In-situ textured concrete finishes

Formliners are materials placed against the form face to provide a negative mould against which the concrete is cast.

Almost any texture or pattern can be reproduced, from rope and board-marked finishes to various stone/rock patterns. The materials commonly used include styrene foam, rigid plastics and fibreglass, profiled steel sheet, and elastomeric materials such as polyurethane and silicone rubbers.

The use of formliners may be a more economical way to achieve a heavily textured finish over large areas, especially if a number of reuses are possible to offset the initial cost. Formliners can generally be reused many times, considerably reducing the cost per square metre. Some formliners can consist of different materials that become a permanent feature of the finish, such as various bricks and stone facings. Textured finishes can also be produced from moulds. Similar to formliners, moulds are mainly used in precast factories for the repeated provision of a pattern. If a pattern / texture is required on both faces, the top surface can be stamped. The pattern can also be designed to create a recurring, yet seemingly continuous pattern over a number of elements.

Set retarders can also be used to provide texture and colour; they are applied to the form face to retard the set of the concrete surface. Once the formwork is stripped, the cement paste on the surface is removed to reveal the aggregates, changing the colour and the texture of the surface. Photo-engraved finishes are typical of this method where an image is revealed by altering the depth of exposure of the coloured aggregate using varying amounts of set retarder.

Water washing is used to expose the aggregates by removing the cement paste prior to the hardening of the concrete surface. While it is usually used for precast concrete elements, it may be used for in-situ work in conjunction with set retarders applied to the formwork surface prior to concrete placement.

Post-shutter tooled finishes

Tooled finishes involve mechanically tooling or hammering the off-shutter finish to produce a rough texture. Common methods include bush hammering, point tooling, abrasive blasting and hammered nib.

Bush-hammered finishes range from removal of the surface cement paste (exposing the aggregates) to extensive removal of the matrix and possible fracturing of the stone. The depth of hammering must be specified (typically 1 to 8 mm) and the appearance verified by a test panel. Note that as the removal of the surface will tend to highlight any imperfections, a good-quality off-shutter finish is required. Also, to avoid

chipping the edges or corners, untreated borders some 25 to 40 mm in width should be specified and provided.

Point tooling provides a very coarse texture about 15 mm in depth. The coarse texture is suitable for larger elements, and will generally remove or conceal any surface imperfections. A large aggregate should be used.

Abrasive blasting can also be used to remove the surface paste or matrix around the stone to expose the coarse aggregate. The depth of removal should be specified, but in no case should more than one third of the aggregate particle become exposed, to ensure adequate bond into the concrete. Acid etching is an alternative method of exposing the aggregate. Its use is generally limited to precast elements.

The coarse texture of tooled surfaces generally provides colour via the exposed coarse aggregate and a surface that is less likely to be affected by staining from atmospheric contamination and weathering.

Coloured concrete

There are a number of ways to provide coloured off-shutter concrete finishes; using white cement; adding a colour pigment to the concrete; applying a coating to the form face that becomes an integral part of the surface finish, or applying a surface stain or coating after the concrete has cured. If the surface is tooled to expose the aggregates, then the use of coloured aggregates is also an option.

The colour of hardened concrete depends on the colours of the fine particles (cement, sand and pigments) used in the mix. As the sand colour has a significant influence on that of the concrete, the colour of sand to be used for coloured concrete work should be carefully selected. This is particularly important in the case of very light-coloured concretes and this includes colours such as yellow and blue. Uniformity of colour is an important aspect of off-shutter concrete. Slight variations in the colour of cement from different factories may occur as a result of differences in the raw materials, and for this reason cement supplies for any project in which colour is important should be obtained from the same factory.

Joints

The location and method by which joints (expansion, control or construction) are incorporated into the concrete structure/element can have a significant influence on the final appearance.

The joints between adjoining panels, shapes and plywood sheets are difficult to disguise and, as with other materials, they are best accentuated by making a feature of them. Typically, a rebate/recess that creates a shadow line within the surface is used. Rebates range in size and shape depending on how prominent a feature is desired, and whether it is part of a surface pattern that may be used to break up large areas and provide a sense of scale to the surface.

The precise position of joints should be specified if the surface finish is critical. The design of the structure will often determine appropriate locations for joints. (For column and beam construction, the junction between individual elements is a logical place to locate joints). Visually, beams are expected to span from column to column, and columns from floor to floor.

Precast elements allow for cost-effective, high precision dimensional and colour consistency, which was essential to the architectural appearance of the Senate, Mexico.

Assessment

Allowing for test panels reduces costs and allows a better assessment to be made of the contractor's ability to produce the specified finish. With proper consideration of the factors necessary to produce the desired as-specified finish, the initial test panel or concrete placement should achieve the required result. Note that it is not possible to assess the colour consistency from a single test panel, so only the physical characteristics and initial colour of the surface can be assessed and used as a control for the remainder of the project.

If some aspects of the finish need to be improved, the contractor then has the opportunity to refine or adjust the materials or procedures in order to achieve the required outcome. The ability to use more than one concrete placement as a test panel is often beneficial if minor adjustments need to be made. Colour consistency can also be assessed with subsequent placements in non-critical sections of the project.

Off-shutter concrete finishes can be assessed objectively only if the project documentation makes it clear what is expected. This is usually achieved by nominating specific items (type of finish, colour, etc) directly, and the general matters (tolerances, etc.) by reference to other documents (e.g. standards).

Once a mutual understanding of what is expected has been established, the assessment of what has been provided is relatively straightforward. On a typical project, these aspects of surface quality would be looked at, and any need for rectification of physical defects established. ▲

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Some properties of concrete made with Ground Granulated Blastfurnace Slag (GGBS) from Saldanha (Part 1)

Scope

PPC Cement commissioned a post-graduate research project at the University of Cape Town (UCT) to assess the performance of concretes containing GGBS as a partial replacement for OPC. The detailed results were published in 2001(1), and this TIP covers these properties in broad outline only. The research was also summarised in Research Monograph No. 6 (2)

Also covered, in more detail, are results of tests carried out in the PPC Technical Services Department (TSD) laboratories in Johannesburg, in the PPC Cape Town concrete testing laboratory, and at the University of the Witwatersrand.

Compressive Strength

The compressive strength of concrete is its most widely specified property, both for historical and practical reasons.

Successful tests have been carried out with up to 90% replacement of cement by GGBS, but the most common substitution level is 50% by mass. At that (50%) replacement level the one day strengths are lower than those for CEM I concrete at the same water/binder ratio, the three day strengths are approximately the same, and at seven and 28 days the compressive strength of the "slag" concretes exceeds that of the CEM I concretes by a significant margin.

Typical results, using CEM I 42,5N from Riebeeck West, are shown graphically below:

Durability Indices

Three indices of durability, and test methods to measure them, have been proposed and subsequently developed at the Universities of the Witwatersrand and Cape Town. The indices are the Oxygen Permeability Index (OPI), Water Sorptivity (WS) and Chloride Conductivity (CC). In the 2001 research project tests were carried out at three water/binder ratios (0,4 0,5 and 0,6) and after one, three and 28 days wet curing. Three binder types were used: CEM I 42,5N (Riebeeck West), CEM I 42,5N/GGBS (50/50 by mass), and CEM I 42,5N/Saldanha GGBS (50/50 by mass). In terms of chloride conductivity (which is the most important index in a marine environment) all three mixes containing the Saldanha slag gave results classed as "excellent" at all three ages, generally performing better than the other blastfurnace slag concretes. WS and OPI results were also "excellent" for binder/water ratios of 0,5 and 0,4 for curing periods of three days and 28 days.

In general it was concluded that concrete with potentially excellent durability can be made if the binder/water ratio does not exceed 0,5 and the concrete is cured for at least three days.

Effect on expansion caused by Alkali-Silica Reaction (ASR)

Accelerated mortar bar expansion tests were carried out at the PPC Laboratories in Johannesburg using greywacke aggregate from the Malmesbury Series. This type of aggregate is known to be highly alkali-reactive.

As can be seen from the above graph, Saldanha GGBS is effective in reducing harmful expansion due to ASR to safe levels if used in a 50/50 blend with CEM I. (The upper limit for this test method is 0,1% expansion at 12 days).

Tests have also been carried out with reactive quartzite with very similar results.

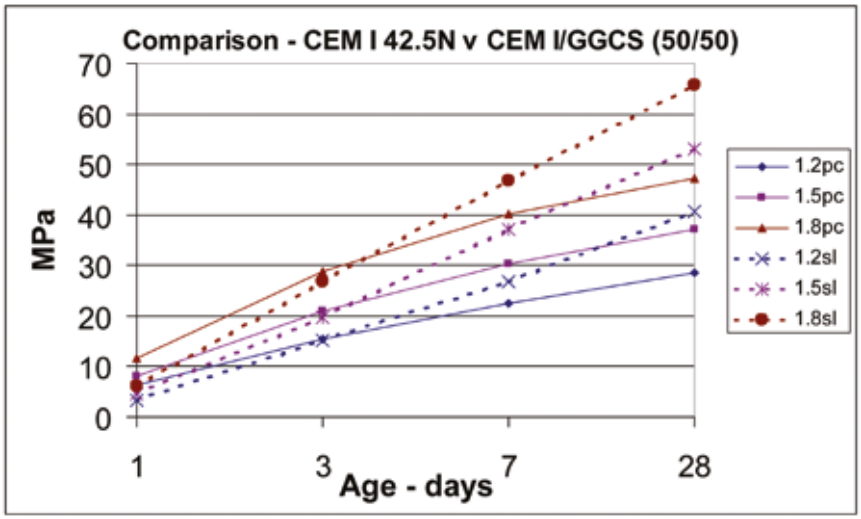
Tests to confirm these results were also carried out at UCT and the Cement and Concrete Institute.

Heat of hydration

Cement (and cement extender) hydration reactions are exothermic which can cause undesirable thermal stresses and subsequent cracking in large concrete pours. Blastfurnace slags tend to have lower heats of hydration than type I cements, but, because of its high reactivity, Saldanha slag has a slightly higher heat of hydration than CEM I 42,5N. The results of tests carried out at the University of the Witwatersrand are given below. For comparison a 70% CEM I (Riebeeck West)/ 30% Fly Ash (FA) blend was also tested.

What this test does not show, however, is that for a given compressive strength, the binder content of the slag concrete will

The codes "1.2", "1.5" etc refer to the binder/water ratio of the mix "pc" stands for CEM I mixes, "sl" for 50/50 slag blend mixes.

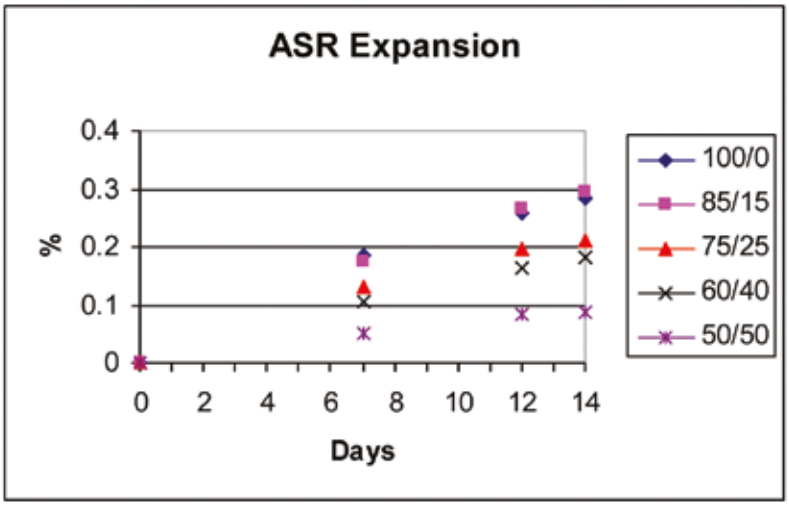


Note that strength results will be dependant on cement source, type and strength class. Trial mixes must be made to assess binder performance.

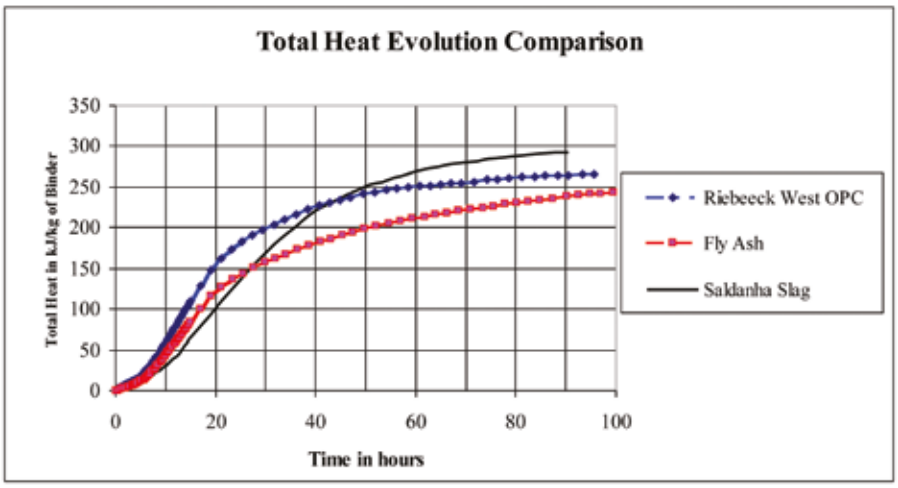
be substantially lower than that of a CEM I concrete, or a CEM I/FA blend concrete, and the total heat of hydration, per cubic metre of concrete, will therefore also be lower. ▲

Steve Crosswell Pr Eng MICT
Technical Marketing Manager

The results of the tests are shown graphically below:



The legend code refers to the binder blend, e.g. 85% CEM I / 15% GGBS



**The binder contents were calculated for a water content of 180 litres/m³ and are illustrative, depending on binder source and type.*

The following table, for a 25 MPa concrete, gives the heat evolution per cubic metre of concrete:

Binder	Binder Content (kg/m³)*	Heat Evolution (MJ/m³)
CEM I 42,5 (Riebeeck West)	240	64
CEM I/FA (70/30)	240	59
CEM I/GGBS (50/50)	200	58

References:

1. Jaufeerally, H; Performance and Properties of Structural Concrete Made with Corex Slag, M.Sc. Thesis, University of Cape Town, 2001
2. Mackechnie, J.R., Alexander, M.G., Jaufeerally, H. ; Structural and durability properties of concrete made with Corex slag, Departments of Civil Engineering, University of Cape Town and University of the Witwatersrand, 2003.

Rocla's Alfabloc retaining walling system

The need to store or partition fertilizer, coal, sand, stone and/or other granular or loose particles separately at site or in a warehouse environment is critical for many sectors of industry. These requirements are easily facilitated by the installation of Rocla's Alfabloc concrete retaining walling system.

Manufactured under licence from Poundfield Products Ltd of the UK, the Alfabloc with its A-frame design is a naturally stable and robust retaining wall block requiring little or no ground fixing while offering many configurations and a quick installation period.

"The Alfabloc is a versatile product that can be utilised across many applications. The traditional retaining wall concept is ideally suited for the separation and storage of granular materials. With a new or existing surface bed forming the foundation upon which the blocks are placed, quick and easy alignment of the Alfabloc is what makes it an efficient option." said Justin Kretzmar, Sales Engineer at Rocla.

"The design of the Alfabloc is what makes it the best precast concrete retaining wall option due to the weight being minimized and evenly distributed, sturdiness and durability. The inner cavity that results from the A-frame design can be used for placement of electrical cabling for lighting, CCTV alarms or any other wiring requirements. The application and/or specification of stored material determines whether the blocks are free-standing or bolted into place" said Kretzmar.

Product Range

Rocla's Alfabloc is available in three height options of 1.2 m, 2.4 m and 3 m to offer the market a wide range of storage capacities. The mini-Alfabloc, at 1.2 m high, has been very successful at offering a very quick, flexible option to storage requirements as well as a new alternative to the New Jersey Barrier for many applications non-road related. Compared to the larger blocks, it is narrower and longer allowing for faster installation.

Applications

All blocks interlock with a cast-in concrete tongue-and-groove joint as standard. Each block has two sockets cast into the top surface, which can be used, with eye-bolts, to easily lift and move the blocks on site or to attach additional items such as roofing structures and razor wire or electric fencing to increase overall height and security.

The Port of Durban erected 22 mini-Alfablocs as a temporary security measure for crowd control, while a Durban-based logistics company utilised the large 2.44 Alfablocs for their manganese stock pile facility.

Rocla themselves have used the 3 m Alfabloc for a retaining wall required for their river sand bunker at their Polokwane manufacturing plant. Time was a critical factor in the installation process due the need to reduce the cost of operational downtime. It only required two weeks to install and secure the 10 Alfabloc units from start to finish.

The Alfabloc has also been utilised at chemical factories, farms and mines as well as at airports, railways and other transport related locations when infra-structure needs to be built, upgraded or replaced. The mini Alfabloc has found a home along railway lines keeping people, wildlife and farm animals safe from moving trains. ▲

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a.b.e. awarded global top quality management accreditation

a.b.e. Construction Chemicals' production plant and head office in Boksburg as well as its new warehouse facility in KZN, have been awarded the internationally-recognised ISO 9001:2008 accreditation.

The company – part of the Chryso Southern Africa Group – attained this important SABS quality management system accreditation following an SABS certification audit. a.b.e.'s original factory at Isipingo, Durban, received ISO 9001:2008 accreditation in 1991.

"The manufacturing activities of a.b.e. – which were formally established back in 1939 – were, for several decades, centred mainly around its Isipingo plant, which then also housed its head office. However, since a.b.e. became part of the Chryso Southern Africa Group at the end of 2010, there has been a steady increase in production operations in Boksburg, which led to our decision to also seek IS0 9001:2008 quality management system status for the factory at the new head office in Boksburg," states Andries Marais, Safety, Health, Environmental & Quality (SHEQ) Manager for Chryso Southern Africa.

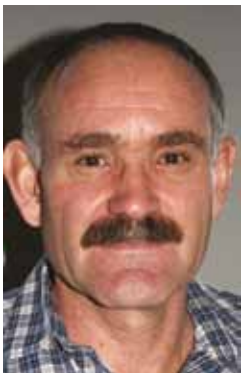
For example, as part of its sustainable development programme, the Chryso Southern Africa Group in 2012 established a new plant for the dustless manufacture of cementitious powdered products at the Boksburg premises of a.b.e. Other products previously imported are now also being produced at a.b.e. in Boksburg.

Marais says that the ISO 9001:2008 accreditation also covers a.b.e.'s new warehouse at Mount Edgecombe in KZN, which means the company's entire national production operation is now compliant with the respected quality management system.

"The process encompasses the entire organisation and has commitment from senior management as well as all those involved in production quality. By achieving ISO 9001:2008 certification, a.b.e. has demonstrated that it can meet the regulatory requirements and apply the system effectively, which will be of substantial benefit to our customers," Marais adds.

Taken into consideration in awarding ISO 9001:2008 certification are production facilities; staff skills and training; services provided, and equipment used for all aspects of the company's operations.

The internal assessments and writing up of the a.b.e. Construction Chemicals Quality Manual were all carried out internally by the Chryso Southern Africa SHEQ division, headed by Marais. In line with all ISO 9001:2008 accreditations, audits to ensure the maintenance of the quality management system will be carried out annually.



Andries Marais, Chryso Southern Africa's SHEQ Manager.

"ISO 9001:2008 is an important milestone for any company," Marais adds. "It helps implement best practice methodology, provides the foundation for better customer satisfaction, and is also an important factor in staff motivation. We believe the a.b.e. accreditation will be of tremendous benefit to the entire Chryso Southern Africa Group."

Chryso South Africa's three production plants and warehouses at Jet Park, Durban, and Cape Town; as well as the company's warehouse at Port Elizabeth, have all been ISO 9001:2008 compliant since 2004. ▲

Further info: Kirsten Kelly, tel 011 395 9700 / www.abe.co.za

The New Engineering Qualifications: Industry Implications

27 June, 2014, at the University of Johannesburg

Announcing a one-day industry workshop on the revised suite of engineering qualifications in South Africa. ECSA and the HEQC have approved comprehensive changes to the structure of engineering diplomas, and introduced an entirely new three-year Bachelor of Engineering Technology degree. These changes will directly affect engineering industries, particularly in terms of post-qualification training and implications of the impending Identification of Engineering Work Regulations. The workshop will provide an opportunity for industry to explore and discuss concerns about the changing structure of the engineering qualifications and industry needs in South Africa.

Participants in the workshop will:

- Learn about the structure and role of the new engineering qualifications;
- Discuss graduate readiness and training, including the role of workplace learning and work-integrated learning;
- Examine professional registration categories and implications of new legislation;
- Consider technical career paths and international standards.

Who should attend?

Engineering professionals, technical managers, members of voluntary associations, human resource managers and practitioners, academics.

Pre-workshop survey

Whether attending the workshop or not, all are invited to fill out a brief survey on industry needs, opinions of engineering qualifications, and graduate readiness. The results will be used to direct the workshop discussions.

To register and/or participate in the survey, please visit: http://tinyurl.com/SASEE-UJ-Workshop
For more information, contact febeevents@uj.ac.za

Pigmented roads for luxury Sunward Lifestyle Centre

Concrete roads, coloured black with a Bayferrox inorganic pigment, were selected ahead of asphalt and other alternative road surfaces for the extensive road network in the new R220 million Sunward Lifestyle Centre shopping complex in Sunward Park, Boksburg.

These pigments are imported by Chryso Southern Africa from Lanxess in Germany, one of the largest pigment suppliers to the global construction industry. Chryso SA is the sole distributor of this range of pigments for the southern African construction industry

Dumaine Els, Chryso SA's Technical Sales Representative based in Jet Park, says Netrac Investments, the developers of the strategically situated new convenience and lifestyle shopping facility, had no hesitation in opting for concrete roads to handle the heavy vehicular traffic expected to visit the 27 stores spread over 17 000 m2. The roads inside the shopping centre grounds lead to over 1 000 parking bays constructed from unpigmented interlocking concrete blocks.

"The developers were seeking the exceptional durability and long-life that concrete roads can provide for a shopping complex that has over 340 000 people living in its catchment area. The roads are expected to carry far above normal vehicular traffic, and the black pigment was selected so that tyre marks and oil spills on the dark concrete surfaces would not be too conspicuous."

Matthews Setlhodi of AfriSam Wadeville (left) and Dumaine Els of Chryso SA, inspecting one of the pigmented concrete roads at Sunward Park Lifestyle Centre.

Constructed by main contractor, Mikon Construction of Boksburg the roads utilised 16,6kg pigment per m^3 of concrete to achieve the required black shading. A total of 47 tons of pigment was needed.

The mix for the 3 000 m^3 of pigmented concrete used to construct the roads was designed by AfriSam's Technical Department and supplied from the company's Wadeville operations. Matthews Setlhodi, Afrisam Team Production Leader in charge of the concrete requirements for the project, says 80-100 m^3 of ready mix concrete were delivered daily to the Sunward Lifestyle Centre construction site by AfriSam over a period of about eight months.

In line with the Chryso Southern Africa Group's emphatic move towards dustless product technology, the free-flowing iron oxide pigmentation is supplied in granular form which is virtually dustless.

Bryan Perrie, MD of The Concrete Institute, and a global authority on concrete roads and pavements, says the decision to opt for pigmented concrete roads at Sunward Lifestyle Centre is commendable and somewhat of a pioneering move for the South African commercial sector. "There certainly seems to be potential for further similar designs at shopping malls, as concrete roads undoubtedly offer exceptional long life for such heavy traffic situations, and the use of quality colour pigmentation would augment the design possibilities even further." ▲

Innovation differentiates Lafarge South Africa

Lafarge South Africa, the local presence of the international Lafarge Group, the world leader in building materials, is proud to be the recipient of Diamond Arrow and Golden Arrow 2014 PMR Awards.

The company has been highly successful in achieving differentiation in the marketplace through its strategy of innovation. Backed by the Group's unequalled technical strength, the company provides the construction industry with innovative product and service solutions in line with the Group's brand baseline of 'Building better cities'. This reflects its ambition to contribute to building cities that are desirable, sustainable living environments accessible to all people.

The company's Diamond Arrow Award winning Readymix team was the highest rated in its category. In 2013, it launched its Efficient Building Systems (EBS), which focuses on efficient, more productive construction methodologies, while meeting society's need for more durable and beautiful concrete structures. The innovative EBS products and services provide solutions to meet key criteria for sustainable building: energy efficiency and carbon dioxide (CO2) performance, affordable fast construction, and unique design for the end-user. Lafarge Readymix innovations that are transforming building methods include the Agilia™ range of self-compacting concrete and the unique Hydromedia™, Lafarge's technical breakthrough in porous concrete.

Lafarge South Africa's cement business line, winner of a Golden Arrow Award, was the first local cement manufacturer to offer a complete range of extended more environmentally-friendly cements throughout all strength classes. It continues to excel at innovation and displaying how the company's cement team heeds its customers and develops solutions for their needs. The recently launched SupaSet is a remarkable ready-to-use product for quickly setting poles in position. A first of its kind in the local market, SupaSet takes only 10-15 minutes to set.

"We extend our appreciation to the construction industry which rated Lafarge South Africa's Readymix and Cement business lines so highly in the PMR Awards" says Lafarge South Africa's Country CEO, Thierry Legrand. "The awards will inspire us to continue using our strength at innovation to achieve even higher levels of customer satisfaction."

About Lafarge

Located in 64 countries with 65 000 employees, Lafarge is the world-leader in building materials, with top-ranking positions in its Cement, Aggregates and Concrete businesses. In 2012, the Group posted sales of 15,8 billion Euros.

Lafarge places innovation at the heart of its priorities, working for sustainable construction and architectural creativity to help build better cities around the world: more beautiful cities that are better connected, have more housing, and are more compact and durable. Since 2010, the Lafarge Group has been part of the Dow Jones Sustainability World Index, the first global sustainability benchmark, in recognition of its sustainable development actions.

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 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. ▲

Additional information is available on the website at www.lafarge.co.za

Quick and efficient cement delivery provides fast turnaround times on wind farm project

The Jeffreys Bay Wind Farm project required cement that was able to provide the high strengths required for the turbine foundations.

Each of the turbine foundations at the Jeffreys Bay Wind Farm project required approximately 335 m³ of concrete.

The 138 MW Jeffreys Bay Wind Farm in the Eastern Cape is characterised by the extremely fast track nature of the project. A consortium for the provision of civils and electrical infrastructure to one of the continent's largest wind farm was formed by Murray & Roberts Construction companies, Concor Civils and Concor Roads & Earthworks, in joint venture with Consolidated Power Projects (Conco) with a contract start date of November 2012.

Murray & Roberts Construction's portion of the project included the construction of 50 km of gravel road, 60 concrete foundations for the wind turbines, route modifications on the N2 highway and the building of an operations and maintenance building, as well as trenching for 200 km of MV cabling to the substation.

Each of the turbine foundations required approximately 335 m³ of concrete and the selection of a suitable cement supplier was based on a number of factors. "We chose AfriSam due to our longstanding relationship with the company, the quality of the cement, its suitability for the project, the pricing and their ability to deliver timeously," Joe Nell, project manager for the consortium, says.

Globeleq is the majority shareholder and is jointly managing the construction of Jeffreys Bay Wind Farm. The company is an independent power industry leader in the emerging markets participating in nearly 14 000 megawatts (MW) of generation capacity in more than 25 countries. The project's consortium partners include Old Mutual, Thebe Investment Corporation, Mainstream Renewable Power South Africa, Jeffreys Bay Community Trust, Enzani Technologies and Usizo Engineering.

The wind farm's civils and electrical infrastructure consortium selected AfriSam's HSC 52.5N cement due to its early strength properties. "The customer required cement that was not only able to provide the high strengths required for the turbine foundations, but that would also expedite the fast track construction programme due to its rapid hardening properties. This versatile cement is cost effective due to its workability, strength and durability properties," Meredith Jordan, AfriSam sales manager: Building, Civil and Manufacturing (BCM), explains.

"Delivery of the 4 000 tons of cement began in March 2013 and the last consignment was delivered in December the same year before the annual building and construction shutdown. The bulk of the product was sent from our Ulco factory, some 80 km outside of Kimberley. This equates to a lead distance in the order of 1 000 km each time we made a delivery. Our depots in Queenstown and East

London were placed on standby as a backup and we were able to meet all our deadlines," Jordan points out.

Nell says that the civils and electrical infrastructure project consortium was given ten milestone dates with which they needed to comply. "We were under extreme pressure but we have managed to meet the first nine milestones timeously. The seamless and expeditious delivery of cement by AfriSam has played a large role in the successful attainment of the turbine foundation deadlines".

Murray & Roberts' Concrete Centre of Excellence was tasked with developing the optimum concrete mix for the high temperatures generated beneath the turbines. The mix also needed to be extremely durable, so the concrete had a fair quantity of fly ash added to accommodate the demands of the end application.

"We established a concrete batching plant at a commercial quarry close to the project and the concrete was transported to various locations on this 3 800 ha site. It was critical to micro manage the interface with all parties, including AfriSam, Concor and Siemens, to ensure that the specified delivery periods were concluded without incident. Apart from the huge physical extent of the project's footprint, at peak we had 650 people on site from the civil and electrical consortium and Siemens, leading to complex logistical planning," Nell adds.

Nell points out that all the roads and the foundations are now completed and the environmental rehabilitation process is underway. "97% of the cabling installation has been completed and the substation was energised on 6 December 2013. Siemens erected 70% of the turbines and the first two circuits were commissioned prior to the December 2013 shutdown. All component deliveries will be completed in February 2014 and the erection of the remaining turbines will be completed before the handover in the second quarter of 2014."

"Joe Nell and his team made the logistics very easy for AfriSam and the healthy and collaborative relationship we developed with the project team was a huge enabler in the smooth workflow process" Jordan concludes. ▲

Lafarge provides concrete solutions for new Bloemfontein reservoir

The Readymix business line of Lafarge South Africa played a key role in the construction of the recently completed Naval Hill Reservoir in Bloemfontein. The 35 megalitre reservoir is part of a new water supply system, which will serve over 45 000 people in Mangaung Metro Municipality, as well as unlock development in the area. Mangaung includes South Africa's judicial capital, Bloemfontein, as well as the neighbouring towns of Botshabelo and Thaba 'Nchu. Lafarge South Africa is the local presence of the international Lafarge Group, the world leader in building materials. The Naval Hill Reservoir project was in keeping with the Group's new brand baseline, 'Building better cities', pledging Lafarge's commitment to provide solutions that help to create better and more sustainable cities, which are desirable living environments for all people.

Construction of the reservoir began in May 2013 and was completed in October last year. The project provided employment for 37 local labourers and 39 skilled labourers. Using Lafarge's highly regarded premium technical cement, Powercrete Plus CEM II 42,5R, the Readymix team supplied 700 m^3 of standard 25 MPa concrete for the foundations, with 30 MPa and 35 MPa high strength grades for the walls.

Naval Hill is the highest point in the area with extremely steep slopes. "We provided a concrete pumping service but getting the concrete to the site was still a challenge as it restricted us to four cubic metre truck loads at a time," comments Anathi Zitumane, Lafarge Product Development Manager – Readymix. "The reservoir was a heavily reinforced structure. We designed high slump pumpable mixes that were easy to place but had early strength gain for rapid demoulding."

The reservoir will enable the extension of water delivery to some disadvantaged communities. It will also serve as buffer capacity for peak water demand periods and, by the positioning of the reservoir on the highest point in the area, have sufficient pressure to provide up to 24 hours emergency supply in the event of electrical or mechanical interruptions.

"Our team worked closely with the main contractor and overcame the challenges of the difficult location," adds Zitumane. "The project was finished on time with excellent concrete finishes. When the country is experiencing many demonstrations protesting about poor service delivery, we are proud to have been involved in the Mangaung Metro Municipality's important water delivery initiative."

Naval Hill – a fascinating history

- *Its name comes from being the site of a British naval-gun emplacement during the Anglo-Boer War*
- *Naval Hill was once home to many leopards and was called 'Mangaung', meaning place of the leopards. The name was adopted by the Mangaung Metro Municipality*
- *To this day, visitors to the area can clearly see a large white horse outlined on the eastern side of the hill, created when a British cavalry regiment used it as a base*
- *It is home to the Franklin Game Reserve, making Bloemfontein one of the few cities in the world to have a game reserve in the middle of an urban area.*

Lafarge South Africa is proud to have contributed concrete and service solutions for Bloemfontein's Naval Hill Reservoir.

Master Builders Solutions® launched in South Africa

New global brand bundles products and solutions for the construction industry

BASF has launched the Master Builders Solutions® brand in South Africa. The brand strengthens BASF's industry orientation: it stands for BASF's commitment to provide the whole construction industry with tailored products and solutions. Master Builders Solutions® has already been introduced in the Asia Pacific region, including Russia, Turkey, the Gulf Cooperation Council and Kazakhstan, and will be completely rolled-out worldwide by the end of the second quarter 2014.

Master Builders Solutions® draws on a number of successful specialty brands. It is based on a more than century-old tradition of innovations for the construction industry. "In Master Builders Solutions, we concentrate our ability to collaborate across technologies and functions on a global scale. That way, we create solutions geared to meet the individual construction challenges of our customers," said Dr. Tilman Krauch, president of BASF's Construction Chemicals division.

The range of products and services marketed under the brand features a global naming system, helping BASF to support customers and partners with constantly high quality and consistent products and services. The portfolio of products and services marketed under the brand embraces chemical solutions for new construction, maintenance, repair and renovation of buildings as well as infrastructure: concrete admixtures, cement additives, solutions for mining and tunnelling, waterproofing, sealants, concrete repair & protection, performance grouts, high-performance flooring products and tiling solutions.

The launch of Master Builders Solutions® in Russia, Turkey, the Gulf Cooperation Council countries such as Saudi Arabia and the United Arab Emirates, Kazakhstan and South Africa will support BASF in further strengthening its position in these emerging markets.

"The introduction of the brand underlines that we are more than a supplier of individual chemical products. BASF combines its products and services under one brand to be the solution provider of choice for the whole construction industry. The new brand also highlights our position as truly global player in the construction chemicals industry," said Dick Purchase, head of BASF Construction Chemicals division in the ORA region (Orient, Russia & Central Asia, Africa).

"South Africa's economy is showing strong growth rates and high investments in infrastructural and other construction projects. With its comprehensive portfolio marketed under the Master Builders Solutions® brand, BASF is offering state-of-the-art construction chemical solutions to support its local partners. "Important projects such as the 347-million m^3 De Hoop Dam in Sekhukhune, Limpopo province, which would supply potable water to people in the province and serve the mining industry along the South African platinum belt, are strengthening the province's social and economic performance.

We are proud to be part of this progress by offering solutions which are based on our global know-how and provided by our local experts," states Morgan Govender, Managing Director, BASF Construction Chemicals South Africa.

The Construction Chemicals division

BASF's Construction Chemicals division offers advanced chemicals solutions for new construction, maintenance, repair and renovation of structures: Our comprehensive portfolio encompasses concrete admixtures, cement additives, chemical solutions for underground construction, waterproofing systems, sealants, concrete repair & protection systems, performance grouts, performance flooring systems, tile fixing systems, expansion control systems and wood protection solutions.

The Construction Chemicals division's 5,700 employees form a global community of construction experts. To solve our customers' specific construction challenges from conception through to completion of a project, we combine our know-how across areas of expertise and regions and draw on the experience gained in countless construction projects worldwide. We leverage global BASF technologies, as well as our in-depth knowledge of local building needs, to develop innovations that help make our customers more successful and drive sustainable construction.

The division operates production sites and sales centres in more than 50 countries and achieved sales of about €2.1 billion in 2013.

BASF – The Chemical Company

BASF is the world's leading chemical company. Its portfolio ranges from chemicals, plastics, performance products and crop protection products to oil and gas. We combine economic success with environmental protection and social responsibility. Through science and innovation, we enable our customers in nearly every industry to meet the current and future needs of society. Our products and solutions contribute to conserving resources, ensuring nutrition and improving quality of life. We have summed up this contribution in our corporate purpose: We create chemistry for a sustainable future. BASF had sales of about €74 billion in 2013 and over 112,000 employees as of the end of the year. BASF shares are traded on the stock exchanges in Frankfurt (BAS), London (BFA) and Zurich (AN). Further information on BASF is available on the Internet at www.basf.com.

BASF and the construction industry

The construction industry is one of BASF's key customer industries. In 2013, BASF's sales to the construction industry totalled around €4.7 billion, representing approximately 6% of BASF Group sales. As a leading provider of raw materials, systems and finish products to the construction industry, BASF provides economically and ecologically sound solutions that facilitate high-quality construction. BASF materials and solutions increase resource and energy efficiency and improve building life expectancy, thus also lowering expenditure on

maintenance and repairs. BASF offers a broad portfolio of building materials used directly on construction sites or integrated into other products. The product range includes for example insulation materials, concrete admixtures, products for the repair of concrete structures, sealants, flooring systems and decorative paints.

Master Builders Solutions® from BASF

Under the Master Builders Solutions® brand, BASF bundles its advanced chemical solutions for new construction, maintenance, repair and renovation of structures. Master Builders Solutions is built on the experience gained from more than 100 years in the construction industry. The comprehensive portfolio under the brand encompasses concrete admixtures, cement additives, chemical solutions for underground construction, waterproofing solutions, sealants, repair & protection solutions, performance grouts, and performance flooring solutions.

Master Builders Solutions® is backed by a global community of BASF construction experts. To solve our customers' specific construction challenges, we combine the suitable elements of our portfolio, our know-how across areas of expertise and regions, and draw on the experience gained in countless construction projects worldwide. We leverage global BASF technologies as well as our in-depth knowledge of local building needs, to develop innovations that help make our customers more successful and drive sustainable construction.

About BASF, South Africa

BASF has been doing business in South Africa over 45 years. Headquartered in Midrand, Johannesburg, the BASF Group in South Africa consists of eight companies with locations in Johannesburg, Port Elizabeth and Cape Town. Apart from a world-class automotive emission catalysts production site in Port Elizabeth, BASF also recently invested in a dispersions production plant in Durban which has been producing acrylic dispersions since third quarter of 2012. The local groups' employee complement is around 1 000 people.

Other local group portfolio includes chemicals, plastics, dispersions, agricultural products and nutrition. BASF products are used for industrial applications in various sectors e.g. paper, packaging, and leather, detergents, cosmetics, construction, mining, agriculture and automotive industries. ▲

Local information visit www.basf.co.za

Lafarge assists with turning a house into a home

When the SABC put out a call on its "Touching Lives" segment of the daily news, Lafarge South Africa didn't hesitate to answer in providing support for the Mosiane family from Mantja Village, outside Mafikeng.

The 25-member family, headed by 62 year old partially blind Nicodemus Mosiane, was living in a two-roomed make-shift dwelling built in 2008, with no sustainable income. Thanks to the generosity of companies such as Lafarge, SABC NW Provincial General Manager Tlotlo Seru will facilitate the handover of a brand new 76 m^2 house on Friday 25 April to this deserving family.

First to step up to the plate, Lafarge provided the ceiling components to create a comfortable home: brandering, ceiling plasterboard, cornices and other ceiling accessories required to finish off the decor of the residence. In addition, 280 bags of Lafarge's innovative and highly renowned Buildcrete cement was provided. Says Charlene Lamb, Country Communications Manager, Lafarge South Africa, "The Lafarge ambition of 'Building better cities' doesn't only apply to large construction sites. It applies to cities, towns and villages. We are committed to supporting our neighbours around our sites and as such are delighted to be a part of helping make a house a home that will improve the quality of life and living conditions for the Mosiane family." Lafarge's cement plant is based in Lichtenburg, North West Province.

"We are delighted to have been able to assist this family in need with top quality products that ensure the longevity of their home. We wish them well as they move into the safety and warmth of their new dwelling," adds Kgomotso Ramoiteki, Lafarge Gypsum Product Manager.

While H-strips, drywall screws, galvanised angles and suspension brackets sound like "construction speak" to others, to this family it means home and no longer living in a patchwork dwelling. "Lafarge understands that every component we manufacture forms part of someone's comfort and that building better cities starts with keeping individual requirements in mind," says Lamb.

HOD North West Department of Human Settlements and Public Safety, Mr Moss Kgantsi and Motsweding FM OAP, Ms Lindiwe Modise were joined by SABC Acting COO Mr Hlaudi Motsoeneng, local Chief Kgosi Mosikare, Ms Lina Miga and Mr Chris Motshabi, as well as representatives from donors Lafarge South Africa, Toro ya Africa and CTM at the handover event in Mantja Village. ▲

Balcony collapse at block of flats

In this new, regular section of Concrete Beton we will 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.
These reports are intended to assist those who may be faced with similar issues, and aims to improve structural safety and reduce failures by using confidential reports to highlight lessons that have been learnt, to generate feedback and to influence change.

Report Overview

A reinforced concrete balcony collapsed at a block of flats which are believed to have been built in 1966. Fortunately, no-one was injured. A Health and Safety Executive (HSE) construction specialist inspector found that the external balcony appeared to be a continuation of the floor slab and served as a residents' only access to individual flats.

Report Content

The balcony was approx. 150 mm thick and cantilevered by approximately 1,3 metres. A majority of the reinforcement, just over 8 mm approximately in diameter, was located in the bottom half of the slab (compression zone) and some of the reinforcement had next to no cover. The closest the reinforcement appeared to get to the tension zone was around the neutral axis. It would seem that the most likely reason for the collapse was the lack of reinforcement in the tension zone. However, the balcony had clearly managed to remain in place for the last 40 years or so, relying on what little tension capacity was afforded by unreinforced concrete.

HSE was advised that there were a number of similar balconies in the area. A specialist firm was employed to undertake structural assessments on a large number of two storey blocks of local authority-owned residential flats. In the majority of cases, the walkways were found to be under strength. The flats were all constructed between the mid 1950's and mid 1970's and have cavity masonry walls supporting a reinforced concrete first floor slab.

In the first group to be examined it was found that in each walkway, the reinforcement was only nominal in size and was lying close to the bottom surface of the slab, even at its support at the face of the building. No reinforcement was located in the upper half of the slabs where it would be expected for cantilevers. The subsequent strength assessment undertaken found that the theoretical resistance in bending was well below that required for full imposed and dead loading and, in some cases, below that required for dead load alone. The local authority undertook precautionary temporary propping of the outer edge of the cantilevers whilst action was considered for long-term strengthening and assessment of other similar stock. There are nearly 200 of these blocks containing between 6 and 16 occupied flats each. Following the original discovery a Risk Assessment (RA) was undertaken to identify priorities for further intrusive investigations. As each tranche of investigations has progressed the RA has been refined to update the risk priority, taking into account any patterns discovered from the findings of the Structural Assessment.

To date the firm has assessed over half of the blocks. Of these, 80% have been found to be inadequately reinforced, generally having the rebar in the lower part of the slabs. Blocks constructed from mid-1970's appear adequate; all having had a Structural Engineer involved in their design. Visible deflection of slabs has not been a good indicator of potential under-strength. The firm now advises clients to consider full structural assessment of such cantilevers rather than just checking their condition alone. Experience so far shows that 1950 to mid-1970's may be a greater risk regarding correct positioning of reinforcement. There is a wide range to the quality of design, checking, construction and maintenance of the 1950's/1960's housing stock and with much of this stock now approaching its originally intended design life of 50/60 years, there needs to be more than just a visual inspection conducted to those structures/parts of structures that could fail catastrophically.

Comments

The built environment will be left with many legacies, some remarkably good, some equally bad. As a consequence the issue of ageing infrastructure is the possibility that poor construction or poor design exists and the engineering community must respond. In this instance, there is a clear and widespread breach where the structures relied on concrete tensile strength only and as a result there could have been brittle failure with no warning. As the reporter says visual inspections are not sufficient and a more rigorous inspection with, for example, cover meters is required. There are also generic issues here which can apply to other cases. Firstly, all structures go into service with a notional safety margin and thereafter degrade, so their safety generally reduces with time. Secondly, with any design, there is always a question for the designer of assuring that what he thought was being built was actually built. Even with records that purport to show what happened during construction there may be inaccuracies. When there is doubt about a generic form of structure, then inspections are necessary to protect those residents who have a right to expect cantilevers to be sufficiently safe. There is a duty to make these findings as widespread as possible. Cantilevers are always potentially vulnerable and this is particularly so for thin slab cantilevers.

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 Structural Safety (CROSS) at www.structural-safety.co.za ▲

Mobile Batch Plant.

Good flow properties exhibited

Finished slab with curing compound on surface.

Inland Branch – Heidelberg Weighbridge Station, site visit

20 members of the Inland Branch took the opportunity to visit this unique site where UTCRC is being used to rehabilitate the traffic lanes entering the weighbridge facility. Hugh Crofford, Senior Contract Manager of King Civil Engineering Contractors (Pty) Ltd, the main Contractor for the project, described to members the project in some detail.

The client, SANRAL had specified the installation of 400 metres of an ultra-thin, continuously reinforced concrete pavement on the 'screening' lane approaching the main weighbridge at the site. The specification included a 65mm thick concrete slab, reinforced with steel mesh, a fast setting time to allow minimum traffic down-time, a compressive strength of 40 MPa at 3 days and 80 MPa at 28 days.

King Civil staff spent many hours designing the concrete mix which ultimately met the criteria set, and ultimately gained approval from the client 3 months after initiating the design work. The final mix comprised 3 sands, 6-7 mm stone, CEM 1 52,5 cement, superplasticiser and steel fibres at an addition rate of 80 kg per m^3.

In view of the fast setting time requirement, the contractor had no choice but to mix the concrete on site. In fact the final mix only allowed 15 minutes working time once poured.

Consequently, they designed their own mobile batch plant with an 800-litre capacity pan mixer, generator, admixture storage tank and dispensing equipment, all mounted on the back of their own flatbed truck. The sand, stone and cement were mixed off-site and delivered in 300-litre capacity bulk bags. These were emptied into the pan mixer after which the superplasticiser, steel fibres and water were added to make one homogenous mix.

Asphalt first had to be removed from the lane, repairs made to isolated base patches, and then the screed could be laid on top. Once mixed, the concrete was poured into place with the truck riding over the reinforcing mesh, which was designed to sit in the centre of the concrete slab. The slump of the concrete was 90 mm, flow was good, but the mix was very sticky due to the high cement content. This resulted in a lot of labour to work the material into position. Poker vibrators were used to compact the concrete.

Finally, the concrete was cured with the use of a resin-based curing compound.

Members spent some time inspecting the lane in question, and watching the mixing and placing of the concrete mix. In conclusion to the visit, Andrew Schmidt, Inland Branch Chairman thanked King Civil Engineering Contractors for the very interesting site visit and a perfect opportunity to see concrete in action. He also thanked AfriSam, the cement suppliers to the project, who had provided some very welcome refreshments on the day. ▲

Winners of the 2014 Golf Day floating trophy were StonCor – well deserved!

Western Cape flying

The Western Cape Branch commenced 2014 with a very successful golf day held at Rondebosch Golf Club – venturing away from the normal venue, they decided to try something new. The move proved to be a good one, with a record 20 four-balls received and a good time was had by all. The response from members and non-members was very positive and the date has already been set for 17th of March 2015. Members are asked to spread the word amongst colleagues and potential new members.

The Branch also held its first Monthly Technical Meeting of 2014 on the 24th of April, at the University of Cape Town. The topic was: The Intricacies of cover as durability parameter- practical experiences from quality measurements on fifteen bridges. Philip Ronne of AECOM presented to approximately 50 people; sharing his experiences with the attendees on this interesting project. The event showed extreme interest from members as well as non-members. The MTM was well attended by engineers, specifiers, readymix suppliers, the City of Cape Town as well as suppliers in the industry.

The invitation was also extended to the Corrosion institute which was met with great enthusiasm from both organisations in sharing the passion of concrete in the southern Africa. The Corrosion Institute expressed a desire to be more involved with future MTM's, Site Visits and the CSSA in general.

The Western Cape Branch would like to extend sincere thanks to BAMR who assisted with sponsoring the event – BAMR is a family run business established in 1946, and supplies quality control instruments in the Coatings and Corrosion related industries (www.bamr.co.za)

Following the success of networking with another industry association, the Western Cape Branch would like to extend an invitation to other societies in the construction industry, to continue the trend of sharing information by taking advantages of technical talks and other events. A practice it intends to continue.

Please keep an eye on the events page on the Concrete Society website or get in touch with one of the friendly committee members. ▲

KwaZulu-Natal update

The Branch began their year with the Annual General Meeting on the 18 March 2014, followed by a Monthly Technical Meeting on the Umgeni Interchange – the speaker – Ashley Sewmungal from Hatch Goba (Pty) Ltd - gave a very good overview of the project so far and discussed various aspects of the project that gave members an insight into the enormity of this project.

On the 10 April, a very interesting site visit was held at the Lafarge Quarry – Ridgeview, with the Quarry Manager – Theo Pretorius.

In June the Durban leg of the ConSem 2014 National Seminar will be held being run nationally.

For the rest of the year there will still be a site visit to the Phoenix Waster Water Works, three Monthly Technical Meetings with the topics of Spring Grove Dam; Bridge Launching and Spalling, the annual Egg Protection and Cube Competition and what has to be one of the best events each year – the Garth Gamble Golf day in September.

The committee of the KZN Branch look forward to meeting members at all these functions.

EVENTS CALENDAR

Inland Branch

DATE	MEETING/EVENT	VENUE	CONVENOR
11 June 2014	Committee Meeting	Lafarge, Longmeadow	Andrew Schmidt
09 July 2014	Committee Meeting	PPC, Sandton	Andrew Schmidt
22 July 2014	Mini-seminar – Recycling of concrete	University of Johannesburg, Bunting Road Campus	Hanlie Turner
13 August 2014	Committee Meeting	At the SARMA Conference	Andrew Schmidt
15 August 2014	EPD Competition - Casting	Not applicable	Donovan Leach & Jannes Bester
22 August 2014	EPD Competition - Crush-In	PPC Jupiter Works	Donovan Leach & Jannes Bester
10 September 2014	Committee Meeting	Sephaku, Centurion	Andrew Schmidt
13 September 2014	Concrete Boat Race	Benoni Sailing Club, Homestead lake, Benoni	Andrew Schmidt, Michelle Fick, Johan van Wyk, & Tina Coetzee
09 October 2014	Committee Meeting	Chryso-abe, Jet Park	Andrew Schmidt
12 November 2014	Committee Meeting	To Be Confirmed	Andrew Schmidt
13 November 2014	Chairman's Breakfast	Blue Valley Golf Estate	Branch Committee Vice Chair

International

DATE	MEETING/EVENT	VENUE	CONVENOR
11 – 13 June 2014	International Concrete Innovation Conference	Oslo, Norway	CIC 2014 Organising Committee
15 – 18 July 2014	SMSB 2014, 9th International Conference on Short and Medium Span Bridges, SMSB-IX	Alberta, Canada	Wayne Gibson
21 -23 July 2014	10th International PhD Symposium in Civil Engineering	Quebec, Canada	Nicolas Rouleau
24 – 25 July 2014	FRC International Workshop: Fibre Reinforced Concrete – from Design to Structural Applications	Montreal, Canada	Prof. Bruno Massicotte

KwaZulu-Natal Branch

DATE	MEETING/EVENT	VENUE	CONVENOR
June 2014	Site Visit	TBC	Committee Member
July 2014	MTM	University of Natal	Committee Member
August 2014	Event: Golf Day	Beachwood Golf Club	Committee Member
September 2014	Event: EPD and Cube Competition	Berea Rovers Club	Committee Member
October 2014	MTM	University of Natal	Committee Member
November 2014	MTM	University of Natal	Committee Member

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EVENTS CALENDAR

Western Cape Branch

DATE	MEETING/EVENT	VENUE	CONVENOR
19 June 2014	Site Visit: Showcasing UCT's new lab	UCT's New Laboratory	Philemon Arito
July 2014	MTM: Geopolymer Analysis	Venue TBA	Billy Boshoff
13 August 2014	Cape Construction Expo (CSSA to host workshop)	CTICC	Adrienne Taylor
September 2014	Cube Crushing Competition: Commencement/Casting	-	Riaan Combrinck
September 2014	Site visit: Group Five – Predator Tank at Two Oceans Aquarium	Two Oceans Aquarium	Jan Ellis/Jerome Fortune
October 2014	Cube Crushing Competition: Awards	-	Riaan Combrinck
20 November 2014	Annual Cocktail Function	Granger Bay Hotel School	Adrienne Taylor

National Office

DATE	MEETING/EVENT	VENUE	CONVENOR
June 2014	Concrete Beton	Posted to all CSSA Members	CSSA
23 - 26 June 2014	Seminar Road Show: ConSem 2014	Durban, Port Elizabeth, Cape Town & Johannesburg	Seminar Committee
26 June 2014	Board Meeting	Johannesburg	CSSA President
31 August 2014	Closing Date for 2015 Fulton Awards Nominations	-	CSSA Administration
September 2014	Concrete Beton	Posted to all CSSA Members	CSSA
08 – 11 September 2014	Seminar Road Show: Design of Concrete Structures – The Latest Developments	Durban, Port Elizabeth, Cape Town & Johannesburg	Seminar Committee
23 October 2014	Board Meeting	Johannesburg	CSSA President
31 October 2014	Membership Renewal Notices	E-mailed to all CSSA Members	CSSA Administration
November 2014	Concrete Beton	Posted to all CSSA Members	CSSA
30 November 2014	Closing Date for 2015 Fulton Awards Entries	-	CSSA Administration

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MEMBERSHIP DETAILS

PLATINUM

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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

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Hatch Goba (Pty) Ltd	Mr Gary Hooper	031-536-9400	gary.hooper@hatch.co.za
Sephaku Cement	Mr Andrew Schmidt	012-684-6300	andrew.schmidt@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 Jonathan Starmer	011-254-5500	jstarmer@stoncor.com
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2015 Fulton Awards

FULTON Awards 2015

Call for Nominations

The Concrete Society of Southern Africa NPC (CSSA) is calling for nominations of projects for the prestigious Fulton Awards, presented every two years by the Society to honour excellence and innovation in design and use of concrete.

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Definitions of the Entry Categories are as follows:

1. CIVIL ENGINEERING STRUCTURE:

A. Projects up to R 100 million in total value | B. Projects over R 100 million in total value

Projects where the Civil / Structural Engineer is the Principal Agent or is the Civil Engineering Project Manager or is the Lead Consultant heading up the project team and the Bill of Quantities and Contract Documentation is generally compiled by the Project Civil Engineer.

2. BUILDING STRUCTURE:

A. Projects up to R 100 million in total value | B. Projects over R 100 million in total value

Projects where the Architect or a Building Works Project Manager is the Principal Agent or is the Project Manager or is the Lead Consultant heading the project team and where the Bill of Quantities and Contract Documentation is generally compiled by the Project Quantity Surveyor.

3. ARCHITECTURAL CONCRETE:

A. Projects up to R 100 million in total value | B. Projects over R 100 million in total value

Architectural projects where concrete has been used as the principal construction material and which demonstrates unique and exceptional structure, surface finishes or particular details, in an aesthetic manner.

4. INNOVATION IN CONCRETE:

Projects or Initiative where totally new materials / techniques / technologies / applications / design and/or analysis concepts or procedures, using concrete as the principal material, have been developed and utilized.





Any project completed during 2013 or substantially completed during 2014 is eligible for entry, and projects may be entered in more than one category.

Nomination Forms:

To download the nomination forms, visit the following website link:
www.concretesociety.co.za/fulton-awards.co.za
Alternatively contact the CSSA Administrator on
Tel: 012 348 5305 or e-mail: admin@concretesociety.co.za

Closing Date For Nominations: 31 August 2014

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