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CONCRETE SOCIETY
OF SOUTHERN AFRICA

Platinum members:
AfriSam, PPC and Lafarge

Accredited Technical Paper:
Plastic Shrinkage Cracking in Conventional Concrete and Low volume Polymeric Fibre Reinforced Concrete

Fulton Award Winner:
Hospital Bend


Durability:
the key to Sustainability

President's Message

I am proud to be a member of the Concrete Society of Southern Africa NPC, even more so, to be President of this society. The reason is quite simple: it is a society that opens doors for its members, as it has for me.

For me these doors have included meeting interesting people, gaining their knowledge of the broader concrete industry, and also giving perspective, to ensure that I always see the bigger picture. For others it has opened doors to a broader base of clients through the Source Book, and been a means of gaining knowledge and providing exposure to current and future technology through local events and national seminars.

It is a society of individuals for the benefit of all members, whether as an individual or nominated by a company. The society is growing, and I can assure members that the current council members are committed to furthering the relevance of the society, and also putting the needs and interest of our members first.

A key focus of the society is to reward excellence in the use of concrete. There is no better way to acknowledge this than the prestigious Fulton Awards, which will be held in 2013. The call for nominations is currently open and I invite all those involved in concrete projects to consider participating and entering. The Fulton Awards are not just about large projects, but about excellence, whether the project is large or small. Please refer to our website for more information www.concretesociety.co.za

As head of the newly established South African National Member Group of the International Federation for Structural Concrete (fib), this European-based organisation has 41 National Member Groups as statutory members, and about 1 000 individual or corporate members in 65 countries. The objectives are to develop, at an international level, the study of scientific and practical matters capable of advancing the technical, economic, aesthetic and environmental performance of concrete construction.

These objectives are achieved by: the stimulation of research; the synthesis of findings from research and practice; the dissemination of the results by way of publications, guidance documents and the organisation of international congresses and symposia; the production of recommendations for the design and construction of concrete structures; and the information of members on the latest developments. The objectives are pursued in conjunction with the existing international technical associations and regional standards organisations. Thanks to this development our members will receive significant benefits, which will be communicated shortly.

I appreciate the support and loyalty of our current members and, as always, look forward to welcoming each new member to the society.

Yours sincerely,
Billy Boshoff
President
Concrete Society of Southern Africa NPC

COVER: The upgrade of the Cape Town N2 freeway Hospital Bend Interchange took top honours and won the 2011 Fulton Awards 'Construction Techniques' category.

VISION: To be the most relevant forum for those who have an interest in concrete and to promote the related services of the CSSA members.

MISSION STATEMENT: To promote excellence and innovation in the use of concrete and to provide a forum for networking and for the sharing of knowledge and information on concrete.

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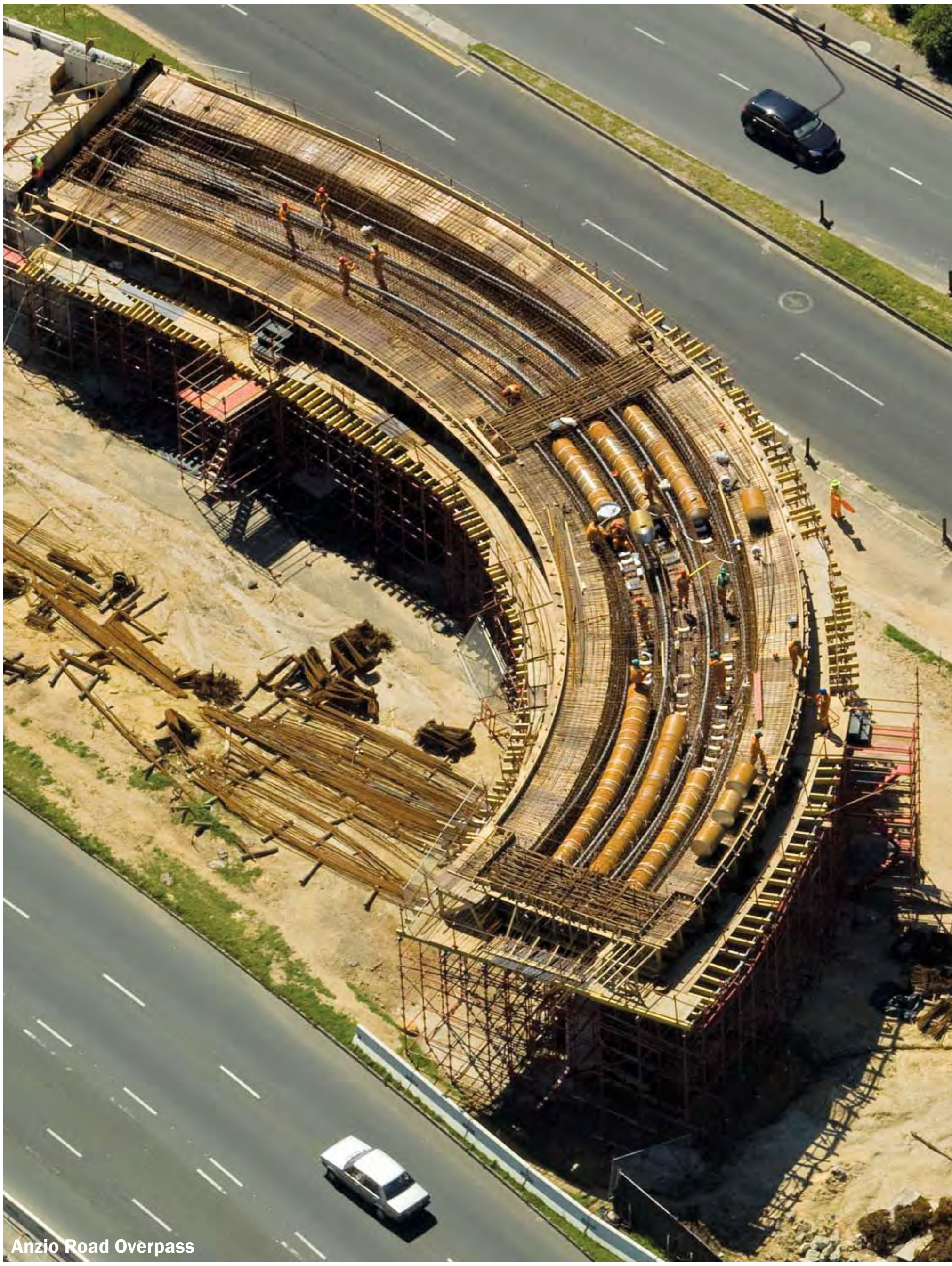
Hospital Bend

The upgrade of the Cape Town N2 freeway Hospital Bend Interchange took top honours and won the 2011 Fulton Awards 'Construction Techniques' category.

The Hospital Bend Interchange is the final upgrade of the N2 freeway to Cape Town International Airport.

The Hospital Bend pre-selection lanes offer motorists an opportunity to select their route -- a safe distance beforehand, and thus reduce the need for extensive weaving manoeuvres.


Anzio Road Overpass

Hospital Bend is one of the busiest gateways into Cape Town, and the route has a high accident rate. The extensive planning process included detailed traffic studies, evaluation of several concepts and consultation with stakeholders.

This resulted in an innovative proposal, with minimal infrastructural changes, or additions, and maximised the existing infrastructure to improve safety on Hospital Bend and traffic operation downstream.

Key design features included complex road geometry, highly variable founding conditions, intricate bridge design challenges, a tight construction programme, unusual construction techniques together with a well planned and managed traffic plan.

The key bridge components of the upgrading included the widening of the Joyce Newton Thompson Bridge to accommodate the inbound preselection lane from Rhodes Drive. The centre span of the deck was supported from temporary overhead girders to allow unhindered traffic flow during construction.

Outbound pre-selection lane from Upper De Waal Drive includes the new 110 m long continuous three span De Waal Drive Overpass. The 2,2 m deep, post tensioned hollow box girder deck was cast in three stages with the second span being supported from an impressive overhead girder support system over the Eastern Boulevard.

New access for Anzio Road included a 94 m long, continuous four span overpass, construction of a sharply curved voided slab deck with a complex geometric alignment, due to the tight spatial constraints. The construction method for the third bridge span required temporary overhead support girders, in order to allow uninterrupted traffic flow with safe minimum vertical clearances.

The bridge deck curvature had to accommodate a vertical curve as well as a horizontal transition curve, leading into a circular curve (radius 23,2 m) with a variable super-elevation (3% to 8%).

The geological conditions as well as the large loads on the foundations necessitated the use of 750mm diameter auguered, cast in situ concrete, end

pre-selection lanes

The completed Anzio Road Overpass and Joyce Newton Thomson bridge widening

The Team

Client: The City of Cape Town

Principal Agent 1: BKS

Principal Agent 2: Orrie Welby – Solomon Associates CC

Subcontractor 1: Haw & Inglis

Subcontractor 2: Hulme & Associates Consulting Structural Engineers

Subcontractor 3: Franki Africa

bearing piles with approximate lengths of 14 m each.

Various bridge types and construction methods were considered during the conceptual design phase. Precast concrete and structural steel composite deck solutions were excluded as feasible solutions, due to the very complex horizontal and vertical alignment of the superstructure. Subsequently, a cast in situ post tensioned concrete voided slab deck and a cast in situ post tensioned hollow box girder deck was selected as the best solution.

Due to the unique deck layout and the three-stage construction sequence, required at the Anzio Road Overpass bridge deck, special attention had to be given to high torsion forces, bearing uplift at the abutment under certain load conditions, creep and shrinkage effects and relatively high post tensioning system losses. The state of the art Austrian software package that was used for the analysis had to be specially adapted by the supplier to correctly model the behaviour of the bridge deck.

Eight post tensioning cables, consisting of 27 strands each, were required in the design, due to the high friction losses in the post tensioning system in this sharply curved deck. A post tensioning jack had to be specially imported from Germany to be able to introduce the required 5510 kN jacking force per cable. The small radius of curvature of the deck also required the design of special reinforcing stirrups, spaced along the length of each cable, to prevent it from punching through the sides of the deck during the stressing procedure.

Fifty percent of the post tensioning cables were stressed during construction in stage one. The remaining cables were stressed as continuous cables during construction in stage three. In spite of the complex post tensioning cable profiles, the on-site results correlated very well and were within specifications.

The deck was post-tensioned in the transverse direction at each pier, with Dywidag bars to withstand the large transverse bending at the supports.

The construction method for the third span, during construction of stage 3, required temporary overhead support girders, in order to allow uninterrupted traffic flow with safe minimum vertical clearances.

The Anzio Road Overpass provides access into the city and includes the construction of a sharply curved voided slab deck with a complex geometric alignment due to the tight spatial constraints. The construction method for

the third bridge span required temporary overhead support girders, in order to allow uninterrupted traffic flow with safe minimum vertical clearances.

A good concrete finish was achieved in spite of the steep deck super-elevation and the challenging work conditions. The reinforced earth walls at both abutments received an exposed aggregate finish to complement the surrounding environment.

The new De Waal Drive link required a continuous three span overpass bridge with a main span length of 45 m. Site condition, proposed span lengths, strict traffic requirements and complex horizontal and vertical geometric alignment of the bridge deck, dictated the bridge type and construction method. The geological condition as well as the large loads on the foundations necessitated the use of 750mm diameter augered, cast in situ concrete, end bearing piles with approximate lengths of 24 m each. The 2,2 m deep, post tensioned hollow box girder deck was cast in situ in three stages. The deck curvature had a radius of 153,6 m variable super-elevation (6.5% to 10%) and a maximum grade of 10%.

The bridge design, which had to make provision for high wind speeds, required specially designed vertical tie anchors at each abutment to counter expected uplift forces. The deck also had short profiled post tensioning cables to counter transverse flexure at each pier.

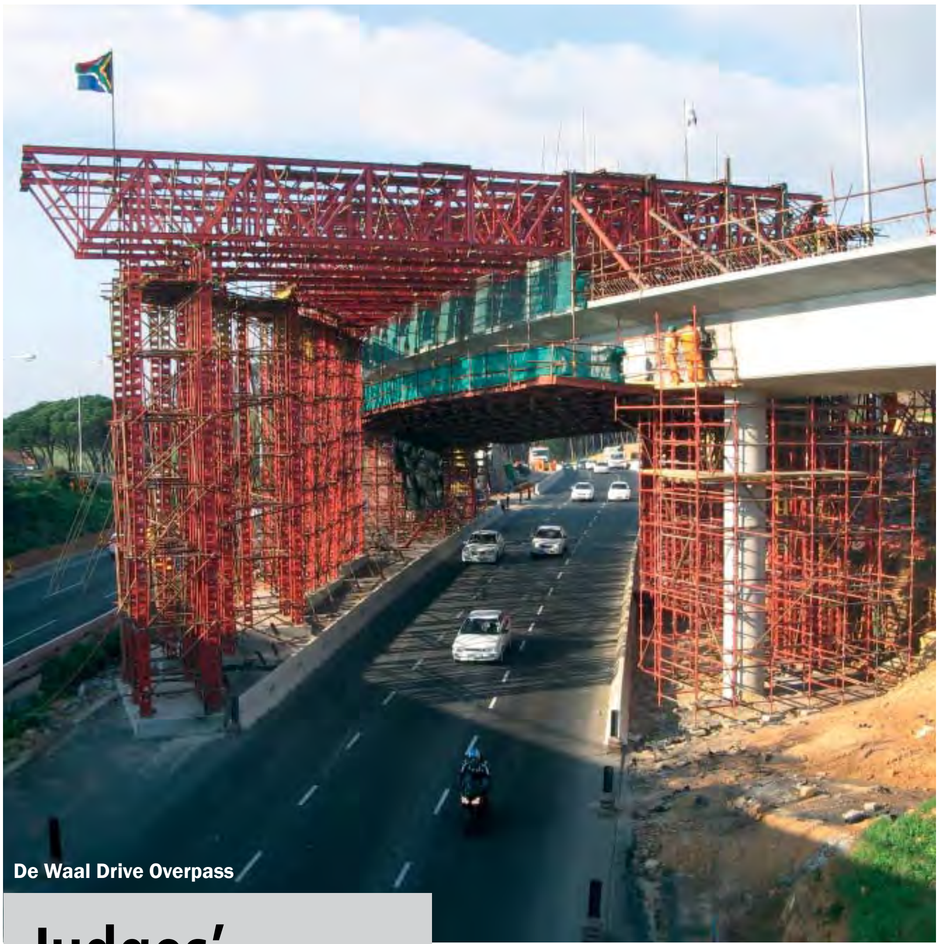
The project team

Strict quality control measures ensured a good concrete finish on the structure. The design specifications stipulated the deck's top slab was cast within seven days after casting the bottom slab and webs, in order to minimise differential shrinkage effects. The contractor was requested to demonstrate his concrete casting techniques on a test panel, to avoid honeycombing and other defects associated with the incorrect placing of concrete. Due to the spatial constraints in the median, reinforced earth walls were used at the abutments. An exposed aggregate finish was chosen to complement the surrounding environment.

The widening of the existing Joyce Newton Thompson Bridge also proved to be a challenge due to the geometric alignment and heavy traffic flow over and under the structure. The centre span of the deck was supported from temporary overhead girders to allow unhindered traffic flow during construction.

As in any project, cost is an important consideration and during all the planning processes the design team's objective was to provide an upgraded facility, at acceptable design standards, while maximising existing infrastructure to limit expenditure.

Construction was completed within the specified contract period and budget while at the same time the feedback by the public, on the impact during construction, has been extremely positive.



De Waal Drive Overpass

Judges' Citation

The extensive planning process embarked upon with this project resulted in some impressive construction techniques. The judges were impressed with the use of the suspended formwork system. The project utilised purpose-made structural steel lattice overhead girders with steel support structures, the design of which required extensive integration of the various design and construction elements.

The Anzio Road Overpass was particularly challenging as the sharply curved bridge deck had to accommodate a vertical curve as well as a horizontal transitional curve, leading into a circular curve with a variable super elevation.

The attention given to the concrete mixes, incorporating supplementary cementitious materials to improve resistance to marine conditions, was impressive. This also reduced carbon emissions and improved the overall sustainability of the bridge structures.

Plastic Shrinkage Cracking in Conventional Concrete and Low volume Polymeric Fibre Reinforced Concrete

Riaan Combrinck and William P Boshoff, *Stellenbosch University, South Africa*

ABSTRACT: Plastic Shrinkage Cracking (PSC) is one of the earliest forms of cracking in concrete and normally occurs within the first few hours after the concrete has been cast. Concrete elements with large exposed surfaces placed in environmental conditions with high evaporation rates are especially vulnerable to PSC.

The surface cracks that form are unsightly and serve as pathways, through which corroding agents can penetrate the concrete, ultimately lowering the overall performance of the structure. Although various precautionary methods exist, these are often neglected or ineffective due to the complex number of factors, which influence PSC and the general lack of supervision.

This paper investigates and describes the behaviour and nature of typical PSC in conventional and low volume polymeric fibre reinforced concrete that has been subjected to conditions with high evaporation rates.

The results indicated that the critical period for PSC formation is between the initial and final setting of concrete. Furthermore, concrete mixes with high bleeding and mixes, containing a low volume of polymeric fibres were shown to reduce PSC. This work is part of an ongoing research project that aims to create a performance-based guideline for the design of concrete elements to prevent/reduce PSC.

1. INTRODUCTION

Plastic Shrinkage Cracking (PSC) is mainly a problem for structural elements with large surface areas, for example bridge decks and floor slabs, which are exposed to environmental conditions with high evaporation rates. Such conditions are common in South Africa and are typically characterised by a low relative humidity, high wind speed and high temperature. The shrinkage or volume change of the concrete, which essentially causes cracking, is mainly due to the loss of free water from within the concrete through evaporation. The ongoing evaporation of water from the concrete surface causes water menisci to form between the particles, which tend to pull the particles together in both the horizontal and vertical direction. Due to an ever-present restraint, the capillary pressure becomes negative. This negative capillary pressure build-up is known to be the main mechanism that causes PSC [1, 2].

At a certain time, the radius of the meniscus between the particles becomes too small to bridge the gap between the particles and air then enters the concrete paste. This time of air entry is the event that initialises cracking and is the only time at which it occurs [2]. Furthermore, the shrinkage will only result in cracking if the concrete is restrained, otherwise free shrinkage would occur. Since concrete restraint is almost unavoidable in practice through the presence of underlying concrete, reinforcing steel, formwork and sub-grade concrete, cracking is required to facilitate the shrinkage or volume change of the concrete [3].

Although capillary pressure, air entry and restraint are required for PSC, there are also several other interdependent factors that influence PSC, for example: evaporation; bleeding; material constituents; setting times; and construction practices [4]. Of the mentioned factors; bleeding probably has the most direct influence on PSC. Bleeding is caused by the settlement of solid particles in the concrete paste due to gravitational forces. As the particles settle they displace water to the surface of the concrete, which compensates for surface drying of the concrete, thus inhibiting the capillary pressure build-up.

Proper construction practices such as curing and temporary windbreaks can in most cases prevent PSC, especially since PSC occurs in a relatively short time period. Another method which has been shown to reduce PSC is adding a low volume of polymeric synthetic fibres to concrete [5, 6]. This is known as low volume fibre reinforced concrete (LV-FRC) which refers to conventional concrete, and contains less than 0.2 % fibres as percentage of the total volume. If PSC occurs, the fibres will bridge the cracks and reduce further crack widening.

The methods mentioned above are often not utilised, or ineffective, due to a lack of knowledge and experience. If PSC is not prevented it may result in serious aesthetical and durability issues in concrete structures. From an aesthetic point of view PSC results in unsightly surface cracks in the concrete, which give a non-uniform appearance. In some cases these cracks can penetrate the full-depth of the concrete slab. More importantly, PSC results in durability issues due to the possibility of corroding agents infiltrating the concrete through the cracks.

This accelerates corrosion of any reinforcing steel, and concrete deterioration that consequently causes a reduction in the performance, serviceability and durability of the concrete structure [6, 7]. Furthermore, cracks formed during the plastic stage of the concrete may be further widened during the long-term drying of the hardened concrete structure, which again results in durability issues [8].

It is evident that PSC can and should be prevented. This paper aims to provide the fundamental understanding of PSC required to facilitate its prevention. It describes the nature and behaviour of typical PSC, with emphasis on the time period where it is most likely to occur. It also investigates the influence of adding a low volume of polymeric fibres to concrete on PSC. The investigation is based on several tests of concrete mixes in harsh environmental conditions inducive to PSC. The experimental results presented include measurement of the capillary pressure, evaporation, bleeding, setting times and crack growth all as a function of time.

2. TEST SETUP

The experiments were conducted in a climate chamber, which can create stable environmental conditions conducive to the formation of PSC. The chamber electronically controls temperature and relative humidity to preset values with a heating element and a dehumidifier respectively, while a variable airflow is created with two axial fans. The climate chamber can reach temperatures of up to 50 °C, relative humidities as low as 10 % and uniform wind speeds of up to 70 km/h.

Figure 1 shows the test compartment of the climate chamber where various moulds are placed for testing. The square moulds are continuously weighed with electronic scales to determine concrete water evaporation.

Figure 1 also shows the rectangular moulds used for PSC measurements as proposed by ASTM C 1579 [9], which were designed to give a single plastic shrinkage crack above the centre insert. The crack area was measured using high resolution images analysed with CAD software as shown in Figure 2

A Vicat needle apparatus was used to determine the initial and final setting times of the concrete in accordance with SANS 50196-3 [10]. As this test is designed for determining the setting time of cement paste, the fresh concrete was sieved through a 4.75 mm sieve to produce a mortar suitable for penetration resistance testing as proposed by ASTM C 403 [11]. The bleeding measurement method is similar to the method used by Josserand & De Larrard [12]. Two cylindrical PVC moulds were filled with concrete after which tracks were created on the concrete surface for bleeding water in which to accumulate. This water is extracted with a syringe and weighed with an electronic scale. The depths of the concrete in the bleeding, evaporation and cracking moulds were 100 mm.

3. TEST PROGRAMME

The standard concrete mix chosen for the experiments was based on mixes used by local ready-mix companies for

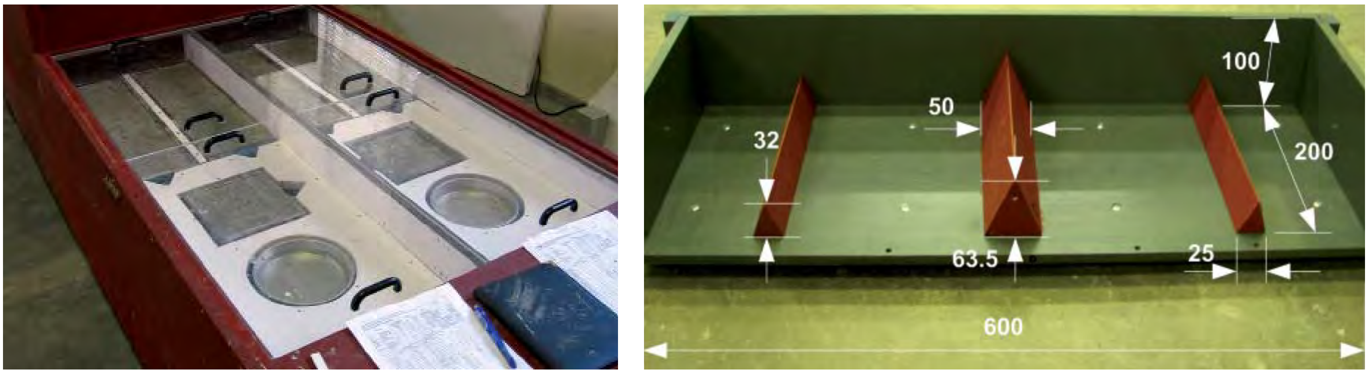


Figure 1: The test compartment of the climate chamber and mould used for crack measurements

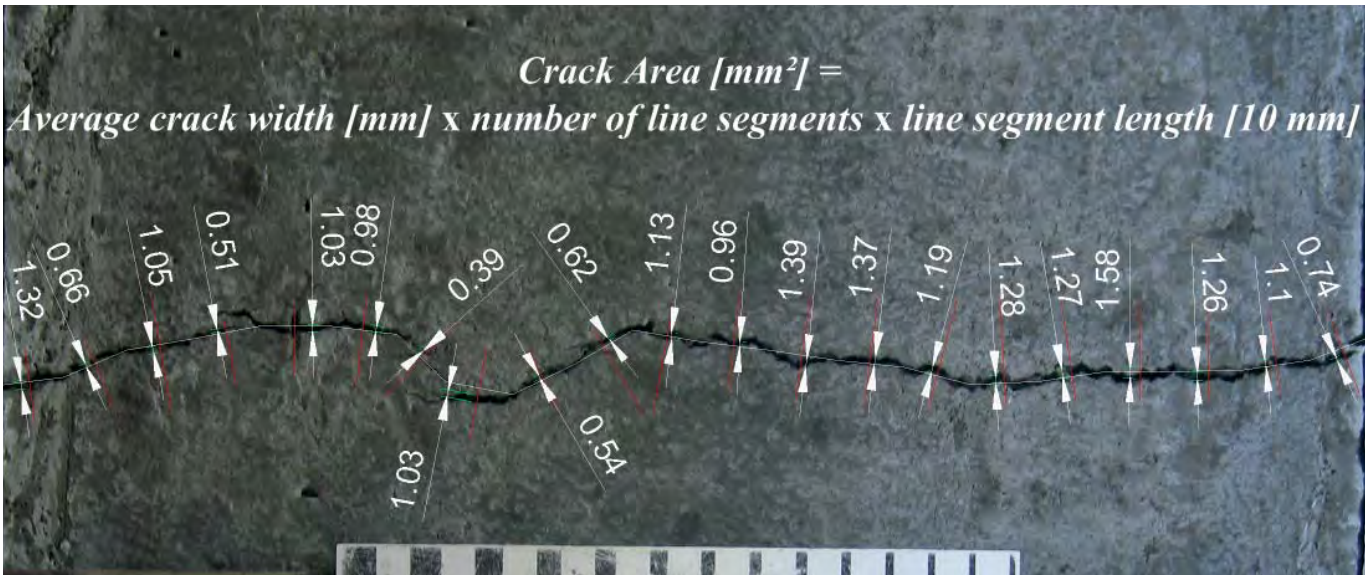


Figure 2: Example of crack area measurement and calculation

Capillary pressure measurement was based on the method used by Slowik [2]. Small electronic pressure sensors were connected to the pore system of each concrete specimen by long metal tubes, which were inserted horizontally 35 mm beneath the surface of the concrete. The tips of the tubes were located at the centre triangular insert of the moulds used for crack measurement which is also the expected cracking position.

industrial floor slabs. Three variations of the standard mix in terms of setting time and bleeding characteristics were also used. The setting times were varied by using a set accelerator and set retarder, whereas the bleeding was increased by using coarse natural sand. Tests were also done by using three different monofilament synthetic fibre types at a dosage for PSC reduction of 0.9 kg/m^3 of concrete [5].

None of the mixes segregated had adequate workability for compaction with a poker vibrator. The 28-day compression strength of all the mixes was more than 25 MPa. Table 1: summarises the mix label, definition and description. Table 2: summarises the fibre properties and Table 3: shows the mix proportions and material constituents of all the mixes. With the exception of the bleeding, all the measurements were conducted in the climate chamber at an extreme environmental condition defined as Climate 1. The bleeding was measured outside the climate chamber at a less severe environmental condition defined as Climate 2. This was necessary to improve the accuracy of the measurement method. Table 4 shows a summary of the environmental conditions. Bleeding measurements were taken every 20 minutes until the final setting time was reached. The time 'zero' is defined as the time when the moulds were placed in the climate chamber, which was about 20 minutes after water was added to the mix. Two crack measuring samples were cast for every mix.

4. RESULTS

Figures 3 to 6 show the results of all the mixes that had visible cracks. Only the first sample of each mix is presented for simplicity and it should be noted that there were no significant differences between the results of the samples of each set.

The figures show the cumulative amount of bleeding and evaporation as well as the time of crack onset, time of crack stabilisation, initial and final setting times of concrete, capillary pressure build-up and the crack area as measured at specific times.

The time of plastic crack onset is defined as the time when the first crack is observed, and the time of crack stabilisation is defined as the time when a clear decrease in the rate of crack growth can be observed. The results of the mixes containing fibres are not presented since they showed no visible cracking

Table 1: Label, definition and description of mixes

Label	Definition	Description
MS	Mix Standard	Used for industrial floor slabs
MR	Mix Retarded	Retarded setting times
MA	Mix Accelerated	Accelerated setting times
MB	Mix Bleeding	Increased bleeding
MPES	Mix Polyester	MS with polyester fibres
MPP	Mix Polypropylene	MS with polypropylene fibres
MFPP	Mix Fluorinated Polypropylene	MS with fluorinated polypropylene fibres

Table 2: Fibre properties

Fibre type	RD	Volume [%]	Length [mm]	Diameter [µm]	Hydro-philicity
Polyester (PES)	1.38	0.07	12	18	Hydrophilic
Polypropylene (PP)	0.91	0.10	12	30-40	Hydrophobic
Fluorinated polypropylene (FPP)	0.91	0.10	12	30-40	Hydrophobic

Table 3: Mix proportions and material constituents

Mix name	MS	MA	MR	MB	MPES	MPP	MFPP
Content	[kg/m³]						
Fine natural sand (FM = 1.5)	503	503	503	-	503	503	503
Greywacke crusher dust (FM = 3.6)	506	506	506	506	506	506	506
Coarse natural sand (FM = 2.3)	-	-	-	486	-	-	-
19 mm Greywacke stone	950	950	950	950	950	950	950
OPC Cement [CEM I - 42.5N] (Surface area = 280 m²/kg)	270	270	270	270	270	270	270
Water	190	190	190	190	190	190	190
W/C ratio	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Plasticiser	1	1	1	-	1	1	1
Accelerator	-	1.51	-	-	-	-	-
Retarder	-	-	1.7	-	-	-	-
Polyester fibres	-	-	-	-	0.9	-	-
Polypropylene fibres	-	-	-	-	-	0.9	-
Fluorinated polypropylene fibres	-	-	-	-	-	-	0.9

Table 4: Environmental conditions

Condition	Relative humidity	Air temperature	Wind speed	Concrete temperature
Climate 1	20 %	40 °C	33 km/h	23 °C
Climate 2	55 %	23 °C	0 km/h	23 °C

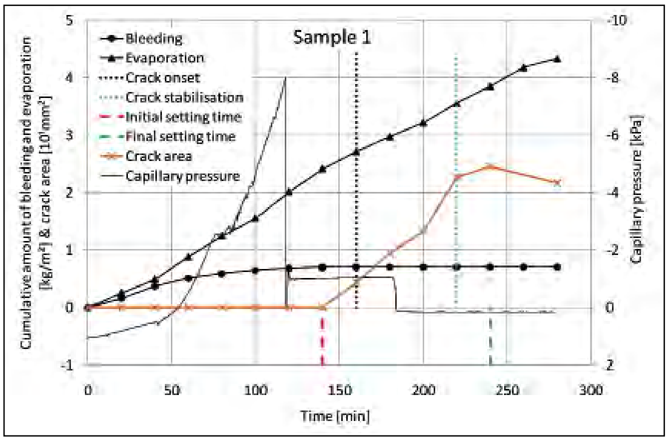


Figure 3: Result of MS (Mix Standard) at Climate 1

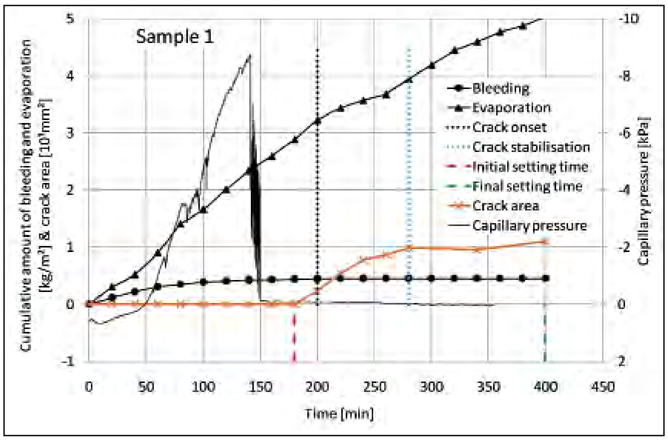


Figure 4: Result of MR (Mix Retarded) at Climate 1

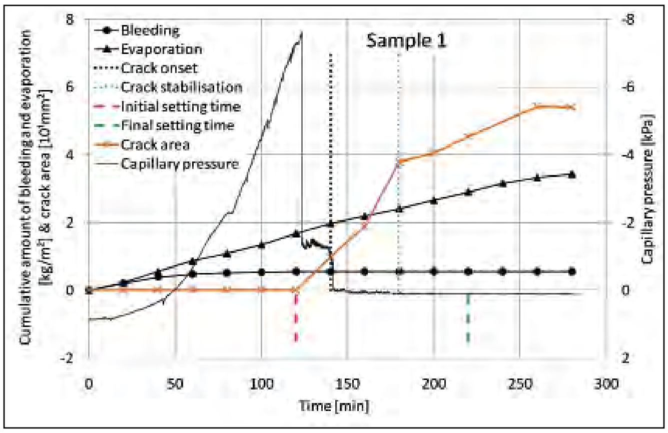


Figure 5: Result of MA (Mix Accelerated) at Climate 1

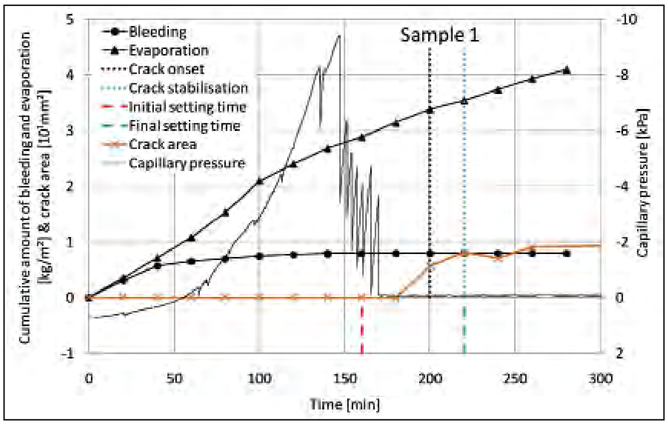


Figure 6: Result of MB (Mix Bleeding) at Climate 1

5. DISCUSSION

5.1 Nature of PSC

Figures 3 to 6 show the general behaviour of typical PSC. Once all the bleeding water on the concrete surface has evaporated the capillary pressure starts building up. This is the drying time, which occurs around 50 minutes after the concrete has been cast for all tests. After the drying time has been reached the negative capillary pressure increases significantly until air entry pressure is reached near the initial setting time of the concrete. Air entry can be recognised by a sudden drop in the capillary pressure. The first cracks are observed just after the initial setting time has been reached. This is called the time of crack onset which notably does not coincide with the time of air entry as would be expected. This is because at the time of air entry the crack has not yet widened, but only exists as a potential void between the concrete particles filled with air and not water [2]. As evaporation and therefore shrinkage continue, the crack widens and only becomes visible to the naked eye (time of crack onset) several minutes after air entry has occurred. The crack increases rapidly within a relatively short period of time and stabilises before the final setting time is reached.

5.2 Critical time period for PSC

Figure 7 summarises the important times for both samples of all the test sets including the tests containing fibres. It should be noted that MA only shows one data point for the time of air entry, since the capillary pressure measurement for the other sample malfunctioned.

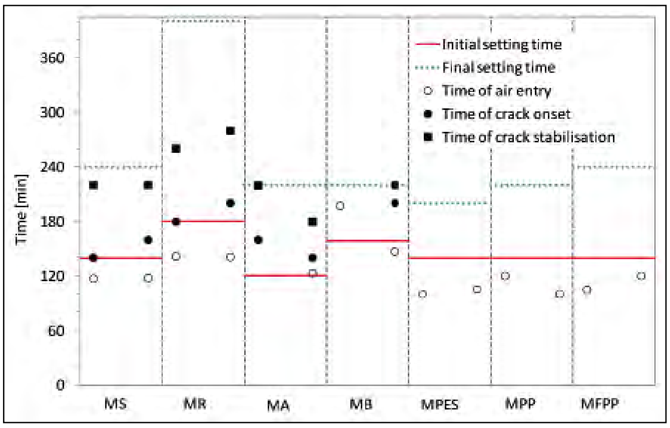


Figure 7 : Summary of important times for both samples of all mixes

The results indicate that cracking starts close to the initial setting time of concrete. Furthermore, there exists a close relationship between the initial setting time, time of crack onset and the time of air entry. This relationship sheds light on the reasons why cracking starts close to the initial setting time. Firstly, no cracking is possible before air entry has occurred [2], since air entry initialises any possible cracks. Secondly, the time of air entry also coincides with the time of maximum vertical settlement [2] which gives the point in time from where the majority of the shrinkage will occur in the horizontal direction. This horizontal shrinkage facilitates the formation of cracks and can be expected to start close to the initial setting time of concrete. However, this does not suggest that the initial set of concrete causes PSC and only indicates that conditions are favourable for the start of PSC at the initial setting time of concrete.

The results also give valuable information on when PSC ends. No new cracks started after the final set of concrete had been reached and crack stabilisation always occurred before the final setting time of the concrete. Nearly 80 % of the crack area at 40 minutes past the final setting time has already been formed by the time of crack stabilisation. Furthermore, per definition the rate of the crack growth after the time of crack stabilisation is insignificant if compared with the rate of the crack growth before the time of crack stabilisation as shown in Figures 3 to 6. The crack growth after the time of crack stabilisation may include cracks due to other types of shrinkage, for example thermal gradient and drying shrinkage. This makes it difficult to distinguish between the types of cracks that form after the time of crack stabilisation. However, based on this work it can be concluded that only PSC occurs before crack stabilisation given there is no differential settlement. Furthermore, the final setting time of concrete serves as a good indication of when PSC ends as the time of crack stabilisation typically corresponds with the final setting time.

The critical period where the majority of the plastic shrinkage cracks start and end is therefore between the initial and final setting times of concrete. Any preventative measure would be most effective if applied during this period.

5.3 Importance of bleeding

Figure 8 shows the cumulative amount of bleeding and the average crack area of both samples for each mix without fibres. The figure indicates that only once the bleeding rate becomes insignificant the cracking starts. It is however important to note that these tests were done in extreme environmental conditions.

The results support the observation that PSC starts close to the initial set of concrete, which in turn is closely related to the time of maximum vertical settlement. Since bleeding is caused by settlement, it would be reasonable to assume that the time of maximum vertical settlement will also coincide with the time when bleeding becomes insignificant. The results confirm this assumption and emphasises the influence of bleeding on PSC.

The results also indicate that MB with the most bleeding showed the smallest crack area and MA with much less bleeding showed the largest crack area. It is clear that bleeding has a significant influence on PSC. In general, the more concrete bleeds, the less the severity of PSC. However, it should be noted that too much bleeding may lead to surface laitance, which results in a concrete surface with poor quality and strength as well as bleed channels and voids under aggregate particles and reinforcing steel [4].

It is often argued that concrete with a delayed setting time is more prone to PSC [13, 14]. The results of MR, that is the concrete containing a retarder, showed the opposite, i.e. less PSC. Also, the MA samples, containing an accelerator, showed an increase in PSC. One possible reason for this is that concrete with a delayed setting will relieve the capillary pressure build up, even though there is a high rate of evaporation. Once the initial set occurs, after which point the PSC

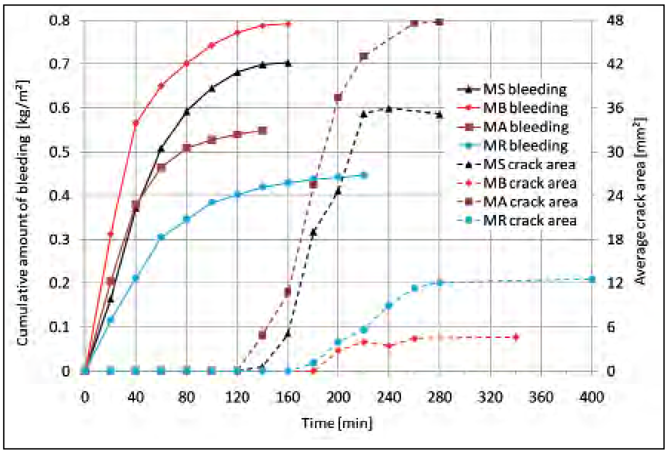


Figure 8: Graph of cumulative amount of bleeding and average crack area for mixes without fibres

can begin, the water available to evaporate is less compared to concrete that sets earlier. The opposite is true for concrete with an accelerated setting time. In this case, once the initial set occurs, more water is available for evaporation, thus increasing the severity of PSC. This, however, requires further investigation; especially since Krönlof et al. [15] has shown that the addition of admixtures often has an unexplainable effect on PSC behaviour.

5.4 Pre-cracking influence of fibres on PSC

Although fibres only start reducing crack growth once the crack has been formed, it still influences the bleeding and capillary pressure which directly influences PSC. The addition of fibres to MS reduced the bleeding significantly as shown in Figure 9.

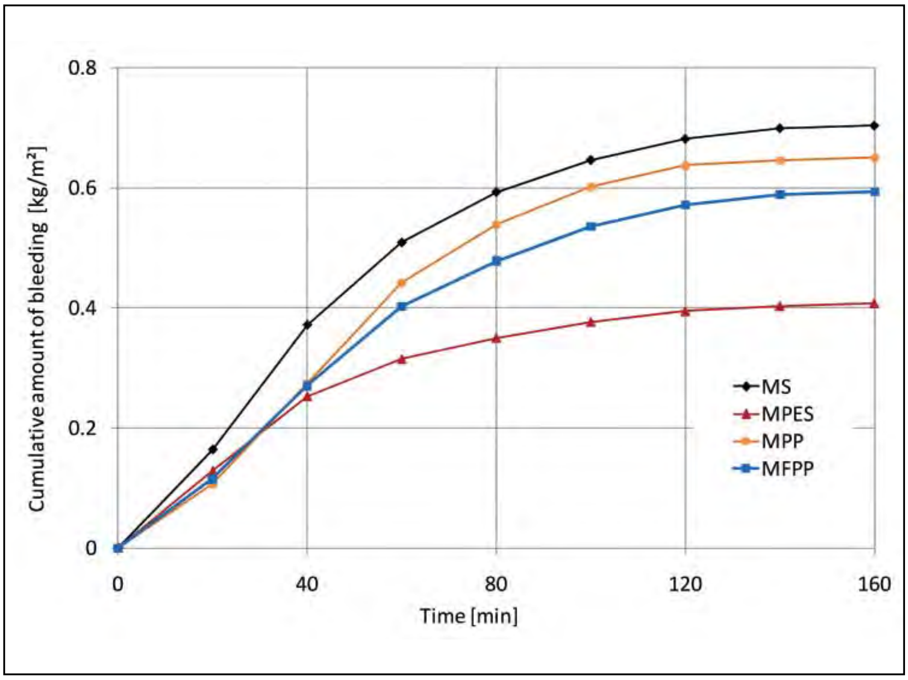


Figure 9: Effect of fibres on bleeding

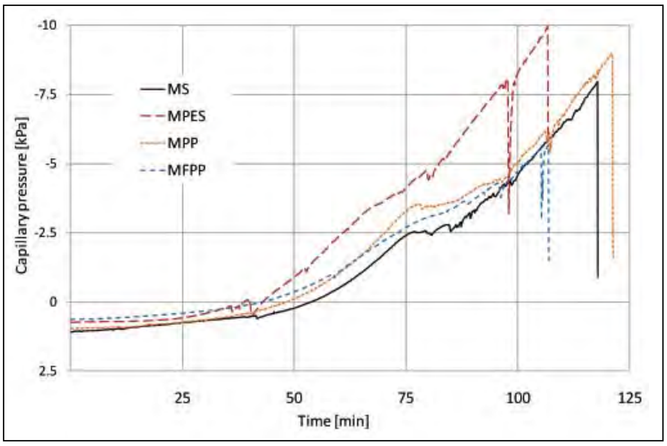


Figure 10: Effect of fibres on capillary pressure

This reduction is due to the fibres which reduce the settlement and therefore the bleeding [16]. The addition of polyester fibres resulted in the largest bleeding reduction, due to its hydrophilic nature which allows the fibre to absorb water. It should be mentioned that in certain cases fibres may increase the bleeding rate of a concrete mix, by acting as channels whereby water can move to the surface [16]. Depending on the effect of the fibres on the bleeding, the capillary pressure will also be influenced. The addition of fibres reduced the bleeding in the tests reported in this paper, and therefore explains the increase of the rate of negative capillary pressure build up as shown in Figure 10. An increase in negative capillary pressure also increases the risk for PSC which to an extent counteracts the reduced risk of PSC due to the addition of fibres.

6. CONCLUSIONS

The following conclusions regarding PSC in conventional concrete and low volume polymeric fibre reinforced concrete can be drawn: PSC does not occur before the initial set of concrete and PSC stabilises around the final setting time. This period is identified as the critical period for PSC

Bleeding has a strong influence on PSC where an increase of bleeding will reduce PSC.

The addition of polymeric synthetic micro fibres can reduce or even eliminate PSC. The addition of a low volume of polymeric micro fibres to concrete typically reduces bleeding. However, the PSC is still reduced as a result of the fibre addition even though the bleeding is reduced.

ACKNOWLEDGEMENTS

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Berg River Dam

Water, water – but not everywhere!

More than 300 delegates attended the recent seminar road show organised by the Concrete Society of Southern Africa NPC in association with the Cement and Concrete Institute.

ConFrex 2012 focused on concrete for fluid retaining and fluid excluding structures, and the event attracted consulting engineers, contractors, suppliers and academia from many sectors of the built environment.

In his introductory message, John Sheath, CEO of the Society and Chair for the seminar proceedings, referred to the State President's Infrastructure Plan and integrated projects requiring more investment in water infrastructure. Investment of R570 billion is required in the next decade across the entire sector and value chain, from source to tap, and waste to source.

To set the scene for the seminar, the key note address was presented by representatives of the Department of Water Affairs, Ockie van den Berg, Chief Engineer: Options Analysis North and Jaap Kroon, Chief Engineer, External Works. Their presentation provided delegates with an insight into the Department's strategy and plans for water retention and supply over the next few decades. The focus was centred on: Strategic Water Resource Planning; Asset Management; and New Infrastructure Investment.

After describing the above in some detail, the speakers assured the audience that there are opportunities for consultants and contractors to address the challenges in the water sector!

There was great interest in the two case studies that were presented, the first by Rob Fraser and David Stables, Berg River Consultants on the Berg Water Project in Franschhoek, Western Cape, followed by Jaco van NieKerk, DWA Directorate: Construction West - De Hoop Dam Project. This was a fascinating look at concrete in action at these two prestigious dam sites. Of particular interest was the innovative use of immersion-vibrated roller-compacted concrete (IV-RCC) on the De Hoop Dam, which is being built on the Steelpoort River on the border of the Mpumalanga and Limpopo Provinces. This technology has enabled the contractor to place

Water, water
– but not everywhere!

concrete at great record- breaking speed, beating all previous records by a wide margin.

On the more technical side, delegates heard details presented on the new proposed South African Design Standard for Concrete for Water-Retaining Structures. This was presented by Dr Celeste Barnado-Viljoen of Stellenbosch University who explained that this new standard was necessary, in the long term, as the currently used British Standard BS8007 has been officially withdrawn. The UK uses EN 1992-3 for the design of water retaining structures. This implies, she stated, that the BS8007 will no longer be maintained by the UK - in terms of revisions to keep up with new technology and knowledge on material behaviour. In the short term this is not a crisis for South Africa, but in the next ten years it will become an issue as better technology and materials emerge. Dr Barnado-Viljoen described the work that had been done to date by a colleague at the University. She appealed to delegates to volunteer to join a Working Group to resolve issues including the basis of design issues, materials, detailing, construction methods, SANS 10100 revision and non-technical issues.

Dr Celeste Barnado-Viljoen

This paper was followed by a presentation on the new SANS 50450

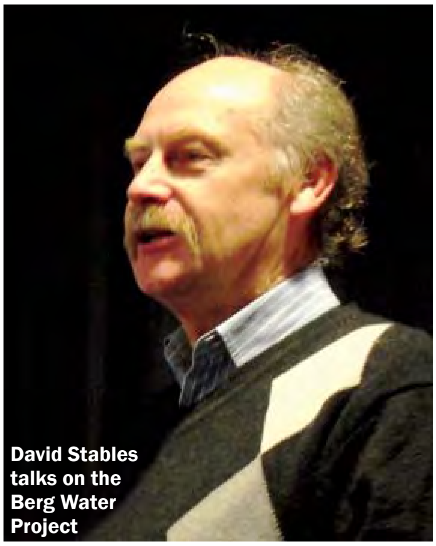
Water, water
– but not everywhere!

specification covering fly ash for concrete. Lehlohonolo Madumo, Technical Manager from Ash Resources, provided a comprehensive overview of this new specification, which covers not only the full requirements and the implication for both manufacturer and user, but also a case study in Bahrain. He was able to demonstrate how the use of a classified fly ash to the new specification can produce a high strength, dense concrete with the minimum of heat hydration.

Waterproofing of concrete was next on the programme and delegates heard from Lewis Lynch of Xypex Africa and Kobus Botma of Stoncor Africa, detailing the available options to clients for waterproofing concrete and the latest developments. This included everything from active crystallisation technology to pre-and-post-applied membranes. Delegates gained a good insight into the mystical world of waterproofing.

The final presentation of the seminar featured Gary Theodosiou from the Cement and Concrete Institute, who described the challenges facing engineers with regard to design and concrete materials for liquid–retaining structures. He emphasised that the construction of successful concrete liquid-retaining structures has special requirements for durability; water tightness; control of cracking and joints; and that common defects are generally associated with porous concrete; uncontrolled cracking; defective joints and continuous leakage paths. He presented a case-study highlighting the various factors that could contribute to the vertical cracking of a reservoir.

Lots of interest shown at the company display stands



David Stables talks on the Berg Water Project

In closing the seminar the Chairman thanked all the speakers for their time and support of the event; the many sponsors who had contributed generously; the Organising Committee comprising, Nick van den Berg, Immediate Vice-President of the Society, Hanlie Turner, Marketing Manager of the C&CI; and CSSA Head Office team Natasja Pols and Jeanine Steenkamp.

He reminded delegates of the forthcoming seminar in October – ‘ConCrax 2012’, which will focus on the cracking of concrete. And he thanked everyone for attending the event.

Lewis Lynch

From the CEO's desk

This last quarter has seen a flurry of activity in the Society with the holding of the Confrex 2012 seminar road show around the country, and the formation of a National Member Group of the International Federation for Structural Concrete (fib) in Europe, which our president has mentioned in his message.

Then there were the government legislative requirements to bring the Society into conformance with the new Companies Act 2008; and the change to a new accounting system to improve productivity and efficiency at Head Office.

A separate report on the recent Confrex 2012 seminar features in this issue. But it is worth mentioning at this early stage that plans have already started on our third road show for this year, ConCrax 2012, which will take place in October. The focus will be on cracking issues related to concrete, a subject which will be unravelled in a most comprehensive and practical way.

The new Companies Act 2008 has been promulgated and comes into full effect in May 2013. Due to the complexity of the terms of the 229-page document outlining the new Act, as it applies to non-profit organisations such as ours, we have taken legal advice, in order to plan our way forward towards full compliance with the new Act.

Key changes in the Society required under the Act include the use of the acronym 'NPC' (Non-Profit Company) after our name, the addition of more director(s) as we are below the required minimum of three, and the change of decision-making power in the Society from the National Council to the Board of Directors. A new Memorandum of Incorporation has been formulated and this will be circulated to members in July for their approval.

It has become more difficult to provide my comment on construction activity with the absence of up-to-date cement sales statistics. But the massive infrastructure development drive, announced earlier this year, by the President in his State of the Nation address, promises to be the major source of growth over the next few years.

In February, R844,5 billion was allocated in the Budget to develop infrastructure over the next three years. Traditional sources of growth – exports and consumption – are under great pressure and, without this promised infrastructure spending, the economy could grow very slowly.

Infrastructure has been the focus for the last seven years. It is difficult to believe the promises of acceleration of further infrastructure spending when there is such an appalling under-spending of capital budgets, which was caused by an acute lack of skills and capacity at all levels of government.

Confidence in the South African property and construction sectors is fading and, according to Grant Thornton's 'International Business Report' for 2012, less than half of the businesses are optimistic about their outlook. These low levels of optimism are a reflection of the tough trading conditions faced by both the property and construction industries.

While times remain tough, property and construction businesses are focusing on existing assets and investing in building, renovations and machinery. Typically, not many are investing in new buildings but rather consolidating and improving their current assets in order to be more attractive to potential tenants, or clients, as the economy turns.

John Sheath

CEO

Concrete Society of Southern Africa NPC

ConCrax 2012

Seminar road show on Cracking of Concrete

Watch out for details of the 3rd in our series of 2012 Concrete Society Road Shows taking place in early October.

Cracks in concrete are a fact of life, but what causes them; how can one prevent them; how does one repair them?

Learn the answers and more, at this unique one-day seminar.

Check e-mail and website for notices

www.concretesociety.co.za

CONCRETE SOCIETY
OF SOUTHERN AFRICA

Chota Motala Inter-change

Members of the KwaZulu-Natal CSSA branch recently visited the Chota Motala Interchange site, in Pietermaritzburg.

Bradley Naidoo, Site Manager, says that the project team has faced a number of challenges including dealing with the existing traffic conditions during the on-going construction and infrastructure work.

During the past 20 years, there has been enormous growth in the number of road users in Pietermaritzburg. Residents have experienced overwhelming levels of traffic congestion driving in and out of Northdale and the surrounding areas.

The South African National Roads Agency Limited (SANRAL) took a decision to construct a multi-level interchange, to ease congestion at the access points for the N3 highway. CSSA member, Group 5, was awarded the R280 million project and work commenced in March 2010.

The contract included: firstly, the rehabilitation, widening and overlaying the N3 over 3kms from Manning Road Bridge to Chatterton Road Bridge. Secondly, the stretch of road from Chota Motala Road, and East Street to Otto's Bluff was widened in each direction. The existing two lanes increased to three, with a raised median inbetween. Thirdly, the replacement or upgrading of bridges was an important part of the 27-month contract.

Chota Motala Bridge has increased in length and width to seven lanes. The incrementally launched bridge spans 223 m long, built on a radius of 175 m. There will be seven spans and six piers. The span lengths will vary from 25 m to 36 m!

On completion, the N3 concrete pavement between Manning Road and Chatterton Road will stretch 3kms. A 100 000m^2 of 180mm CRCP will be used. CRCP will be paved onto a 50mm asphalt interlayer, and there will be four lanes spanning 17,8m between Chota Motala and Sanctuary Road Interchanges, as well as three lanes spanning 14,1m.

Floating concrete

The annual Concrete Boat Race has proved an elusive dream for some and a floating concrete reality for others.

Making a splash, the concrete boats will take to the water on September 29th. In line with new safety legislation at social events, all the necessary plans and precautions have been put in place to ensure that this fun challenge will be enjoyed by over a thousand members and their guests.

Chairman's Breakfast

The Chairman's Breakfast on November 22nd promises to end the year on a high note, with guest speaker and renowned South African author, Arthur Goldstuck.

He is currently head of World Wide Worx, a research organisation, and has led research into ICT issues, such as the impact of IT on small business, the role of mobile technologies in business, and technology challenges of the financial services sector.

Goldstuck grew up in Trompsburg, Free State, South Africa and resides in Johannesburg.

His South African best-selling books include: 'The Hitchhiker's Guide to Going Mobile', 'The Burglar in the Bin Bag' as well as five books on South African urban legends. He has also contributed to numerous South African and international publications, including The Times of London and Billboard.

More details on upcoming events are available on the CSSA website.

Inland Branch Chair, Hanlie Turner, and the Inland Branch Committee, thank all the loyal sponsors for their ongoing support and the Society's branch members for loyally supporting the events.

She says, "Please get involved in our concrete future!"

Egg-cellent skills

Students have a chance to show off their engineering skills in the Egg Protection Device competition.

Last year, a record number of entries were received and 26 teams took part in the challenge for the coveted title and prize money. Some teams failed as eggs broke and devices failed in their attempts to win. This year's 'crush-in' will be held on August 24th and the competition promises to be even fiercer.

Paving the way

The Inland Branch membership currently stands at 353 paid-up members, comprising material suppliers, consultants, specifiers, contractors, academics and students.

The Inland Branch committee remains enthusiastic and committed to adding value for its members and guests at all the events.

During May, a technical seminar conducted by independent paving consultant, John Cairns, demystified the new concrete paving standard, SANS 1058. Many of the smaller paver manufacturers who attended the event said that they now feel more confident tackling the materials, manufacturing, testing procedures and requirements of the new standard.

New initiatives

'Cement & Concrete – a commitment to sustainability' is the topic for a technical meeting scheduled for August 14th. Renowned international speaker, Professor Arnon Bentur from Israel, will open the afternoon event with a presentation on 'Low clinker cements / concretes and the implications for the industry'. Dr Dhiraj Rama from the Association of Cementitious Materials Producers and C&CI CEO, Bryan Perrie, will share the current initiatives that South Africa has embarked on towards ensuring that the cement and concrete industries are truly sustainable and environmentally responsible.

CONCRETE SOCIETY OF SOUTHERN AFRICA INTERNATIONAL EVENTS 2012/2013			
DATE	MEETING/EVENT	VENUE	CONVENOR
15th - 18th Aug	The Star Interbuild Africa 2012	Expo Centre, NASREC, Johannesburg	-
6th Sept	ICCRRR 2012 in conjunction with RILEM Week	UCT, Cape Town	Dr Hans Beushausen
28th – 30th Jan 2013	ACCTA 2013 International Conference	Johannesburg	Prof Herbert Uzoegbo
6th - 8th May 2013	International IABSE Spring Conference	Rotterdam, Netherlands	The Korean Group of IABSE
27th - 29th May 2013	International Conference on Concrete Sustainability	Tokyo, Japan	Japan Concrete Institute

CONCRETE SOCIETY OF SOUTHERN AFRICA KWAZULU-NATAL 2012			
DATE	**MEETING/EVENT**	**VENUE**	**CONVENOR**
17th July	MTM – Mgeni Interchange	Room 124, Centenary Building, UKZN Campus	Raj Naidoo
21st August	MTM – Update on SANS 10100	Room 124, Centenary Building, UKZN Campus	Theresa du Plessis
18th Sept	Technical meeting (Living with the new generation cements)	To be Advised	Craig Handler Raj Naidoo
27th Sept	Golf Day	Bluff Golf Course	Andries van Rensburg
16th Oct	Site Visit	Durban Harbour – Maydon Wharf	Ken Newton (ktw@mweb.co.za)
20th Nov	President & CEO Visit	To be Advised	Raj Naidoo

CONCRETE SOCIETY OF SOUTHERN AFRICA INLAND BRANCH 2012			
DATE	**MEETING/EVENT**	**VENUE**	**CONVENOR**
11th July	Committee Meeting	C&CI, Midrand	Armand van Vuuren
8th August	Committee Meeting	C&CI Midrand	Hanlie Turner
14th August	Mini Seminar – Sustainability	Blue Valley Golf and Country Estate	Jannes Bester/Natalie Johnson/Tina Coetzee
17th August	Egg Protection Device – Casting Date	Not Applicable	Darren Jacobs
24th August	Egg Protection Device – “Crush In”	PPC Jupiter Works	Darren Jacobs
12th Sept	Committee Meeting	C&CI, Midrand	Hanlie Turner
29th Sept	Annual Concrete Boat Race Day	Victoria Lake, Germiston	Michelle Fick/Andrew Schmidt
10th Oct	Committee Meeting	C&CI, Midrand	Hanlie Turner
2nd Nov	Chairman’s Breakfast	To be advised	Hanlie Turner

CONCRETE SOCIETY OF SOUTHERN AFRICA NATIONAL OFFICE PROGRAMME 2012			
DATE	**MEETING/EVENT**	**VENUE**	**CONVENOR**
18th Oct	Council Meeting	Johannesburg – Venue to be Confirmed	Prof Billy Boshoff
October	Concrete Seminar – Cracking in Concrete	Durban, Port Elizabeth, Cape Town, Johannesburg	John Sheath
November	Concrete Beton	Posted to all CSSA Members	Crown Publications

CONCRETE SOCIETY OF SOUTHERN AFRICA INTERNATIONAL EVENTS 2012/2013			
DATE	**MEETING/EVENT**	**VENUE**	**CONVENOR**
9th – 11th July	Concrete in Low Carbon Era	Dundee, Scotland	Prof M R Jones

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2013 Fulton Awards

Call For Nominations

FULTON Awards 2013

The Concrete Society of Southern Africa (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. We are proud to announce that the Cement and Concrete Institute is confirmed as the Anchor Sponsor for the 2013 Fulton Awards.

For the 2013 Awards there will be 6 categories:

CIVIL ENGINEERING STRUCTURE:

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.

BUILDING STRUCTURE:

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.

ARCHITECTURAL CONCRETE:

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.

SUSTAINABLE CONCRETE:

Projects that demonstrate the innovative use of concrete through the implementation of sustainable strategies during the design, construction and use phase.

COMMUNITY STRUCTURE:

Structures that have made a significant contribution to the formation of socially viable environments and the values of communities, with a high participation of stakeholders (client, users, local communities, local authorities, non-governmental organizations and others).

INNOVATIVE CONSTRUCTION:

Structures 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 2011 or substantially completed during 2012 is eligible for entry, and projects may be entered in more than one category.

For nomination forms, contact the CSSA Administrator:

Tel: 012 348 5305 or e-mail: admin@concretesociety.co.za or visit the Concrete Society website on www.concretesociety.co.za

Anchor Sponsor of the 2013 Fulton Awards

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Closing Date For Nominations 31 August 2012