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Accredited Technical Paper:
New Technologies for
Sustainable Concrete

Fulton Awards:
Balanced Cantilever
Structures – for Gautrain

AfriSam Build with Confidence

PPC CEMENT

BASF The Chemical Company

LAFARGE

President's Message

It is a new year and, for some of us, a new beginning. I, however, realised once again that the excitement of a new year is short-lived and wears off just as quickly as my Christmas holiday flew by. The CSSA office is a buzz with arrangements for the Fulton Awards; to be held in June. The judging has just been completed and I am looking forward to the prestigious awards ceremony. There were a number of high quality projects entered and the Fulton's weekend promises to be a memorable event. As this is a major event for the Society, we will only be holding two road shows this year.

The first event was held recently and we revisited the ever relevant topic on Self Compacting Concrete. The second event will be held later this year and will focus on the testing of concrete. Thank you to all the members who continue to support these events.

I am proud to report that our membership has grown. Membership fees ensure that the Society continues to promote excellence in the use of concrete, as well as creating a platform for networking, sharing of knowledge and information about concrete.

Membership benefits include: discounts for Engineering Council of South Africa membership fee and registration fees for seminars. This is typically far more than the yearly CSSA membership fee. As a member you will be invited to local branch events and this includes technical talks/meetings and site visits.

I would also like to encourage you to contact your Branch Chairman if you wish to become more involved in the CSSA at branch level.

The CSSA recently became a 'National Member Group' of Fédération Internationale du béton (the International Federation for Structural Concrete) and part of the benefits are useful technical documents or bulletins, which are available in pdf format on our website for members only.

There are 52 documents including: Structural Concrete Text Book, Structural Connections for Precast Concrete Buildings, and Practitioners' Guide to Finite Element Modelling of Reinforced Concrete Structures, amongst many others.

I wish our readers all the best for the rest of 2013 and hopefully by the end of the year the building industry activity will have risen to new heights.

Sincerely,

Billy Boshoff

COVER: The Viaduct which carries the Gautrain on its journey to and from Pretoria has become a landmark feature, towering over the national roads. The Bombela Civils Joint Venture constructed the impressive concrete structure using the balanced cantilever method.

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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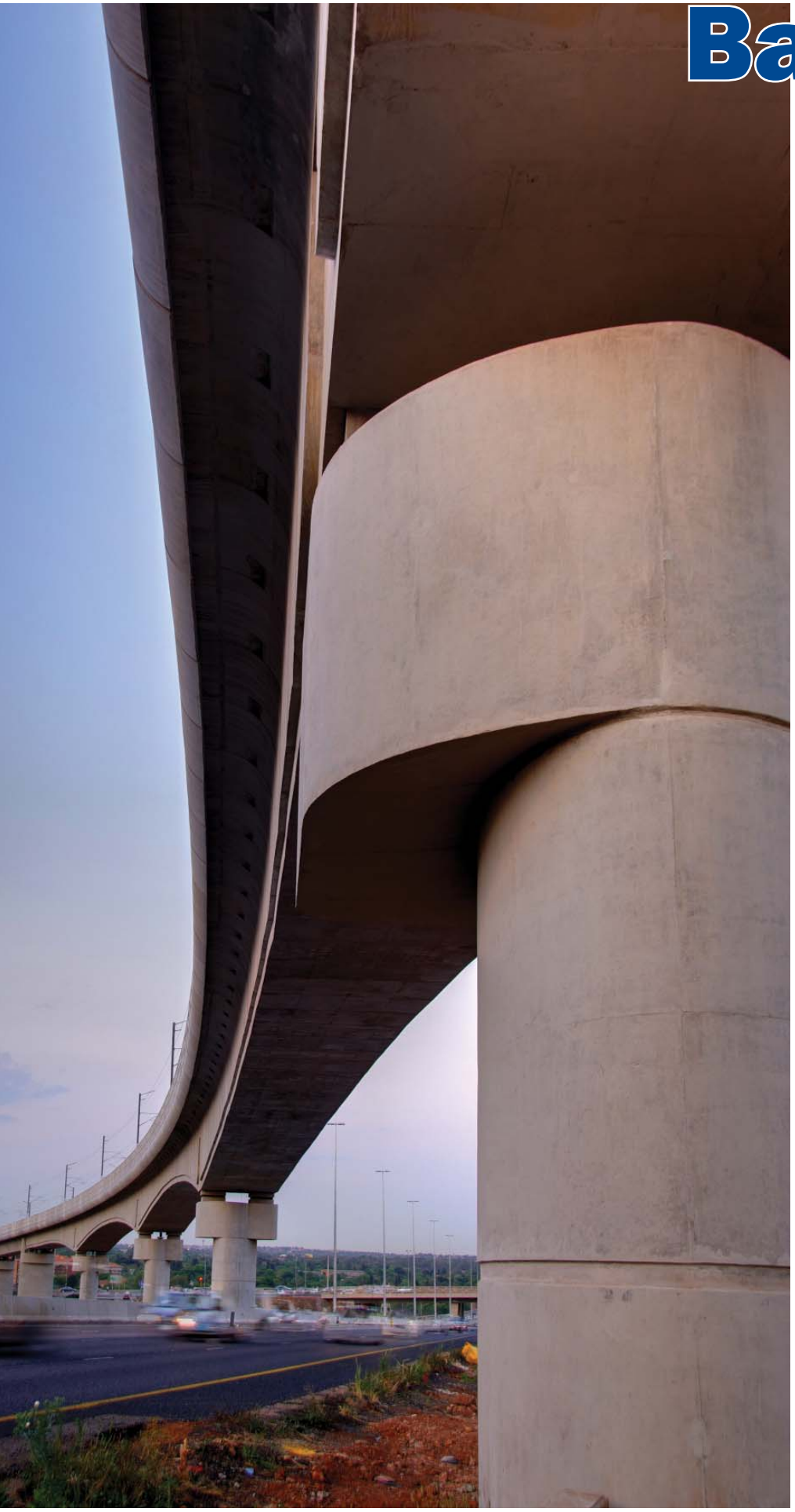


Balanced

Two viaducts which carry the Gautrain on its journey to Pretoria have become landmark structures. Towering over the N14 and N1 respectively, these impressive concrete structures were constructed by the Bombela CJV using the balanced cantilever method of construction.

The longer of the two is the Jean Avenue bridge which crosses the N14 and is approximately 580m in length. The John Vorster Drive viaduct crosses the N1 and is approximately 500m long. Both concrete viaducts are six span structures with spans ranging from 60m to 120m. The only notable difference between these two balanced cantilever structures is that the John Vorster viaduct is on a constant horizontal curve with a radius of 1 170m. Both have seven piers, each incorporating one abutment and one pier, which are shared with the precast segmental viaducts that link the balanced cantilever viaducts on either side of Centurion.

The use of the balanced cantilever construction technique provided an efficient and economic solution to the bridging of the highways and it was also selected for its ease of constructability. This technique is considered ideal for concrete box girder bridges with medium to long spans, and the bridge decks have variable depth box girders which are 3,5m deep at the mid span and either 6,2m or 7,5m deep at the section adjoining the piers. The deeper sections are located at the longer spans.

The balanced cantilever structures cross the existing highways and intersections at an acute angle, limiting the areas in which the piers could be sited. The piers are either 3m x 7,5m or 4,8m x 7,5m elliptical shaped structures. This gives an aesthetically pleasing shape to the piers but was also an appropriate structure shape given the imposed site constraints. Due to the N1 road widening, South African National Roads Agency Limited only allowed a 3m zone in the median of the highway for pier

Cantilever Structures

construction. The pier, therefore, had to be constructed parallel to the roadway resulting in a 'twisted' pier head to accommodate the oblique angle of the deck. The majority of the piers are founded on reinforced concrete shafts with a 7m diameter. This type of foundation, where the shaft depths reach in excess of 30m, was dictated by the complex dolomitic geological conditions.

The structural design of the balanced cantilever was carried out in the Bouygues design office in Paris. The internationally renowned bridge architects, Lavigne, were employed to produce the architectural design for the structures. Lavigne chose to implement the theme of flowing curves throughout the structure and included the signature 'bird wing' recess on the Segment on Pier (SOP) to create a feeling of lightness. The recess also served the purpose of visually reducing the depth of the deck.

Another feature introduced by the architects was the stainless steel strip in the lower part of the parapets, which brings emphasis to the rail structure situated on the deck. The introduction of the recess and curves in the deck, piers and pier head resulted in interesting challenges for both structural design and formwork design in order to bring the architects' ideas to life.

Other challenging facets of the design included: The foundations in dolomitic conditions, where the accidental load case for a 15m sinkhole forming alongside the shaft foundation was considered. Temporary load cases had to be considered throughout construction, including careful control of the construction sequence, as well as the monitoring of the loads in the temporary props to ensure the cantilever was behaving as predicted in the design. Precision geometric control of the cantilevers in order to ensure a pair of cantilevers met at mid-span within tight rail tolerances. This included computer modeling of the cantilevers in order to predict deflections due to the concrete segments, cantilever and external stressing, construction loads and temperature effects.

The construction programme and sequencing was governed by the design of the balanced cantilever structures and throughout the programme it was essential that this was strictly adhered to. The piers were constructed in advance with construction being done simultaneously on both balanced cantilever structures. The SOPs were then constructed using conventional construction techniques. These SOPs formed the starting point for the construction of the cantilevers.

The cantilever segments, which were typically 3,5m in length at John Vorster and 3,4m at Jean Avenue, were constructed sequentially from each side of the SOP to ensure that the structure remained in balance.

The reinforcing for the segments was prefabricated in fixing jigs on the ground and the entire cage was then lifted into the formwork and installed in place. Concrete was generally placed using mobile pumps. This had to be done cautiously and in a defined sequence to avoid excessive pressure build up during the pour. Following the concrete pour, the cantilever cables were tensioned. It is significant to note that separate post-tensioning cables were used for each pair of segments. The cables could only be tensioned once a minimum concrete strength of 30MPa had been reached and it was not possible to launch the form travellers until the cables had been tensioned.

For this reason, early age strength was essential to ensure that the cycle times for the construction of the segments were kept to a minimum. Over the duration of the project an average cycle time of between four and five days was achieved for a pair of segments.

Construction continued in this sequence until the end of that cantilever section had been reached and then a closure pour was made to connect the adjacent cantilevers. The form travellers were used to do the closure pour except at the end spans where the closures were constructed from the side span falsework.

Although in theory the balanced cantilever remains in balance during construction, there is always a point at which there is an unbalance due to the sequencing of construction activities. To ensure that the balanced cantilever remained balanced during construction four temporary props were constructed around each of the piers. The form travellers were 'underslung', whereby the formwork was supported on trusses, which were suspended from a C-frame beneath the cantilevers of the box girder section. This methodology was chosen primarily to allow for installation of the prefabricated reinforcing segment cages in order to optimise the cycle time.

Each form traveller had a total mass of approximately 70t and was launched in approximately 500mm increments utilising hydraulic rams. Two pairs of form travellers were used per viaduct. The form travellers and all other

formwork for the various structural elements was designed and fabricated in Thailand by SMS Plan Co.

The side spans at either end of the viaducts, which ranged between approximately 5m and 25m in length, provided the connection between the outer cantilevers and the abutments or the piers at the extremity of the balanced cantilever viaducts. These were also typically constructed in the same lengths as the cantilever segments using falsework that was supported on scaffold shoring.

It was, however, not possible to adopt this solution at the northern end of John Vorster as this pier straddled an existing culvert. A complex system of fabricated steel trestles and trusses was used to support the falsework which cantilevered from the pier.

Concrete was batched at Bombela CJV's batch plant in Centurion and brought to site in readymix trucks. The concrete was then cast. The decision to batch and not to purchase from one of the commercial suppliers was made given the volumes required as well as the stringent durability requirements for the concrete on this project, which was considered outside the normal commercial supply scope.

A specific requirement on the project was for the concrete to reach 30 MPa at 16 hours while still maintaining a workability of 170mm to 200 mm slump for 120 minutes. This is generally not thought to be achievable as the early strength requirement works against the long and high workability requirement of this particular application. In order to achieve this advanced recrystalisation technology (ARC) an innovative South African based technology was used. This concrete technology has been developed in South Africa and is being aggressively promoted through the Murray & Roberts Concrete Centre of Excellence.

ARC technology is the use of chemical and crystal design methodologies that make full use of the water crystal formed known as concrete. The concrete mix design itself has a 20% pulverised fly ash (PFA) content, which assists in reducing the carbon footprint substantially.

Initial planning included importing specially designed steam plants from Thailand, at a substantial cost, to facilitate the early strength requirement. The use of this technology would have been logistically challenging on this project due to limited access to electricity. In addition, controlling the thermal insulation via thermal blankets and thermal formwork would have been exceptionally difficult considering the height of construction and the varying ambient conditions, through both winter and summer. This is where the ARC technology came into its own and the requirement for steam curing was mitigated.

Significantly, on this project it was decided to use maturity meters to monitor concrete strength gain. Prior to this project the maturity method of testing had not been used on any large project, let alone on a balanced cantilever viaduct.

Testing of concrete is normally done via a 100mm or 150mm test cube or cylinder, which is then taken as a representative of a mass of 50 plus tonnes of concrete. The above traditional quality control testing would have been ineffective and not representative of the concrete and was not suitable for testing the concrete strength for a number of reasons including the dimensions of the element, the environmental exposure of the elements and the thermal gradient of the concrete mix design itself.

All possible in-situ testing was researched in order to identify a testing methodology, which would provide better accuracy and greater representation of the actual in-situ concrete. It was concluded that multiple thermo couples and a maturity function would provide the most representative and most appropriate testing regime. The 46 possible maturity functions were well researched and it was finally decided that the Nurse-Saul function would be the most accurate for this concrete mix design.

The Nurse-Saul function has been used in conditions where 100% rapid hardening cement or steam curing was required, and due to the plastic and hardened properties of the concrete mix design the Nurse-Saul function was selected. No steam curing was used to attain the required 30MPa at 16 hours.

The Team

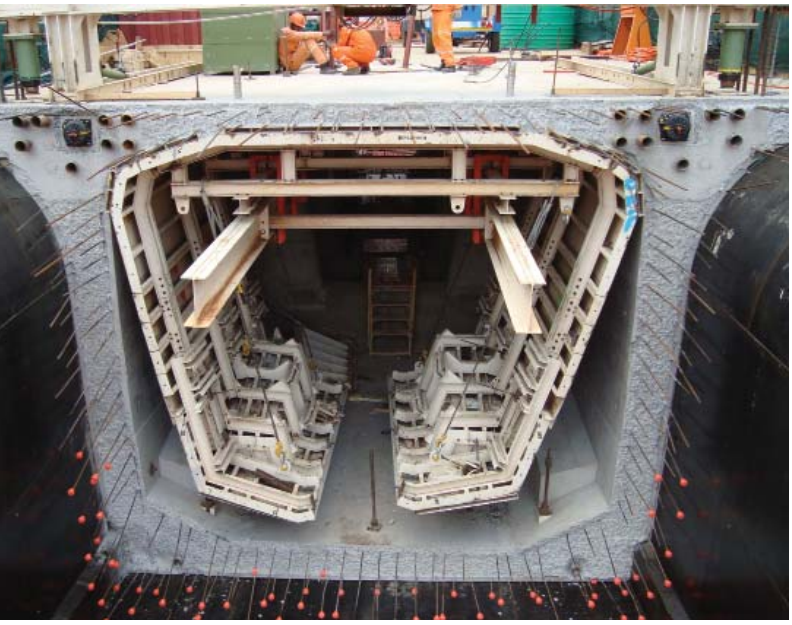
Client: Gauteng Provincial Government

Principal Agent 1: Bombela Civils Joint Venture

Principal Agent 2: Bombela Turnkey Contractor

Subcontractor: Bombela Concession Company

Submitted by: Bombela CJV



From the CEO's desk

Well, we have hit the ground running so far in 2013, primarily with the judging of the prestigious 2013 Fulton Awards entries. After receiving all the registered formal submissions, we reached 28 projects for adjudication. This is slightly down on last year, but then we have not had a flurry of stadia, road upgrades or another 'Gautrain' in the past two years.

The quality of projects, however, has not declined and judging has taken place on bridges, roads, dams, tunnels, universities, offices, houses and even a cement factory. The culmination of all this is of course the Fulton Awards weekend. It is being held, once again, in early June at the Champagne Sports Resort in the Drakensberg. Registration for this prestigious affair has already opened and readers are urged to register quickly to ensure their places.

Leading up to the awards weekend is the TotallyConcrete Expo being organised by Hypenica, owners of Concrete TV. The **TotallyConcrete Expo** is Africa's largest must-attend event, showcasing the manufacture, transport, processing and use of concrete.

The uniquely interactive exhibition offers extended access across Africa to the entire concrete spectrum from technologists to consulting engineers. The expo has a formidable line-up of 80 speakers from 20 African countries, five pre-conference seminars and three high-level conference tracks, 500 delegates and approximately 2 500 visitors.

Our first seminar road show was held around the country in the last week of February and a full report can be read in this issue.

On a more formal topic, I am pleased to report that, as a result of the recent round-robin election amongst members, the Concrete Society now has a Board of Directors comprising seven members and, as required by the new Companies' Act, will be the decision-making body of the organisation for the future. This will be effective from March 18th. Our new Directors include: Professor Billy Boshoff - President and Chairman; Tseli Maliehe - Vice-President; Nicholas van den Berg - Immediate Past President; Bryan Perrie - Elected; Peter Flower - Elected; Colin Kalis - Elected; John Sheath - CEO, Concrete Society

As some members are elected as Directors by voting members, provision must and will be made for the election of at least one-third of those elected Directors, each year. Our Branch Chairpersons are, of course, vital to the successful running of the Society, particularly at their respective regional levels. They will be invited to attend all Board meetings to provide feedback and input into the successful running of the organisation. We are now well past membership renewal time and I appeal to those members wishing to renew for 2013 to do so as soon as possible, to ensure maximum benefit from your membership for the year.

John Sheath
CEO
Concrete Society of South Africa

New Technologies for Sustainable Concrete

Dr Peter C Taylor, PE (IL), *Associate Director, National Concrete Pavement Technology Centre, Institute for Transportation, Iowa State University*

ABSTRACT: The focus of this paper is to look at some innovative ideas that show promise of improving the sustainability of concrete systems in the near term. The discussion includes a definition of sustainability in the context of providing societal needs for infrastructure and examples of innovative technologies that show promise of improving sustainability of concrete structures and pavements. The technologies addressed include materials, mixtures and construction approaches.

WHAT IS SUSTAINABILITY?

Fundamentally, being sustainable in the context of the built environment is simply good engineering – the art of balancing limited resources to provide the best possible infrastructure to meet growing demands.

In the past, economic factors were the only ones considered, while sustainability considerations require that environmental and social factors be considered as well (Figure 1).

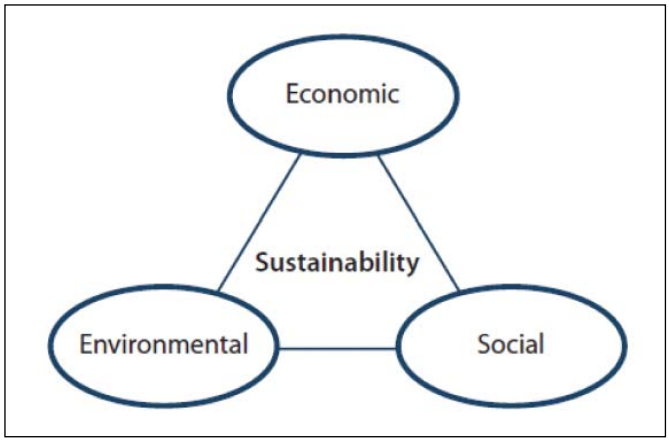


Figure 1. Representation of the critical aspects of sustainability

In addition, the analysis should include the entire life cycle of the project and address all impacts from the point of inception until the structure is removed and disposed of or recycled (Figures 2 and 3). This makes the process considerably more complex and demands wisdom in balancing and weighting the relative importance of the various parameters that have to be considered. It should be noted that over-emphasising any of economic, environmental and societal needs will lead to an imbalance which is, by definition, unsustainable [1]

At heart we are trying to provide for the needs of the present population without compromising the resources available to their children. Another way to express it would be: The use of practices and materials in concrete construction that provides a durable structure, while minimising the use of energy and non-renewable resources, and generating a minimum of pollutants in the most cost effective manner possible, while maximising the benefits to society.

As construction involves use of significant quantities of energy and materials, there will almost always be some environmental impact until significant changes in the way we obtain materials and build things with them are developed and adopted. In the meantime, we need to be diligent about reducing, as best we can, environmental impacts without sacrificing engineering quality.

A fundamental premise behind improving sustainability is to make our structures last as long as needed with a minimum of repair or rehabilitation.

Barriers to innovation are often institutional, such as standards or specifications that do not permit new ideas, and conservatism and fear of litigation forces engineers to choose to do things the way they have in the past. Any new idea, therefore, has to be rigorously demonstrated to be reliable and cost effective.

This is a very broad topic and any discussion about sustainability is inevitably skewed by the experiences and interests of those involved in the discussion. The focus of this paper is to look at some innovative ideas that show promise of improving the sustainability of concrete systems in the near term.

WHAT ARE WE TRYING TO CHANGE?

As stated above, we are trying to provide for the needs of the present population without compromising the resources available. It can be debated what the critical parameters are, but

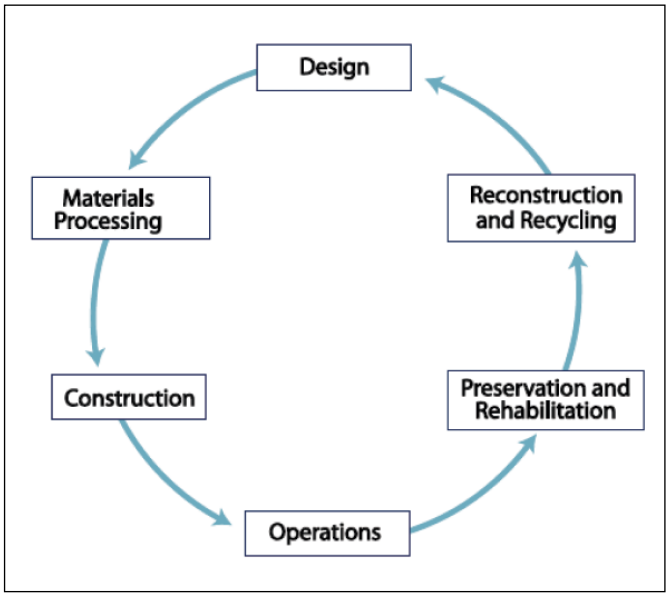


Figure 2. Sustainable engineering must expand to a complete life-cycle analysis

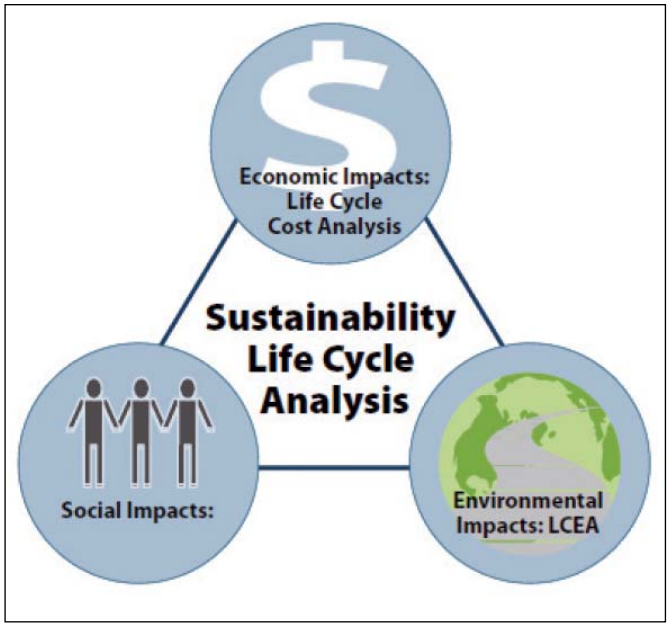


Figure 3. Economic, environmental, and social factors must be identified, measured, and balanced

there seems to some agreement that the most critical points to consider in the context of concrete construction include:

- Economic measures
  - Cost
- Environmental measures
  - Global warming potential (carbon footprint)
  - Human toxicity
  - Energy requirement
  - Hazardous waste generated
  - Materials
- Societal measures are not often discussed but may include
  - Infrastructure sufficiency and reliability
  - 'Liveability'
  - Impacts such as noise, traffic delays and safety

It should also be noted that each phase of the life of a structure will have a different impact. For instance, manufacture of cement does generate carbon dioxide. This is due to the nature of the chemical reactions, but during the use of operations or recycling phases, a concrete system is largely inert or may indeed capture CO_2. On the other hand fuel consumption during construction of a pavement is significantly less than that used by the traffic on it.

All of these issues are complex and interrelated. The remainder of this paper, however, will focus on materials and construction technologies that are currently available or nearing implementation, which have the potential to significantly benefit one or more of the measures listed above.

HOW DO WE MAKE CONCRETE MORE SUSTAINABLE?

Materials

A number of innovative materials and approaches are available or under development that contribute in some way to reducing the impacts discussed above.

Cements

While Portland cement carries with it a significant carbon footprint and energy requirement to manufacture, it is used in relatively small quantities in concrete mixtures. However, reducing the amount of Portland cement in a given element is an effective way reducing the construction phase impact of a structure. This can be achieved by reducing the amount of clinker in cement, or reducing the amount of cement in a mixture and using concrete efficiently in the design. The alternative is to consider non-Portland based cementitious materials.

Reducing the clinker content can be achieved by using blended systems, either blended at the cement plant or at the batch plant. Specifications have generally limited the dosages of limestone or Supplementary Cementitious Materials (SCM) because of concerns about setting times, early strengths, or frost resistance. This trend is beginning to change as users become more familiar with the materials and are prepared to modify their practices in order to accommodate the side effects of increasing SCM dosages. Work is ongoing on investigating how much SCM can be used in a given situation without compromising strength or durability of the final system [2]. One example of this change is the adoption of a performance based specification (ASTM C 1157) for cement that has no chemical requirements. Some of the other cements discussed in this paper are being marketed as 1157 compliant cements despite their containing no Portland cement.

A number of cementitious systems are being investigated that are either more efficient, or carry lower carbon and energy burdens than Portland cement:

- CeraTech Inc. is marketing non-portland cements that are claimed to comply with the performance requirements of ASTM C 1157. They are manufactured using activated pozzolanic materials. Performance of the system is claimed to be equivalent or superior to Portland cement [3,4].
- CCS Materials are conducting work under a Department of Energy grant to produce a substitute for Portland cement that reportedly requires less energy and is CO_2 negative. Strengths are described as similar while strength gain is very rapid [5].
- Ecocement is marketed as non-structural cement based on a mixture of Portland cement and magnesia that has the potential to sequester CO_2 as part of the hardening process [6].
- Novacem is a product developed at Imperial College and is being marketed as a carbon negative material based on magnesium silicates [7].
- Geopolymers are a broad class of materials characterised by chains or networks of inorganic molecules. The greatest potential seems to be in those comprised of aluminosilicate materials. These rely on thermally activated materials such as kaolinite, fly ash or slag) to provide a source of silicon (Si) and aluminum (Al), which is dissolved in an alkaline activating solution and subsequently polymerises to create the hardened binder. These are also referred to as alkali-activated cements. Many systems have been patented, but they are generally difficult to produce and work with. There are also safety risks associated with the high alkalinity of the activating solution. The systems require more processing, resulting in increased energy consumption and greenhouse gas generation [8].

Other ideas are regularly announced in the media but little technical information is available about them at present.

Significant barriers include: Portland cement is very cheap and industry is familiar with its application and resistant to change. This topic has captured the interests of inventors and scientists and a number of significant changes are likely to occur in the near future.

In the meantime, work on Portland cement is likely to include finding alternative sources of raw materials that will not involve the decomposition of carbonate but rather use calcium rich industrial by-products.

Aggregates

Synthetic aggregates have been produced by pressing or sintering fly ash and other industrial by-products for many years [9, 10]. These have the advantage of reducing the need for non-renewable resources and at the same time, reducing waste associated with leaching and contamination. The processing of materials and transportation required offsets some of these advantages. There use has often been limited by economic factors rather than any technical concerns.

Lightweight aggregates have proved successful and are used to reduce the weight of concrete elements. Sustainability benefits include the reduction in structural mass, which leads to lower support systems required and reduced transport costs. This balances the increase of energy required to manufacture them. In some applications, concrete made with these materials offers better insulation properties, through reduced heating and cooling demands, which may be significant.

A relatively new application for lightweight fine aggregate is to ensure that the aggregate is fully saturated before being placed in the mixture, with the purpose of allowing the absorbed water to assist with internal curing. This is particularly beneficial to very low water cement ratio mixtures where internal desiccation is probable. The benefits are a marked reduction in cracking risk and improved hydration of the element interior where exterior water will not reach [11]. Reduced cracking will most likely make a significant contribution to increasing the longevity of structures such as bridge decks.

An increasing trend that will have a significant effect of reducing energy required for construction is the use of recycled concrete as aggregate, particularly in the case of pavements where equipment is available to crush the existing pavement in situ [12]. Work is ongoing on how to develop quality assurance tools to ensure that the existing concrete is not going to cause later deleterious effects in a mixture.

An innovative approach to manufacturing aggregate is being developed by Calera Corporation, which uses carbon dioxide and brine. Work is also ongoing to produce pozzolanic materials using the same approach. The key benefit of the methodology is that it is reportedly able to capture significant quantities of gaseous carbon dioxide [13, 14].

Other materials

Sinak Corporation is marketing a surface treatment compound based on lithium silicate [15]. It is marketed as both a finishing aid and as a curing compound. The silicate in the material combines with the hydration product of the cement thus sealing the surface and reducing permeability. The benefit of this approach is that unlike traditional curing compounds it is not easily polished off the surface. It has also been reported that it reduces the risk of cracking and improves the surface durability.

Soybean oil is commercially available as an emulsion and has shown promise in concrete curing. It has been tested for moisture retention when used as a surface application and when integrally mixed. Results indicate that soybean oil substantially reduces moisture loss from fresh concrete and provides greatly improved de-icer scaling resistance. This material has potential to be beneficial in projects in environmentally sensitive areas where traditional curing compounds are not allowed [16].

Titanium dioxide modified cements are being marketed by Italcementi and reported to reduce pollution and provide a self-cleaning surface to the concrete [17]. Work is underway to assess the extent of the benefit to the atmosphere and water run-off afforded by this technology. A test section of a Two-Lift Paving system has been planned in St Louis, Missouri in which TiO_2 cement will be used in the top lift.

CONSTRUCTION

Innovative construction practices may be considered when used appropriately and can improve the sustainability of concrete systems.

Pervious concrete is a mixture with little or no fine material resulting in a system that is very permeable. Parking lots and local streets made with this material capture storm water and allow it to seep into the ground thus recharging groundwater and reducing the amount of that has the accommodated in water treatment plants. This is a significant benefit in locations where the amount of hard surface on a given property is limited because of concerns about water storage and treatment. Work has been conducted to develop mix proportioning methods and to ensure that such mixtures are resistant to the effects of cold weather. The surface noise is reported to be extremely quiet with respect to traffic [18, 19].

Ultra high performance concrete is a mixture containing significant amounts of fibre and high cementitious contents. Lafarge is marketing a proprietary system known as Ductal that achieves strengths up to 400MPa. It has been used in structural elements and in bridge decks. While the high binder content and energy required for steam curing carries a relatively high carbon footprint, the extreme efficiency of materials use and potential longevity mean that the system may still be considered sustainable [20, 21].

Two-Lift construction of pavements involves running two slipform paving machines, one close behind another to form a double layer system. While this approach is relatively commonplace in Europe, it is still in demonstration phase in the US. Advantages include using local materials that are normally an unacceptable wearing surface, such as aggregates can be used in the thicker lower lift, while a harder imported material can be used in limited quantities on the top layer. The economic effects of this approach are still being investigated in the US [22]. Another advantage of using a Two-Lift system is small, single-sized aggregate can be used in the top lift that is later exposed by acid washing. This surface has been demonstrated to be durable and quiet [23].

CONCLUSION

There is a significant need for a standardised approach to be developed that will allow engineers to quantify and demonstrate the relative benefits of any given approach, or innovate system, and this is the focus of a significant amount of work at present.

Life cycle cost analyses are relatively familiar and a number of models are available. Life cycle environmental analysis has been outlined in broad terms in ISO 14000 documents, but considerable work is required to prepare detailed methodologies and collect valid databases of materials' environmental factors. Such work is currently underway by the Massachusetts Institute of Technology (MIT) Arizona State, University of Cape Town and the Federal Highway Administration who are looking at the societal impacts.

The other needs include methods to produce affordable cementitious systems with lower environmental impacts. These may include methods to capture and take advantage of CO_2 and mercury by-products. As aggregate sources become more limited, there is likely to be considerably more effort focused on finding alternative aggregate sources or on how to use materials that are currently considered unacceptable.

Part of this work is likely to be looking at developing specifications with a greater emphasis on performance requirements, rather than on recipe based approaches. This means that risk is passed onto the contractor, who is looking for a greater potential reward. Associated with this trend is the need for good test methods that measure the properties accurately. Training and education is required to provide specifiers and builders with knowledge and skill to take advantage of some of the innovative approaches described above.

The topic of sustainability is complex, the research needs are daunting and the consequences are global. This means that there is a huge opportunity for all to provide the infrastructure required to meet the needs of the planet.

ACKNOWLEDGEMENTS

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REFERENCES

1. Van Dam, T., and Taylor, P., Building Sustainable Pavements with Concrete, Briefing Document, Ames, IA, National Concrete Pavement Technology Center, August 2009.

2. Bentz, D., Ferraris, C., De la Varga, I., Peltz, M.A., and Winpigler, J.A., Mixture Proportioning Options for Improving High Volume Fly Ash Concretes, International Conference on Sustainable Concrete Pavements: Practices, Challenges, and Directions, September 15–17, 2010—Sacramento, California.

3. Hicks, J., Hydraulic Cement Production from Coal Combustion Products, International Conference on Sustainable Concrete Pavements: Practices, Challenges, and Directions, September 15–17, 2010—Sacramento, California.

4. CeraTech, Accessed July 2010, http://www.ceratechinc.com/cement.asp

5. Fugro Consultants, Inc., Advanced High Performance Materials For Highway Applications, A Report On The State Of Technology, Federal Highways Administration, Report No. FHWA-HIF-10-002, February 4, 2010.

6. TecEco Pty Ltd., Accessed July 2010, http://www.tececo.com.au/products.eco-cement.php

7. Novacem., Accessed July 2010, http://novacem.com/

8. FHWA, Geopolymer Concrete, Federal Highways Administration, Tech Brief, Accessed July 2010, www.fhwa.dot.gov/pavement/concrete

9. International Conference on 'Ash A Valuable Resource', CSIR, Pretoria, February 1987.

10. Lytag., Accessed July 2010, http://www.lytag.net/

11. Henkensiefken, R., Briatka, P., Bentz, D.P., Nantung, T. and Weiss, J., Plastic Shrinkage Cracking in Internally Cured Mixtures, Concrete International, Vol 32, pp.49-54, 2010.

12. Meijer, J., Environmental Benefits of Two-Lift Pavements, CP Tech Center, National open House, Salina, Kansas, October 15-16, 2008, http://www.cptechcenter.org/projects/two-lift-paving/documents/-Environmentalbenefits-JMeijer.pdf, Accessed July 2010.

13. Clodic, L., Patterson, J., Ryan, C., and Holland, T., Next Generation Paving Materials Using Mineralized CO2 Captured From Flue Gas, International Conference on Sustainable Concrete Pavements: Practices, Challenges, and Directions, September 15–17, 2010—Sacramento, California.

14. Calera Corporation, Accessed July 2010, http://www.calera.com/index.php/home/

15. Sinak Corporation, Accessed July 2010, http://www.sinak.com/Products/pdf/Lithium_Cure_PIS_100104.pdf

16. Kevern, J.T., Using Soybean Oil to Improve the Durability of Concrete Pavements, International Conference on Sustainable Concrete Pavements: Practices, Challenges, and Directions, September 15–17, 2010—Sacramento, California.

17. Pepe, C., Amadelli, R., Pimpinelli, N., Cassar, L., Doped-TiO2/Cement Matrices Photoactive Materials, Proc. of the RILEM Int. Symp. on Environment-Conscious Materials and Systems for Sustainable Development, Koriyama, 6-7 Sept. 2004

18. Kevern, J.T., Schaefer, V.R., Wang, K. and Wiegand P., Durability of a New Generation of Pervious Concrete Mixtures Designed for Roadway Applications, International Conference on Sustainable Concrete Pavements: Practices, Challenges, and Directions, September 15–17, 2010—Sacramento, California.

19. NRMCA, Accessed July 2010, http://www.perviouspavement.org/

20. Bierwagen, D., Abu-Hawash, A., Keierleber, B., Wipf, T., Review of Ultra-High–Performance Concrete (UHPC) PI Girder Bridge in Buchanan County, Iowa (Design, Construction, Testing, and Monitoring), Accessed July 2010, http://www.intrans.iastate.edu/pubs/midcon2009/BierwagenUHPC.pdf

21. Lafarge, Accessed July 2010, http://www.ductal.com/index.php?lang=fr

22. CP Tech Center, Accessed July 2010, http://www.cptechcenter.org/projects/two-lift-paving/index.cfm

23. Rasmussen, R., Garber, S., Sommer, H., Cackler, E.T, Gisi, A., and Fick, G., Use Of Exposed Aggregate Concrete Surfaces As A Sustainable Practice, International Conference on Sustainable Concrete Pavements: Practices, Challenges, and Directions, September 15–17, 2010—Sacramento, California.

Self Compacting

...the way of the future

Members and guests were exposed to a day of both technical and practical presentations at the recent Self Compacting Concrete seminar road show – SCC 2013, organised by the national office. Events were held in Durban, Port Elizabeth, Cape Town and Johannesburg.

In his opening address, John Sheath, CEO of the Concrete Society and Chair of the seminar, described self compacting concrete (SCC) as an innovative concrete material, which is highly flowable and non-segregating that can flow into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation. This is due its fresh properties characteristics. He said, "It has the potential to dramatically alter and improve the future of concrete placement and construction processes." Sheath went on to say that the objective of these seminars was to bridge the gap between research and practice; link science with the practical and describe a number of projects and types of applications, where SCC had been used successfully.

Brenton Brouard from Chryso SA's presentation described the various component materials required to ensure a successful SCC. He spoke about the chemical admixtures, cements, fillers and aggregates, detailing their attributes and role in overall mix design.

This was followed by a very lively presentation by George Evans representing the Cement and Concrete Institute, who gave very sound advice to delegates on the specification, testing and performance of SCC.

Tests include:

- Filling ability/Flowability
- Passing Ability (through the reinforcement)
- Segregation Resistance
- Compressive Strength
- Dimensional Stability
- Durability

He emphasised that self compacting concrete is all about the production and placing of the flowable material. Once the SCC is placed in the form or mould it then becomes conventional concrete with the standard requirements in terms of strength, stability and durability.

The highlight of the presentation was the pouring of 140 slender columns that surround the Soccer City Stadium, all of which were cast using SCC. The complex shape and column angles presented a number of challenges as well as the fact that they contained 860kg per m³ of steel reinforcement. "This simply could not have been constructed with conventional concrete", says Evans.

The SCC liquid, free-flowing material requires special attention when it

Concrete

comes to formwork. Vaughan Burgess from Form-Scaff presented some sound technical advice when he described the pressures involved in casting SCC, particularly when it came to the rate of pouring the concrete. He cited some examples of where insufficient time had been allowed for earlier pour layers to gain any strength before the next pour, resulting in too high a pressure in the formwork and subsequent bursting of all the liquid concrete.

His final word to the delegates was to 'slow down' – resist the temptation to cast the concrete as quickly as possible.

Stephan Zeranka, a PhD student at Stellenbosch University presented the results from his work carried out on the use of steel fibres in self-compacting concrete.

He showed that the superior workability of self-compacting concrete (SCC) can be used to improve the uniform dispersion and effective utilisation of fibres, which is necessary for the wider and reliable structural use of fibre-reinforced concrete (FRC). Combined benefits of SCC in the fresh state and properties of FRC in the hardened state are possible. This can lead to new possible fields of application, he concluded. Moving to a more practical presentation, Hennis van Zyl from Lafarge presented his experiences with a proprietary self compacting concrete system. The successful South African

projects he described illustrated some of the many advantages of using this type of concrete placement such as speeding up project time, passing highly congested reinforcement, getting into limited access areas and providing excellent architectural finishes.

The afternoon session began with a presentation by Professor Rainer Haldenwang from the Cape University of Technology, who reported on work being carried out in the effect of superplasticisers on the reproducibility of SCC. He took delegates through a précis of the theory of Rheology, which provided some fascinating details about the deformation and flow of matter. This included details of the use of rheometers that can be used to measure the rheology of concrete.

Professor Haldenwang discussed the research work that his BTech students had carried out on the rheology of concrete mixes containing different superplasticisers, and then summarising the reproducibility results.

Arup engineers Ric Snowden and Pheku Montwedi took delegates through the use of high slump concrete (not SCC) on two projects – the K29/N14 Interchange Bridge and the precast segments for the Gautrain viaducts. In both cases it was shown that if SCC had been used on these projects, many

of the problems would not have been experienced. Ric Snowden was very supportive of the principle of SCC and suggested that engineers should in future be specifying this where appropriate.

The final presentation of the seminar was a comprehensive look at projects around the world that had successfully used SCC in their construction.

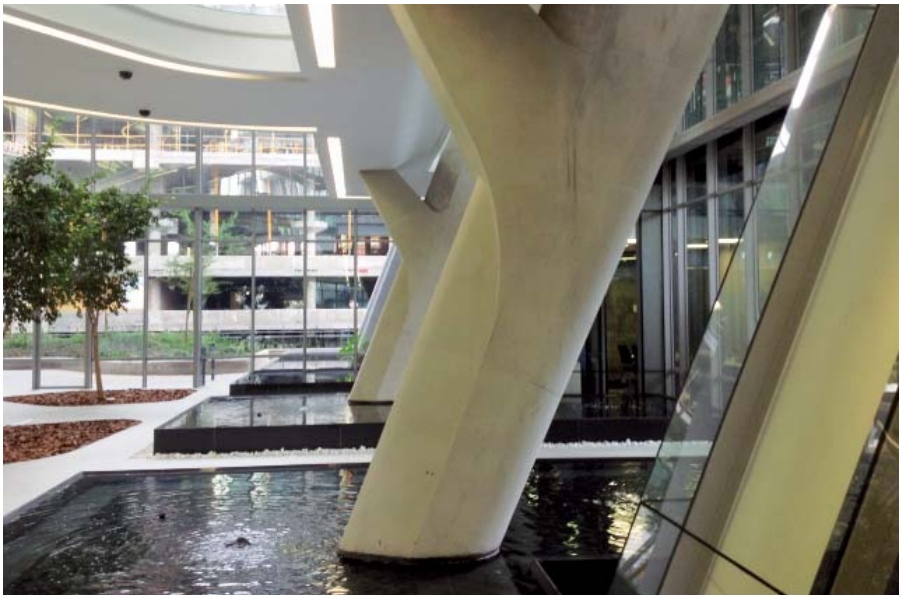
Daniel van der Merwe, an architect from the Cement & Concrete Institute, illustrated the use of this unique material in a multitude of architectural structures. These ranged from churches and libraries to music halls and residences in Europe, Asia and South America.

All these projects had used SCC very successfully and illustrated the incredible finishes that this material can offer. He stressed, however, that when deciding upon fair-faced SCC through formwork, design objectives should be communicated.

The formwork pattern plan, formwork sheeting jointing, sheeting type - and porosity, planning of joints and corners, formwork anchors and spacers should all be defined.

There should be an agreement on the sample or test surface panels, these can be used for reference, as well as assessment criteria and budgeted accordingly.

In his closing remarks, the seminar Chair, John Sheath expressed his thanks to the speakers, the sponsors, the Head Office staff and the delegates for their support for and their participation in the SCC seminar.



KwaZulu-Natal Chatter

KwaZulu-Natal members enjoyed a site visit to Spring Grove Dam, located upstream of the existing Mearns Weir and approximately 2km south-west of Rosetta Village in the KwaZulu-Natal Midlands.

The catchment area is 339km². The dam will have a gross capacity of 139,5 million m³ at full supply level. It has been classified as a Category III Dam in terms of the South African National Committee on Large Dams (SANCOLD) 1991 guidelines.

Some interesting facts include: an earth fill right flank section, a 70m long and 33m high Roller Compacted Concrete (RCC) crest, RCC non-overspill left flank and an 18m long outlet block on the right.

Concrete and RCC was produced on site, using two wet batch plants. The crest section consists of 95 600m³ RCC as well as the dam wall and affiliated structures and 45 000m³ of conventional concrete.

The RCC mix had a high paste volume and was a relatively new technology in South Africa. The mix consisted of 50kg Cem I cement and 110kg fly ash per m³, with a strength specification of 15MPa, which had to be achieved after 365 days. Although the visit took place on a wet and rainy day, it was an interesting experience to watch RCC being produced and placed.

The Spring Grove Dam will provide much-needed water to the municipalities via the transfer of water to Midmar Dam.

Eastern Cape Branch Chatter

The Eastern Cape branch expects to have an exciting schedule ahead of us this year, especially with the upcoming Fulton Awards.

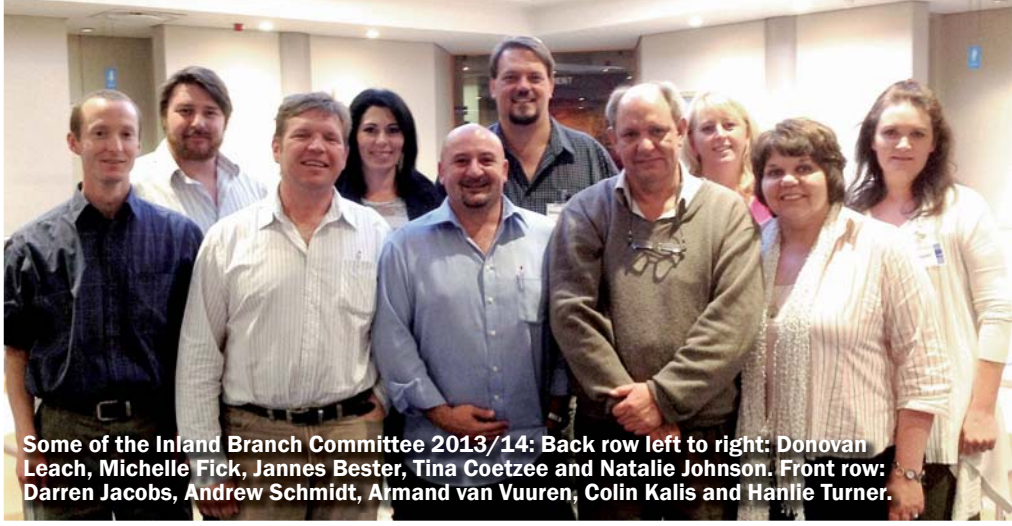
Last year, three national events were well supported by members and the casino development visit had a record attendance.

There are a number of potential site visits this year including: Wind Farm Blue Horizon Bay; Olifantskop Reservoir; the Jacking of Sundays River Bridge and a visit to a Port Elizabeth quarry to look at the production of aggregates.

Arrangements have still to be confirmed but we expect to arrange a number of other site visits during 2013.

The branch would like to encourage members to be actively involved with the Society and welcome suggestions for future events and site visits.

Inland Branch Chatter



Some of the Inland Branch Committee 2013/14: Back row left to right: Donovan Leach, Michelle Fick, Jannes Bester, Tina Coetzee and Natalie Johnson. Front row: Darren Jacobs, Andrew Schmidt, Armand van Vuuren, Colin Kalis and Hanlie Turner.

The Inland Branch has a jam-packed programme for 2013, focusing on innovative events in order to reach new audiences and potential CSSA members. This will create even more networking opportunities for existing members.

On March 14th a CPD-accredited seminar is scheduled for Bloemfontein to extend the CSSA footprint beyond the traditional branches.

This seminar: 'Concrete in Action', will comprise presentations on concrete materials and standards; an industry perspective on concrete cracking and the proportioning and handling of concrete as applied to floor construction.

The Quarterly Technical Meeting has been planned for May, which will focus on the research into concrete being conducted by tertiary students.

We believe that interacting with students is an investment in the professional workforce of the future.

This type of meeting also gives industry a chance to evaluate the research being done at tertiary level. This is often made possible by industry sponsorships and it gives the students an opportunity to interact with potential employers.

In June, the Fulton's Awards will be held in Gauteng. It has been recognised that not all interested parties are able to attend this prestigious gala event in the Drakensberg.

In line with the other branches, the Inland Branch will therefore host its own satellite event on June 13th. More information on all Inland Branch events can be found on the website.

Hanlie Turner
Inland Branch Chair

CONCRETE SOCIETY OF SOUTHERN AFRICA
National Office – Event Calendar

DATE	MEETING/EVENT	VENUE	CONVENOR
1st Week of March 2013	2013 Fulton Awards Weekend – Bookings Open	–	CSSA Administration
18 March 2013	Annual General Meeting	Premier Hotel, OR Tambo, Kempton Park	Prof Billy Boshoff
19 March 2013	Board Meeting	Premier Hotel, OR Tambo, Kempton Park	Prof Billy Boshoff
End of March 2013	Concrete Beton	Posted to all CSSA Members	Crown Publications
End of April 2013	Source Book 2013/2014	Posted to all CSSA Members	Crown Publications
7 – 9 June 2013	2013 Fulton Awards Weekend	Champagne Sports Resort, Drakensburg, KZN	Fulton Awards Organising Committee
Mid June 2013	2013 Fulton Awards Concrete Beton	Posted to all CSSA Members	Crown Publications
27 June 2013	Board Meeting	Premier Hotel, OR Tambo, Kempton Park	Prof Billy Boshoff
End of August 2013	Concrete Beton	Posted to all CSSA Members	Crown Publications
30 September – 3 October 2013	Concrete Testing Seminar Road Show	Johannesburg, Cape Town, Port Elizabeth, Durban	John Sheath
17 October 2013	Board Meeting	Premier Hotel, OR Tambo, Kempton Park	Prof Billy Boshoff
31st October 2013	Membership Renewal Notices	E-mailed to all CSSA Members	CSSA Administration
End of November 2013	Concrete Beton	Posted to all CSSA Members	Crown Publications

CONCRETE SOCIETY OF SOUTHERN AFRICA Inland Branch – Event Calendar			
DATE	**MEETING/EVENT**	**VENUE**	**CONVENOR**
First Quarter			
12 March 2013	Committee Meeting	C&CI Midrand	Hanlie Turner
14 March 2013	Mini-seminar	Protea Hotel Willow Lake, Bloemfontein	Natalie Johnson/Tina Coetzee
10 April 2013	Committee Meeting	C&CI Midrand	Hanlie Turner
8 May 2013	Committee Meeting	C&CI Midrand	Hanlie Turner
14 May 2013	Mini-seminar	Blue Valley Golf Estate	Jannes Bester/Natalie Johnson/Tina Coetzee
5 June 2013	Committee Meeting	C&CI, Midrand	Hanlie Turner
13 June 2013	Fulton Awards – Inland Branch	Scarlet Ribbon, Edenvale	Andrew Schmidt/Natalie Johnson
10 July 2013	Committee Meeting	C&CI, Midrand	Hanlie Turner
14 August 2013	Committee Meeting	C&CI, Midrand	Hanlie Turner
16 August 2013	Egg Protection Device – Casting	–	Darren Jacobs
20 August 2013	Mini Seminar	Blue Valley Golf Estate	Jannes Bester/Natalie Johnson/Tina Coetzee
23 August 2013	Egg Protection Device – 'Crush In'	PPC Jupiter Works	Darren Jacobs/Donovan Leach
11 September 2013	Committee Meeting	C&CI, Midrand	Hanlie Turner
28 September 2013	Boat Race Day	Victoria Lake, Germiston	Michelle Fick/Andrew Schmidt
9 October 2013	Committee Meeting	C&CI, Midrand	Hanlie Turner
13 November 2013	Committee Meeting	C&CI, Midrand	Hanlie Turner
21 November 2013	Chairperson's Breakfast	Blue Valley Golf Estate	Hanlie Turner

CONCRETE SOCIETY OF SOUTHERN AFRICA International Event Calendar			
DATE	**MEETING/EVENT**	**VENUE**	**CONVENOR**
14 – 18 April 2013	ACI Spring 2013 Convention	Minneapolis, MN, USA	Jeff Coleman & Kevin MacDonald
6 – 8 May 2013	International IABSE Spring Conference	Rotterdam, Netherlands	The Belgian & Dutch Groups of IABSE
27 – 29 May 2013	International Conference on Concrete Sustainability (ICCS13)	Tokyo, Japan	Japan Concrete Institute
10 – 14 February 2014	fib-Congress 2014 Mumbai	Mumbai, India	IMC-fib of The Institution of Engineers (India)

CONCRETE SOCIETY OF SOUTHERN AFRICA KZN Branch – Event Calendar			
DATE	**MEETING/EVENT**	**VENUE**	**CONVENOR**
19 February 2013	MTM	Room 124, Centenary Building, UKZN Campus	Theresa du Plessis
12 March 2013	AGM & Concrete Achiever Award	Room 124, Centenary Building, UKZN Campus	Raj Naidoo
16 April 2013	MTM	Room 124, Centenary Building, UKZN Campus	Raj Naidoo
21 May 2013	MTM	Room 124, Centenary Building, UKZN Campus	Theresa du Plessis
25 June 2013	Site Visit	To Be Advised	Andries van Rensurg
23 July 2013	MTM	Room 124, Centenary Building, UKZN Campus	Ken Brown
20 August 2013	MTM	Room 124, Centenary Building, UKZN Campus	Rod Raw
17 September 2013	Egg Protection Device and Cube Competition	To Be Advised	Craig Handler/Theresa du Plessis
1 October 2013	KZN Golf Day	Beachwood Golf Club	Andries van Rensburg/Beverley Reid
22 October 2013	Site Visit	To Be Advised	Phil Everitt
19 November 2013	President and CEO Function	To Be Advised	Beverley Reid/Greg Parrott

CONCRETE SOCIETY OF SOUTHERN AFRICA Western Cape Branch– Event Calendar			
DATE	**MEETING/EVENT**	**VENUE**	**CONVENOR**
1st Tuesday of Every Month	Committee Meeting	UCT Social Club	Adrienne Taylor
18 April 2013	Site Visit – Portside	Portside – Cape Town	Kevin Kimbrey
16 May 2013	Golf Day	Parow Golf Club	Vice Chairman
12 June 2013	Fulton Awards – Western Cape Branch	Kelvin Grove	Jerome Fortune
18 July 2013	Technical Meeting	UCT Chemical Engineering Building	Hans Beushausen
15 August 2013	Site Visit	To Be Confirmed	Ken Newton
19 September 2013	Site Visit	To Be Confirmed	Ken Newton
19 September 2013	Commencement of Cube Casting Competition	–	Etienne van der Klashorst
17 October 2013	Technical Meeting with Cube Crush	UCT Chemical Engineering Building	Etienne van der Klashorst
21 November 2013	Annual Year End Cocktail Function	Granger Bay Hotel School Restaurant	Jerome Fortune
3 December 2013	Committee Year End Dinner	To Be Confirmed	Committee

Company Membership Details

Platinum	Principal Member	Address	Tel No	Email
AfriSam SA (Pty) Ltd	Mr Mike McDonald	PO Box 15 Roodepoort 1725 Gauteng	011-758-6000	mike.mcdonald@za.afrisam.com
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Stoncor Africa (Pty) Ltd	Mr Jonathan Starmer	PO Box 2205 Halfway House 1685 Gauteng	011-254-5500	jstarmer@stoncor.com
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