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CONCRETEBETON

Mahatma Gandhi Road Sewer Extension

Background to Draft National Standard for the Design of Water Retaining Structures

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Cover: Mahatma Sewer Extension Project was commended by judges in the Innovative Construction category for overcoming challenging design constraints and the innovative way that final construction was approached.

Editor's comment

The year is racing by and we are already well into the third quarter with this, our third in-house publication of the 'new-look' Concrete Beton. We have received very positive feedback from members on the quality and content of our journal and we are inspired to continue improving the publication with each issue.

Our aim is not only to meet the needs of our members in terms of content and relevance to ensure they receive value for money from the journal, but also to raise the profile of the journal in the greater built environment sector, so that it becomes the preferred read for all things concrete.

In this issue we bring you a local accredited technical paper. Something we plan to feature on a regular basis, to bring you the very best in latest research and technology in concrete. When space allows, we will continue to bring you technical papers from overseas, so that readers are kept abreast of world trends.

A few weeks ago we asked members through an electronic survey what they thought of the Society as an organisation; how we were meeting their needs and what they would like to see us offer as part of our value proposition in the future. The results of this survey are revealed in this issue and these have already been discussed at a recent meeting of the Board of Directors.

Not all the suggestions made can be adopted, particularly those that are already offered by other similar organisations, but we will attempt to meet all viable requests and especially those that contribute positively to our overall mission of promoting excellence in concrete.

Thank you to all those members that participated – your input was greatly appreciated.

Enjoy the read!

John Sheath
Editor

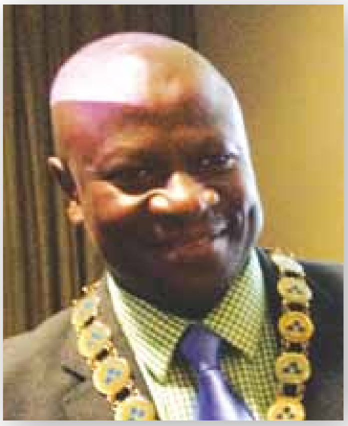
President's message

The rest of 2014 is going to be hectic, judging by the activity experienced by the Society so far this year!

Yet another successful road-show seminar (ConSem 2014) was held in Cape Town, Port Elizabeth, Durban and Johannesburg at the end of June, and good delegate attendance continues to emphasize the importance of, and the need for, good quality technical information for the industry.

We are very grateful to engineers, contractors, owners, and indeed the whole industry for their continuing support of our events, all aimed at achieving our overall mission. I would also like to extend my gratitude and appreciation to our esteemed presenters at this event, without whom there would not have been a seminar.

Our next road show "FloorSem 2014" would have just taken place, by the time members receive this issue, but I am confident that this will also have attracted many delegates wanting to hear about the latest technology and practice in laying concrete floors – a very dynamic/rapidly changing 'hot' topic at the moment.



President, Tseli Maliehe

The end of August brought with it the deadline for receiving nominations for the 2015 Fulton Awards and I am pleased to announce that we have some very interesting and unusual projects already submitted. I encourage all to consider entering this prestigious awards scheme and to submit your nominations now. Yes, we have extended the deadline until the end of September, so to avoid disappointment we can receive more nominations for a further month.

The procedure for this is very simple. Just complete a two-page form at this stage (available on our website) so that we are aware of the scale of the awards, particularly from the judging point of view. We have to map out the programme very carefully to enable the judges to adjudicate the projects within a reasonable time frame, and cost. Full entry packs will follow on from these nominations which require a little more work, but then you will have until the end of November to complete these.

Lastly, enjoy the read and God Bless!

Yours Sincerely

Tseli Maliehe

President – Concrete Society of Southern Africa

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

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

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Mahatma Gandhi Road Sewer Extension

The Mahatma Gandhi Road Sewage Pump Station occupies a prime site within the Durban Point Development Corporation's (DPDC) up-market development zone, and the pump station needed to be relocated to a site adjacent to the North Shaft of the Durban Harbour Tunnel. This new site for the Pump Station was some 250 metres from the original position.

The original Pump Station is supplied by a gravity sewer of diameter 1,35 metres, which services the greater Durban catchment area including the CBD and Berea areas from the Umgeni River in the north and Umbilo River to the south. In order to supply the new Pump Station position, the gravity sewer needed to be extended by 221 metres.

Design considerations

The design constraints for the gravity extension were the existing pipeline on the upper end and the hydraulic design levels of the new Pump Station on the lower end. These levels resulted in a pipeline ranging in depth from 7 to 9 metres below ground level. The ground water table in the area is at 2 metres below ground level.

The alignment of the new pipeline was required to run in the centre of the roadway which is a double lane in both directions and is the main feeder road for the Point Precinct. Furthermore, there existed a historically protected building between the start and end point of the new alignment which meant that a straight line design was not possible.

1.1. Geology

The site is located at the mouth of the Durban harbour in an area previously occupied by the mouth of the natural estuary of the rivers

draining into the south Durban basin, and prior to that, by the mouth of the Umgeni River.

A total of five boreholes were drilled along the sewer extension alignment. Extending from ground level to depths ranging from 1.0 to 2.0 m was a layer of fill material which comprised the road layer works. Underlying this were sands, slightly gravelly sands and gravelly sands that were almost indistinguishable from the in-situ sands below.

Underlying the surface fill horizon was a consistent layer of light brown to brown, generally medium dense to very dense, fine to medium grained sands up to a depth of 5.0 m, with occasional layers of silty to clayey sands below 5 m depth. In some areas the sands became medium-coarse grained and contained shell fragments.

Holocene marine sands, which extended to depths in excess of 10 m, typically comprised a poorly graded, fine to medium grained sand with a minimal amount of fines.

Measurements using a standard dip meter, showed groundwater levels to be 2.0 m to 2.8 m below the road level. Permeability test results based on pump tests carried out during the investigation indicated that the in-situ permeability (‘k’), of the sandy materials underlying the proposed pipeline route ranged between 5,16 x 10^{-2} and 5,8 x 10^{-1} cm/s.

Feasibility Designs

The objectives of the initial study were to evaluate the various sewer pipe extension installation techniques by investigating technical, financial and social-environmental considerations upon which the selection of the method would be based. Some of those objectives of the study were, inter alia:

- Investigate installation options within the constraints of the site and alignment;
- Investigate known construction risks and implications thereof;
- Provide the suitable recommendations based on the Client’s requirements.

These constraints and the available technology (together with environmental and economic aspects), were used for the determination of the most favourable sewer pipe extension method, which was found to be pipe-jacking using a Micro-Tunnel Boring Machine. Some of the constraints and risks identified within the vicinity of the pipe installation and appurtenant works were:

- Disruption to traffic on Mahatma Gandhi Road, a major urban road servicing the Durban Harbour mouth area;
- Numerous buried services criss-crossing the road which would negate the benefit of shallow installations and open-trench methods;
- Ground settlement associated with construction procedures involving lowering of the groundwater table or loss of implementation of ground stabilisation can cause significant and costly damage to some of these services and road-works;
- Potential ground settlement, thus causing damage to the historical, protected buildings on the north side of the road and sewer extension alignment;

Micro-Tunnelling machine.

- Ground conditions in the area consisting primarily of dense sands and lagoonal sediments with permeability in the order of ‘k ≈ 10^{-1} cm/s’;
- Limited working space and strict alignment controls associated with Horizontal Direction Drilling (HDD) method;
- The structural integrity of the 50-year old underground chamber adjacent to the existing pump station.
- Launching shaft and connection to the incomer sewer was likely to be in the middle of the busy, Mahatma Gandhi Road;
- Breaking through into the existing tunnel north shaft heavily reinforced walls and treatment of the ground behind the “piercing location” where the shaft wall was cut;
- Curved sewer extension to follow the road alignment to avoid tunnelling under the old buildings;
- Cost and availability of the equipment were viewed as additional constraints for the project.

Microtunnelling

The micro-tunnelling Machine manufactured by Herrenknecht and operated by Coleman Tunnelling Africa was used for the project. The Micro-TBM was an AVN 1200TC with a ‘Mixed Ground’ Cutting Wheel. The AVN 1200TC is an AVN – type machine for 1200mm internal diameter jacking pipes.

The Tunnel Length is 221 metres, consisting of:

- 113 metres Straight section from the jacking pit.
- 102 metres arc length with 350 metre radius, curved section to bypass the protected historical, Harbour Master Building.
- 6-metre straight section, breaking into the existing Harbour Tunnel north shaft.

The length of the tunnel was in excess of the designed length for the conventional hydraulic drive from container to machine, so as a result, an electrically driven hydraulic power-pack within the micro-tunnel was


Pipe section being lowered into jacking pit.

used to accommodate the longer distance tunnel drive. Due to the length of the tunnel as well as the curved section, two intermediate jacking stations, with eight 646kN and 700mm stroke hydraulic cylinders were installed, to reduce the jacking pressures on the front pipes. Intermediate jacks were installed at 33m and 133m behind the machine.

The control cabin on the surface, was located so that the operator had uninterrupted views of the jacking pit bottom where the hydraulic rams effectively "pushed" the pipes forward. The cabin was equipped with an "operator control panel", PLC and computer control system, on-screen visualization, operator window to view shaft and jobsite, remote control for the jacking frame and two 'intermediate jack (IJS)' hydraulics". A Laser Guidance System was fixed in the jacking pit, to the set reference alignment and grade to monitor the relative position of the TBM cutting head. The laser target position was relayed to the control cabin to allow the operator to effect steering adjustments as necessary. When the tunnel reached the curve, a Gyro Scope Guidance System to control line and level was used. The systems were checked manually using standard surveying equipment every 40 metres to ensure that the positioning system remained accurate. The TBM reached the end point within a deviation of less than 20mm which is testament to the accuracy of the guidance system.

The lubrication system used bentonite to reduce stress development on the jacking pipe due to friction between the jacked pipes and surrounding ground. Every third pipe had a system of bentonite injection positions at three equal orientations on the internal surface of the pipe. The lubrication was able to be injected into the small annulus between the pipe and the ground, effectively reducing the friction created in this area. The system sent feedback to the control cabin regarding lubrication flows at each position thus informing the operator where additional lubrication was needed at any time during the drive.

This type of TBM uses a pressurised slurry system for two very important parts of the operation. The first is to generate a positive pressure at the cutting face of the excavation. As the horizontal alignment of the tunnel was some 5 – 6 metres below the natural water table, this results in a positive pressure at the cutting face. In order that the face did not collapse the slurry was pumped into this area to maintain a pressure slightly higher than the ground pressure.

The excavated material was transported back to the surface, via a slurry return pipeline into a separation plant. Water was used initially as the transporting medium, although the addition of bentonite in extreme ground conditions was allowed for and was used on this project, as the ground conditions became unsuitable for the use of water. The separation plant, with a capacity of 250 m^3/hr, was equipped with a vibrating shaker screen rack, two 15" hydro cyclones, and an agitator (to prevent solids from settling out) and were connected to a sedimentation tank. The excavated material was separated from the slurry medium which was recycled and re-used in the system.

Each pipe was lowered into the Jacking Pit via a crane and inserted into the collar of the previously inserted pipe. A wooden packing was inserted between the two pipes such that no point loads occurred during jacking resulting in cracking of the concrete. The hydraulic jacks were then closed onto the other end of the pipe and the drive was then continued. The entire pipeline was jacked forward from the rear end of the pipeline.

The pipes needed to be designed, not only for the permanent loading conditions, but also the temporary forces on the pipes during installation. The Contractor was responsible for designing the pipes for this temporary loading and the operator was responsible for keeping the jacking forces below this load. Should the forces on the jacks have become too high then the operator had the option of using the inter-jack stations to reduce the forces on the pipes.

The breakthrough of the TBM at the end of the drive in the "reception shaft" was undertaken through a specially designed steel receiving eye with a double rubber ring seal. As the TBM was driven through this ring the rubber seal prevented ground water and the slurry from draining into the shaft. The installation of the 221 m micro-tunnel took 24 days to complete.

Pipe design

One of the Client's requirements was that due to the difficulty in gaining access to the sewer-line in the area and the importance of the whole sewer system, the 1200 mm internal diameter reinforced concrete pipe was to be designed for a 100-year life span. The reinforced, 145 mm wall thickness concrete pipes with characteristic strength of 40MPa were designed, taking into consideration the known fact that the Durban marine environment is highly corrosive. This, combined with the fact that the concrete sewer pipe would be below the saline groundwater table, required high durability concrete to be specified. Although the extrados of the pipe would be permanently submerged, measures had to be put to place to minimise material attack by salt water. These materials included stainless steel collars and rubber seals for pipe joints. A special grade (AISI 32507), duplex stainless steel was used for its resistance to pitting corrosion. To eliminate chemical (sewage gases and hydrogen sulphide) attack to the concrete, the pipe intrados was lined with a 'cast-in', continuously-welded thin sheet of HDPE. These

Stack of pipes awaiting jacking.

Final breakthrough after 24 days.

considerations and protection measures would enhance material durability to achieve the intended 100-year design life and beyond.

The selection of the pipe material in this application was based on constructability and corrosion resistivity. Although concrete may not be as good as HDPE in terms of corrosion resistance, the strength requirement for the jacking operation made concrete the first choice. The unique combination of the concrete for strength, the HDPE liner for corrosion (and abrasion) and the duplex stainless steel collars resulted in a final design of the pipes that achieved all the objectives the brief required.

The design of the jointing system also gave the flexibility for the pipe jack to negotiate the 350 m radius without having to construct additional reception shafts.

Pipe Construction

As mentioned previously, the pipe construction has three main components namely; reinforced concrete, stainless steel collar and an internal integrated HDPE lining. The wall thickness of the pipe rings is 145 mm and the internal diameter is 1200 mm in diameter. The pipes had to be constructed to match exactly the dimensions of the TBM jacking rig. For this reason the pipes had to be constructed in Germany by a company called Gollwitzer Pipe. Because this company had constructed pipes for this size of TBM on a previous project, the moulds were already existing. For the pipes to be constructed in South Africa, the moulds would have needed to be procured which would have incurred additional costs and time.

The pipes were cast in vertical standing moulds with the stainless steel collars and the HDPE lining cast in-situ. Each pipe is 2.15 metres in length.

Environmental impact

A full Environmental Impact Assessment was not required for the construction of the new Pump Station as it effectively was replacing an existing facility of similar size and capacity in more or less the same vicinity. This did not however, mean that the effect on the environment was not taken seriously. The client had very stringent Health, Safety and Environmental Specifications which were applied to this portion of the works.

Even though most of the work was underground, there were possible impacts to the environment. The bentonite used for the slurry and lubrication systems is non-toxic and has a very low direct impact to the soils with which it had contact. Bentonite is, in fact, a natural clay-type material. Notwithstanding the above, any bentonite spills into the storm water system would effectively end up in the harbour and, if settling on the marine beds, would block and suffocate fish breeding grounds. Areas susceptible to spillages were monitored closely and bund walls were erected here.

Other environmental impacts such as oil and diesel spillage from machinery were a risk and also closely monitored. The equipment utilised on the tunnelling portion of this project was in very good condition and most was either new or very close to new.

One of the benefits of using a micro-tunnel for this application over a conventional open trench, is the limited effect on the environment. Open trenching would have resulted in risks such as collapsing soils, exposed services such as sewer and storm water pipelines, and the lowering of the natural water table via dewatering for prolonged periods.

Conclusions

In conclusion, the micro-tunnel portion of this project is deemed to be unique and innovative for the following reasons:

- The long design life requirement of the product.
- The combination of materials of construction of which concrete being the main component.
- The micro-tunnel was the first of its kind in South Africa with specific reference to size, length and curved alignment.
- Least impact to the environment. ▲

PROJECT TEAM

Client – eThekwini Municipality – Water and Sanitation Department
Design Engineers – Goba (Pty) Ltd
Main Contractor – Group Five
Tunnelling Contractor – Coleman Tunnelling Africa

Background to the Draft SA National Standard for the design of Water Retaining Structures

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ABSTRACT

The technical background to the draft standard for the design of water retaining structures is provided in this paper. SANS 10100-3 (Draft) Design of concrete water retaining structures, has been developed under a WRC project (K5-1764) and serves as input to a SABS TC98 Working Group (WG) to draft the National Standard. The background information serves the purpose of providing the information required by the WG for understanding the technical basis and intentions of the draft standard. Modification of the draft standard into a South African National Standard (SANS) will require an extension of the present background to record the motivation for the decisions of the WG. This information will allow for effective future development of subsequent editions of the standard.

An overview is provided of the scope of the various reference documents containing the technical basis and the way in which information from these references have been incorporated in SANS 10100-3 (Draft). Reference is then made at a more detailed level to the basis of the various sections of the draft standard. Specific clauses and those of the corresponding standard or reference source of information which are invoked in formulating the respective requirements or procedures are emphasised where justified.

1. INTRODUCTION

A draft standard for the design of concrete water retaining structures was developed as part of a Water Research Commission Project. For convenience this draft standard is referred to as SANS 10100-3 (Draft) Design of concrete water retaining structures. The final project report (WRC 1764 2010) presents both the draft standard and the technical basis for its formulation consisting of both the critical assessment of related reference standards an research particularly directed to provision for local conditions.

SANS 10100-3 (Draft) is intended to serve as the point of departure for the formal standards development process under the appropriate SABS Technical Committee structure ultimately to be approved and published as a South African National Standard (SANS). This paper extracts and summarises the technical basis for the draft standard from the investigations reported in WRC 1764 (2010) to serve as a background report for the present draft. This provides both the motivation for the procedures of the draft standard and an appreciation of its intentions.

Although the background report to the draft standard is primarily aimed at the intended Working Group (WG) who will have the responsibility for developing the final version, it also provides a summary of critical issues related to the design of water retaining structures in South Africa, which should be of general interest. The subsequent stages of development of the draft standard should consist of expert input by the WG and public comment of the Draft South African Standard (DSS). The present background report will need to be modified to reflect the final technical basis for modifications following from this development and review process. The final background report should serve as archive for future updating of the standard, provide some insight to designers, and may serve as input to a commentary for a guidance document.

A specific characteristic of SANS 10100-3 (Draft) is that, for various reasons, it is compiled as a single standard out of a number of reference standards. The point of departure is to base it on the relevant Eurocode Standards, although there is not a single self-contained Eurocode standard for water retaining structures. At the same time the local standard should also be consistent with other local standards, particularly the general standard for structural concrete and the loading code.

The reference standards and supporting documents on which SANS 10100-3 (Draft) is based, consists of:

(i) **EN 1992-3:2006**, which is the primary Eurocode Standard providing for the design of concrete water retaining structures, as part of the more general scope of silos and tanks (EN 1992-3, 2006);

(ii) **BS 8007:1987**, the standard which serves as the de facto South African standard for water retaining structures (BS 8007, 1987);

(iii) **EN 1992-1-1:2004**, which is at an advanced stage of being adopted as the new South African standard for structural concrete design (EN 1992-1-1, 2004);

(iv) **SANS 51992-1-1 (WG Draft)** (SANS 51992-1-1 WGD, 2013), similar to the relationship between BS 8007 and the general structural concrete standards and BS 8110;

(v) **EN 1991-4:2006**, the Eurocode Standard which provides for actions on water retaining structures and silos (EN 1991-4, 2006);

(vi) **SANS 10160:2011**, the South African Loading Code, with specific reference to the basis of structural design (SANS 10160-1:2011);

(vii) **WRC Project K5-1764 Final Report (2010)**, serving as a general source of background information on design procedures for water retaining structures (WRC K5-1764, 2010); and

(viii) **Guidelines for the Working Group**, a document which was compiled to motivate the New Work Item Proposal for a standard on the design of concrete water retaining structures and launching of a Working Group, also provides some general background information (WRC K5-2154-1, 2012).

This paper presents the background to SANS 10100-3 (Draft) consecutively in more detail, consisting of the following:

(i) An overview of the scope of the various reference documents and the way in which information from these references has been incorporated in SANS 10100-3 (Draft).

(ii) The basis of the various sections and, where justified, the specific clauses of SANS 10100-3 (Draft) and the corresponding standard or source of information which is invoked in formulating the respective requirements or procedures.

The process of the development of a South African National Standard on the design of concrete water retaining structures consists of a number of stages as follows, with this paper providing the background at the completion of stage (i):

(i) **Pre-normative Draft**, as compiled during WRC Project K5-1764 – Completed.

(ii) **Working Group Draft (WGD)**, as modified and refined by the WG – to be submitted to SANS TC98 SC-2 Concrete Structures.

(iii) **Committee Draft (CD)** to be approved by ballot by SC-2, before submission to SABS for final review and approval.

(iv) **Draft South African Standard (DSS)** obtained through editing into required Standard format by SABS and checked for technical content by TC98 SC-2.

(v) **Published DSS** through publication by SABS for public comment and incorporating response to comments.

(vi) **South African National Standard SANS 10100-3** publication as a SA National Standard after approval by the Standards Board.

2. OUTLINE OF REFERENCE STANDARDS AND SUPPORTING DOCUMENTS

The way in which the reference standards and documents are used or are related to SANS 10100-3 (D) is briefly reviewed herein.

2.1 EN 1992-3 as primary reference

Following the replacement of BS 8007 by the equivalent Eurocode Standards, the approach taken was that Eurocode should also serve as primary reference for a future South African Standard for the design of water retaining structures. However, Eurocode does not provide a dedicated standard for this class of structure, but combines this class with standards for silos for storage of granular solids and for general containment structures for storage of materials over the range -40 °C to +200 °C.

The most important task is therefore to extract only the requirements relevant to water retaining structures from EN 1992-3 in a logical and consistent manner. Water retaining structures generally require severe performance requirements as an important class of specialist structure, particularly with regard to serviceability. Nevertheless, EN 1992-3 primarily focusses on the complications deriving from silo design and temperature effects.

An issue to consider is whether the Eurocode standard format is to be maintained, or to formulate the standard according to the SANS format and layout. Format change is not allowed in adopted CEN / EN standards, but this restriction will not apply to the intended SANS 10100-3 standard, which will be an adaptation of the aforementioned standard.

2.2 Provisions from BS 8007 for continuity with local practice

Important features from BS 8007 that have proven satisfactory and essential to local practice have been incorporated in the current draft of SANS 10100-3. In addition to the adapted procedures from EN 1992-3 and the various other reference standards, the extracts from BS 8007 represent quite a substantial portion of SANS 10100-3 procedures. The extracts from BS 8007 can be seen as giving more detailed guidance to the designer, expressly stating various design situations relevant to WRS that should be considered during the planning, design, detailing, construction, testing, and operation phases of a project.

The scope of SANS 10100-3 is maintained from that of BS 8007, outlining procedures relevant to the storage of liquids at ambient temperatures below 35 °C (commonly found in swimming pools and industrial structures). EN 1992-3 on the other hand deals with WRS as part of a larger spectrum of containment structures which focuses mainly on the complex subject of silos storing granular solids, thereby providing more general design guidance related to WRS. Specific procedures from BS 8007 included in the SANS 10100-3 draft are:

- Basic requirements on flotation
- Design working life, durability, and quality management
- Design situations (general guidance on load cases and combinations)
- Operational safety considerations
- Maintenance and operation
- Inspection and testing of the structure
- Deflections
- Reinforcement to control restrained shrinkage and thermal movement
- Surface zones in concrete members (Annex C)
- Depiction of details of movement joints given in Annex N

2.3 EN 1992-1-1 / SANS 51992-1-1 as general standard

As part of a policy of sparse formulation applied to the Eurocode standards, EN 1992-3 only provides additional requirements and procedures relevant to its scope of structures as an extension to the general requirements and procedures given in EN 1992-1-1. The general standard for structural concrete is therefore an integral part of the design of water retaining structures. This is however not dissimilar to the relationship between BS 8007 and BS 8110.

Consistency between EN 1992-3 and EN 1992-1-1 will be transferred to the future SANS 10100-3 due to the process of adopting the Eurocode general standard for structural concrete EN 1992-1-1 as new South African standard SANS 51992-1-1 to replace SANS 10100-1. This removes any potential inconsistencies between SANS 10100-3 (D) and the present SANS 10100-1, which represents the conditions under which the draft standard was compiled.

2.4 EN 1991-4 providing basis of design and actions procedures

Provisions for loading on tanks for containment of liquids are included in EN 1991-4:2006 Actions on structures – Silos and tanks together with loading on silos containing granular solids. Due to the complicated nature of silo actions, this topic completely dominates the standard. Provisions for the basis of design, referring to performance requirements, design situations, partial load and combination factors are also included in EN 1991-4:2006 and EN 1992-3:2006. These provisions are extensions of and consistent with the procedures provided in EN 1990:2002 Basis of structural design.

2.5 SANS 10160 serving as general loading code

Loads on tanks containing liquids are outside the scope of the South African Loading Code SANS 10160:2011 which is primarily directed towards buildings and industrial structures. In Part 1 nominal provision is made for loads from fluids (levels controlled or uncontrolled) and in Part 5 for hydrostatic loads in the geotechnical context. No explicit provision is however made for determining characteristic load values. Furthermore, the indicated partial factors for hydrostatic loads are not consistent with EN 1991-4.

Consideration of EN 1991-4 therefore provides the opportunity to ensure equivalent consistency and filling in the gaps between SANS 10100-3 and SANS 10160 as is the case for EN 1992-3; EN 1991-4; EN 1990; EN 1991 in general.

2.6 Considerations from WRC Project K5-1764

The WRC K5-1764 Project set out to develop and calibrate a South African National Standard for the design of WRS, of which SANS 10100-3 (Draft) was one of the outcomes. The main investigations conducted towards the establishment of SANS 10100-3 procedures could be classified under: (1) Basis of design, (2) Materials, (3) Detailing, and (4) Construction methods. Where full development and calibration have not been achieved, prima facie procedures based on sound engineering judgement should be adopted in the interim, with research needs clearly identified and incorporated in future code revisions as appropriate. Some pertinent issues considered during the selection of the procedures for SANS 10100-3 (Draft) are reflected in the discussions that follow.

2.6.1 Basis of design

Basis of design is concerned with the methods that establish the requirements for safety, durability, and serviceability of structures, with due regard to aspects of reliability. The selection of the partial and combination factors for hydraulic loads, calibration of the cracking model for the Serviceability Limit State (SLS), assessment of the performance and subsequent calibration of the design model for the shear design of members with stirrups, and proper calibration of key material models (elastic modulus, creep, shrinkage) are the main basis of design issues relevant to the performance of WRS. It is pointed out in the K5-1764 report (WRC K5-1764 2010) however, that although the general principles for the development of reliability based design procedures are presented in Eurocode EN 1990 (consequently SANS 10160-1 as well), these principles are not fully applied to the formulation of design procedures for WRS. Therefore, much engineering judgement has been applied in providing for the basis of design requirements in SANS 10100-3 (Draft). In the absence of a rational calibration, Annex B in SANS 10100-3 (Draft) has been established to specify the actions, partial factors and combinations of actions for tanks as derived from EN 1991-4.

The onerous set of rules given in EN 1992-3 regarding cracking and its limits have been omitted in SANS 10100-3 (Draft) until such a time that appropriate crack width criteria can be justified by a local study. Stringency or lack thereof in this regard highly influences and affects the cost of WRS and is thus a critical aspect that should be well defined through proper characterisation and calibration. In the interim, the limits for crack width from BS 8007 (related to EN 1992-1-1 exposure class) are incorporated for use in SANS 10100-3 (Draft).

In terms of basis of design procedures, the K5-1764 report mostly provides a general assessment which gives a sound platform for an in-depth investigation into the reliability performance of WRS. It is therein stated that the results of such in-depth investigations are not expected to be available in time for implementation in the proposed design procedures but will provide expert knowledge to the support of subsequent revisions.

2.6.2 Materials

Some limited level of characterisation of various material models was achieved according to local data representative of South African conditions and practice. Where data were available, it was compared to either SANS models, BS models, EN models and other internationally recognised models (CEB-FIP, RILEM), or a combination thereof. Where no test data was available, the predictions of the various models were compared through parametric analyses to gauge the differences in the design outcomes of the different models. In terms of the applicability and suitability of material models, an assessment for WRS provides limited research capacity in support of the models to be adopted in the general concrete standard. Hence, recommendations on material models from the K5-1764 report mostly warrant consideration by the WG on the revision of SANS 10100-1 (hereafter renamed to SANS 51992-1-1). If not incorporated in SANS 51992 1 1, a separate procedure may be incorporated specifically for WRS in an informative Annex of SANS 10100-3.

Material models relevant to WRS include compressive and tensile strengths of concrete and their development rates, elastic modulus (stiffness) in relation to its associated parameters (strength, curing etc.), the influence of curing on material properties, the influence of formwork type on the heat of hydration, the relation between aggregate type and the coefficient of thermal expansion, creep and shrinkage models, as well as the heat of hydration and strength evolution characteristics of various binder compositions. Some of the various materials issues taken into consideration for SANS 10100-3 (Draft) are:

- South Africa will maintain the cube strength specification of concrete compressive strength but, like the Eurocode, will provide a Table in the revised SANS 51992-1-1 giving the relationship between cube strengths and cylinder strengths.
- The tensile and compressive strength models from EN 1992-1-1 were found to generally apply and were recommended for use in the revised SANS 51992-1-1.
- Information on the elastic modulus and its relation to aggregate type and strength development of concrete were recommended to be maintained in the revised versions of SANS 51992-1-1 as based on work by Alexander and Davis (1989, 1992a & b) on locally available aggregates for concrete.
- The EN 1992-1-1 models for creep and shrinkage were found to generally apply but with a note not to consider curing and loading ages beyond 14 days.

A concise treatment of all outstanding material model and characterisation issues for the current and future development are provided in the Guidelines for the Working Group. In some instances

Table 3.1. Basis of various design procedures included in SANS 10100-3 (Draft)

SECTION	CLAUSE	ISSUE / HEADING	SOURCE, TREATMENT AND COMMENTS
1 General	1.1.2 (104)	Scope of design. Temperatures for liquids	Kept in-line with local practice, as derived from BS 8007.
2 Basis of Design	2.1.1 (105)	Flotation	Taken from BS 8007. Considered as relevant guidance to the designer for WRS, consistent with present practice for South African structural standards.
	2.1.3	Design working life, durability and quality management	
	2.8	Design situations	
	2.9	Operational safety considerations	
	2.10	Maintenance and operation	
	2.11	Inspection and testing of the structure	
	2.12	Deflections	
3 Materials	3.1.1 (103)	General. Reference is made to Annex K	Annex K will be deleted as it deals with concrete properties at temperatures outside the scope of SANS 10100-3. Delete reference to Annex K
	3.1.11	Heat evolution and temperature development due to hydration	Importance of heat evolution established but with no design guidance. The WG should consider providing a NA.
6 Ultimate limit states	6.2.3 (109)	Suggestion to conservatively apply cot h = 1for shear design of members with links	Taken from the Bridge code EN 1992-2 to promote designing conservatively to avoid the sudden brittle shear cracking of WRS due to shear (diagonal tension).
7 Serviceability limit states	7.3.1	General considerations for cracking	The onerous set of rules for crack widths from EN 1992-1-1 are omitted pending justification from local investigation. BS 8007 limits are maintained but tied to EN exposure classes. The exposure classes are to be incorporated in the revised editions of SANS 10100-1, CC1 and CC2 on durability.
9 Detailing of members and particular rules	9.1 (104)	Reinforcement to control restrained shrinkage and thermal movement	Taken from BS 8007. Considered as relevant guidance to the designer for WRS.
Annex A		Basis of design - supplementary paragraphs to SANS 10160 for tanks: Loads on tanks from liquids	Normative stipulations for the treatment of actions are provided in annexes. Stipulations are taken from EN 1991-4; as it is not treated in EN 1990. In future it could be added to SANS 10160-1 although it is outside the general scope of SANS 10160.
Annex B		Actions, partial factors and combinations of actions on tanks	
Annex C		Surface zones in concrete members	Taken from BS 8007. Considered as relevant guidance to the designer for WRS. Requires better presentation and labelling of Figures as well as better referencing from the main SANS 10100-3 procedures.
Annex K		Effect of temperature on the properties of concrete.	To be deleted. Outside of SANS 10100-3 scope.
Annex N		Figure of joint details from BS 8007	Taken from BS 8007. Considered as relevant guidance to the designer for WRS. The figure should be labelled properly.

where local data is scarce or not traceable, the K5-1764 report states that informative Annexes may be incorporated in SANS 10100-3 from comparable international research. Some of these aspects are discussed under Possible National Annexes for SANS 10100-3 (Draft).

2.6.3 Detailing and construction methods

Following an industry survey to capture the salient aspects of local conditions and practice, it was noted that designers tend to use in-house methods or experience as guidance for the determination and specification of some critical parameters. The K5-1764 report establishes that designers use parameters for temperatures (coefficient of thermal expansion, heat of hydration), restraint factors and material parameters which they have accumulated from experience, or from experienced designers in their companies. A very similar situation exists for certain construction details which designers specify on their drawings. Although joint details may have originated from the British code, there may be slight variances for local preferences. This information is accumulated by designers through experience. The need for information on some design parameters to be used in South Africa therefore exists and should be considered by this WG. In the interim, however, the joint details from BS 8007 have been included in Annex N of SANS 10100-3. For the cases of coefficient of thermal expansion and heat of hydration, UK research conducted by Bamforth (2007) has been suggested for use in SA. This decision is motivated mainly by the fact that the same base rock groups commonly used for aggregates in SA also exist in the UK; such referencing would also be in-line with the tradition of adopting British standards for local use. Further investigation is needed in this regard, specifically regarding the heat of hydration of newer South African cements.

3. BASIS FOR SANS 10100-3 (DRAFT) SECTIONS AND CLAUSES

The general formulation of SANS 10100-3 can be viewed to consist systematically of first identifying the procedures relevant for the design of WRS as extracted from the general EN 1992-3 standard for containment structures. Thereafter, additional procedures applicable to the design of WRS from various other sources, primarily BS 8007 to maintain consistency with local practice, are incorporated in a logical format to give rise to a concise and competent design standard to aid in the design of local WRS's. Table 3.1 presents the basis of some of the pertinent issues considered during the establishment of the procedures in the current version of SANS 10100-3 (Draft). Sections and clauses not included in Table 3.1 are taken from EN 1992-3 without amendment. Note that clause numbers are consistent with EN 1992-1-1, resulting in intermittencies in the numbering sequence.

4. POSSIBLE ANNEXES FOR SANS 10100-3 (DRAFT)

4.1 Reorganisation of Annexes in Draft

In the present version of SANS 10100-3 (Draft) additional provision for the basis of design for tanks and stipulations for actions, partial factors and combinations of actions are given in separate annexes, as extracted from EN 1991-4:2006. Justification for the treatment of these topics is based on the premise that they should be included in the overall basis of design standard, which is EN 1990 for Eurocode and could be SANS 10160-1 for South Africa.

However, since this material is presented in a normative manner and the Eurocode arrangement is not followed strictly for this standard; the integral presentation of these stipulations in Section 2 would both simplify the standard and ensure that there is no misunderstanding of its normative status.

4.2 Additional Annexes

In addition to the Annexes that have already been established as part of the current version of SANS 10100-3 (Draft), numerous other Annexes dealing with various issues have been recommended to be included in the code. The recommendations for additional Annexes stem mainly from the K5-1764 report. The additional aspects to consider for tentative incorporation into SANS 10100-3 as National Annexures include:

- The coefficient of thermal expansion of concrete should be considered, borrowing from Bamforth (2007), as the same typical rock groups are found in SA and are extensively used for aggregate for concrete. Bamforth further gives design considerations for early-age concrete and heat of hydration.
- Guidance on the construction of precast reservoirs outlining all relevant design, construction, operation and maintenance issues to be considered.
- The influence of binder composition or aggregate type on elastic modulus.
- The influence of curing on elastic modulus.
- Relative humidity and its regional characteristics.
- South African conditions, particularly highlighting the problems that can occur due to pure water found in mountain streams and rain water.

4.3 National Annex in accordance with Eurocode

Since SANS 10100-3 will be an adapted standard, based not only on Eurocode but also including other material, there is no need to stipulate the selected Nationally Determined Parameters (NDP) in a separate South African National Annex. Where these NDP's are relevant, they are included directly in the normative stipulations. This arrangement is in contrast to that for SANS 51992-1-1 which represents a direct adoption of EN 1992-1-1.

5. CHARACTERISATION OF WRS PERFORMANCE

This background paper is presented primarily from the perspective of the compilation of a South African Standard for the design of WRS from existing standardised procedures. It is implied that the final standard will be based on pragmatic decisions on how best to provide for local needs and conditions. However, such decisions should take account of the previous WRC project on which the proposed approach to be taken is based and the first draft of such a standard is compiled. A number of topics and issues can be identified for which further investigation can contribute to proper characterisation of the performance of WRS.

5.1 Reliability basis of design

The differentiation of the serviceability limit state (SLS) into irreversible, reversible, long term and appearance design situations is the most notable element of the reliability framework relevant to WRS. The following aspects of the serviceability performance of WRS require attention:

(i) Performance level for cracking of concrete: In EN 1992-1-1 concrete cracking is treated as a reversible SLS for which the least severe action combination scheme applies. The implication is also that a low level of reliability performance would apply when reliability analysis and calibration is done.

   a. The importance of WRS as specialist structures may justify a higher reliability classification, with associated performance levels. Generally, WRS should be classified at the equivalent SANS 10160-1 Reliability Class 3, requiring upwards adjustment of partial factors and/or levels of quality management.

   b. Similarly the performance requirement for cracking should be set at a higher reliability level due to the importance of this specific limit state. When stating performance levels in terms of target reliability index values (b_T) (Retief & Dunaiski, 2009), typical values of b_T = 0,5 applies to cracking in buildings and b_T= 1,5 – 2,0 apply to the irreversible SLS.

(ii) A reliability assessment of crack prediction based on the EN 1992-1-1 procedures for representative WRS confirms the importance of a number of factors (McLeod et al., 2012):

   a. Reliability based design outcomes are more economical than the stipulated procedures, even when a high level of performance is set. Refined calibration of the design procedures can therefore result in more economical structures.

   b. The design outcome for the cracking SLS is significantly sensitive to the target level of reliability set as a performance requirement: The amount of tensile steel for b_T = 1,5 and 2,0 is respectively 10% and 15% more than for b_T = 0,5 as default value.

   c. Nevertheless, the more stringent crack width limits stipulated in EN 1992-3 for WRS often result in a substantial increase in tensile steel required to satisfy performance requirements: When the crack width limit stipulated by BS 8007 of 0,2 mm is reduced to 0,1 mm or 0,05 mm, the amount of tensile steel for a representative case is increased by a factor of 1,4 and 2 respectively.

(iii) Crack limit: The rational basis for the more onerous crack limits stipulated in EN 1992-3 as compared to BS 8007 needs to be established. Probability-based economic optimisation could provide such a rational basis, but would require input on the likelihood of self-healing for a range of crack widths, in addition to quantification of the consequences of SLS failure.

(iv) Reliability of structural resistance and accompanying quality management: Although the current version of the SANS 10100-3 (Draft) omits the onerous set of rules pertaining to cracking proposed by EN 1992-3 pending the results of a local support study, it appears likely that Tightness Classes will be prescribed in future and accompanied by locally suitable limits. Such action would call for a revised scheme of quality measures relating to Tightness Classes and allowable crack width limitations to ensure adequate performance of WRS in South Africa.

5.2 Structural performance

5.2.1 Shear resistance

Due to its sudden and brittle mode of failure, shear failures are not desirable in any structure, especially WRS for which cracking limitations

represent a fundamental design requirement. The design for shear stresses is to be carried out with the available procedures of the future general South African concrete design standard SANS 51992-1-1. SANS 51992-1-1, as does EN 1992-1-1, will foreseeably enforce the Variable Strut Inclination Method (VSIM) for the provision of shear reinforcement to reinforced concrete members.

The VSIM brings about some economy of link design – it allows notably higher shear stresses as compared to the additive semi-empirical approach employed in the currently operational SANS 10100-1 as adopted from BS 8110 – but has portrayed some inconsistent and potentially unsafe behaviour against the amount of shear reinforcement provided in design Caldera & Mari, 2007; Mensah, 2012). The unbiased and uncalibrated VSIM has been shown generally to have a large conservative bias (particularly at low amounts of shear reinforcement), associated with a large spread and variability. The results of a parametric correlation and regression investigation of laboratory tests have indicated that the VSIM progresses to become marginally safe to unsafe when relatively high amounts of shear links are provided in design.

As a result of these findings, a limitation has been placed on the application of the Eurocode shear design method in the Draft Standard SANS 51992-1-1. For elements where shear reinforcement in elements exceed a certain limit, designers are referred to other methods, such as the shear design method in SANS 10100-1.

5.3 Materials

As described in Section 2.6.2, evaluation of the suitability of relevant material models to South African practice and conditions stopped short of full characterisation and calibration. Nevertheless, the recommendation has been that the general provisions in BS EN 1992-1-1:2004, in combination with the WRS-specific BS EN 1992-3:2006, are suitable for use in a South African WRS given the adaptations and notes in Section 2.6.2.

Research and characterisation needs include early-age properties of concrete and reinforcing steel. Specialist literature on early-age development of concrete properties exists (e.g. Bamforth, 2007), but is not based on specific South African conditions, practice, or materials. Heat of hydration, strength and stiffness evolution, bleeding, capillary pressure, plastic and settlement shrinkage may dominate early age-behaviour, which in turn may determine eventual crack patterns and width in hardened concrete of WRS. Of particular significance are local cements and cement replacement materials, but also chemical additives which are known and intended to alter fresh behaviour and early-age behaviour.

Characterisation of reinforcing steel available in South Africa is essential to enable WRS structural designers to use the various steel design material models included in the envisaged SANS 51992-1-1, adopted from Eurocode. Whereas a linear elastic perfect plastic stress-strain material model remains available, two more categories of reinforcing steel are allowed, for which post-yield strain-hardening is considered up to threshold strain levels. Furthermore, mild steel bars (SANS920), typically used in the form of smooth round bars for stirrups in South Africa, typically fall outside the scope of steels considered in Eurocode, for which minimum yield strengths are between 400 and 600 MPa.

5.4 Detailing and construction methods

The critical parameter for reinforcement quantities, spacing and bar sizes, is, in general, crack width limitations under serviceability conditions. The draft standard provides simplified limitations on minimum percentage of reinforcement as a provision for restrained cracking due to temperature and moisture effects. These numbers were taken from BS8007, seeing that simplified rules such as these are not given in EN 1992-1-3. In addition, experience has shown that these values have served the industry well over the years.

Also, deemed to satisfy rules from BS 8007 are given for reinforcement stresses to limit crack widths under externally applied direct tension or flexure. These would in general result in conservative results.

A section in the Draft Standard addresses the arrangement of prestressing tendons and ducts, as well as anchorages and couplers. These sections were taken directly from EN 1992-1-3. However, an Annexure on the design of cylindrical prestressed concrete structures was taken directly from BS 8007.

The Draft Standard does not include a section on construction methods and on appropriate quality control procedures. This aspect may need attention when a final version of the Standard is developed.

6. CONCLUSIONS

Standards for structural design represent acceptable design practice and the resulting performance of the structures designed in accordance with the stipulated procedures. The final judgement on a standard is therefore made by the profession when a draft standard is published for public comment. The technical background to the draft allows for such judgement to be made not only at face value, but also from considerations on which the formulation is based. The technical basis of design standards typically derives from two main sources, the assessment of research information and experience from practice. In the development of design standards, the use of previous standards serves as a rich source of information consisting of the synthesis of the two sources of input. Most design standards are not fully self-contained, but need to be used in conjunction with related standards, for instance a loading code to be used together with a materials-based standard.

This paper records the pre-normative stages of the development of a South African standard for the design of concrete water retaining structures. Following a wide range of related investigations, reported extensively in the final report of a WRC Project (WRC 1764, 2010), a summary of the main considerations on which a draft standard is based is presented. The two main features of the pre-normative investigations are the need to consider a number of related standards and the need to provide for local conditions, practice, and experience. The main driver to the process was the replacement of the British Standards (BS 8007 & BS 8110) by Eurocode Standards. This was complemented by the need to have a local standard that provides for an important class of structure.

The design of water retaining structures is primarily controlled by the serviceability limit states. The technical background consequently focusses on design requirements for cracking and related provisions for detailing, materials specification and construction practice. A decisive consideration was that the requirements and procedures stipulated by Eurocode for crack control were significantly more stringent than those of BS 8007. It was also concluded that BS 8007 provided useful information not included in Eurocode. It was decided to formulate the draft standard in accordance with Eurocode but with insertions extracted from BS 8007.

The next step consisting of the conversion of the Draft Standard into a South African National Standard requires full appreciation of both the justification for proposed treatment and the identified critical issues. Experienced-based judgement is applied to resolve remaining issues, modify, or extend the draft as deemed necessary to ensure that the final product represents acceptable design practice. The present background will need to be updated to include all the considerations on which the final standard is based.

In retrospect, many issues still require proper calibration and characterisation not only on a national, but international platform as well, mostly concerning the establishment of rational design procedures for WRS based on the principles of structural reliability.

Further characterisation of material models for local data is warranted, particularly concerning information on the strength evolution of concrete exposed to different curing regimes, the heat evolution of concretes comprising different binder compositions, as well as the coefficient of thermal expansion in relation to the respective aggregate used locally in South Africa.

However, in the interim, sound engineering judgement should be applied in selecting appropriate procedures for critical design parameters for incorporation in SANS 10100-3 where no credible or convincing local data are available.

Guidelines are not included on construction procedures in the Draft Standard, but a follow up project for the development of a construction manual is recommended. The important parameter would be to define the relevant quality control procedures to ensure correct implementation of the design.

7. ACKNOWLEDGEMENTS

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REFERENCES

Alexander MG & Davis DE (1989). ***Properties of aggregates in concrete***, Part 1. Hippo Quarries Technical Publication, 44p.

Alexander MG & Davis DE (1992a). ***Properties of aggregates in concrete***, Part 2. Hippo Quarries Technical Publication, 48p.

Alexander MG & Davis DE (1992b). ***The influence of aggregates on the compression strength and elastic modulus of concrete***, The Civil Engineer in South Africa, May 1992, vol. 34, No. 5, pp 161-170

Bamforth PB (2007). ***Early-age thermal crack control in concrete***. CIRIA 660. CIRIA London, MWL Digital, UK.

BS 8007 (1987): ***British Standards Code of Practice for the Design of Concrete Structures for Retaining Aqueous Liquids***, British Standards Institution.

BS 8110 (1997) ***Structural use of concrete – Part 1: Code of practice for design and construction***. British Standards Institution.

Cladera A & Mari AR (2007). Shear strength in the new Eurocode 2: A step forward? ***Structural concrete***, 8 (2), pp 57-66.

Collins MP & Mitchell D (1987). ***Prestressed Concrete Basic***s. Canadian prestressed concrete.

EN 1990 (2002). ***Eurocode – Basis of structural design***. European Committee for Standardisation (CEN), Brussels.

EN 1991-4 (2006). ***Eurocode 1: Actions on structures – Part 4: Silos and tanks.*** European Committee for standardisation (CEN), Brussels.

EN 1992-1-1 (2004). ***Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings.*** European Committee for Standardisation (CEN), Brussels.

EN 1992-2 (2005). ***Eurocode 2: Design of concrete structures – Part 2: Concrete bridges - Design and detailing rules.*** European Committee for Standardisation (CEN), Brussels.

EN 1992-3 (2006). ***Eurocode 2: Design of concrete structures – Part 3: Liquid retaining and containment structures***. European Committee for Standardisation (CEN), Brussels.

McLeod CH, Wium JA & Retief JV (2012). ***Investigation of reliability model for cracking in South African reinforced concrete water retaining structures.*** Proceedings 10th International Probabilistic Workshop, Stuttgart.

Mensah KK (2012). ***Reliability Assessment of Structural Concrete with Special Reference to Shear Resistance.*** Masters thesis submitted to Department of Civil Engineering, University of Stellenbosch, Stellenbosch, South Africa.

Retief JV & Dunaiski PE (2009). ***The limit states basis of structural design for SANS 10160***. In Retief JV & Dunaiski PE (Editors) Background to SANS 10160. SUN Media, Stellenbosch. ISBN 978-1-920338-10-7.

SANS 10100-1:2000. ***The structural use of concrete – Part 1: Design.*** South African Bureau of Standards, Pretoria.

SANS 10100-3: Draft, ***SANS 10100 Part 3 – Design of concrete water retaining structures***. Unpublished Draft – see WRC K5-1764 (2010).

SANS 10160-1:2010. ***Basis of structural design and actions for buildings and industrial structures, Part 1 to 7***. South African Bureau of Standards, Pretoria.

WRC K5-1764 (2010). ***Water Research Commission – The development and calibration of South Africa's National Standards for Water Retaining Structures.*** Institute of Structural Engineering (ISE), University of Stellenbosch.

WRC K5-2154-1 (2012). Guidelines for the Working Group. ***Water Research commission – The implementation of a South African National Standard for the design of Water Retaining Structures.*** Institute of Structural Engineering (ISE), University of Stellenbosch.

Some properties of concrete made with Ground Granulated Blastfurnace Slag (GGBS) from Saldanha (Part 2)

Scope

This TIP covers the properties of fresh (plastic) concrete made with GGBS from Saldanha, as well as concrete finish and colour. Unless otherwise stated the properties refer to concretes made with a blend of 50% CEM I 52,5N and 50% GGBS (by mass).

Workability

The substitution of 50% GGBS for CEM I 52,5N does not materially affect the consistence of the mix as measured by the slump test, but it does affect the workability or "user friendliness" of the concrete. The concrete is more cohesive and easier to work with and compact. This effect is somewhat dependent on the fine aggregate properties and one can expect rich mixes made with sands with high dust contents to be rather sticky.

Bleeding

Bleeding is the accumulation of mix water on the surface of freshly compacted concrete and is caused by the settlement of the solid constituents of the concrete which displace some of the mix water upwards. Apart from the accumulation of water on the surface, severe bleeding results in voids under the coarse aggregate particles and under reinforcing steel. This impairs bond of the concrete to the steel.

GGBS concretes bleed at a substantially lower rate than Portland cement concretes under the same circumstances, but they have the potential to bleed for a longer period as their setting time is longer. The net effect in practice appears to be reduced bleeding over a longer period of time.

Plastic shrinkage cracking

Plastic shrinkage cracking occurs when the rate of evaporation of water from the surface of concrete exceeds the rate of bleeding. In other words when the surface of the concrete dries while the underlying concrete is still plastic. Weather conditions that promote plastic shrinkage cracking are strong winds, high temperatures and low humidity, all of which are prevalent in late Spring and Summer in the Western Cape. Concrete mix properties that make the concrete susceptible to cracking are low bleeding rate and cohesiveness. Concretes designed for pumping are particularly prone to this type of cracking.

As two effects of GGBS are to improve cohesion and reduce bleeding, the probability of plastic shrinkage cracking is increased, but to what degree it is not possible to say as there is no standard test to measure plastic shrinkage. In any event, as a general rule, precautions to reduce the possibility of cracking should be adopted if the weather conditions are unfavourable, regardless of binder type.

Plastic settlement cracking

This type of cracking occurs in concretes which are prone to excessive settlement and bleeding. Cracks normally appear over the top reinforcement in slabs, next to stirrups in columns, and wherever settlement of the concrete is restrained such as over void formers and at re-entrant corners in formwork.

Because GGBS concretes are more cohesive and less susceptible to settlement, plastic settlement cracking seems to be very rare.

Cohesiveness

GGBS concretes are more cohesive than Portland cement concretes. This is because the slag is more finely ground than most Portland cements.

Setting time

Slag concretes take longer to set than Portland cement concretes. As the setting time is defined arbitrarily, and the process is temperature and admixture (and sometimes aggregate) sensitive, it is not possible to give exact setting time figures for concrete on site. Tests conducted under laboratory conditions at UCT in accordance with test method ENV 196-3 indicate that setting is delayed by between 70 and 100 minutes, depending on the slag content of the concrete.

Colour of fresh concrete

GGBS is lighter in colour than cement and fresh concrete is correspondingly lighter in colour than Portland cement concrete.

Colour of hardened concrete

The surface of hardened concrete dries to a light grey colour, but newly stripped concrete and freshly fractured surfaces are dark green/blue in colour. This is caused by chemical reactions with iron compounds in the slag. The colour fades back to light grey as the concrete dries out and these compounds oxidise.

Pigmented concretes made with GGBS are brighter in colour than equivalent Portland cement concretes.

Surface finish

Surface finish is generally better than with equivalent Portland cement concretes. ▲

Steve Crosswell Pr Eng MICT
Technical Marketing Manager, PPC.

AfriSam's composite technology personifies its ethos of innovation

AfriSam's C-Tech cements are pushing the limits of cement and concrete technology to produce products with exceptional performance characteristics which are also environmentally responsible.

"Our achievements in the arena of composite technology (C-Tech) personify AfriSam's ethos of innovation, aimed at ensuring that our customers always enjoy the benefits of high performing products," Mike McDonald, manager of AfriSam's Centre of Product Excellence, says. "This methodology is also driven by our commitment to support the environment by producing cements with ever lower carbon footprints.

"Our C-Tech products are the result of an on-going development process that began in 2000 and is still moving forward, beyond conventional boundaries. The mineral components in these cements have been engineered to make the resultant composite cement superior to pure cement. These products offer a spectrum of functional attributes that provide our customers guaranteed quality performance."

C-Tech technology reduces the carbon intensive Portland clinker content of cement ensuring that AfriSam cements tread more lightly on the environment. Their mineral components carries significantly less embodied carbon than clinker, effectively reducing the carbon footprint associated with the cement production process.

In the process, AfriSam is also able to conserve natural resources such as limestone. The use of C Tech minerals in the manufacturing of composite cements make constructive use of by-products from other industries, reducing the need to landfill these materials.

The introduction of engineered mineral components in increased proportions to cement clinker presents AfriSam customers with enhanced functional performance qualities. For instance, whether concrete is being used on a major construction site or for a D.I.Y. project, good workability is important. The less water required to reach the desired consistency and workability the better, as less water promotes higher concrete strength levels. The lower water demand of AfriSam C-Tech cements is a result of the additional mineral components employed and the use of carefully selected chemical admixtures.

Another superior attribute of these cements is reduced heat of hydration. C-Tech cements typically generate heat over a longer period of time, substantially lowering these thermal gradients and reducing the likelihood of cracking.

The use of fly ash results in a dense concrete matrix that prevents deleterious materials such as aggressive chemicals and sulphate containing liquids from entering the concrete. This resistance to ingress of deleterious elements gives the composite cements their corrosion resistance properties. While any steel reinforcement exposed to chloride ions in solution is prone to corrosion, GGBFS is known to capture the chloride ions that cause corrosion in steel reinforcement, thereby enhancing the corrosion resistance properties of composite cements.

The finer particles in GGBFS, fly ash and limestone afford composite cements reduced permeability properties. This resistance to water and sulphate penetration from the refined pore structures helps protect the concrete from attack, preventing deterioration.

AfriSam C-Tech cements also contain mineral components that produce superior long term strengths compared to pure cements, where strength gain typically flattens out from 28 days onward. ▲

Safe wall designs with Terrasafe

"In response to market demands, a design service called TERRASAFE, a service that provides first-class engineering, management, and specialist technical assistance to users of any of the Terraforce products, was launched early 2011."

After implementing a sustainable and ethical business model for 35 years, Terraforce can, together with their local and international partners, report a steady and positive business outcome. In spite of a long global recession, Terraforce has, on average, maintained continuous growth.

To achieve this, Terraforce, partially made available a multitude of information for the benefit of their customers. To a certain extent this strategy did encourage some imitators and copycats, the free-riders of the industry.

Clients that wish to receive Terraforce wall designs from Fred Laker, an engineer specialising in this field since 1997, need to provide following input regarding their requirements:

- Geotechnical report and/or density tests, if available.
- Photographs of the site.
- Completed Terraforce questionnaire for gravity, composite or terraced walls.
- Any information on previously proposed designs involving other methods.

After all requirements and technical data is processed and approved, the client will receive one or more cross-section designs that can be applied to site. This approach has worked successfully for various projects, past and current, in South Africa and other countries.

As more and more clients requested provision of site supervision and professional indemnity insurance, Terrasafe added this additional service to its portfolio. The cost for the extra assistance will naturally be higher and is based on a percentage of the Terraforce project value. Currently it will only be available for installations that can feasibly be managed from Cape Town, but in time may be extended to other centres in South Africa and overseas, in association with engineers that are based near those sites.

Terrasafe has, and currently is, specifying Terraforce products for building sites in South Africa, Namibia, Swaziland, Chad, Australia, India, Spain, Canada, UAE, Qatar, Bahrain, and the U.K.

Ten key findings from the Lafarge Education Trust (LET)

Positive results for Lafarge Education Trust's upliftment programmes.

Thierry Legrand (Former CCEO Lafarge South Africa), Graeme Bloch, Waheeda Carvello (Chief Education Specialist), Cheryl Carolus (Chairperson: Lafarge Trusts), Eugene Schalkwyk, Teboho Mahuma, Tsholofelo Moshimane, Ilse Boshoff, Felix Motsiri and Mpogeng Nkgadima

Professor Graeme Bloch, Wits School of Public and Development Management and Mpogeng Nkgadima, CEO, Lafarge Education Trust, measured LET's contribution towards improving the quality of education in South Africa to find out how well this initiative has worked.

The Lafarge Education Trust has contributed tremendously in assisting with the ailing education system in disadvantaged areas with most of the upliftment taking place in the backyard of Lafarge South Africa – the North West Province and Kwa-Zulu Natal. Here are their key findings:

1. Education change is hands-on, it takes time, and it involves continual fluctuation in outputs. By avoiding a spray-and-pray approach, it's possible with a small amount of money (less than R6m pa), to achieve a great deal.
2. LET learned that education change is complex. A good school must be judged on its academic outputs: can learners read and count? This is the very point of schooling. But the most important finding was that the advancement of the entire family is vested in the education success of their child or children.
3. However, even where LET has been funding bursary holders at a range of institutions and focusing on filling the skills shortage in areas such as civil, electrical, industrial, mechanical and mining engineering, the old boys' clubs have operated to exclude some graduates, and this is one of the reasons for lack of employment and needs to be addressed.
4. Bodibe in the North West Province is a small rural community controlled by a Tribal Council. The major employer in the area is Lafarge South Africa and when LET introduced their upliftment programme they faced resistance from the Council. Council leaders stated that principals may not attend the University of the Witwatersrand. LET gave them a month to reconcile, which they did after the community marched on the tribal authority to show their disdain.
5. LET met with stakeholders at schools in Bodibe in 2009 and promised infrastructure improvements including administration blocks, libraries, classrooms as well as labs and computers. Twelve schools came on board and LET has since built over 13 classrooms, a number of libraries and administration blocks for teachers and other staff.
6. Adopt-a-School was the first partner and employed unskilled artisans and trained them under strict monitoring and strong guidelines ensuring a visible sign of progress and improvement within the community. REAP and Trees for Africa also came on board creating multifaceted solutions.
7. LET went a step further and unified the community through sport, especially football leagues. The Dreamfields Football League was granted access to national league and played in the finals.
8. With Adopt-a-School involvement, the Boy Scouts involved themselves in environmental clubs and food gardens. Old Mutual Foundation came to the party too – testing eyes of young children at schools. More than 10 per cent of young learners could barely see the board for literacy training.
9. A challenge remains in that there is still much to be measured, especially using the matric pass rates to measure outputs at school level and to measure the role of the district in ensuring pedagogical success.

10. Ways have to be found to overcome the challenge of teacher training and management as well as encouraging empowerment of communities as even a business or NGO cannot guarantee a permanent presence.

The Lafarge Community Trust (LCT) and Lafarge Education Trust (LET) were created in 2006 by major building materials company, Lafarge South Africa the local presence of the international Lafarge Group, the world leader in building materials. The company's Lichtenburg Cement Works has a long-standing relationship with the Bodibe community, which provided the motivation for the inaugural education upliftment initiatives organised by the Trusts.

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

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

About Lafarge

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

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

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

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

Afrisam supplies concrete to final phase of Lynnwood bridge complex

Greig Bastion, WBHO contracts manager responsible for the project.

AfriSam has supplied 13 000 m^3 of 30 MPA enhanced suspended slab mix for Phase 3 of the Lynnwood Bridge complex, in compliance with the developer's Green Star specifications. The company has supplied the concrete required for all three phases of the Lynnwood Bridge complex, located on the North East corner of the N1 Highway's Lynnwood Road off-ramp. Phase 3, the final element of the complex, is on track for completion by year end.

Construction makes use of conventional concrete reinforced slabs. Phase 3 is located at the lowest level of the Lynnwood Bridge complex in terms of elevation, necessitating lateral support being incorporated to anchor the complex.

WHBO is now putting the finishing touches to Lynnwood Bridge Phase 3, which comprises two 7 500 m^2 A-grade office blocks (building A and building B), each five storeys high.

The bulk of the concrete required was delivered by May 2014, with much smaller quantities being supplied until the end of the project. Main contractor WBHO reports that the concrete mix has achieved very good early strengths on the project, typically way above the requirement. It was delivered to site in readymix trucks and reticulated around the site by means of a WBHO static pump, with concrete being pumped more than 140 metres in many cases before reaching a specific pour.

"We have a longstanding relationship with WBHO and have completed many successful projects with this contractor to date," AfriSam key account consultant, Margaret Lawrence, says. "Our involvement on the Lynnwood Bridge Complex is based on this excellent track record of consistent quality and reliability."

AfriSam has also supplied concrete to several other building developments in the same area, sourcing the required readymix primarily from its Ferro plant in East Lynne, Pretoria North, backed by its Kwagga plant in Pretoria West and its Rosslyn plant, also in Pretoria North.

Atterbury is developing the Lynnwood Bridge complex, a prime 74 000 m^2 mixed-use development comprising three premium A-grade office buildings, a retail component, a hotel and bulk land under development. Two of the buildings — named for long-lease tenants Aurecon and Adams & Adams — are single tenanted, while the third will be multi-tenanted.

Lynnwood Bridge Phase 3 comprises two 7 500 m^2 A-grade office blocks (building A and building B), each five storeys high. Additional Aurecon personnel will occupy building A which has been linked by means of a steel bridge to its existing offices in the neighbouring building. Phase 3 rests on five levels of basement, each about 4 500 m^2. At podium level there is a split into the two standalone towers, which are linked through a bridge and a staircase. In the centre of each of the buildings is a main atrium that, in the case of building A ascends five floors and in building B, four floors.

The developers have partnered with Aurecon, which is also responsible for the majority of engineering design disciplines on the project, to oversee the green building elements of the project. Phase 3's two towers will form part of the submission for the Green Star SA rating as one development with a single rating, which means both towers are jointly required to achieve a high level of performance. This will be achieved through careful modelling of the towers' performance and constant tweaking of the building systems to achieve desirable performance levels.

Bulk earthworks began on Lynnwood Bridge Phase 3 in November 2012, including excavation of the five basement levels through the lowest point of the complex. Months of dewatering followed, with the site pumping out more than 300 000 litres per day in peak rainy season. Pumps will be permanently installed in the basement to remove future ingress of groundwater.

"Other than pumping out these high levels of groundwater, a major challenge on this project was the size of the foundations," Greig Bastion, WBHO contracts manager, says. "Each base had to be shuttered, with some bases requiring more than 250 m^3 concrete. The surface area of bases covered 50% of the total footprint on the structure of 4 500 m^2 with a total volume of 2 700 m^3 being poured."

When the structure reached podium level, transfer beams were introduced to accommodate the desired column positioning. The concrete poured into these beams, some of which were up to one metre wide and nearly two metres deep, contributed to a fifth of the total volume on the project.

Construction makes use of conventional concrete reinforced slabs, but the fact that Phase 3 is located at the lowest level of the Lynnwood Bridge complex in terms of elevation, has necessitated lateral support being incorporated to anchor the complex.

"One of our limitations in terms of the basement work is that we can't de-tension any of the anchors on the lateral support for the five basement levels, specifically on the southern side of the building, until we have the entire structure complete up to roof level as the full weight of the structure is needed to stabilise the complex," says Bastion.

The new building takes up almost the entire 5 000 m^2 stand and access is very tight. Materials enter the site through a single gate and everything else is craned onto the property. Two tower cranes move materials around the site, while hoists and Bobcats drive material into the construction areas. ▲

Change of country CEO at Lafarge South Africa

Lafarge South Africa, the local presence of the international Lafarge Group, the world leader in building materials, has announced Country CEO, Thierry Legrand, has taken up a new assignment after being with Lafarge South Africa for five years. Legrand's new responsibility will be as SVP of Transformation and Acceleration at Lafarge's head office in Paris. In his new role Legrand will focus on developing innovation within the Lafarge Group.

Legrand has been with the Lafarge Group for twenty years. He was transferred to South Africa in 2009 as CEO of Lafarge South Africa Holdings and successfully integrated the company's local cement, aggregates, readymix concrete, gypsum and fly ash business lines into a country organisation, while also driving the company's ambition of contributing to building better cities.

With effect from 1 August 2014, he was succeeded by Kenneth MacLean, previously Lafarge Group SVP, Performance Aggregate based in Paris. MacLean started with the company in 1987 and over the past 27 years has held a wide range of senior positions in Lafarge Canada and Lafarge North America.

MacLean holds both a Civil Engineering degree and a Business Administration degree, and is amongst others, a member of Professional Engineers Ontario and of the Association of Professional Engineers and Geoscientists of New Brunswick.

"I am excited to be here in South Africa," notes MacLean. "This fascinating and vibrant country has always interested me. I am looking forward to the challenge of leading the company in the developing and highly competitive market."

AfriSam poised to increase market share with opening of third Eastern Cape depot

The establishment of a depot in Port Elizabeth allows AfriSam to provide the level of service expected from a cement supplier of choice.

AfriSam is poised to increase its market share in the Eastern Cape with the opening of a third rail to road depot in the province — this one in Markman Industrial, Port Elizabeth — to supplement the company's existing depots located in East London and Queenstown. The new depot, efficiently serviced via its own rail siding, incorporates a 1 000 ton bulk cement silo capacity and a 3 600 ton bag holding capacity. "Historically we've enjoyed a very strong presence in the eastern side of this province, supplying these areas from our Ulco plant in the Northern Cape via the two rail to road depots," Grant Neser, AfriSam sales and marketing executive, says. "This allows us to take advantage of the cost effective rail rates down to the depots, allowing AfriSam to focus on the last leg by road.

"Although we could have serviced the western area of the province directly from Ulco or via East London, after looking at all the options it was found that the most cost effective way to provide the quality service we want to offer in this area would be with another fully-fledged rail to road depot. The 1,8 ha site has been sized to ensure we have a significant amount of bulk capacity to support customers who use bulk cement in the vicinity of Port Elizabeth. At the same time, we've increased our bulk capacity in both East London and Queenstown to entrench security of supply in the province.

"The establishment of a depot in Port Elizabeth also allows us to provide the level of service expected from a cement supplier of choice. We intend to capture a significant share of the market in the Port Elizabeth area through our commitment to superior quality and service excellence," Neser says. "This has traditionally been a market dominated by a single supplier and our arrival offers local customers more choice. We're confident that we will compete favourably in this market with our quality products, a highly responsive sales team, skilled technical support team and reliable supply infrastructure."

The Port Elizabeth depot supplies AfriSam's 52,5N High Strength Cement in bulk, as well as bag products that include AfriSam All Purpose Cement and the specialist road stabilisation product, AfriSam Roadstab. ▲

The newly established AfriSam Port Elizabeth depot, situated in the Markman Industrial Park, occupies a 1.8 ha property that incorporates a 1 000 ton silo capacity and 3 600 ton bag holding capacity, as well as a rail siding designed to accept both bulk and bag deliveries.

PPC takes information sharing and concrete innovation to next level

Concrete is the most widely used man-made material in the world and is a cornerstone of civilization. The leading supplier of cement in southern Africa, PPC Ltd has launched the Cement & Concrete Cube (C3), a dynamic information sharing and collaboration platform.

The C3 will facilitate collaboration, interaction and information sharing between cement and concrete users, designers, academics, industry experts and enthusiasts. Participants will connect to find information and contribute to interest groups through blogs, wikis, documents, graphics and comments in private or public groups on this platform.

"This is certainly a first of its kind in the cement and concrete industry. C3 is more than a professional directory, pin-board or social chat page - the facility to upload and share information in all formats makes C3 so unique," said Hanlie Turner, PPC's Specialist of Technical Information Services.

The C3 will make information more easily accessible for improved efficiency and productivity. The streamlined interaction with experts will also ensure a flow of information and knowledge transfer. The site is powered by an intelligent search engine that allows searching for information, and will suggest content and connections with people with similar interests.

"The platform will not only enable public access to the information database but allows connections between PPC's own team members. We believe that experts and thought leaders will be able to inform and influence the industry through this platform and in doing so take the concrete and construction industry in Africa to the next level," said Turner.

C3 also incorporates paid-for-content in the form of a focused technical library with academic and industry journals and book subscriptions which will give expert users access to the latest international research in the field of cement and concrete. Our newsdesk feed for South Africa and Africa is also available on C3.

"The C3 will include all material relevant to our industry in the widest sense. As a dynamic platform, we envisage that the content and scope will grow over time, to reinforce PPC's strength beyond the bag ethos," concluded Turner. ▲

The PPC Cement & Concrete Cube will be available to all stakeholders – to access the platform, register at www.ppc.co.za

Wall reinforcement cages collapse

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

These reports are intended to assist those who may be faced with similar issues, and aims to improve structural safety and reduce failures by using confidential reports to highlight lessons that have been learnt, to generate feedback and influence change.

Report Overview

A contractor reported that he had experienced two cases of wall reinforcement cages collapsing. In both cases the walls were part of the construction of new RC water tanks where the height of the walls exceeded 6 m and the vertical reinforcement was relatively light (12 mm or 16 mm bars). In both cases the site teams had identified a risk of collapse, but the temporary works put in place to restrain the cages proved inadequate in both design and management.

Report Content

One of the collapses happened over a weekend during which high winds were experienced. The other collapse appears to have been instigated by pulling sideways on the partially completed cage while the reinforcement was being fixed. Both of the reinforcement cages were inherently unstable in the temporary condition before shutters were erected. In both cases, although the subcontractor responsible for erecting the reinforcement had identified the risk of collapse and taken steps to mitigate the risk by providing props, these were ineffective.

The following advice has been given internally to mitigate the risk of further collapses:

1. Where wall reinforcement is more than 3 m high, the temporary stability of the reinforcement should be managed as a temporary works item.
2. The stability of reinforcement should preferably be assessed by calculation. Alternatively, the reinforcement should be assumed to need propping and suitable propping should be designed and installed.
3. Propping designs need to be reviewed by the responsible Temporary Works Coordinator and any deficiencies such as a lack of information on connections and fixings corrected prior to use.
4. The propping should be installed either before fixing starts or incrementally as fixing proceeds, but the required sequence needs to be briefed to all involved with the construction activities. Generally, the propping should be on one side only to permit erection of formwork on the other side of the wall.
5. The method statements for propping installation, reinforcement fixing and formwork erection should include hold points for the Temporary Works Coordinator to inspect the installed temporary works at suitable points in the construction process.

Comments

There have been many cases where rebar cages have collapsed, sometimes with fatal consequences, and it appears to be a risk about which there is limited awareness. Reports suggest that recommendations are not readily available. In general it should be self-evident when there will be temporary stability issues during construction. However, it may be that the expectations of each party in relation to the skill and understanding of others is not always justified.

How much should the designer expect the contractor to know? Who in the contractor's supply chain should have the experience? When does expert knowledge take over from common sense? Experienced steel fixers might know when a cage is stable as a result of familiarity and on-the-job training. However, the steel fixers on a project with unusually high wall or column lifts might not have had previous relevant experience and not recognise the risk of instability. Even if some risk is seen the knowledge as to how to stabilise a cage may not be there.

Similarly those others who are engaged in the design and construction process may not have the specialist knowledge to recognise when stability is becoming of concern. Or they may believe that is in the hands of experts who know what they are doing. Who is responsible for which actions in that difficult transition that occurs in the temporary stages of permanent construction? Is this a role for the Temporary Works Coordinator? These questions cannot be answered here, but the industry as a whole should initiate steps to promote education and give advice.

In the UK reinforcement cages, prior to concreting, may be considered to be temporary works and their management should comply with BS 5975:2008+A1:2011 Code of practice for temporary works procedures and the permissible stress design of falsework. The Temporary Works Forum (TWF) has also received concerns regarding reinforcement cages and is currently writing a good practice guide. (www.twforum.org.uk).

The Washington State Department of Labor & Industries published a narrative report on the death of a steel fixer when a rebar cage collapsed (SHARP Report No; 71-100-2011) (i) which included the following requirements and recommendations:

- Ensure that reinforcing steel for columns, walls, and similar vertical structures is guyed or supported to prevent collapse.
- Make sure there is a programme to address hazards and abatement methods when installing reinforcing for columns, walls, and similar vertical structures.
- Ensure that the inspection of rigging and equipment is done by a qualified rigger.
- Use bracing that is in good working order.
- Frequently inspect and replace defective equipment and material.
- Make sure that bracing and guying are able to support the forces imposed.
- Ensure that loads are secured and will not inadvertently become displaced when released.
- A qualified person should design methods of bracing reinforcing steel when being placed into position.
- A competent person should determine if additional methods must be used to support reinforcing steel beyond guying and bracing.

The terms "qualified" and "competent" are not defined and may have different meaning in different countries. In California there were 56 collapses of bridge column cages in the 15 years pre-2010 which prompted a research project: "Stability of bridge column rebar cages during construction(ii). The lateral behavior and stability of bridge column rebar cages were investigated to reduce the potential of failure and collapse during construction. Included in the report are research findings and some proposed guidelines for improved rebar cage stability. Current architectural designs incorporating "blade" columns of buildings as well as bridges means extra vigilance is required.

(i) http://www.lni.wa.gov/Safety/Research/Face/ReptNarr/Narratives/Default.asp

(ii) http://www.dot.ca.gov/newtech/researchreports/reports/2010/2010-11_task_1098-geotech_and_structures.pdf

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

Cape Town engineer honoured by the Concrete Society

A the recent meeting of the Board of Directors of the Concrete Society of Southern Africa, Honorary Life Membership of the Society was bestowed on Mr Peter Flower, Director: Water and Sanitation for the City of Cape Town.

Flower, a registered Professional Engineer and Fellow of the South African Institution of Civil Engineering and the Water Institute of Southern Africa, has been actively involved in the Concrete Society for the last 35 years. His long association with the Society was driven by his passion for excellence in the use of concrete and the important role that it plays in the effective provision of water services. He signed up as a member of the Western Cape Branch in 1979, joined the branch committee after 2 years and later served as secretary for 3 years before being elected to the position of vice-chairman and then chairman in 1989, 1990 and later again in 1997.

His mentor in the Society was one of the founding members, Chris Thompson, an Honorary Life Member, from whom he learnt an enormous amount of the history, tradition and effective running of the Society.

At the national level, Flower served on the CSSA Council (now the Board of Directors) for a total period of some 20 years in positions of Treasurer, Vice-President, President, Past-President and Elected Member. He was Treasurer for 2 years in 1995/6, and in the following year was elected to the office of Vice-president and then President in 1998. This was a particularly difficult period, when the role of the president changed from that of “a figure-head” to an “executive” one. Peter played a key role in ensuring the sustainability of the Society during this troubled period, when the director resigned and the administrator and other permanent staff had to be retrenched, leaving the day-to-day management up to the executive committee with assistance from an outsourced administrator.

Peter Flower
Pr Eng BSc (Eng) GDE FSAICE FWISA

A few years later he was again elected as Vice-President, followed by a two-year term in 2002/3 as President. Over the years he has chaired and served on many society committees, including Finance, Membership, Education Committees as well as Organising Committees for Fulton Awards, National Symposia and Conferences. He re-establishing and edited the CSSA Administrative Manual containing the Articles of Association, the Constitution and the Rules of the CSSA as well as the revised Business Plan. This document has since been amended to meet the revised legislative requirements and is now referred to as the CSSA Terms of Reference.

He made a study of the history of the Fulton Awards over the years and wrote an article on the subject and developed a schedule with the details of all the awards that have been made since the inception of this prestigious concept of “Recognition of Excellence” in the construction industry established to honour Sandy Fulton. This is now regularly updated and incorporated in the special Fulton Edition of Concrete Beton every 2 years.

Commencing in 1979, Flower has had a fulfilling career with the City of Cape Town, involved with, and responsible for, much of the development of the bulk water supply infrastructure for the region over the years. For many years, he managed the City’s Bulk Water Branch of the Water Department, which is responsible for catchments, management of dams, treatment of the raw water and bulk storage and conveyance of treated water to the City and its neighbouring municipalities.

Before moving into the City’s senior management he was responsible for the planning, design and construction supervision of many concrete construction projects involving very large reservoirs, pump stations, pipelines and water treatment plants, most notable of which was the R550 million (1991 pricing) Faure Scheme with its 500 Megalitre per day treatment plant, 640 Megalitre reservoir with precast pre-stressed concrete roof beams and slabs and 35 km of 2.4 and 1.8 m diameter cement mortar lined and concrete sheathed steel pipelines, which he project managed.

Flower has presented several technical papers on construction and water-related subjects both locally and overseas, and has had a number of them published.

In July 2013, he was appointed to the position of Director: Water and Sanitation for the City of Cape Town, responsible for the R5,6 billion per year business of providing a sustainable water and sanitation service to the formal and informal sectors of the Cape Town Metropolitan Council with infrastructure assets of some R57 billion.

President of the Concrete Society and Chairman of the Board, Mr. Tseli Maliehe praised Peter Flower for the loyal support and leadership that he had exhibited to the Society over many years, and stated that he knew of no more a worthy recipient of Honorary Life Membership. ▲

Report Back on ConSem National Seminar

The constituent materials used in the production of concrete were unpacked at the recent seminar ConSem 2014, organised by the Society. A total of 250 delegates attended the event, which was held in Durban, Port Elizabeth, Cape Town and Johannesburg, where industry experts in concrete technology and application describe the latest developments in cement, extenders, aggregate, admixtures, specifications and concrete research.

The scene was set by Bryan Perrie, from The Concrete Institute, who presented an overview of the manufacture of cement, the various types that can be produced in terms of SANS 50197 and SANS 50413, and the availability of the various generic types of cement by supplier by region. Particular focus was made on the industry measures being taken in reducing the CO^2 emissions in the production of both cement and concrete.

Prof Mark Alexander from the University of Cape Town presented an overview of the influence of aggregates on hardened concrete and reminded delegates that aggregates make concrete ‘fit-for-purpose’ by imparting to concrete:

- Volumetric stability
- Thermal expansion compatibility with reinforcing steel
- Stiffness, strength and toughness
- Durability
- Ease of use
- Cost-efficiency

He continued by describing the effects of aggregates on concrete in terms of the ITZ (Interfacial Transition Zone), strength, deformation properties, elastic modulus, shrinkage, creep, thermal properties and durability. The section on Alkali-Silica Reaction was particularly interesting and relevant in the South African context.

Bryan Perrie presented his second paper of the seminar which focused on cementitious extenders and their application. Aspects covered included types of extenders, their availability, methods of use, and application examples. The latest specifications for these supplementary cementitious materials were described as well as their use and the specific features and benefits they offered when added to concrete.

Flexible concrete

Once referred to as ‘snake oil’, chemical admixtures were described by Graeme Smith (and by Hennie van Heerden in Port Elizabeth and Cape Town) of Sephaku as complex, formulated chemical products that enhance the performance and final properties of concrete. They have become the “fifth ingredient of concrete”.

Smith (and van Heerden) covered in some detail the dispersant role of plasticisers explaining that the normal plasticiser is adsorbed onto cement particles, repelling cement particles by electrostatic or steric repulsion and thereby stopping cement from flocculating in clumps and trapping water. This increases the fluidity of the mix. The presentation continued with a detailed overview of self-compacting concrete (SCC) which resulted from the development of PolyCarboxylate Ether (PCE) Superplasticisers. It was said that any SCC mix design must consistently achieve:

- Good flow
- No segregation
- Good passing ability through reinforcement /no blocking
- Appropriate viscosity / speed of flow

In addition, SCC mix design requires an in depth knowledge of concrete mix design and materials, as well as consistently good constituents.

In conclusion, mention was made of the wide range of other admixtures that were available to change and/or enhance the properties and performance of concrete, including those for air entrainment, waterproofing, shrinkage compensation, acceleration, retardation and spray applications.

In each centre hosting the event, a local project featuring the modern approach to concrete mix design, application and use of materials was presented, and these were:

Durban Mahatma Gandhi Road Sewer Pump Station: Kendall Slater, Hatch Goba

Port Elizabeth Dedisa Peaking Power Plant, Coega: Campbell Moloi, Ansaldo Energia

Cape Town Portside Building: Cyril Attwell, Murray and Roberts

Johannesburg Electrical Cabins for Wind Farms: Justin Kretzmar, ISG Group

The afternoon session began with a fascinating look into the world of concrete research presented by Professor Elsabé Kearsley from the University of Pretoria. Delegates were exposed to the future of concrete with recycled aggregate; ‘green cement’; ultra-thin, high-strength concrete; ultra-thin, continuously reinforced concrete pavement; more appropriate test methods and specifications and centrifuge modelling.

The final session of the day was given to George Evans of PPC who, in his own inimitable style brought the various topics of all the presentations together into one and showing how good (but not perfect) concrete could be produced, consistently.

Good concrete, he concluded, is the result of good planning involving everyone in the chain. There is no such thing as perfect concrete he suggested - many well-designed concrete mixes are perfect for a given application, but some are better than others. Time will tell how durable the structure is, and therefore how good the concrete really is……. ▲

Members have their say!

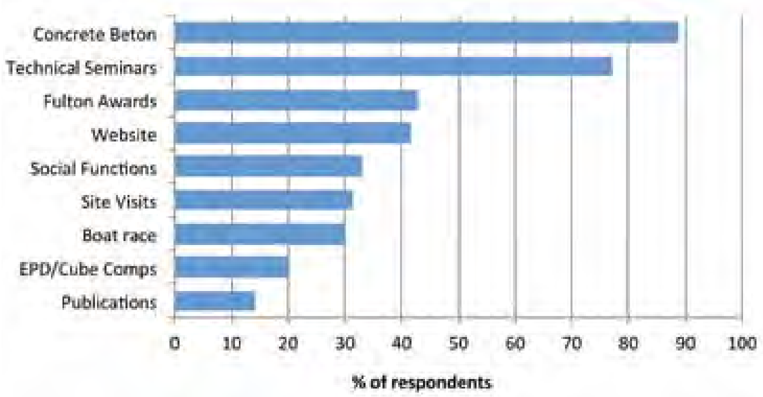
Compiled by John Sheath, CEO, Concrete Society of Southern Africa NPC

A couple of months ago members were asked to express their feelings through an electronic survey on various aspects of the activities of the Concrete Society. Response was a little disappointing (can only assume most of you are happy) at 10% of membership, but nevertheless the results gave us some insight into our current image and the value proposition that we offer.

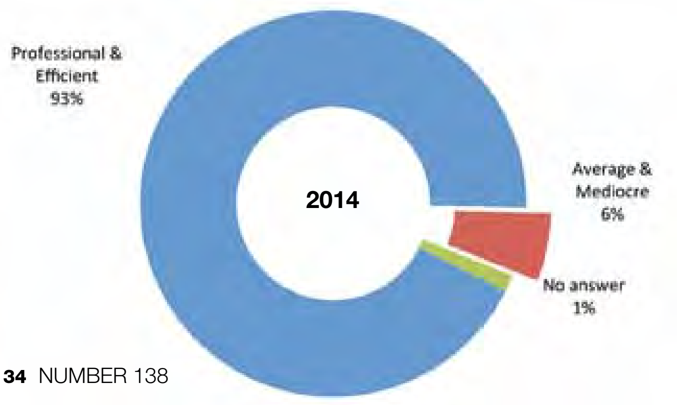
Naturally we will be using the results of this survey as a basis for future plans, but many of the suggestions are either not practical/viable, do not fit into our overall mission of promoting excellence in concrete, or are existing services offered by other organisations.

Some of the key findings from the survey are summarized here and where possible compared to the findings of the 2011 survey:

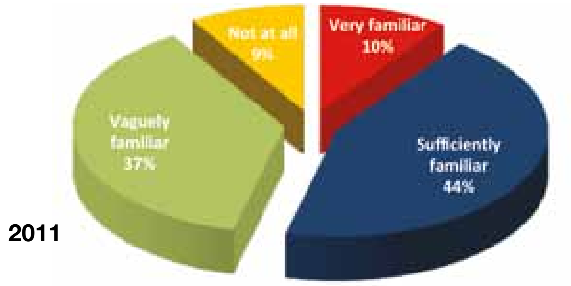
1. Concrete Beton and Seminars are used/attended by approx. 80% of members responding

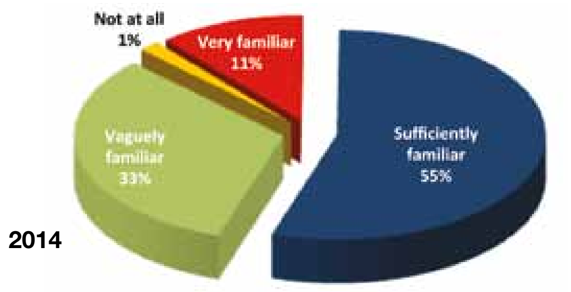


2. Nearly 70% of respondents have been members for more than 5 years
3. 93% of members see the CSSA as professional and efficient



4. Only 48% of respondents consider the CSSA as purely a technical organisation (73% in 2011). However, 36% of members see the Society as a combination of both a technical and marketing organisation
5. 66% of members believe they have sufficient or more knowledge of the strategy and direction of the Society. This still needs improving.





6. By far the majority feel that our image is best described by the words – Professional/Technical/Impartial/Proactive/Effective and Innovative,
7. Several of the suggested additional services are already provided by The Concrete Institute – e.g. advisory service, training and publications.

Verbatim suggestions that will be investigated further include:

- Assist persons in obtaining recognition for the work done in developing new types of concrete, greener concrete, smarter concrete
- A job and candidate listing facility (merely a listing facility with a 1-month auto expiry date for every listing to keep it current)
- Promoting/showcasing younger members in our industry to ensure sustainability for the Society (make this a special sponsorship opportunity)
- Maybe a basic concrete knowledge web page, or some kind of mind map of concrete, then attach all info from visits, meetings etc., to the mind map.
- CSSA should focus more on technical aspects and training of future engineers/technologists i.e. be more involved at tertiary institutions
- CSSA should increase the networking opportunities between the various groups in industry - bring Contractors together with specifying engineers and the suppliers to the industry.

- The interaction between students and industry seem to be taking a dominant role and appear to be the main spend in the CSSA budget. Balance needs to be restored between 'future' clients and current clients
- I would like to see a quarterly industry review where specialist analysts review the market and give their view on forecasts as well as driving factors within the industry.

8. Members responded very well to the request for topics they would like to see covered in future seminars. Some measure of consolidation of these will be necessary, but a summary is given below:

- High Performance Concrete (2)
- More precast seminars (2)
- Architectural/ Aesthetic Concrete
- More practical seminars on construction sites and practical problems with concrete
- Plaster and Mortar
- Concrete Technology Developments - concrete seminars for concrete technologist / specialists
- Modern admixtures. Their use and best application
- Worldwide trends in concrete. Site experiences from mega projects
- Concrete repair, rehabilitation and retrofitting. Concrete diagnostics (6)
- Using the SANS 10100 - workshop with worked examples (2)
- Design of fibre reinforced concrete
- Water retaining and excluding structures
- Green Concrete Practices
- Floor hardeners and coatings for industrial applications. Concrete Floor design
- Durability - Mix designs for and testing for (2)
- Concrete surface beds with fibre reinforcing and post tensioned (2)
- Presentations on relevant projects in the city, how concrete is changing the city, acceptance control
- Suitability of extended cements in the South African construction environment
- Open discussions on Portland Cement vs Activated Extender (slag and fa) Concrete vs Geo-polymer Concrete.
- A focus on environmental impact of each type of concrete, the carbon footprint of a given structure with each type of concrete, suitability of the concrete to placing and finishing conditions and long term sustainability of each type of concrete.

We thank all those members who contributed to this survey with their responses. CSSA remains a Society of individuals, and we will always listen to our members and their needs. ▲

The Western Cape Branch continues 2014 on a positive note

The Western Cape branch continues to provide interesting and thoughtful MTM's and we are pleased to report another three successful events held since our last report.

On the 29th of May we hosted a MTM by Prof. Mark Alexander of UCT and Steve Crosswell from PPC Cement with a very timely subject; ""Alkalis in concrete and developments in Western Cape Cements". Fortunately for us, there was another event running concurrently at UCT, which meant added exposure and attendance at this particular meeting – another opportunity of showcasing our passion for concrete and increasing awareness of branch activities!

Members at the UCT Lab Site visit

In June we hosted a site visit at the University of Cape Town laboratory – which is known as the "home of durability research". Durability index tests were demonstrated to all visitors by one of our Western Cape Committee members, Philemon Arito. Philemon led the visitors on a great show and tell expedition, from one small room where the machine is that tests the tensile strength in concrete to where the testing of water absorptivity takes place. One of his colleagues assisted him in showing the tests he does on piles with the help of his accelerometer testing machine.

Last but not least, in July Prof. Billy Boshoff from the University of Stellenbosch hosted a talk on "High Performance Concrete" – which covered the following topics: High Strength Concrete (HSC), Conventional Concrete (CC), Ultra High Strength Concrete (UHSC), Self Compacting Concrete (SCC), Strain Hardening Cement-based Composites (SHCC), Fibre Reinforced Concrete (FRC) and Geopolymer. Again, the meeting was well attended by our members, as well as a few non-members venturing to check it out.

The rest of 2014 is set to be just as informative and exciting with our annual cube-crushing competition setting off in September – the rules are slightly different and it promises to be an exciting event, with thanks to sponsorship from Lafarge.

We are also pleased that all of our MTM's have been acknowledged with CPD accreditation – which shows the content continues to be professional and relevant to the industry.

The annual cocktail function is to be held at the Grainger Bay Hotel school on the 20th November – don't forget to diarise the date!

The committee has also set up a Western Cape e-mail address for ease of management and consistency, so you can now reach all of our committee members on one email address: westerncapecssa@gmail.com – drop us a line if you have any queries about what we are up to.

Our committee members would like to thank industry and sponsors alike for their ongoing support of our branch activities and look forward to an even better 2015. ▲

KwaZulu-Natal Branch Chatter

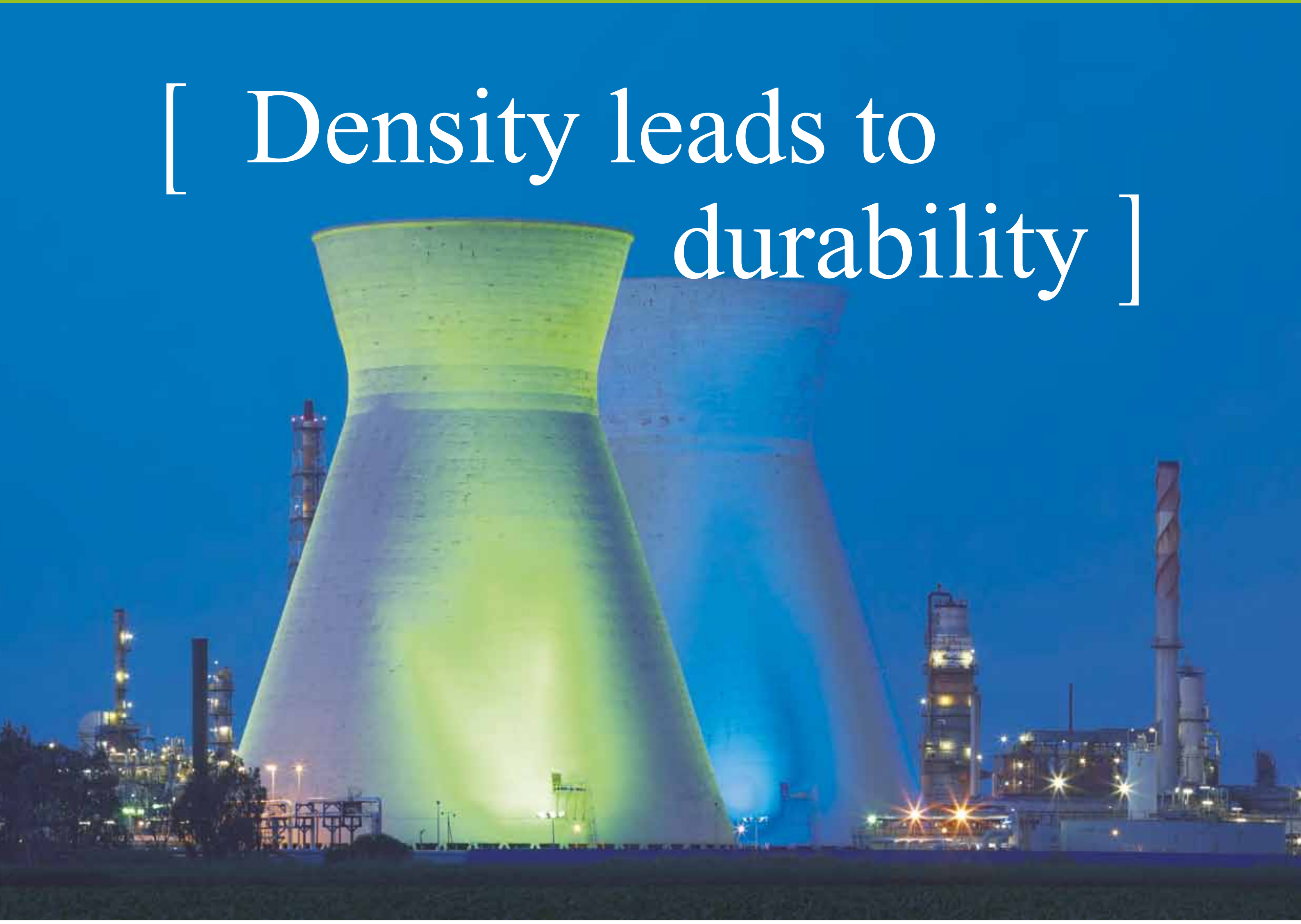
The national seminar ConSem 2014 - was run in KZN on the 23 June 2014. It was an excellent seminar and well attended by the KZN region. As usual we had an excellent selection of speakers – we are very lucky in South Africa to have access to such great speakers and experts in their fields.

On the 24 June 2014 we had a most interesting site visit to the Phoenix Waste Water Works. It was a very eye opening experience for those who attended, as well as a nose-holding in some cases. The working of the entire facility was covered.

The MTM on Spring Grove Dam was a look at the magnitude of such a large project, and the insight to mix design, placing, compacting and the entire process was very interesting.

Two more Monthly Technical Meetings with the topics of Bridge Launching and Spalling still lie ahead for October and November 2014. The Annual Egg Protection and Cube Competition are in August 2014 and what has to be one of our best events each year – the Garth Gamble Golf day is on the 12 September 2014, at Beachwood Country Club.

The committee of the KZN Branch look forward to seeing you at the above functions.


[Density leads to
durability]

Inland Branch presents concrete recycling

Concrete recovery or recycling is practiced in many countries, including South Africa, and the 60 delegates attending this Inland Branch seminar heard from industry representatives just how this was achievable.

The scene was set by Bryan Perrie, Managing Director of The Concrete Institute, who presented some very interesting facts about the amount of annual construction and demolition waste (C&DW) that was produced in various countries around the world (e.g. 510 million tons in Europe, 325 million tons in the USA and 77 million tons in Japan).

The presentation continued with a close look at the sources of concrete waste, and the applications to which this material could be put to use. It was clearly shown that there are significant benefits to recovering concrete waste material, but for high volume usage, there is a need for controls and site sorting; legislation is needed regarding C&DW in landfills, and the design of new buildings should in future consider reuse and recycling.

Calvin Billett

The next presentation was by Calvin Billett from Pronto Building Materials who described his company's experience with recycling waste concrete from readymix operations and recycling of waste foundry sand. Focusing on the use of waste foundry sand Calvin confirmed that this could be put to many good uses, e.g. as a plaster or building sand; as a foundry sand; as a filler sand in concrete/asphalt to increase the fattiness of the mix (quality/economics), and even as a lawn dressing.

There is a reluctance currently to recycle used foundry sand because firstly it is (erroneously) considered to be hazardous, consistent supplies are difficult to obtain, the fineness of the sand being used by most foundries does not lend itself to use in concrete and the principal of recycling is not generally supported by with the foundry or readymix industries.

However, in spite of all this, Pronto is successfully recycling foundry sand (albeit of a coarser grade) and data shown by Calvin on the mix design used illustrated that good quality readymix concrete can be produced on a continuous basis.

Calvin concluded by calling upon the foundry and concrete associations to take up the case for more use of recycled foundry sand and concrete with the relevant government department.

The seminar continued with a presentation by Les Stelling (Midserve Concrete Pumping) who described some of the equipment that was currently available for handling waste concrete. The highlight of this was the volumetric batching trucks which allow for on-site production of concrete and is uniquely different to the conventional "drum type" transit mixer. The components needed to engineer concrete - sand, stone, cement, water and admixtures - are loaded into separate compartments on the mobile batching plant.

Moving on to recycled concrete use, Les exposed delegates to the Lock-Block system which was devised 25 years ago by a professional engineer in Canada. The original idea was to create a massive precision dry-stacked engineered concrete wall unit that could be cast from leftover concrete right in the yard at a concrete plant. This has developed into a highly successful business producing and supplying concrete retaining wall blocks and traffic barriers.

Another company successfully recycling concrete waste is Echo Prestress (Pty) Ltd., and Monique Eggebeen, its Managing Director described in her presentation the process that had been adopted at their precast plant. An impact crusher broke the waste slabs (that had been manually broken down to approximately 50mm pieces of rubble), in a single pass and this material was then travelled to a vibrating double deck screen with a 0-6 mm passing for the sand and 6-9.5 mm passing for the stone. Reinforcing steel is recovered and resold.

The crushed concrete remains slightly pozzolanic due to the presence of some unhydrated cement in the material and the resultant crushed aggregate is very dry and has high angularity. The material also has higher water demand due to dryness and fines. A maximum of 20% of aggregate can be added to the concrete mix for "dry" cast products.

For standard wet and self-compacting concrete a higher percentage of waste can be added. Overall coarseness of crushed concrete requires a small percentage of finely graded plaster mix. For self-compacting concrete the percentage of fine plaster sand increases, to maintain the consistency of the design mix.

Monique confirmed that as a separate 'cost' centre in the organisation, it is possible to make positive returns in such an operation, especially when one can sell off the recycled material to third parties such as earthworks contractors.

The final presentation came from the CEO of the SA Institute of Foundrymen, John Davies. Metal foundries use large amounts of sand as part of the metal casting process. Foundries successfully recycle and reuse the sand many times in a foundry.

When the sand can no longer be reused by the foundry, it is removed and is termed "foundry sand".

John described to delegates why foundry waste (sand) should be used more by such industries as construction. It would conserve raw materials and energy; minimize pollution of soil, water, and air resources; turn waste into a valuable resource; reduce disposal costs and above all, improve competiveness of foundries in South Africa.

The Institute of Foundrymen is looking to the future and plans to market foundry wastes to end users; establish a Steering Committee (liaison, scientists, regulatory agencies, foundry representatives); educate stakeholders about metal casting: tour foundries; see wastes; discuss challenges; evaluate existing regulations and focus efforts; hold seminars, workshops, and demonstration projects.

His concluding remarks were "Think of foundry waste as a valuable by-product. Waste is not a waste if beneficially used". ▲

EVENTS CALENDAR

DATE	MEETING/EVENT	VENUE	CONVENOR
Inland Branch			
10 September 2014	Committee Meeting	Sephaku, Centurion	Andrew Schmidt
13 September 2014	Concrete Boat Race Day	Benoni Sailing Club, Homestead Lake, Benoni	Andrew Schmidt, Michelle Fick, Johan van Wyk & Tina Coetzee
09 October 2014	Committee Meeting	Chryso-abe, Jet Park	Andrew Schmidt
12 November 2014	Committee Meeting	To Be Confirmed	Andrew Schmidt
13 November 2014	Chairman's Breakfast	Blue Valley Golf Estate	Branch Committee Vice Chair
International			
14 - 16 September 2014	34th Annual Cement and Concrete Science Conference	Sheffield, England	Dr. Neil Lowrie
09 -11 October 2014	New Zealand Concrete Industry Conference	Taupo, New Zealand	Jeff Matthews
26 - 30 October 2014	American Concrete Institute Fall Convention	Washington DC, USA	William Gaspar
KwaZulu-Natal Branch			
September 2014	Event: Golf Day	Beachwood Golf Club	Andries Van Rensburg
October 2014	MTM: Bridge launching	University of Natal	Steve Schulte
November 2014	MTM: Spalling	University of Natal	Phil Everitt
Western Cape Branch			
September 2014	Cube Crushing Competition: Commencement/Casting	-	Riaan Combrinck
September 2014	Site visit: Group Five – Predator Tank at Two Oceans Aquarium	Two Oceans Aquarium	Jan Ellis/Jerome Fortune
October 2014	Cube Crushing Competition: Awards	-	Riaan Combrinck
20 November 2014	Annual Cocktail Function	Granger Bay Hotel School	Adrienne Taylor
National Office			
September 2014	Concrete Beton	Posted to all CSSA Members	CSSA
08 – 11 September 2014	Seminar Road Show: FloorSem 2014 The Ultimate Concrete Flooring Seminar	Durban, Port Elizabeth, Cape Town & Johannesburg	Seminar Committee
23 October 2014	Board Meeting	Johannesburg	CSSA President
31 October 2014	Membership Renewal Notices	E-mailed to all CSSA Members	CSSA Administration
November 2014	Concrete Beton	Posted to all CSSA Members	CSSA
30 November 2014	Closing Date for 2015 Fulton Awards Entries	-	CSSA Administration

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BRONZE

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Wacker Neuson (Pty) Ltd	Mr Rainer Schmidt	PO Box 2163 FLORIDA Gauteng 1710	011-672-0847	rainer.schmidt@wackerneuson.com
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2015 Fulton Awards

FULTON Awards 2015

Call for Nominations

The Concrete Society of Southern Africa NPC (CSSA) is calling for nominations of projects for the prestigious Fulton Awards, presented every two years by the Society to honour excellence and innovation in design and use of concrete.
We are proud to confirm that PPC Limited is the Anchor Sponsor for the 2015 Fulton Awards.

Definitions of the Entry Categories are as follows:

1. CIVIL ENGINEERING STRUCTURE:
A. Projects up to R 100 million in total value | B. Projects over R 100 million in total value

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

2. BUILDING STRUCTURE:
A. Projects up to R 100 million in total value | B. Projects over R 100 million in total value

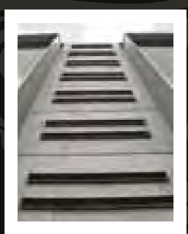
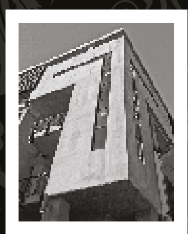
Projects where the Architect or a Building Works Project Manager is the Principal Agent or is the Project Manager or is the Lead Consultant heading the project team and where the Bill of Quantities and Contract Documentation is generally compiled by the Project Quantity Surveyor.

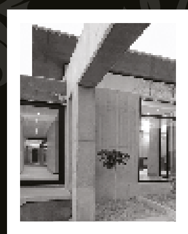
3. ARCHITECTURAL CONCRETE:
A. Projects up to R 100 million in total value | B. Projects over R 100 million in total value

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

4. INNOVATION IN CONCRETE:

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



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

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

Closing Date For Nominations: 31 August 2014

2015 Fulton Awards Anchor Sponsor