Concrete Beton

Number 127
March 2011

The Official Journal of
The Concrete Society
of Southern Africa

CONCRETE SOCIETY
OF SOUTHERN AFRICA

Platinum members:
AfriSam, PPC and Lafarge

Accredited Technical Paper:
The New South Africa
Loading Code SANS 10160

Fulton Award Winners:
O R Tambo
'Brune Bridge'

AfriSam
Build with Confidence

PPC CEMENT

LAFARGE


Preserving nature's
resource

President's Message

The start of a new year presents the opportunity to reflect on what has passed and contemplate what is to come in 2011.

The beginning of 2010 saw the handing over of the CSSA Presidency to John Sheath. And at the end of 2010 this was marked by the handing over of this role to me. Is the quick changeover indicative of its being a hot potato?

Amidst the staging of a successful 2010 FIFA World Cup, and weathering the storms of a worldwide financial crisis, the CSSA has been busy enjoying the success of growing company membership, which has moved us forward to the appointment of a full-time Chief Executive Officer – a first for many years now.

So 2011 will certainly be a year where we will build momentum for this new change. Last year was the culmination of years of hard work and debate through successive presidents.

The quick changeover was precipitated by the fact that John Sheath, 2010 President, has been appointed as the Society's new CEO, leaving the position of President vacant.

The council decided that I should fulfil this role for 2011 until the current Vice-President, Billy Boshoff, is able to take up the position in 2012 for the full two years.

After a successful FIFA 2010 World Cup and, for many, a slow start to 2011, we trust that optimism will return to the construction industry, as investors gain confidence in the ability of South Africa, and other African countries, to weather the financial storms.

We also hope that government will be able to build capacity and spend the millions allocated by Treasury.

What lies around the corner is the 2011 edition of the Fulton Awards, a bi-annual event showcasing the magnificent concrete projects either completed, or nearing completion, within the past two years. We are certainly looking forward to this event, which will be staged at the Champagne Sports Resort in KwaZulu-Natal, in June.

We are anticipating and hoping for a vibrant and exciting year ahead.

Nic van der Berg
President
The Concrete Society of Southern Africa

Cover: Ngqura Container Terminal Phase 1 in Port Elizabeth. The earthworks, roads and services consisted of 1 million cubic metres of bulk earthworks.

Homeleigh Pump Station

The Fulton Awards Construction Techniques commendation was awarded to Buffalo City Municipality for the construction of the 600 kℓ elevated tank at Homeleigh Pump Station.

Due to increased demand in the north eastern fringes of East London, the Buffalo City Municipality considered it opportune to provide elevated storage here. In 2005 they appointed CBM Africa Consulting Engineers to undertake the design and oversee the construction of this facility.

It was evident from the outset that aesthetic considerations in the selection of the shape and form of the structure were of paramount importance. The structure had a design storage volume of 600 kℓ, with a bottom water level of 30 metres, above natural ground.

It became clear that reinforced concrete was the construction material of choice for the following reasons: It had the flexibility required to construct the shape and form. Cost effectiveness, coupled with durability and low maintenance were key design considerations.

Afristruct Projects commenced work on the site in mid February 2006 and indicated that they were considering a unique construction method, namely to precast the bowl at a low level, lift it into its final position and tie it into the cast in situ structure monolithically. This was in order to reduce the large volumes of staging required when the bowl is conventionally cast in situ in its final elevated position.

This decision resulted in design and detailing changes to the following structural elements: The lower edge of the bowl – the 650 ton bowl was suspended by four lifting strands and the associated bending and shear was accommodated in a thickened edge beam. A lifting platform was incorporated to the top of the structure that became part of the roof element on completion. The lifting platform cantilevered out from the 2,1 metre shaft and supported four 350 ton jacks during lifting.

Changes were also made to the roof slab to enable it to be cast integrally with the bowl at ground level prior to lifting. The stem to bowl transition was also strengthened substantially and a detail was developed using high strength threaded bars to anchor the bowl into the cast in situ stem.

The lifting of the bowl to the structure is unique in South Africa for the following reasons. This was the third lift in South Africa at the time, but it still remains the heaviest single lift at 650 tons. While the other lifts in the country have made use of temporary structural members to support the lifting jacks, this lift used structural elements designed and constructed specifically for the lifting but then incorporated into the final structure.

During the lift a 16 channel data logger was used to give instantaneous readouts of jack pressure and extension, in order to ensure that adjustments could be made to the lift to meet all possible eventualities.

Concrete has shown itself to be an extremely versatile material, not only in meeting the demand for a complex form but also in accommodating the unique construction method. In this instance it is no cliché to say that concrete really did rise to the occasion.

The project team includes contractor: Afristruct Projects; subcontractor: Wilson & Pass Inc and Freyssinet Posen; the principal agent: CBM Africa and the client: Buffalo City Municipality.

Judges' Citation

The judges were particularly impressed by the insightful and innovative proposal by the contractor to 'heavy-lift' the concrete bowl, which would be precast at a lower level, in order to overcome problems of staging availability and construction cost experienced at the time.

The size of this particular lift being an apparent record in South Africa, construction procedure is also worthy of special note.

This project bears witness to good communication and co-ordination between the contractor and the design engineer in order to achieve a highly successful and inspirational end result.

O R Tambo

The R2-billion Central Terminal Building project at the O R Tambo International Airport is an imposing landmark at Africa's busiest airport. The Kempton Park building sets a new benchmark for design efficiency, functional flexibility and construction quality. The terminal, which has been built between the international and domestic terminals at the airport, forms the central link between these terminals, as well as linking with the multi-storey parking garage and the new Gautrain station.

Although different structural systems for the terminal were investigated, the architectural requirements for large open concourses and public areas to accommodate the periodic influx of large numbers of passengers, led to the choice of a 15 m x 15 m concrete column grid. With further constraints imposed by the adjacent floor levels and floor plate thicknesses, the most economical and flexible structural frame proved to be a post-tensioned coffered floor system, supported by predominantly unbraced concrete columns. The inherent durability of concrete, together with the aesthetic appearance of off-shutter concrete and the limitless forms and shapes that concrete can be moulded into, were some of the added benefits of using concrete as the primary structural material.

One of the special features of the structure was the use of intricate 3 m x 3 m x 2,7 m deep column heads that were used to split combined columns in the basement into multiple columns that support floors from the ground floor (or arrivals level) upwards. These split columns were used to maximise the space available for the baggage handling facilities in the basement.

The structural design used two-way spanning post-tensioned coffered slabs. This combines the weight-saving features of coffered slabs with the reduced reinforcement requirements of post-tensioned slabs. Although the use of coffered slabs and post-tensioned slabs are fairly common in South Africa, the use of these two technologies in combination is unusual. In this instance, it was the optimal solution to accommodate the combination of

large spans, limited structural depth and high permanent loads on the slabs. The huge oval atrium of approximately 50 m x 40 m above the central concourse area on the arrivals levels is the focal feature.

The architects made innovative use of the atrium to marry the different floor levels, north and south of the atrium, with a variety of ramps, stairs, and lifts. Four huge off-shutter Y-shape columns form the key elements of the atrium and provide primary support to the atrium roof. The client, Airports Company South Africa, felt strongly that the terminal should be well lit with natural light. The architects therefore used sophisticated modelling software to create a design that ensured maximum sunlight that would

Judges' Citation

The mere fact that this technically complex project was executed within such tight physical and time parameters is exemplary. The architectural and structural engineering coordination appears to have been well resolved at an early stage, resulting in a crisp, well conceived and well constructed project.

The use of a high quality off-shutter concrete on various structural elements to produce significant aesthetic features which complement the modern architectural style, has significant merit.

The successful use of post-tensioned, two-way spanning concrete coffer slabs of very long spans to accommodate the basement for baggage handling equipment, is significant.

The judges were also impressed with the feeling of openness that has been achieved within the building.

This remarkable project provides a valuable and long needed facility for travellers to and from South Africa and provides an impressive gateway to visitors.

This is a project that all South Africans can be proud of.

penetrate the central atrium void for most of the day throughout the year.It is a superb example of the innovative use of concrete as a functional, aesthetically striking structural solution, designed and built by a dedicated team of professionals.

The team included: main contractor: CTP Joint Venture and subcontractor Bentel Associates, David Langdon and Farrow Laing; and principal agent OLA Joint Venture. The project was submitted by Africon in the Fulton Awards 'Building Project' category.

The New South African Loading Code SANS 10160

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ABSTRACT: Design standards play a key role in the process of structural design and construction. The loading code often plays a leading role in establishing design procedures, such as limit states design, in addition to the specification of *minimum loads*.

This is the case of the present South African Loading Code (SA LC) SABS 0160:1989. Following Eurocode practice of a separate standard to establish *the basis of structural design*, the new SA LC SANS 10160 formally introduces such a head standard for structural design (Part 1) in addition to updated provisions for the scope of loads treated in SABS 0160:1989 (self-weight, imposed, wind, seismic and crane loads). It includes the introduction of new load types from Eurocode (geotechnical, thermal actions and actions during execution). The paper provides an outline of SANS 10160, its relation to the previous SA LC, reference to and compatibility with Eurocode, and the way in which local conditions and practice are taken into account.

1. INTRODUCTION

The current South African Loading Code SABS 0160:1989 (referred to subsequently as SABS 0160 for brevity) introduced a new generation of structural design standards to the country and region. It is used together with various other materials-based standards for the design of concrete (SANS 10100), steel (SANS 10162), timber (SANS 10163) and masonry (SANS 10164) structures.

At the South African National Conference on Loading in 1998 (SA-NCL) the need for an update of the SA LC was identified (Day & Kemp 1999). The SA Institution of Civil Engineering Working Group on the SA Loading Code was launched in 1999. The guiding principles derived from the 1998 conference were to update load provisions whilst maintaining compatibility with materials-based codes and enhancing harmonisation with international practice. The main effort went into a critical review of the various provisions for minimum loads.

The 1998 conference showed the inconsistencies between SABS 0160 and the voluntary version of Eurocode ENV 1991, which inhibited the use of ENV 1997 for geotechnical design in South Africa. In an effort to convert Eurocode into a normative European standard (EN 1990 – EN 1999) it became clear that South African practice for load combinations was consistent with one of the options allowed in EN 1990, as so-called Nationally Determined Parameters.

This Eurocode development removed a critical inconsistency between a major programme for the development of structural design standards in Europe and South African practice. The door was therefore opened, not only for geotechnical design but also for accessing the wealth of information coming from the Eurocode programme in the revision of the SA LC.

Pilot investigations were first performed to consider the application of the Eurocode standards and parts for imposed loads, wind and crane induced actions, with limited consideration of the basis of structural design. At the same time it provided an opportunity to perform an extensive assessment of the characteristics and merit of Eurocode standards, particularly with reference to the scope of SABS 0160. The pilot survey confirmed the advances achieved by the development of Eurocode through its various stages as a draft standard (1980's), voluntary standard (1990's), normative standard (1998+) and now in the process of being implemented as national standard (2005+) by member states. The time scale of development is also indicative of the extensive scope of Eurocode, difficulties with harmonisation amongst the practice of member states, and unification between the ten standards consisting of 58 parts, with vital input to be provided in the national annex for each part by each member state.

The complexity of the Eurocode set of standards and the specific needs for a South African loading code implied the need for a systematic process, based on clearly defined guidelines for the formulation of the SA LC, as opposed to merely 'adopting' the Eurocode.

2. DEVELOPMENT OF SANS 10160

The development of SANS 10160, within the context of the Eurocode, required a proper formulation of a reference base for the process. This was done in the context of the purpose and function of SANS 10160 and provision for local conditions and practice. It required an extensive assessment of the Eurocode in general, with specific attention to the relevant standards and parts. The process can be considered as an optimisation of the scope of SANS 10160 within the wealth of advances captured in the Eurocode.

Attributes of Structural Design Standards

Structural design standards usually develop through an iterative process of updating and improving a current standard, for which substantial experience has been gathered. When a new generation of standards is introduced, however, it is necessary to consider the function of the standard, and consequently the objective with its development. Such requirement applied to the formulation of SANS 10160. The following attributes of a structural design standard have a decisive influence on its formulation: Regulatory function in setting safety requirements by authorities; Statement of acceptable design practice as expressed by the profession; Role and function of the specific standard in relation to other design standards; Scope of application of structures provided for Scope of contents of design procedures included (comprehensive versus selective; standard practice versus advanced procedures).

These attributes are determined by the primary sponsors of the structural design standard, who take responsibility for its development, use and maintenance. Such ownership is traditionally taken by regulatory authorities, industry groups, or the engineering profession.

Responsibility for the South African Loading Code is taken by the engineering profession, with some support given by industry groups for the various materials-based design standards. In contrast, the development of the Eurocode, which is sponsored by the European Union, is an instrument to promote a European-wide construction industry, without trade barriers (CE 2002). These differences in sponsorship and ownership result in important differences in the attributes of the respective standards.

Reference Base for SANS 10160

The principal objective for the development and ultimate use of SANS 10160 is to assist design practitioners in discharging their professional duties, of ensuring public safety; to clients in designing economic structures, and to the profession in providing effective and efficient procedures. The scope of structures is limited to building and similar industrial structures, which form the bulk of general design practice. Provision is not made for advanced structures or specialist design procedures.

This is in stark contrast to the Eurocode, which covers the comprehensive scope of structures for buildings and civil engineering works. It includes the full complement of conventional structural materials. It provides for the wide range of environmental conditions amongst its member countries, and has the objective to maximise harmonisation amongst the diverse traditions of structural engineering and construction practice.

An important feature of the Eurocode is that allowance has to be made for the requirement that safety falls under the national jurisdiction of member states. The formulation and layout is complicated by the need to provide for the Nationally Determined Parameters (NDP), which is captured in a National Annex for each of the fifty-eight Parts of the ten Eurocode Standards EN 1990 to EN 1999!

At the same time such provision for adjustment allows for the formulation of SANS 10160, such as to fully provide for local conditions and practice, whilst maintaining harmonisation and consistency with the Eurocode, which is equivalent to that of member states.

A reference base for the development and formulation of SANS 10160 evolved from the two primary sources (i) the current SA Loading Code SABS 0160 and the directives for its revision expressed at the 1998 conference (ii) the relevant Eurocode standards and parts as they were converted into normative European standards. A constraint is that the institutional framework, design and construction practice and environmental conditions applicable to SABS 0160 have essentially been maintained.

Reference to SABS 0160

The reference base of SABS 0160 is essentially maintained in terms of its role and function in structural design practice as follows:

Scope of structures: Buildings and similar industrial structures; including buildings with crane support structures as an important class. Design verification method: The use of reliability-based partial factor Limit States Design (pfLSD)

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Professor Peter Dunaiski is Vice Dean: Teaching and Professor in Structural Engineering at Stellenbosch University. His field of interest is in structural steel with specific interest in experimental techniques. Dunaiski has taught structural engineers at postgraduate level over many years and he manages an active research programme in the field. He was a member of the SAICE Working Group on the SA Loading Code, championing several parts of SANS 10160, and is the chairperson of the SABS TC59 Sub-Committee 59I 'Basis of structural design and actions'.

Acknowledgement

The authors would like to acknowledge the contributions of Working Group members and to dedicate the paper to the late Professor Alan Kemp.

This paper was submitted prior to the publication of SANS 10160 in 2010.

procedures are maintained. Range of loads: Provision for self-weight; imposed loads for floors, roofs and partitions; wind loads; seismic loads and design were maintained from SABS 0160, with updates to incorporate recent development

Scope of procedures: The procedures are primarily directed towards general design practice for standard structures.

Materials-based standards: Consistency with current materials-based standards has to be maintained. The onus is placed on standards still using allowable stress design to make the necessary adaptations.

Reference level of reliability: The present level of reliability is judged to be appropriate due to the absence of any evidence that it is insufficient, (Milford 1988, 1998), and found to be similar to American practice and provides the basis for maintaining consistency with materials-based standards.

A number of deficiencies in SABS 0160 were identified at the 1998 conference, requiring particular attention during the revision process:

Wind loads: The SABS 0160 procedures for wind loads are based on outdated models, which require a substantial revision. Seismic actions and design: The seismic design procedures had no credibility amongst designers in the seismic regions of the area, requiring critical re-evaluation.

Geotechnical design: There is substantial inconsistency between structural and geotechnical design practice in the design of foundations.

Technology base: Although there is an extensive experience base for structural design, constraints on resources limit the systematic capturing of such experience. Similarly research capacity is limited to the investigation of specific topics, rather than the comprehensive development and calibration required for code development.

Eurocode as Technology Base

Reference to the Eurocode was identified not only as remedy to the deficiencies identified in SABS 0160 but also as a potential technology base, for a revised SA Loading Code and beyond. The advantages of using the Eurocode as a technology base for SANS 10160 includes the following:

Advanced standard: Eurocode represents the compilation of a set of standards, which incorporates the most advanced procedures from its member states, supported by extensive research over several decades. The advances include, for example, the introduction of a head standard to define a common reliability-based basis of design, advances in structural fire design, provision for advanced materials such as high performance concrete. International harmonisation: A high degree of harmonisation has been achieved, whilst remaining deficiencies can be clearly identified and assessed.

Comprehensive standards: The scope of application is comprehensive in terms of structures, materials, conditions and relevant procedures. Internal consistency in design is achieved across the range of structures from buildings through bridges, reservoirs, towers, structural steel to geotechnical design; from self-weight to earthquake loads. Range of conditions: Environmental conditions range from the cold Nordic countries to the Mediterranean; institutional conditions range from member states, where design standards are part of the law, to situations similar to that of South Africa.

Principles for Reference to the Eurocode

The principles followed in referencing SANS 10160 to the Eurocode consisted of the following:

Selection of Eurocode Parts: All the Eurocode Parts relevant to the combination of the scope of buildings and SABS 0160:1989 were considered. This implied the extension of the SABS 0160 scope and consideration of nine Parts from EN 1990, EN 1991, EN 1997 & EN 1998. Only the sections and procedures relevant to the scope of SANS 10160 were utilised.

Consistency with the Eurocode: Full consistency with the Eurocode is maintained, providing for incremental extension of SANS 10160 or the introduction of other standards from the Eurocode.

Format, layout and style: SANS 10160 is compiled into the format of SA standards, including a compact layout (as opposed to the elaborate Eurocode formulation to allow for NDP options with a separate National Annex).

Reliability levels: Due to the wide tolerances of reliability allowed by the NDP options, the current reliability levels could be maintained for SANS 10160 whilst achieving consistency with the Eurocode within the restricted scope of application.

Standard level of practice: Advanced procedures from the Eurocode were considered to be beyond the scope of SANS 10160. In a few cases, procedures taken over from the Eurocode were simplified. Sufficient consistency was however maintained to allow for the use of advanced Eurocode procedures locally by specialists (e.g. dynamic effects of wind loads).

Provision for local conditions: The general Eurocode procedures were used for local environmental conditions to determine appropriate representative values for wind, temperatures and seismic ground movement.

3. COMPILATION OF SANS 10160

Steps in the compilation of SANS 10160 consisted broadly in the formulation of each topic, consisting of the basis of design and the selected class of action. In addition to the consideration of the reference material from SABS 0160 and the Eurocode and related background information, other international standards were also consulted. In selected cases calibration exercises were complemented by research projects which ran parallel to the standards development programme.

Layout of SANS 10160

Due to the self-contained nature of the various actions compiled together as the new SA Loading Code SANS 10160, the respective topics are structured as eight independent parts.

The standard can, however, only be used as an integral design standard and is consequently published as a single document.

Reference of SANS 10160 to the Eurocode

The main updates and extensions applied to the respective SANS 10160 Parts, as based on the Eurocode, consist of the following, limiting in every case the sections and procedures to those relevant to buildings:

Part 1 Basis of structural design: A separate Head Standard is introduced to establish the basis of structural design from EN 1990. Procedures for the treatment of accidental design situations, including requirements for structural robustness, are extracted from EN 1991-1-7.

Part 2 Self-weight and imposed loads: Occupancy classes specified and new classes of imposed loads are introduced from EN 1991-1-1. Characteristic values are established from independent surveys.

Part 3 Wind actions: Procedures for the calculation of wind actions and the extensive set of pressure and force coefficients are based on sections relevant to buildings from EN 1991-1-4. Free field wind velocities and profiles, based on terrain roughness are modified from SABS 0160 information.

Part 4 Seismic design and actions: The format of EN 1998-1 and some procedures form other international standards are used to modify SABS 0160 procedures. The map giving ground acceleration across the country is updated.

Part 5 Geo technical basis of design and actions: A new standard is introduced from EN 1997-1, considering also requirements specified in EN 1990 for geotechnical design within the scope of SANS 10160.

Part 6 Actions induced by cranes and machinery: The SABS 0160 procedures for crane induced actions are replaced by that from EN 1991-3; new procedures for actions induced by harmonically rotating machinery are introduced with modifications from EN 1991-3.

Part 7 Thermal actions: Provisions for thermal actions are introduced from EN 1991-1-5, including maps for characteristic maximum and minimum temperatures extracted from the TMH-7:1981 procedures for bridge design.

Part 8 Actions during execution: Procedures for this critical stage in the life of a structure are introduced from EN 1991-6, incorporating only sections relevant to buildings.

The special case of an accidental design situation, which provides for actions on structures exposed to fire, is treated in EN 1991-1-2. Such actions are however not included in SANS 10160.

This important category of action requires the availability of unified provisions for materials-based design procedures, in the Eurocode.

This topic is deemed to satisfy rules in the materials-based standards. Inclusion of provisions for actions due to fire would require co-ordinated development with these standards.

Although there are substantial differences between the Eurocode and SANS 10160 in layout and format, scope of application and procedures.

These differences are directly related to distinctions in institutional, regulatory, environmental and technical conditions of the two regions.

Substantial harmonisation and consistency of SANS 10160 with the Eurocode is being maintained, to the extent that SANS 10160 can be considered as a specific subset of the Eurocode.

SANS 10160 Parts in Relation to the Design Process

The relationship between the respective SANS 10160 Parts and in relation to the materials-based standards is shown schematically in Figure 1. Part 1 applies not only to the actions on buildings, the geotechnical design of foundations and the design for earthquake resistance, but also to the limit states requirements for the materials-based design standards.

Background Report

Since SANS 10160 represents a substantial revision of SABS 0160, proper substantiation of the changes and additions is required. A Background Report has thus been produced to capture the main sources and references; considerations and assessments; decisions and motivations applied in the formulation of SANS 10160 (Retief & Dunaiski 2009). The background information should primarily be considered when SANS 10160 is evaluated for acceptance into design practice by the profession. The Background Report should also serve as the point of departure for its inevitable future revision and updating.

Due to the close link between the Loading Code and the respective materials-based standards for structural design, viz. structural concrete, steel, timber and masonry, the Background Report also serves to validate the use of SANS 10160, with the present materials standards through the demonstration of how consistency between SANS 10160 and SABS 0160, has been maintained. Background on the basis of design also provides important information for the future revision of materials-based design standards or even the introduction of new standards, particularly for related geotechnical design.

4. OUTLINE OF SANS 10160

A brief outline of the main features of SANS 10160 and its various Parts are provided here, as extracted from the Background to SANS 10160 (Retief & Dunaiski 2009).

Part 1 Basis of structural design

Part 1 serves as a general standard to specify procedures for determining actions on structures and structural resistance in accordance with the partial factor limit states design approach. The requirements and procedures are formulated to achieve acceptable levels of safety, serviceability and durability of structures, within the scope of application of SANS 10160.

Procedures for the basis of structural design include: requirements for the specified minimum values for actions on structures presented in SANS 10160-2 to SANS 10160-8; the determination of design values for the effects of combined actions on the structure under a sufficiently severe and varied set of limit states; general requirements for sufficient structural resistance reliability to which the related materials-based design standards should comply.

Part 1 provides a proper reliability framework, which applies not only to actions and their combinations, but also to the resistance as specified by the materials-based standards. The reliability framework consists of extended limit states and associated design situations, reliability classes for buildings, and guidelines for reliability management related

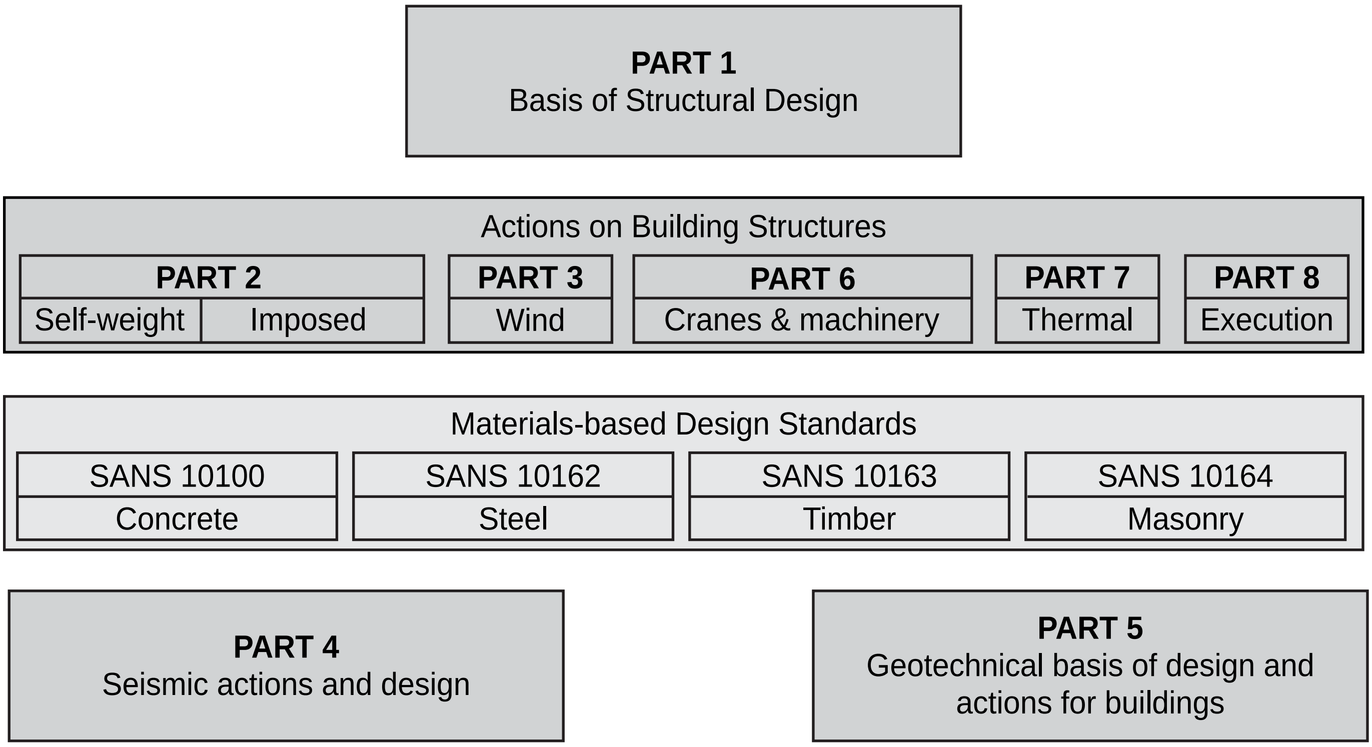

Figure 1 Schematic view of the relationship of SANS 10160 parts and materials-based standards

to quality management. Specific new developments include requirements for the treatment of accidental design situations, design for robustness, the use of design assisted by testing and improved serviceability criteria. International harmonisation is improved through consistency of Part 1 with ISO 2394:1998 and EN 1990. Extensive reliability calibration was implemented, as reported in Retief & Dunaiski (2009), see also Holický & Retief (2005) Holický et al (2007).

Part 2 Self-weight and Imposed Loads

Part 2 presents procedures for the treatment of self-weight and imposed loads on buildings. Procedures for determining self-weight of structural and non-structural materials as permanent loads are given, including recommended values of material densities.

Minimum characteristic values for imposed loads as variable actions are given for loads on floors, as a function of the occupancy and use of the building, for imposed roof loads and horizontal loads on balustrades and partitions.

The specification of actions due to self-weight for buildings from EN 1991-1-1 has generally been maintained in SANS 10160-2, with the main difference being the simplification of the requirements due to the scope of SANS 10160 being limited to buildings.

Extended tables of densities are provided in an informative annex. The most important way in which SANS 10160-2 refers to EN 1991-1-1 for imposed loads on building structures is to follow its layout format, and to introduce a number of imposed load mechanisms, particularly relevant to industrial buildings and processes such as helicopter landing pads on top of buildings. Imposed load values are based on extensive comparisons (Retief & Dunaiski 2009, Retief et al 2001). Provisions for imposed roof loads differentiate between execution and sustained conditions (Retief & de Villiers 2005).

Part 3 Wind Actions

Part 3 covers procedures for the determination of actions on land-based structures due to natural winds. The scope of application is limited to the general type of buildings and industrial structures (in line with the scope of SANS 10160) and is restricted to structures for which wind actions can be treated as quasi-static. For wind sensitive structures the procedures given in EN 1991-1-4 may be used. The calculation of the wind pressure is based on the 10 minute mean wind speed representative of the mature frontal wind experienced in the coastal regions of South Africa. The application of an appropriate gust factor makes provision for thunderstorms and wind climate of the interior of the country. Provision for strong winds generated by thunderstorms (Goliger & Retief 2002) required careful consideration (Goliger 2005). Research on the strong wind climate of South Africa is continued (Kruger et al 2008, 2009). The exponential pressure profiles for wind speed with height are maintained, based on an improved definition of terrain categories. The much more detailed procedures for calculating the wind pressure on building surfaces are based on recent wind tunnel testing.

Part 4 Seismic Actions and General Requirements for Buildings

Part 4 covers earthquake actions on buildings and provides strategies and rules for the design of buildings subject to earthquake actions. Provisions for actions on structures exposed to earthquakes are revised and updated (Wium 2006). The specification of seismic design of standard structures is extended, but procedures are restricted to situations where principles of proper layout and detailing are complied with, requiring the application of advanced procedures for situations beyond the scope of SANS 10160-4.

Part 5 Basis of Geotechnical Design and Actions

Part 5 represents an extension of the scope of SANS 10160 to set out the basis for geotechnical design and gives guidance on the determination of geotechnical actions on buildings and industrial structures, including vertical earth loading, earth pressure, ground water and free water pressure and actions caused by ground movement.

Procedures are given for determining representative values for geotechnical actions. The main advantage achieved by these new Provisions is that (i) consistency between geotechnical and structural engineering practice has been achieved and (ii) that EN 1997 Geotechnical design can be used in local practice. The development of Part 5 was supported by extensive assessment and research (Dithinde 2007; Dithinde et al 2009).

Part 6 Actions Induced by Cranes and Machinery

Part 6 specifies imposed loads associated with overhead travelling bridge cranes on runway beams at the same level; and also actions induced by a limited range of stationary machinery causing harmonic loading.

The standard includes improved provisions for crane induced actions by the introduction of new models based on the mechanics of the movement of the crane and proper specification of the combination of actions (Dymond et al 2006). Partial load factors for crane-induced actions are based on extensive calibration (Dymond 2005).

Part 7 Thermal Actions

Part 7 introduces new procedures that cover principles and rules for calculating thermal actions on buildings, as well as their structural elements.

Its main features are to introduce provisions for thermal actions based on the South African climate, including the classification and representation of actions, the determination of temperatures and temperature gradients in buildings.

Part 8 Actions during Execution

Part 8 introduces new procedures that cover principles and general rules for the determination of actions, which should be taken into account during the execution of buildings.

Its main features are to introduce provisions for actions on structures during execution of the construction works, including actions on the partially completed works and temporary structures.

It consists of procedures for the identification of design situations and representation of actions and their effects on the incomplete structure, considering all activities carried out for the physical completion of the work, including construction, fabrication and erection. The code stipulates the normative requirements of ensuring the safety of the structure during all stages of construction.

The allocation of responsibilities must be determined through contractual agreements between all parties involved.

5. CONCLUSIONS

The introduction of the new SA Loading Code SANS 10160 should have a significant impact on structural engineering practice. Existing procedures and load models have been updated and extended and new procedures have been introduced. The extensive reliability framework provides for wide ranging conditions and performance classes which should lead to structures with improved fitness for purpose. The following general conclusions can be drawn from the process of the development and compilation of SANS 10160 (Retief & Dunaiski 2009).

SABS 0160 as SA Loading Code: The essential properties of SABS 0160 as the South African Loading Code for the design of buildings and similar industrial structures have been maintained. This includes maintaining the present levels of structural performance, although allowance is made to improve its consistency.

An important consequence is that consistency of SANS 10160 with the present materials-based design standards has been maintained.

Specified procedures: Provision for actions that were specified in SABS 0160 were substantially overhauled and updated. Important additions that have been made to SANS 10160 include a number of design situations and actions, the formal treatment of the basis of structural design, and a unified treatment of geotechnical design, and its interface with structural design.

The Eurocode and international harmonisation: the Eurocode was used as reference to SANS 10160, and thereby provided access to an extensive source of information, structural engineering technology and experience.

Most important however, is the extensive scope of structures, conditions, materials and practices across which the Eurocode succeeded in achieving consistency and unification. Much effort was spent to marry the comprehensive nature of the Eurocode with the specific needs of a South African Loading Code.

From a South African perspective, a degree of international harmonisation has been achieved that went well beyond initial expectations. From a Eurocode perspective, SANS 10160 represents one of the first applications of the Eurocode principles beyond its group of Member States.

This opens the door to future cooperation and the use of Parts of Eurocode in situations where there is no equivalent South African code. It also contributes concretely to the extended application of the Eurocode as a reference to other South African structural design standards.

The development of SANS 10160 provided the opportunity to do wide range supporting research, investigations and calibration which provides a solid knowledge base for its future use.

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Western Cape

The Western Cape Branch held a number of interesting and successful events over the past eight months.

Bryan Perrie, Managing Director of the Cement & Concrete Institute, presented 'Concrete – It is greener than you think' providing some interesting facts. Dr Manu Santhanam, from the Indian Institute of Technology, Madras, presented 'Concrete Developments & Trends in India'. Members were given an insight into trends and mega projects in India.

Professor Viktor Mechtcherine

The Annual Concrete Cube Competition, sponsored by AfriSam, was held on October 21st at the University of Stellenbosch. The aim was to achieve the highest possible ratio of 28 day cube strength divided by the cube mass squared. Students from UCT dominated the final results, taking first, second and third places respectively, Bruno Salvoldi's ratio was 25.35; Azni November's ratio was 21,57; Mike Otieno's ratio was 21,34; and non student Charles May took fourth spot with a 23,08 ratio.

In October, Phil Smith from PRDW Consulting Engineers presented a Technical Meeting and gave an overview of the Widening of Durban Harbour. On November 10th at the University of Cape Town Professor Bo Westerberg from Sweden presented, 'Design of concrete structures according to Eurocodes'.

The Annual Cocktail Party was held on November 11th at the CPUT Hotel School, in Granger Bay. The event was sponsored by PPC and David Grier, an inspirational speaker, celebrity chef and extreme adventurer, shared his most recent fund-raising adventure, the first ever joint continuous run of the Great Wall of China, some 4 000km in 98 days!

The New Year started with the branch Annual General Meeting on February 17th. Professor Viktor Mechtcherine, an internationally renowned researcher from the Technical University of Dresden in Germany, was the guest speaker. The presentation gave an overview of recent advances in concrete materials. Attention was directed to new types of fibre reinforced concrete such as strain-hardening cement-based composites and textile reinforced concrete as well as the application of super absorbent polymers as multipurpose additive for concrete construction. The 2011/2012 committee members are Chairman: Etienne van der Klashorst; Vice Chairman: Elsje Fraser; Past-chairman: Dr Billy Boshoff; Treasurer: Christo Adendorff: Secretary: Paul Zietsman and members: Dr Hans Beushausen, Kevin Kimbrey, Joseph Mofokeng, Jerome Fortune and Riaan van Dyk.

Student participants in the Cube Competition

From the CEO's desk

I have now almost completed my second month as CEO of the Concrete Society, and there certainly hasn't been a dull, or quiet, moment. In fact I am writing this message at Cape Town airport having just spent the last two days with the President of SAICE, Seetella Makhetha, judging the local Fulton Awards entries.

The Western Cape region submitted seven projects out of a national total of 31, a near record number of entries for the Fulton Awards ranging from 'wavy' concrete roofs on a house at the foot of Table Mountain to world class stadia such as the Green Point Stadium in Cape Town and the Peter Mokaba Stadium in Polokwane.

Reading the excellent submissions of the entries in hard copy nowhere near gives one the feel for the scale and intricacies of some of the projects already seen, and I thank Nick van den Berg, our President, for giving me the opportunity to be part of the adjudication team.

A huge thank you to all those members who diligently completed the survey questionnaire recently circulated – we had almost a 20% return rate, which in research terms, is far better than average. Once the data is consolidated and analysed members will be provided with a summary of the findings and details of actions we as a Society, need to take in order to meet your needs.

We are shortly embarking on our Durability Seminar roadshow and by the time you have read this, we hope that a successful round of seminars would have been completed. Certainly judging from the response that we have received for attendance, greatly assisted by SANRAL, I might add, this is a very topical and important aspect to concrete, that engineers in particular are keen to learn more about. I hope you enjoy this edition of first Concrete Beton of 2011, and as previously indicated; your comments on the publication, positive or otherwise, would be well received.

Yours in concrete,

John Sheath
Chief Executive officer
Concrete Society of Southern Africa

Structural repairs to Bridge

Fulton Awards Special Category Repair and Maintenance Project commendation was awarded to the 'Brune Bridge', which spans the Olifants River.

Bridge BN998, nicknamed the 'Brune Bridge' is located on road P120/1, approximately 15 km south east of Witbank, en route to Kriel, in Mpumalanga. The 90 m long reinforced concrete structure constructed in 1950 is an open ribbed arch type bridge structure consisting of three spans. The 9,1 m wide reinforced concrete deck, inclusive of raised sidewalks, is supported on a system of transverse and longitudinal beams and is connected to the arches via reinforced concrete rib columns. The entire structure is founded on mass concrete spread footings dowelled into hard rock.

During the principal bridge inspections conducted in Mpumalanga during 2003-2005, it was discovered that the condition of the bridge had deteriorated significantly. As a result, the structural integrity of the bridge had become questionable. The bridge structure required immediate attention and a more detailed investigation of the structure was approved by the Mpumalanga Provincial Government: Department of Roads and Transport. The detailed investigation confirmed the severity of the defects. A rehabilitation project for the structural repairs to bridge BN998 was subsequently approved and construction of the proposed repair work commenced towards the end of 2007.

Both the exceptionally high rainfall experienced during the latter part of 2007 and early 2008 as well as the location of the bridge structure at the tail end of the Witbank Dam, contributed to the construction challenges experienced during the construction period. In particular, the design and construction methodology of the proposed repair work had to be revised several times to accommodate high water levels prevalent in the river. The existing superstructure was widened to an overall width of 11,68 m. The parapet was upgraded to F-shape type barriers adjacent to the travelled way and precast concrete pedestrian hand rails along the outer edges of the structure.

Transverse beams supporting the deck slabs were strengthened and widened using a combination of reinforced grout (for the widening of the beams) and reinforced micro-concrete (for the extension of the beam to the full width of the bridge deck).

Similarly, the arch members were strengthened using reinforced grout. Areas submerged by the high water levels in the river were repaired with grout that contained Migrating Corrosion Inhibitor (MCI) additives that prevent further corrosion of reinforcement.

BN998 over the Olifants

During construction, the condition of the structural steel bearings was further investigated and was found to be in remarkably good condition. No further action or repair was required.

Inspection of the concrete foundations revealed no structural defects and therefore required no repair work. New cantilever reinforced concrete approach slabs were constructed at both approaches to the structure in order to alleviate the effect of settlement of the backfill behind the abutments. Throughout the whole design and construction stages great emphasis has been placed on retaining the special character and aesthetic appeal of the old bridge.

The Civil Engineering Project's team includes: contractor: Stefanutti and Bressan Civils; subcontractor: Stoncor and Sika; the principal agent: Nyeleti Consulting and the client: Mpumalanga Provincial Government.

Judges' Citation

The innovative thought processes of the design engineers in their attempt to conserve our natural and historical heritage, when embarking, on this project is particularly inspiring.

The option of investigating the refurbishment of this bridge, as opposed to demolishing and rebuilding, provided cost and environmental benefits due to the road not having to be aligned and was thereafter accepted and instituted. This fact appealed particularly to the judges.

They also noted the complexity of the refurbishment work and the manner in which that was completed without negatively impacting on the aesthetics of the existing bridge.

The fact that serious regard was given to the environment, using a temporary platform to catch any debris, and avoid pollution, is noteworthy.

The judges were impressed by the concrete spall repair systems adopted, and by the fact that some of the work was performed underwater, all with extensive quality control procedures.

The ingenious method adopted for widening the bridge to promote safety is also exemplary.

Roadside

Reinforced concrete pavement between Ugie and Langeni

The reinforced concrete pavement forms a vital link between Ugie and the Langeni Sawmill as it connects two east-west strategic trunk routes the R61 to Queenstown, Ngcobo and Mthatha, and the R56 to Molteno, Elliot, Ugie, Maclear, Mount Fletcher and Matatiele. It is the main access route for timber companies and agricultural produce.

The isolated communities and emerging farmers will benefit from the upgrade. The design gradient of 11% over the steep mountain pass section meant that the road pavement would be subject to slow moving heavy axle loads, with consequent pavement distress problems. The need for a low maintenance solution as well as the fact that axle loading limits are generally not well regulated in the Eastern Cape region, led to the selection of a continuously reinforced concrete pavement as the most appropriate pavement design solution. The concrete mix design specified a 26 mm concrete stone to enhance the flexural strength which was specified as 4,5 MPa. No river sand was available and therefore sand had to be crushed from the available dolerite on site. These concrete aggregates generally result in harsh mixes which are not suitable for hand placing and the achievement of an acceptable surface texture. The shape of the dolerite aggregates, and particularly the fine fraction, was improved by the use of a vertical shaft impact crusher in the tertiary crushing phase. Several trial mixes were designed and tested on trial sections of concrete pavement. The mix designs were modified according to workability criteria, and strengths were verified by laboratory control testing. A higher cement content than the minimum specified cementitious content of 265 kg/m^3 had to be used in order to achieve a more workable mix. This was despite the addition of a plasticising admixture.

The methods used for the construction of the concrete pavement construction were designed to maximise the use of labour.

The concrete placing team consisted of 18 skilled labourers with a team of 15 skilled labourers preparing road forms and steelfixing ahead of the concrete placing team. Concrete was delivered to site in mixer trucks from a dry weigh batching plant at the rate of 80 m^3 per placing team per day.

The concrete pavement was constructed on a mountain pass which was subject to rain and mist in summer and snow in winter.

Special planning and protection of the works had to be carried out. A thermal blanket made from a double layer of geofabric covered with plastic sheeting on both sides, acted as barrier to rain and cold and was applied after final texturing. The rideability of the pavement is excellent. This project is a landmark in the Eastern Cape and shows how infrastructure projects initiated by humble motivation from local villagers, can be taken on board by government departments and developed for the benefit of all in the area. The project has provided greatly improved infrastructure and public transport to isolated communities and has created market opportunities for emerging farmers.

The team includes: contractor, LM3 Joint Venture; and the client: Department of Roads and Transport in the Eastern Cape. The entry was submitted by HHO Africa/Camdekon Joint Venture in the Civil Engineering 'Unique Design Aspects, Construction Techniques'.

Judges' Citation

This project was well conceived and executed on the whole.
It was heartening to observe the attention and dedication that were given to the environmental issues to ensure the lowest possible impact on the sensitive indigenous forest and fynbos biome regions traversing the road. Also noteworthy is the fact that the use of a continuously reinforced concrete pavement option provided a long term low maintenance, sustainable solution, resulting in a sustainable solution. The amount of training of individuals in the local, previously unskilled community, in constructing these concrete works will surely stand them in good stead in finding valuable employment of a similar kind in future.

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Hibernian Towers

The 22 storey Hibernian Towers is a residential up-market development situated at one of the most prestigious locations in the Strand.

The project was initiated by Quaypower Properties to provide local and international clients with a luxury multi-storey apartment building, with accommodation ranging from one room to three-bedroom apartments. In addition, provision has also been made for office and retail space. Parking requirements were also addressed. The first four floors make up the building's podium which has a 3 840 m^2 footprint. Above the podium are the remaining three portions, two individual towers and an atrium, which link the two towers.

The concrete lines and bulk are key features of the architecture. Because of the shape of the structure, reinforced concrete was the most appropriate type of construction. The proximity to the sea makes the use of structural steel problematic in terms of corrosion protection.

The building's special features start at ground level with several unusually large pile caps, the largest of which required 115 m^3 of concrete and 15 500 kg of steel.

The lateral forces that are imposed on the structure as a result of acceleration of the ground during an earthquake are carried to the ground by means of structural walls. The most critical portion of the tower walls is the plastic hinge region. No splices in vertical rebar were allowed between levels 5 and 6 in all structural walls and corresponding boundary elements. As a result, vertical bars were approximately 8 m in length. Specific seismic detailing was applied to the structural walls and columns.

The design, and more significantly, the construction of the slabs were complicated by the irregular column grid and slab geometry.

The central atrium structure consists of reinforced concrete beams following the atrium circumference, repeating every second level. Circumferential columns provide support to these beams. These columns started at level 5 and were supported on transfer structures at level 5. In addition, a reinforced concrete bridge links the two towers at each level.

A total of 13 800 m^3 of concrete and 2 020 tons of reinforcement was used in the construction of the structure. The team included: contractor: J van der Sluys; the client: Studio D'Arc Architects on behalf of property owner, Quaypower. The project was submitted by KV3 Engineers.

CONCRETE SOCIETY OF SOUTHERN AFRICA EASTERN CAPE BRANCH			
DATE	**MEETING/EVENT**	**VENUE**	**CONVENOR**
11th April 2011	Site Visit – Red Location Museum	New Brighton, Port Elizabeth	Branch Committee
8thJune 2011	Fulton Awards Branch Function	Venue to be confirmed	Branch Committee
11th October 2011	Technical Talk – Epoxy Flooring	Venue to be confirmed	Branch Committee
CONCRETE SOCIETY OF SOUTHERN AFRICA INLAND BRANCH			
7th April 2011	Branch Committee Meeting	C&CI, Waterfall Park, Midrand	Armand van Vuuren
5th May 2011	Branch Committee Meeting	C&CI, Waterfall Park, Midrand	Armand van Vuuren
12th May 2011	Mini Technical Seminar – Concrete Lintels	Venue to be Confirmed	Hanlie Turner
9th June 2011	Branch Committee Meeting	C&CI, Waterfall Park, Midrand	Armand van Vuuren
7th July 2011	Branch Committee Meeting	C&CI, Waterfall Park, Midrand	Armand van Vuuren
4th August 2011	Branch Committee Meeting	C&CI, Waterfall Park, Midrand	Armand van Vuuren
11th August 2011	Mini Technical Seminar – High Performance Concrete	Venue to be Confirmed	Hanlie Turner
12th August 2011	Egg Protection Device Competition – Casting Date	Not Applicable	Darren Jacobs
19th August 2011	Egg Protection Device Competition – Test Date & Prize Giving Function	PPC, Jupiter Works Carousel, Johannesburg	Darren Jacobs
1st September 2011	Branch Committee Meeting	C&CI, Waterfall Park, Midrand	Armand van Vuuren
17th September 2011	Annual Concrete Boat Race Day	Victoria Lake Club, Germiston	Trevor Sawyer
6th October 2011	Branch Committee Meeting	C&CI, Waterfall Park, Midrand	Armand van Vuuren
4th November 2011	Chairman's Breakfast & Chairman's Award, followed by Branch Committee Strategic Meeting	Sunnyside Park Hotel, Princess of Wales Terrace, Parktown, Johannesburg	Natalie Johnson
CONCRETE SOCIETY OF SOUTHERN AFRICA WESTERN CAPE BRANCH			
21st April 2011	Site Visit	Blue Route Mall Redevelopment	Paul Zietsman
13th May 2011	Annual Golf Day	Kuils River Golf Club	Graham Balharry/Riaan van Dyk
9th June 2011	Fulton Awards Branch Function	Venue to be Confirmed	Etienne van der Klashorst/Ken Newton
21st July 2011	Technical Meeting – Waterproofing Seminar: Graham Balharry	UCT Chemical Engineering	Joseph

CONCRETE SOCIETY OF SOUTHERN AFRICA NATIONAL OFFICE PROGRAMME 2011			
DATE	MEETING/EVENT	VENUE	CONVENOR
1st Quarter of 2011			
16th March 2011	AGM	Emperor's Palace	CSSA President
16 – 17th March 2011	Council Meeting	Emperor's Palace	CSSA President
2nd Quarter of 2011			
April 2011	Source Book	Sent out to all CSSA Members	Crown Publications
3 – 5th June 2011	2011 Fulton Awards Weekend	Champagne Sports Resort	Francois Bain
June 2011	Fulton Awards Concrete Beton	Sent out to all CSSA Members	Crown Publications
30th June 2011	Council Meeting	Emperor's Palace	CSSA President
3rd Quarter of 2011			
July 2011	Concrete Beton	Sent out to all CSSA Members	Crown Publications
4th Quarter of 2011			
13th October 2011	Council Meeting	Emperor's Palace	CSSA President
November 2011	Concrete Beton	Sent out to all CSSA Members	Crown Publications
November 2011	Council Nominations	Sent out to all CSSA Members	CSSA Administration
November 2011	Concrete Flooring Roadshow	Johannesburg, Durban, Port Elizabeth, Cape Town	To be confirmed