BACKGROUND TO SANS 10160

BASIS OF STRUCTURAL DESIGN AND ACTIONS
FOR BUILDINGS AND INDUSTRIAL STRUCTURES

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Background to SANS 10160

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FOREWORD

The Draft South African Loading Code SANS 10160 *Basis for structural design and actions for buildings and industrial structures* represents a substantial revision of the present Standard SABS 0160:1989 (Amended 1993) *The general procedures and loading to be adopted in the design of buildings*. Proper substantiation of the changes and additions is therefore required. The purpose of this *Background Report* is to capture the main sources of reference; assessments; decisions and motivations applied in the formulation of SANS 10160 (Draft).

The background information should primarily be considered when SANS 10160 is evaluated for acceptance into design practice by the profession, and subsequently its approval for publication by SABS as a South African National Standard. The *Background Report* should also serve as the point of departure for the inevitable future revision and updating of SANS 10160. The lack of background to various sections of SABS 0160:1989 was in fact found to seriously impede its revision, particularly during early stages of the activities, some of which were carried through to the final stages!

The *Background Report* is not intended to serve as a commentary to the future use of SANS 10160 in design practice, since the function of a commentary would require substantially different contents and presentation in order to clarify the application and intentions of the various stipulations and procedures. However the background reported here should provide additional understanding as a complementary source in cases where critical consideration of design implications is required.

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 on the future revision of materials-based design standards or even the introduction of new standards, particularly for related geotechnical design!

The development of SANS 10160 (Draft) took a decade to complete, from the initiation of the review process at the South African National Conference on Loading (SA-NCL) which was held in 1998! There are some explanations and justifications for this drawn out process, but also some positive consequences. Guidelines given at the Loading Conference were rather general and the technology base for the revision was not clear. Although responsibility for the revision process was taken appropriately by SAICE, particularly the Joint Structural and Geotechnical Divisions, the work was done on a voluntary basis, without resources being allocated, even for direct expenses. Strong motivation from practice for an updated South African Loading Code only emerged relatively recently, as the result of the strong upturn of the construction industry.

The extended duration of the revision allowed for some significant developments to take place, particularly the development of the Eurocode Standards for structural design. Interest in the voluntary Eurocode standard on geotechnical design ENV 1997:1995 initiated the SA-NCL due to incompatibilities between SABS 0160:1989 and Eurocode basis of design ENV 1991-1 at that stage. Significant further development of Eurocode subsequently took place in parallel with the South African review process, which removed these incompatibilities.

The conversion of the ENV Eurocode into normative European Standards as the EN Eurocode started in 1998. The first EN Eurocode Standards were published in July 2002. The last of the nine Parts related to the scope of the South African Loading Code was published as recently as September 2006, illustrating the parallel mode of development of SANS 10160 with the finalisation of the Eurocode reference standards. However the final step of implementation of these Standards and Parts by the publication of the related National Annex by the various Member States is not yet complete. It should be noted that the Eurocode Standards only become operational upon publication of the related National Annex. By the end of July 2008, in the UK the BS EN NA of only four Parts had been published.

Since Eurocode has evolved as an important reference for SANS 10160 (Draft), the rate of progress can be considered to be quite reasonable. In fact, direct interaction with Eurocode activities put the development on a fast tract, comparable to that of Member States by cutting short the lag that would have resulted from waiting for the ultimate publication of the Eurocode Parts.

The revision program also allowed the implementation of some academic research to take place. Not only did some useful insight derive from these investigations, but it also provided the base for 'voluntary participation' by academics in the activities.

ACKNOWLEDGEMENTS

SAICE WG MEMBERS

Membership of the SAICE WG on LC reflects a fair mixture of representatives from practice and academics (Some prominent members of the WG, being practitioners with a strong research base, or academics with extensive design experience, causes this classification to be rather fuzzy!). Needs for standardised design procedures and conditions are identified from practice. This function was fulfilled to a large extent by the SA-NCL. Acceptable requirements and procedures are identified and formulated by researchers and academics. The final formulation results from a joint decision making process where concept formulations are critically reviewed for sufficiency and clarity, also from an implementation point of view. A similar process was reflected in the preparation of concepts by champions for each topic which are supported by smaller groups.

WG Members: Peter Day; Prof Peter Dunaiski; John Duncan; Dr Adam Goliger; Dr Graham Grieve; Mike Hull; Dirk Loubser; Roy Mackenzie; Dr Alvin Masarira; Don Midgley; Dr Tony Paterson; Prof Johan Retief; Prof Chris Roth; Tim ter Haar; Prof Jan Wium: Nick Wright.

***Retired WG Members*:** Prof Alan Kemp; Dr Geoff Krige; Schalk Pienaar; John Lane; Tony Goldstein.

***Readers of WG Drafts*:** Victor Booth; Alan Berry; Keith Bokelman; Dr Hennie de Clercq; Karl Eschberger; Dr Bob Harrison, Ferdie Heymann; Nicol Labuschagne; Dr Irvin Luker; Prof Deneys Schreiner.

EUROCODE CEN TC250 SC1 & SC7

SANS 10160 can truly be considered to be an early conversion of Eurocode principles and procedures into operational design standards beyond the boundaries of the Eurocode Member States. The lag between the completion of Eurocode Standards and their application as National Standards is quite similar to that between Eurocode and the completion of SANS 10160. Although there are substantial differences in layout and format, scope of application and procedures, these differences are directly related to differences in institutional, regulatory, environmental and technical conditions of the two regions. Substantial harmonisation and consistency have however been maintained between SANS 10160 and Eurocode, basically with SANS 10160 that can be considered as a specific subset of Eurocode.

The high degree of harmonisation of SANS 10160 with Eurocode which is achieved with minimal lag between the development of SANS 10160, in comparison with the deployment of Eurocode, is a direct result of the high degree of accessibility and interaction provided by various individuals and Eurocode CEN TC 250 Sub-Committees. As previous chairperson of SC1 *Actions on structures*, Prof Haig Gulvanessian CBE played a pivotal role in the process of providing fast track access to developments which provided the motivation for referencing SANS 10160 to Eurocode. Continued interaction with SC 1 is maintained under the chair of Dr Nick Malakatas. Similar positive co-operation and support was received from SC7 *Geotechnical design*. Amongst the many colleagues who contributed to the exchanges at different levels, the interaction and co-operation with Prof Milan Holický should be mentioned specifically.

Part 1 – Basis of Structural Design

1-1 An Overview of the Revision of the South African Loading Code SANS 10160

Retief JV, Dunaiski PE & Day PW

1 INTRODUCTION

The current South African Loading Code SABS 0160:1989 (Amended 1993) has been substantially revised, updated and extended into the draft standard SANS 10160. The central role of the SA Loading Code in structural design practice has been further expanded in the draft standard, mainly through an extension of the provisions for the basis of structural design. The scope of the standard is also extended in terms of the range of actions for which specifications are provided. Provision for geotechnical design also represents a notable extension of the standard.

These developments require proper assessment before they are implemented in South African structural design practice. In South Africa, responsibility for structural design standards is taken primarily by the profession, supported by research institutions and materials-based institutions from industry. South African structural design standards therefore reflect the consensus of the profession on acceptable design practice for structural safety and economic performance of structures, as opposed to the dictates of the regulatory authorities.

In addition to the requirement of inviting public comment on any Draft South African Standard (DSS) before it is published as a South African National Standard (SANS), it is imperative that the profession reviews not only the contents of the new standard but also the basis on which it was formulated. There is also a need to record the considerations and assessments involved in drafting the standard for future reference, particularly during its inevitable future revision. In many cases, the development of SABS 0160 in the 1980's was severely restrained by the lack of background information. Proper understanding of the basis for the requirements and procedures of SANS 10160 will assist in its use in practice, particularly in difficult or marginal conditions.

This *Background Report* is therefore compiled to record the efforts made to gather related information, to establish the needs and requirements, to select appropriate procedures and then to implement them in the new SANS 10160. It also provides comparisons with existing practice. The various sections of the *Background Report* are generally compiled into three steps consisting of (a) a review of advances in standard practice within the context of South African conditions; (b) the selection of appropriate procedures, models and values for the requirements and stipulations; and (c) assessment of the implications of the stipulations in comparison to present practice. Where justified, the various steps are dealt with in separate chapters of this report. In the background to the basis of design, an overview is also given of the integral process of revision as it evolved with time and from which general principles have been distilled.

As the new draft standard does not yet have a date, it cannot be distinguished from the old code by its year of publication. For convenience and brevity the old standard is referred to as SABS 0160 and new standard as SANS 10160.

In this chapter, SANS 10160 is introduced, the revision process is summarised, the various Parts of the standard are outlined, and finally abstracts of the chapters of the *Background Report* are provided.

2 OUTLINE OF SANS 10160

The revised South African Loading Code SANS 10160 is best introduced by providing an outline of its structure and contents. Some reflection on its function and purpose is also required against which the revised contents can be considered.

2.1 Function of SA Loading Code

The function of the SA Loading Code is to provide the principles and design rules as well as the actions (loads) that need to be taken into account in the design of buildings and similar industrial structures. The basis of design for structural performance establishes the ability of structures to sustain actions and maintain their integrity and robustness. This basis of design applies not only to the assessment of actions and their effects on the structure, but also to the provision of sufficient resistance in accordance with the materials-based design standards, e.g. for structural concrete, steel, timber and masonry.

The scope of structures provided for in the old code SABS 0160, the general design procedures to be applied, the associated levels of reliability and the actions to be considered have generally been maintained as have the materials-based design standards which are intended to be used in conjunction with the new standard. Changes to the scope and contents of SABS 0160 are typically due to the incorporation of improved models and procedures, many of which are being implemented internationally.

The general basis of structural design uses limit states design procedures and partial factors to achieve appropriate levels of reliability for the safety and performance of structures. It is the intention that the code should specify all requirements for design which are independent of the specific structural materials used. Changes from the previous edition of this standard result mainly from an extension of design situations provided for. This should result in improved consistency of the reliability of structures by improving the reliability where necessary, but also by removing unwarranted conservatism.

The principle has been adopted that acceptable performance of structures designed according to existing procedures provides confirmation of sufficient levels of reliability. This provides the basis for the continued use of existing materials-based design standards together with this standard. The full potential of the extended reliability framework provided in the new code *vis-à-vis* the design of more efficient or advanced structures utilising modern structural materials will be realised when the materials-based design standards are also revised accordingly or when new compatible standards are introduced.

2.2 Structure of SANS 10160

For practical convenience, SANS 10160 will be published as a single document. However, due to the independent nature of the topics covered, it is divided into separate Parts. This separation into Parts allowed related material to be kept together whilst still complying with SABS requirements for layout and numbering (SANS 1-1:2003). The eight parts of SANS 10160 are as follows:

Part 1	*Basis of structural design*
Part 2	*Self-weight and imposed loads*
Part 3	*Wind actions*
Part 4	*Seismic actions and general requirements for buildings*
Part 5	*Basis of geotechnical design and actions*
Part 6	*Actions induced by cranes and machinery*
Part 7	*Thermal actions*
Part 8	*Actions during execution*

The *general procedures* given in SABS 0160 were upgraded into the separate Part 1 which provides the *basis of structural design*. The set of actions provided for in SABS 0160, viz. self-weight, imposed loads, wind actions and crane induced actions, were separated into individual Parts and the content was revised and updated. An important addition to the scope of SANS 10160 is the provision for *geotechnical design and actions* contained in Part5. Other additions include actions induced by stationary rotating machinery, thermal actions and actions during execution which include construction, maintenance and modification.