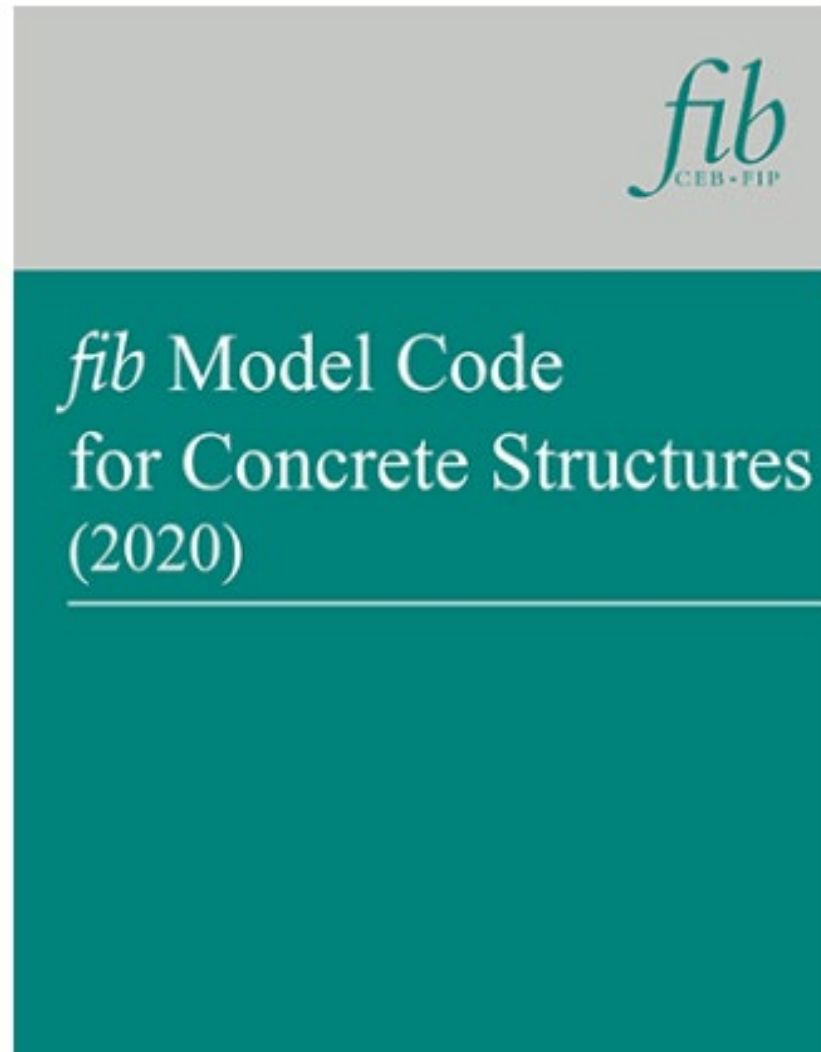


# CONCRETEfix

## Introduction to the International Federation of Structural Concrete, *fib*, and the Model Code



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Inligtingtegnologie / Lefapha la Boetsenere,  
Tikologo ya Kago le Theknolotši ya Tshedimošo

# OVERVIEW

1. SANS 51992-1-1: 2025 link to the *fib* Model code – Sarah Skorpen
2. South Africa's history with *fib* – Billy Boshoff
3. Introduction to *fib* – *fib* Secretary General, David Fernandez-Ordenez
4. Examples of where the *fib* Model Code can be helpful for concrete design in South Africa – Kim Timm and Sarah Skorpen
5. Membership categories – Sarah Skorpen

# SANS 51992-1-1: 2025

ISBN 978-0-626-43461-8

SANS 51992-1-1:2025

Edition 1

EN 1992-1-1:2004

Edition 2

## SOUTH AFRICAN NATIONAL STANDARD

### Eurocode 2: Design of concrete structures

### Part 1-1: General rules and rules for buildings

This national standard is the identical implementation of EN 1992-1-1:2004, and is adopted with the permission of CEN, Rue de la Science 23 B-1040 Brussels.

**WARNING**  
This document references other documents normatively.

Published by the South African Bureau of Standards  
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Tel: +27 12 428 7911 Fax: +27 12 344 1568  
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**SABS**

## Design of concrete structures Publication of SANS 51992-1-1 and SANS 51992-1-1-1

The new South African standard for design of concrete structures was published in March 2025 as SANS 51992-1-1 (Eurocode 2: *The design of concrete structures – Part 1-1: General rules and rules for buildings*) and SANS 51992-1-1-1 (Eurocode 2: *The design of concrete structures – Part 1-1-1: General rules and rules for buildings* (NATIONAL ANNEX TO SANS 51992-1-1)).

The review of SANS 10100-1(2003) *The structural use of concrete: Part 1 Design* began in 2007, led by an SABS working group comprising representatives from universities and consulting firms. This initiative followed the ongoing efforts to revise SANS 10160 *Basis of structural design and actions for buildings and industrial structures*. One of the key early discussions was whether to compile a new, locally developed standard – similar to the approach taken with SANS 10160 – or to adopt an existing international standard.

The adoption of load combinations in SANS 10160 that aligned with the Eurocode influenced the working group's decision to adopt Eurocode 2 for South Africa, with its own local national annex. In keeping with the tradition of SANS 10100-1 (1992), which was based on the British Standard BS 8110, the British National Annex to Eurocode 2 was used as the starting point and then adapted to suit South African conditions where required.

A draft national annex to Eurocode 2 for South Africa was submitted to SABS in February 2012, initiating a lengthy administrative process to adopt a Eurocode in South Africa for the first time. By design, Eurocodes are structured as main documents intended to be applied alongside a national annex, developed by each individual country. However, this concept of standard adoption in which a national annex forms part of the process was unfamiliar to SABS, resulting in significant procedural delays.

After several years of overcoming administrative hurdles, the draft was finally released for public comment in 2024 in accordance with standard SABS procedures. Valuable feedback was received and incorporated, leading to the final publication of the standard in March 2025. A transition period will now follow during which SANS 10100-1 and SANS 51992-1-1 will coexist until December 2026, after which SANS 10100-1 will be withdrawn.

The new standard covers the design of concrete building structures. Designers will find that most procedures remain similar to those in the existing SANS 10100-1, with a few notable differences. Among these are a revised approach to shear design,

a more detailed procedure for concrete columns, and more extensive guidance on durability. There are also differences in the L/d ratios used for concrete slab design.

Unlike the Eurocode, where fire design is covered in a separate standard, the South African version incorporates the fire design clauses from SANS 10100-1 directly into the national annex (SANS 51992-1-1-1). Additionally, the formulations for crack control in reinforced concrete members differ from those found in the annex of SANS 10100-1, and the new standard includes enhanced guidance on the design of precast concrete elements.

Following closely on the heels of SANS 51992-1-1 is the development of SANS 10100-3 *Design of Concrete Liquid Retaining Structures*. This locally developed standard has been in progress since 2013, led by an independent working group, with a first draft completed some time ago. As SANS 10100-3 is based on SANS 51992-1-1, its progress has been contingent on the latter's publication. However, it also faces its own set of administrative hurdles that must be addressed before it can be published.

#### ACKNOWLEDGEMENTS

The following members of the Working Group are recognised for their continuous contributions in bringing the adoption process to completion: Prof Gideon van Zijl, Prof Johan Retief, Prof Elsabe Kearsley, Prof Chris Roth, Prof Mitchell Gohnert, and Dr John Robertts.

#### CALL FOR PARTICIPATION

While the publication of SANS 51992-1-1 and SANS 51992-1-1-1 was underway, a new version of Eurocode 2 was published in 2023. As a result, a new South African working group will be established to begin the first revision of these standards. In parallel, work on SANS 10100-3 will continue.

Professionals and academics in the construction industry are invited to participate in these working groups. Those interested in contributing can contact Khanyisa Baloyi from SABS at [khanyisa.baloyi@sabs.co.za](mailto:khanyisa.baloyi@sabs.co.za) or Dr Christina McLod (Chair of Technical Committee TC: 98/SC02 – Design of Concrete Structures) at [mcleodc@ukzn.ac.za](mailto:mcleodc@ukzn.ac.za).

#### Prepared by

Prof Jan Wium  
Working Group Chair

# EN 1992-1-1

BRITISH STANDARD

## Eurocode 2: Design of concrete structures —

Part 1-1: General rules and rules for buildings

ICS 91.010.50, 91.080.40

BS EN  
1992-1-1:2004  
*Incorporating  
corrigendum  
January 2008*

## SANS 51992-1-1:2025 and SANS 51992-1-1-1:2025

- SANS 51992-1-1:2025 – Design code
- SANS 51992-1-1-1:2025 – National Annex
- Based on BS EN 1992-2004

## Eurocode 2 (EN 1992-1-1:2004/2010)

- Many of the design concepts were adopted from the **CEB-FIP Model Code 1990**

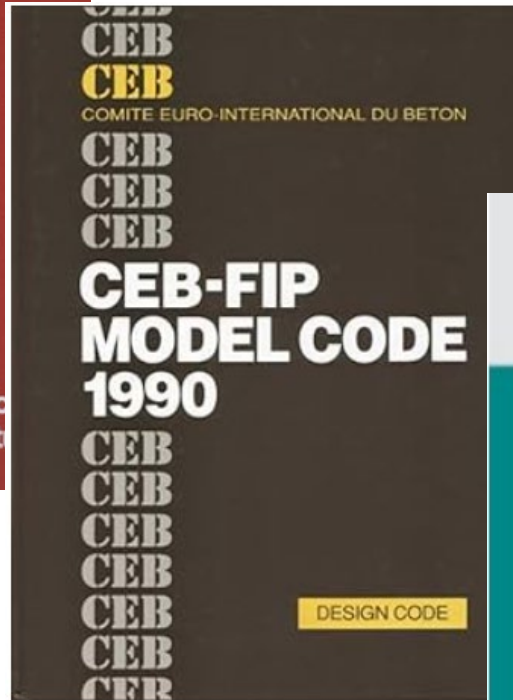
## Second-Generation Eurocode 2 (2021/2023 revision)

- The ongoing revision of Eurocode 2 is heavily influenced by the **fib Model Code 2010**. (e.g. the new provisions for steel fibre reinforced concrete (FRC))

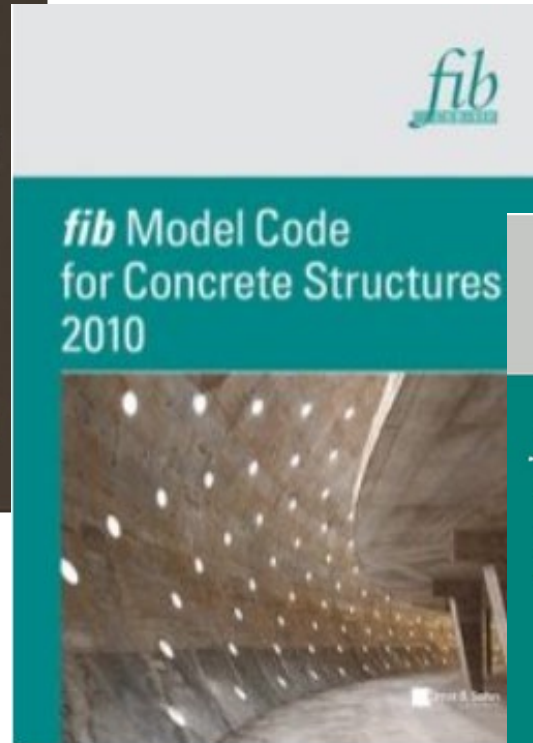
# fib Model Code Development

ceb-fip model code  
for concrete structures

**CEB-FIP Model  
Code 1978**



**CEB-FIP Model  
Code 1990**



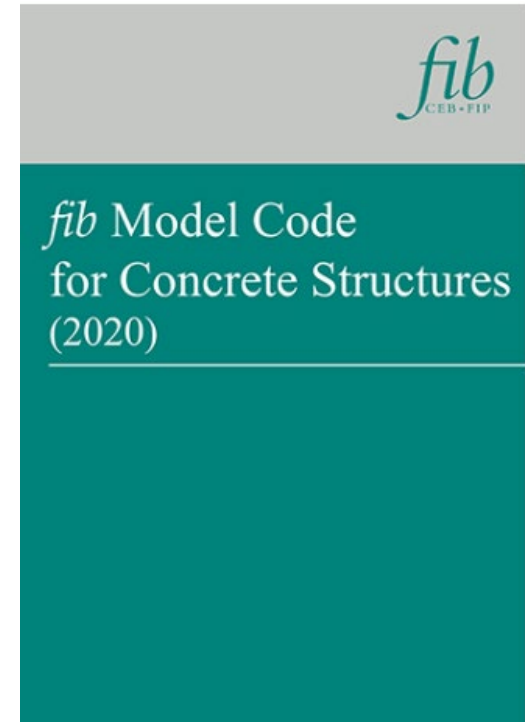
**fib Model Code 2010**



# *fib* Model Code – Relevance to RSA

The *fib* Model Code is not a legally binding standard, but it plays a critical role in shaping design practice worldwide:

- Foundation for national codes - e.g. EC2
- Insight into what is coming for future code updates
- Bridge between research and practice - *fib* Bulletins
- Performance based design - move away from prescriptive rules
- Durability and sustainability
- Advanced analysis methods - supports nonlinear analysis and more realistic modelling of structural behavior
- A reference for out of code design
  
- Upcoming courses on SANS 51992-1-1:
  - 23rd April: CONCRETEFiX;
  - 28-29 May: Adopting SANS 51992-1-1 (Stellenbosch);
  - June: Concrete Society Roadshow.



**South Africa's history with *fib***

**Introduction to the  
International Federation of  
Structural Concrete, *fib***



***fib* Secretary General: David Fernandez-Ordóñez Hernández**

Dr. Ingeniero de Caminos by the Polytechnic University of Madrid (Dr. MSc. Civil Engineer)

# ***fib* Model Code**

# ***fib* Model Code 2020**

- **Scope and Terminology** (Ch. 1-2): Defines the scope of the code and fundamental terminology.
- **Basic Principles** (Ch. 3-10): Sustainability, life-cycle management, performance-based design, and principles for design, execution, and conservation.
- **Principles of Structural Performance Evaluation** (Ch. 11-12): Details assessment techniques.
- **Actions on Structures** (Ch. 13): Loads and actions.
- **Input Data for Materials** (Ch. 14-19): Concrete, reinforcement (steel/non-metallic), and fiber-reinforced concrete (FRC/UHPC).

# ***fib* Model Code 2020**

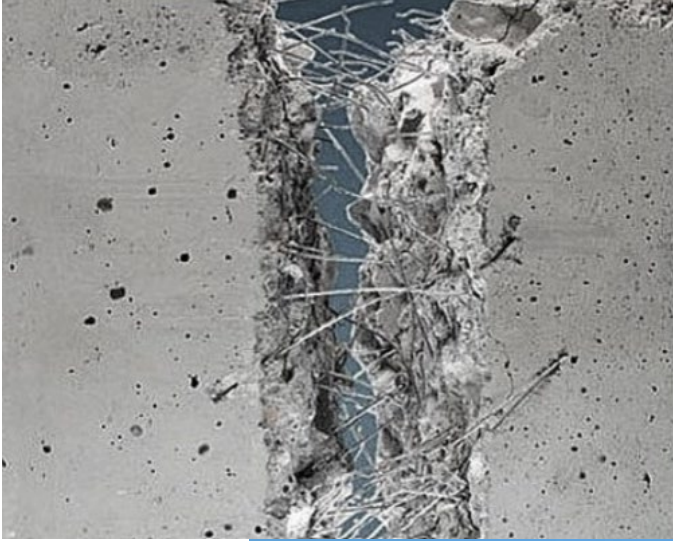
- **Input Data for Interfaces** (Ch. 20-25): Bond behavior (steel, non-metallic, existing concrete).
- **Design and Assessment** (Ch. 26-34): The main structural technical section, covering conceptual design, analysis, and performance evaluation.
- **Execution** (Ch. 35-37): Covers construction management and interventions.
- **Conservation** (Ch. 38): Maintenance and management.
- **Circularity and Dismantlement** (Ch. 39): Deals with the end-of-life aspects of structures.

# ***fib* Model Code 2020**

- **Input Data for Interfaces** (Ch. 20-25): Bond behavior (steel, non-metallic, existing concrete).
- **Design and Assessment** (Ch. 26-34): The main structural technical section, covering conceptual design, analysis, and performance evaluation.
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- **Circularity and Dismantlement** (Ch. 39): Deals with the end-of-life aspects of structures.

# SANS 10100 limitations

## Concrete Material Properties



- High strength concrete – precast construction, bridges, tall structures
- Fibre reinforced concrete – precast construction, surface beds
- E value,  $\alpha$ , drying shrinkage – integral bridge design

# Concrete Strength

## SANS 10100-1

### 3.4.2 Properties of materials

#### 3.4.2.1 Modulus of elasticity (concrete)

**3.4.2.1.1** Unless better information is available for normal density concrete, use the relevant short-term modulus of elasticity given in table 1, appropriate to the serviceability limit states.

**Table 1 - Values for modulus of elasticity of concrete,  $E_c$**

| 1   | 2  |
|---|--|
| Cube strength of concrete at the appropriate age or stage under consideration | Modulus of elasticity of concrete, $E_c$ |
| MPa   | GPa                                      |
| 20  | 25                                       |
| 25  | 26                                       |
| 30  | 28                                       |
| 40  | 31                                       |
| 50  | 34                                       |
| 60  | 36                                       |

# Concrete Strength

SANS 51992-1-1:2025

| Strength classes for concrete |      |     |     |     |     |      |     |     |      |      |     |      |     | Analytical relation / Explanation |  |
|-------------------------------|------|-----|-----|-----|-----|------|-----|-----|------|------|-----|------|-----|-----------------------------------|--|
| $f_{ck}$ (MPa)                | 12   | 16  | 20  | 25  | 30  | 35   | 40  | 45  | 50   | 55   | 60  | 70   | 80  | 90                                |  |
| $f_{ck,cube}$ (MPa)           | 15   | 20  | 25  | 30  | 37  | 45   | 50  | 55  | 60   | 67   | 75  | 85   | 95  | 105                               |  |
| $f_{cm}$ (MPa)                | 20   | 24  | 28  | 33  | 38  | 43   | 48  | 53  | 58   | 63   | 68  | 78   | 88  | 98                                | $f_{cm} = f_{ck} + 8$ (MPa)  |
| $f_{ctm}$ (MPa)               | 1,6  | 1,9 | 2,2 | 2,6 | 2,9 | 3,2  | 3,5 | 3,8 | 4,1  | 4,2  | 4,4 | 4,6  | 4,8 | 5,0                               | $f_{ctm} = 0,30 \times f_{ck}^{(2/3)} \leq C50/60$<br>$f_{ctm} = 2,12 \cdot \ln(1 + (f_{cm}/10)) > C50/60$ |
| $f_{ctk,0.05}$ (MPa)          | 1,1  | 1,3 | 1,5 | 1,8 | 2,0 | 2,2  | 2,5 | 2,7 | 2,9  | 3,0  | 3,1 | 3,2  | 3,4 | 3,5                               | $f_{ctk,0.05} = 0,7 \times f_{ctm}$<br>5% fractile   |
| $f_{ctk,0.95}$ (MPa)          | 2,0  | 2,5 | 2,9 | 3,3 | 3,8 | 4,2  | 4,6 | 4,9 | 5,3  | 5,5  | 5,7 | 6,0  | 6,3 | 6,6                               | $f_{ctk,0.95} = 1,3 \times f_{ctm}$<br>95% fractile  |
| $E_{cm}$ (GPa)                | 27   | 29  | 30  | 31  | 33  | 34   | 35  | 36  | 37   | 38   | 39  | 41   | 42  | 44                                | $E_{cm} = 22[(f_{cm})/10]^{0,3}$<br>( $f_{cm}$ in MPa)   |
| $\epsilon_{c1}$ (‰)           | 1,8  | 1,9 | 2,0 | 2,1 | 2,2 | 2,25 | 2,3 | 2,4 | 2,45 | 2,5  | 2,6 | 2,7  | 2,8 | 2,8                               | see Figure 3.2<br>$\epsilon_{c1}^{(l/100)} = 0,7 f_{cm}^{0,31} < 2,8$                                      |
| $\epsilon_{cu1}$ (‰)          | 3,5  |     |     |     |     |      |     |     |      | 3,2  | 3,0 | 2,8  | 2,8 | 2,8                               | see Figure 3.2<br>for $f_{ck} \geq 50$ Mpa<br>$\epsilon_{cu1}^{(l/100)} = 2,8 + 27[(98 - f_{cm})/100]^4$   |
| $\epsilon_{c2}$ (‰)           | 2,0  |     |     |     |     |      |     |     |      | 2,2  | 2,3 | 2,4  | 2,5 | 2,6                               | see Figure 3.3<br>for $f_{ck} \geq 50$ Mpa<br>$\epsilon_{c2}^{(l/100)} = 2,0 + 0,085(f_{ck} - 50)^{0,53}$  |
| $\epsilon_{cu2}$ (‰)          | 3,5  |     |     |     |     |      |     |     |      | 3,1  | 2,9 | 2,7  | 2,6 | 2,6                               | see Figure 3.3<br>for $f_{ck} \geq 50$ Mpa<br>$\epsilon_{cu2}^{(l/100)} = 2,6 + 35[(90 - f_{ck})/100]^4$   |
| $n$                           | 2,0  |     |     |     |     |      |     |     |      | 1,75 | 1,6 | 1,45 | 1,4 | 1,4                               | for $f_{ck} \geq 50$ Mpa<br>$n = 1,4 + 23,4[(90 - f_{ck})/100]^4$  |
| $\epsilon_{c3}$ (‰)           | 1,75 |     |     |     |     |      |     |     |      | 1,8  | 1,9 | 2,0  | 2,2 | 2,3                               | see Figure 3.4<br>for $f_{ck} \geq 50$ Mpa<br>$\epsilon_{c3}^{(l/100)} = 1,75 + 0,55[(f_{ck} - 50)/40]$    |
| $\epsilon_{cu3}$ (‰)          | 3,5  |     |     |     |     |      |     |     |      | 3,1  | 2,9 | 2,7  | 2,6 | 2,6                               | see Figure 3.4<br>for $f_{ck} \geq 50$ Mpa<br>$\epsilon_{cu3}^{(l/100)} = 2,6 + 35[(90 - f_{ck})/100]^4$   |

Table 3-1 Strength and deformation characteristics for concrete

# Concrete Strength

*fib* Model Code 2020 – Chapter 14

| Concrete grade | C12 | C16 | C20 | C25 | C30 | C35 | C40 | C50 |
|----------------|-----|-----|-----|-----|-----|-----|-----|-----|
| $f_{ck}$       | 12  | 16  | 20  | 25  | 30  | 35  | 45  | 50  |
| $f_{cu}$       | 15  | 20  | 25  | 30  | 37  | 45  | 55  | 60  |

| Concrete grade | C55 | C60 | C70 | C80 | C90 | C100 | C110 | C120 |
|----------------|-----|-----|-----|-----|-----|------|------|------|
| $f_{ck}$       | 55  | 60  | 70  | 80  | 90  | 100  | 110  | 120  |
| $f_{cu}$       | 67  | 75  | 85  | 95  | 105 | 115  | 130  | 140  |

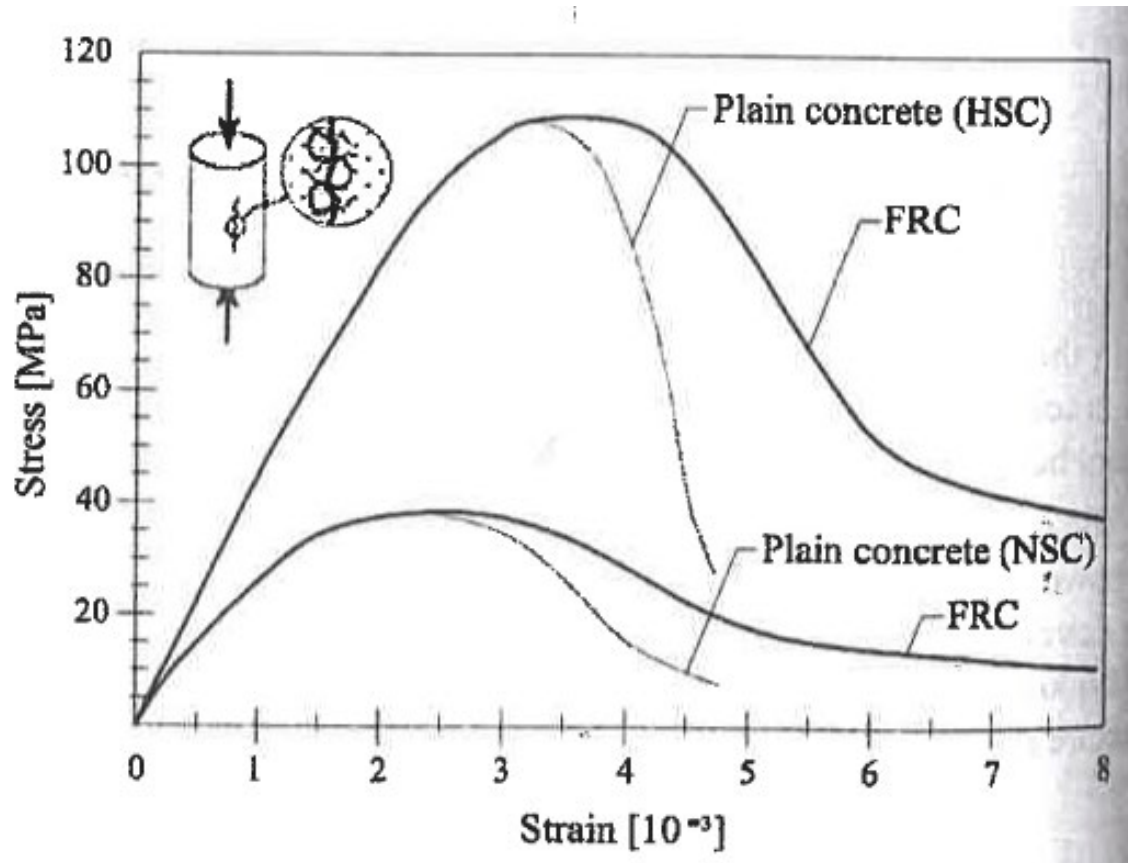
Characteristic Strength Values for normal weight concrete (MPa)

Table 12.6-1 *fib* Model Code 2020

# Fibre Reinforced Concrete

SANS 10100-1 – No reference

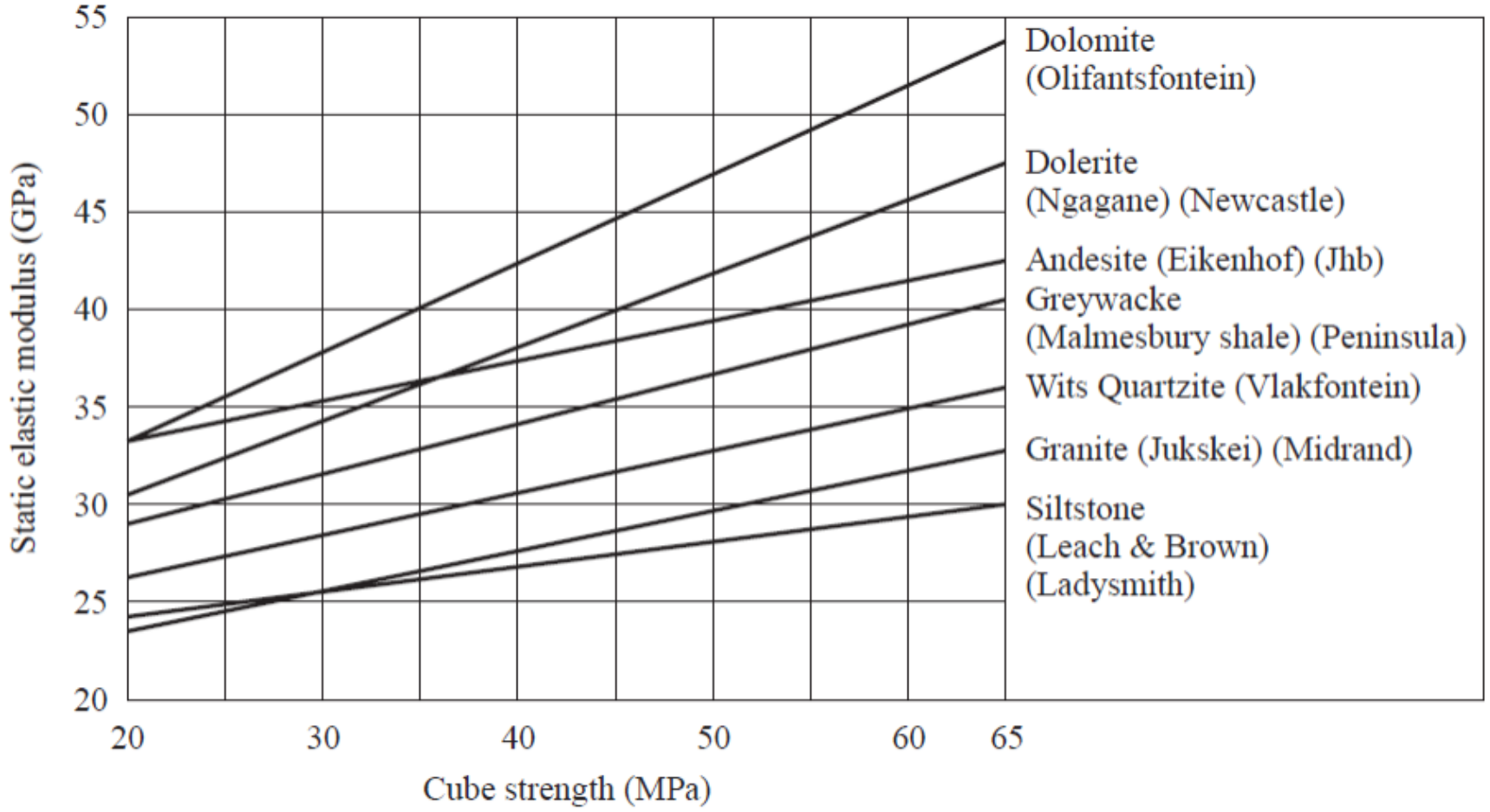
fib Model Code 2020 – Chapter 18



Difference between plain and fibre reinforced concrete having normal and high strength under axial compression – fib Model Code (2020)

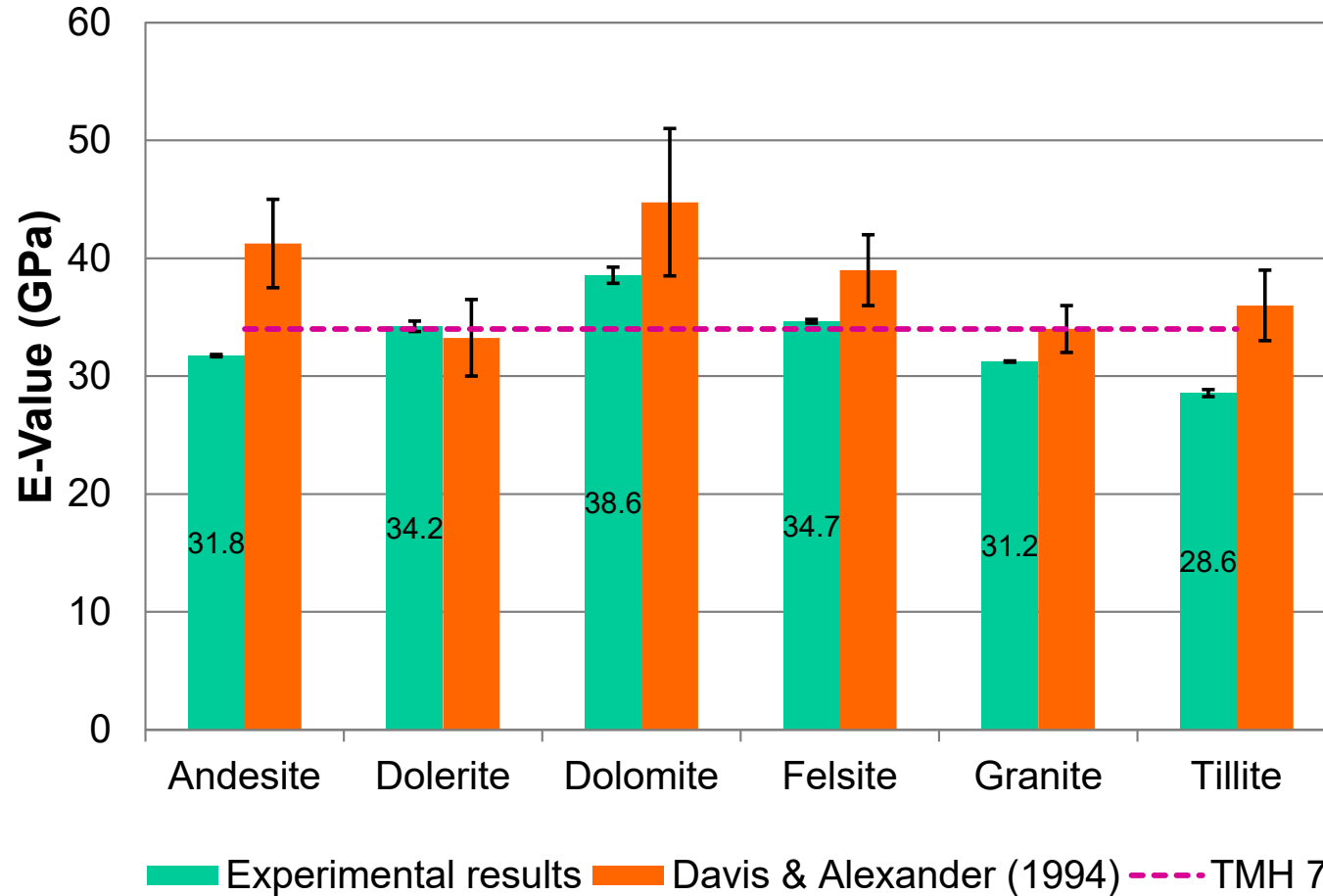
# Concrete Modulus of Elasticity (E-Value)

Aggregate type



Relationship between Modulus of Elasticity and Compressive strength (Alexander & Davis)

# Concrete Modulus of Elasticity (E-Value)



SANS 10100-1:  $E_{50 \text{ MPa}} = 28 \text{ to } 40 \text{ GPa}$

TMH 7 Part 3:  $E_{50 \text{ MPa}} = 28 \text{ to } 40 \text{ GPa}$

# Concrete Modulus of Elasticity (E-Value)

## SANS 10100-1

Strength:  $E_{c,28} = K_0 + 0.2f_{cu,28}$  (GPa)

$E_{c,28}$  = static secant MOE

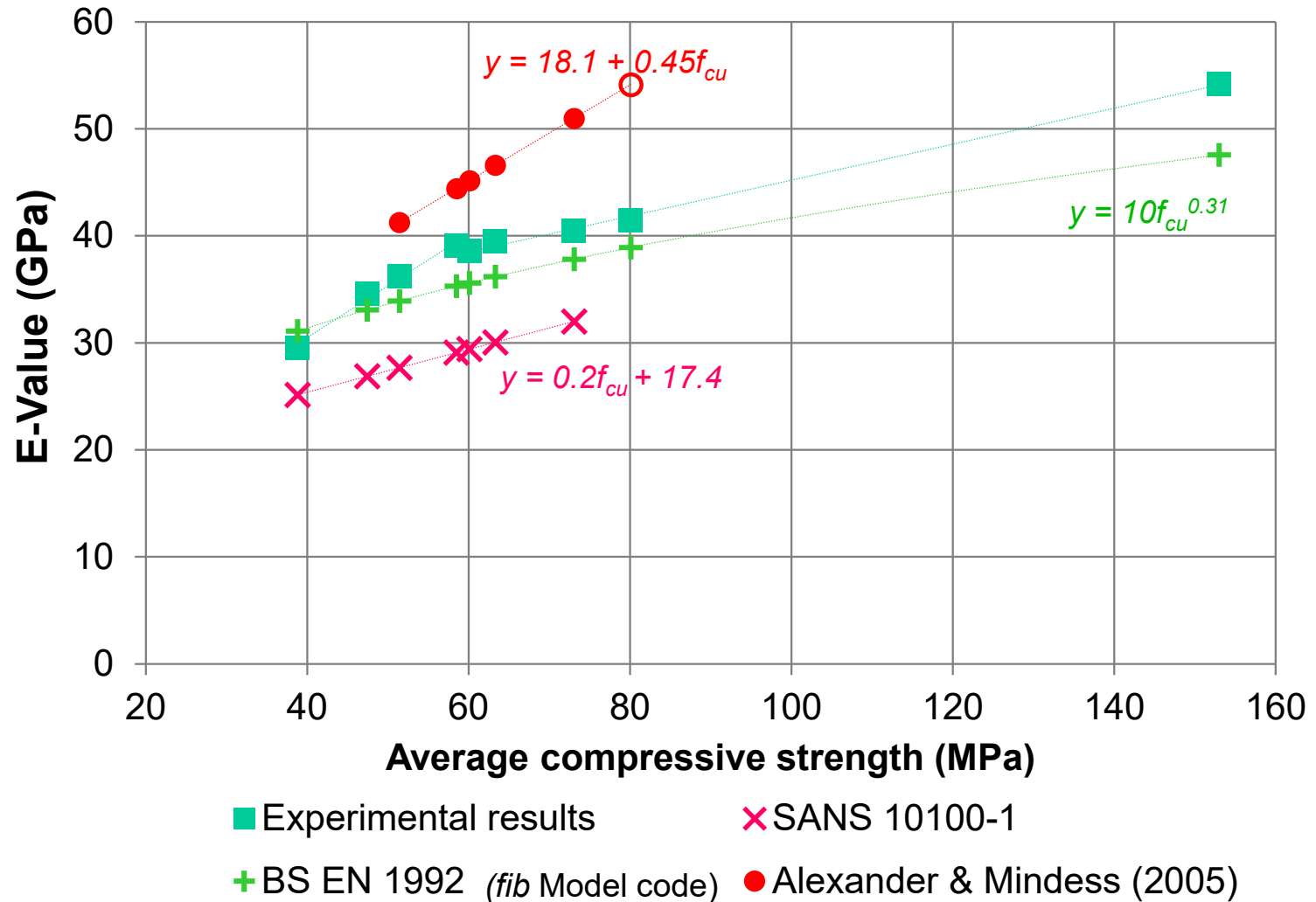
$K_0$  = constant related to the modulus of elasticity of the aggregate (20 GPa in SABS 10100)

$f_{cu}$  – characteristic cube strength at 28 days

**Table C.1 - Modulus of elasticity of normal-density concrete**

| 1                                       | 2                           | 3             | 4                               | 5             |
|---|-----------------------------|---------------|---------------------------------|---------------|
| Characteristic strength $f_{cu}$<br>MPa | Static modulus $E_c$<br>GPa |               | Dynamic modulus $E_{cq}$<br>GPa |               |
|   | Mean value                  | Typical range | Mean value                      | Typical range |
| 20                                      | 25                          | 21-29         | 35                              | 31-39         |
| 25                                      | 26                          | 22-30         | 36                              | 32-40         |
| 30                                      | 28                          | 23-33         | 38                              | 33-43         |
| 40                                      | 31                          | 26-36         | 40                              | 35-45         |
| 50                                      | 34                          | 28-40         | 42                              | 36-48         |
| 60                                      | 36                          | 30-42         | 44                              | 38-50         |

# Concrete Modulus of Elasticity (E-Value)



Dolomite concrete

# Concrete Modulus of Elasticity (E-Value)

*fib* Model Code 2020 – Chapter 14

$$E_{ci} = E_{c0} \alpha_E \left( \frac{f_{ck} + \Delta f}{10} \right)^{1/3}$$

$E_{ci}$  = Modulus of elasticity in MPa at 28 days

$f_{ck}$  – characteristic strength in MPa

$\Delta f$  – 8 MPa

$E_{c0} = 21.5 \times 10^3$  Mpa

$\alpha_E = 1.0$  for quartzite aggregates. For different types of aggregates this value can vary between 0.7 and 1.2. See Table 14.7-1

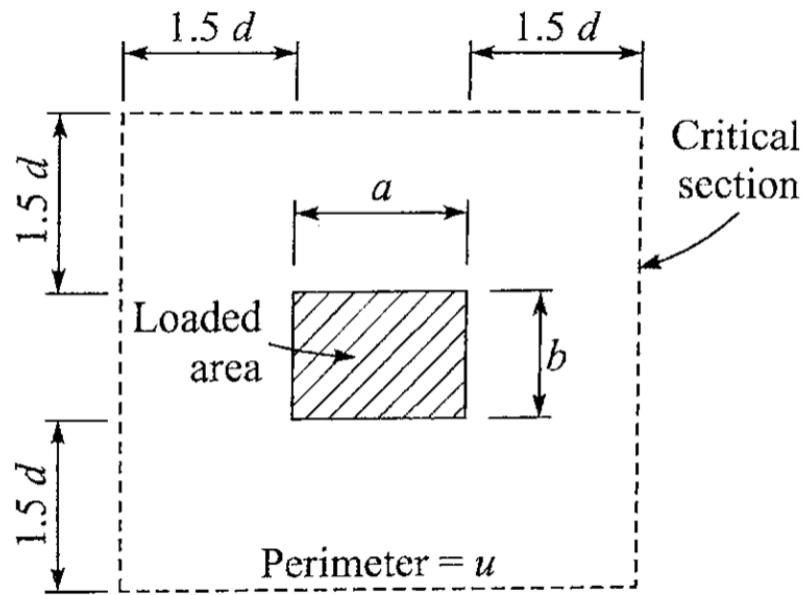
Table 14.7-1: Effect of types of aggregate on the modulus of elasticity

| Types of aggregate                    | $\alpha_E$ | $E_{c0} \cdot \alpha_E$<br>[MPa] |
|---------------------------------------|------------|----------------------------------|
| Stiff aggregates, e.g. Basalt*)       | 1.2        | 25'800                           |
| Ordinary aggregates, e.g. Quartzite*) | 1.0        | 21'500                           |
| Soft aggregates, e.g. Sandstone*)     | 0.7        | 15'100                           |

\*)Properties can strongly vary depending on local geology

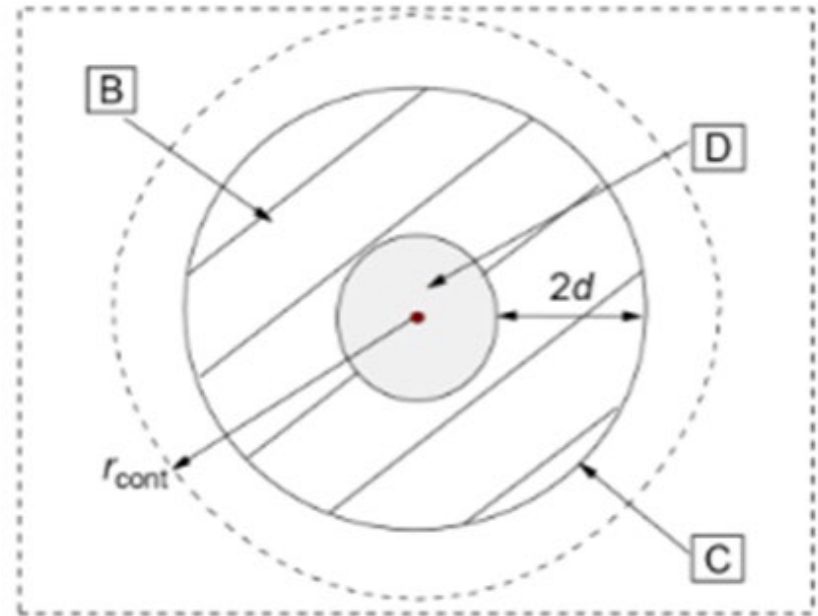
# SANS 10100 limitations

## Punching Shear

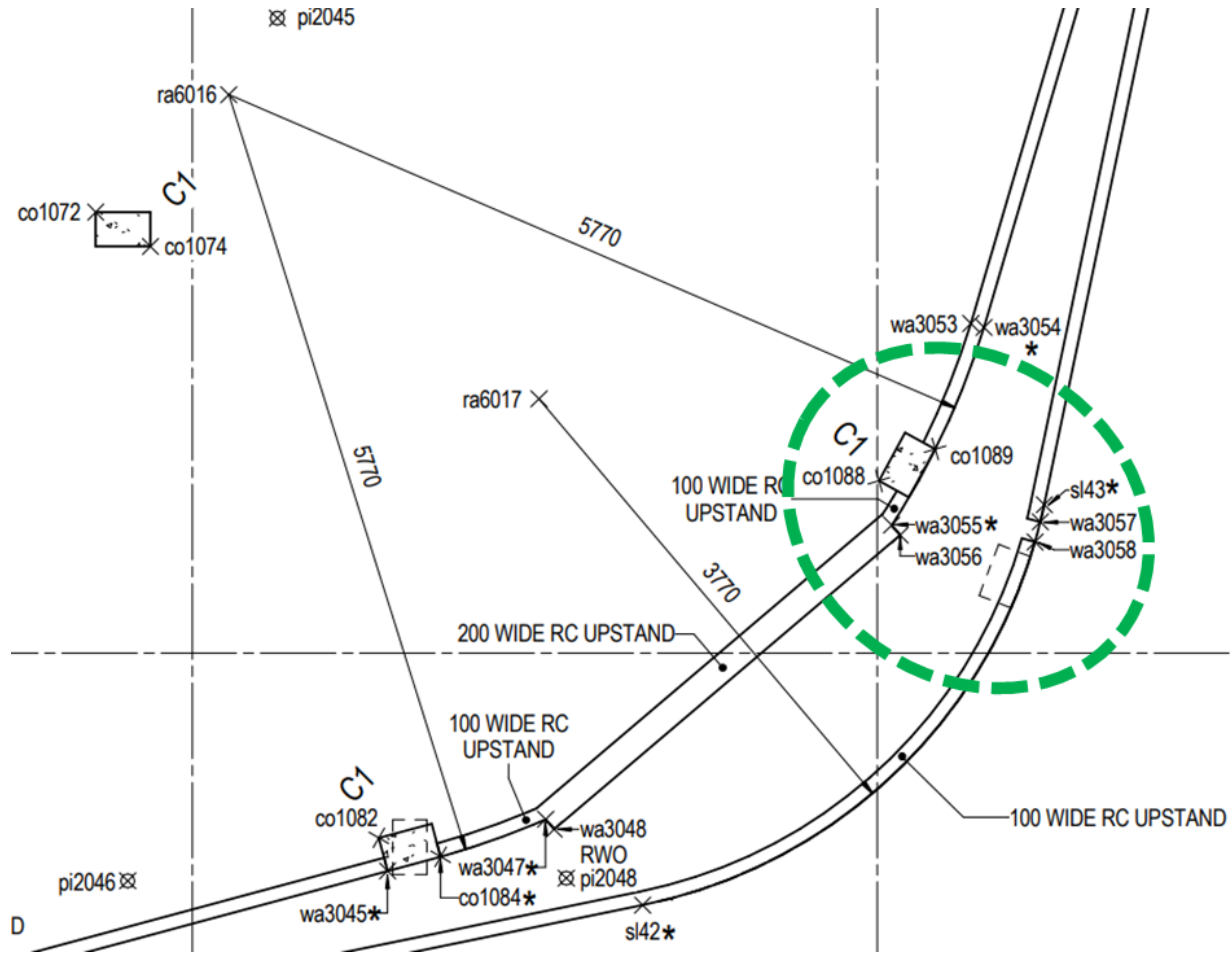


SANS 10100

EN 1992:2004



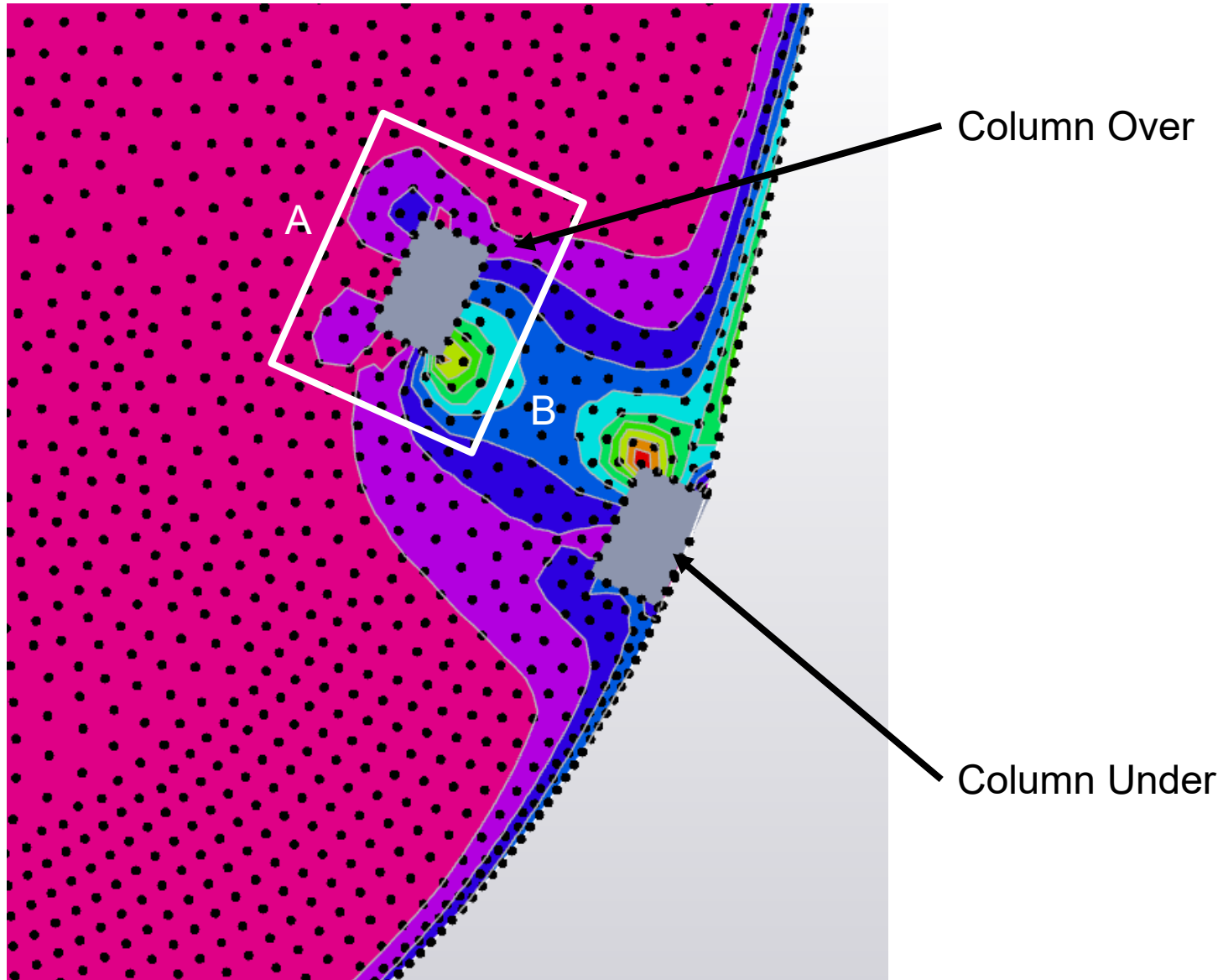
# SANS 10100 limitations



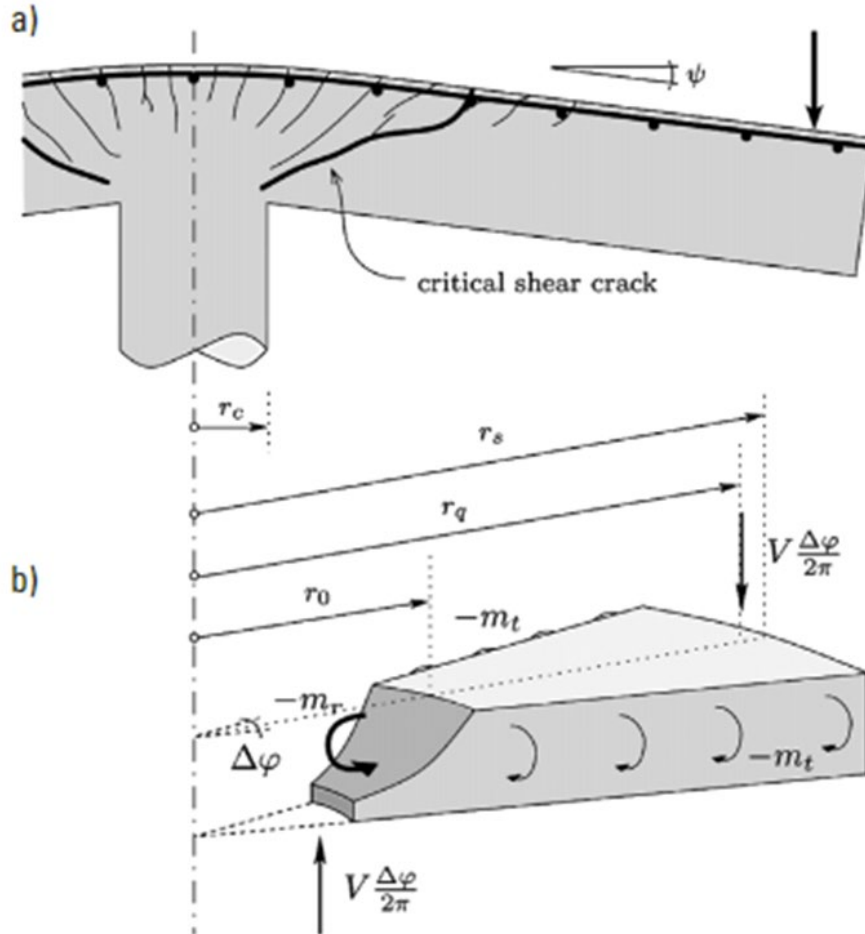
(5) The rules given in 6.4 are principally formulated for the **case of uniformly distributed loading**. In special cases, such as footings, the load within the control perimeter adds to the resistance of the structural system, and may be subtracted when determining the design punching shear stress.

(2) Control perimeters at a distance less than  $2d$  should be considered where the concentrated force is opposed by a high pressure (e.g. soil pressure on a base), or **by the effects of a load or reaction within a distance  $2d$**  of the periphery of area of application of the force.

# SANS 10100 limitations



# fib Model Code 2010 Punching



## Critical Shear Crack Theory:

- 1) You calculate the rotation of the slab ( $\varphi$ ) that corresponds to the shear force acting on the element ( $V_E$ ).
- 2) You calculate the shear resistance of the element ( $V_R$ ) based on the rotation of the slab ( $\varphi$ ).
- 3) If the  $V_E < V_R$  then your element is fine in shear. If not then modification is required.

Level of Approximation system

Muttoni et al.

# ***fib* Membership**

# fib Membership



## Individual

Student  
Young engineer  
Ordinary  
eSubscribing  
Subscribing



## Corporate

Associate  
Supporting  
Sponsoring



## National

Statutory

- Online viewer access to the CEB Bulletins and FIP report

- Online viewer access to the fib Bulletins
- Online viewer access to the fib Model Code for Concrete Structures 2020
- Online viewer access to the CEB Bulletins and FIP reports

- Becoming part of international pre-codification in general
- NMGs can contribute to the fib Model Codes (published approximately every 10 years)
- Voting rights in the General Assembly and in the Technical Council

# ***fib* National Membership**

Head of delegation – Sarah Skorpen

Deputy head of delegation – Kim Timm

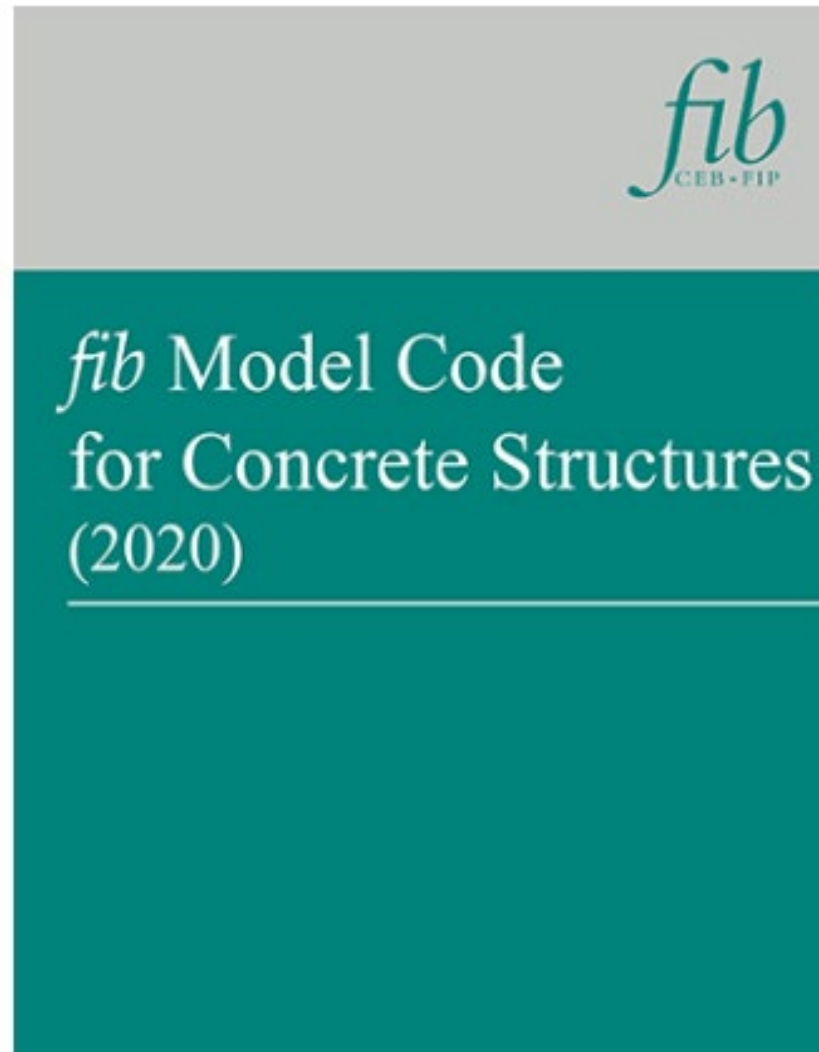
Concrete Society of Southern Africa: *fib* National Membership Group Committee

- Structural Engineers
- Academics – concrete structures
- Any other interested party

If you are interested to become part of the NMG Committee contact Natasja Pols  
[natasja.pols@concretesocietysa.org.za](mailto:natasja.pols@concretesocietysa.org.za)

# CONCRETEfix

## Introduction to the International Federation of Structural Concrete, *fib*, and the Model Code



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Built Environment and  
Information Technology  
Fakulteit Ingenieurswese, Bou-omgewing en  
Inligtingtegnologie / Lefapha la Boetšenere,  
Tikologo ya Kago le Theknolotši ya Tshedimošo