International Federation for Structural Concrete
Fédération internationale du béton

fib and Sustainability.

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David Fernández-Ordóñez
fib Secretary General

18 December 2024

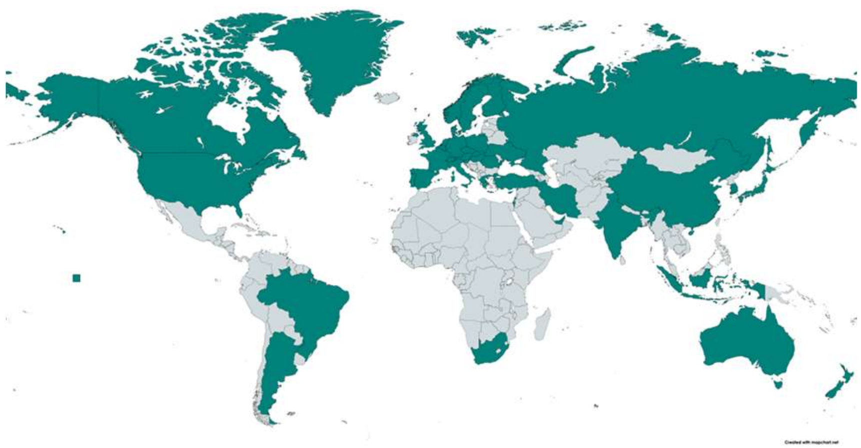
A *B*ridge between *R*esearch and *P*ractice

International Federation for Structural Concrete

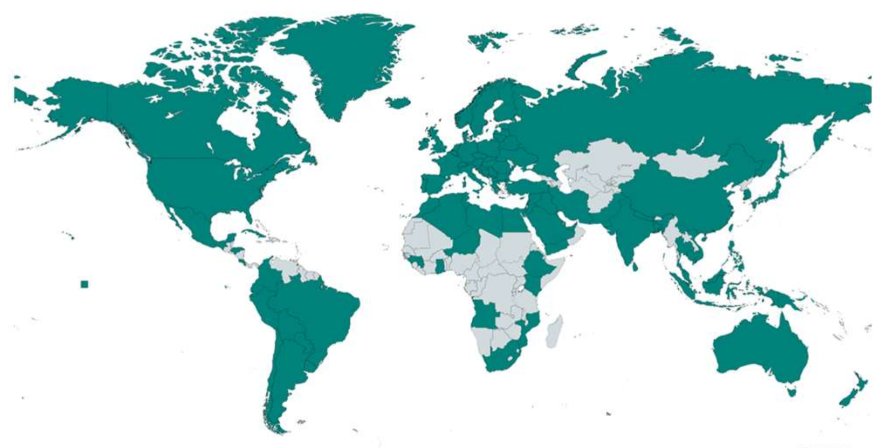
Creation of the *fib*

CEB 1953 + FIP 1952 → 1998 → *fib* CEB-FIP

40 *fib* statutory members



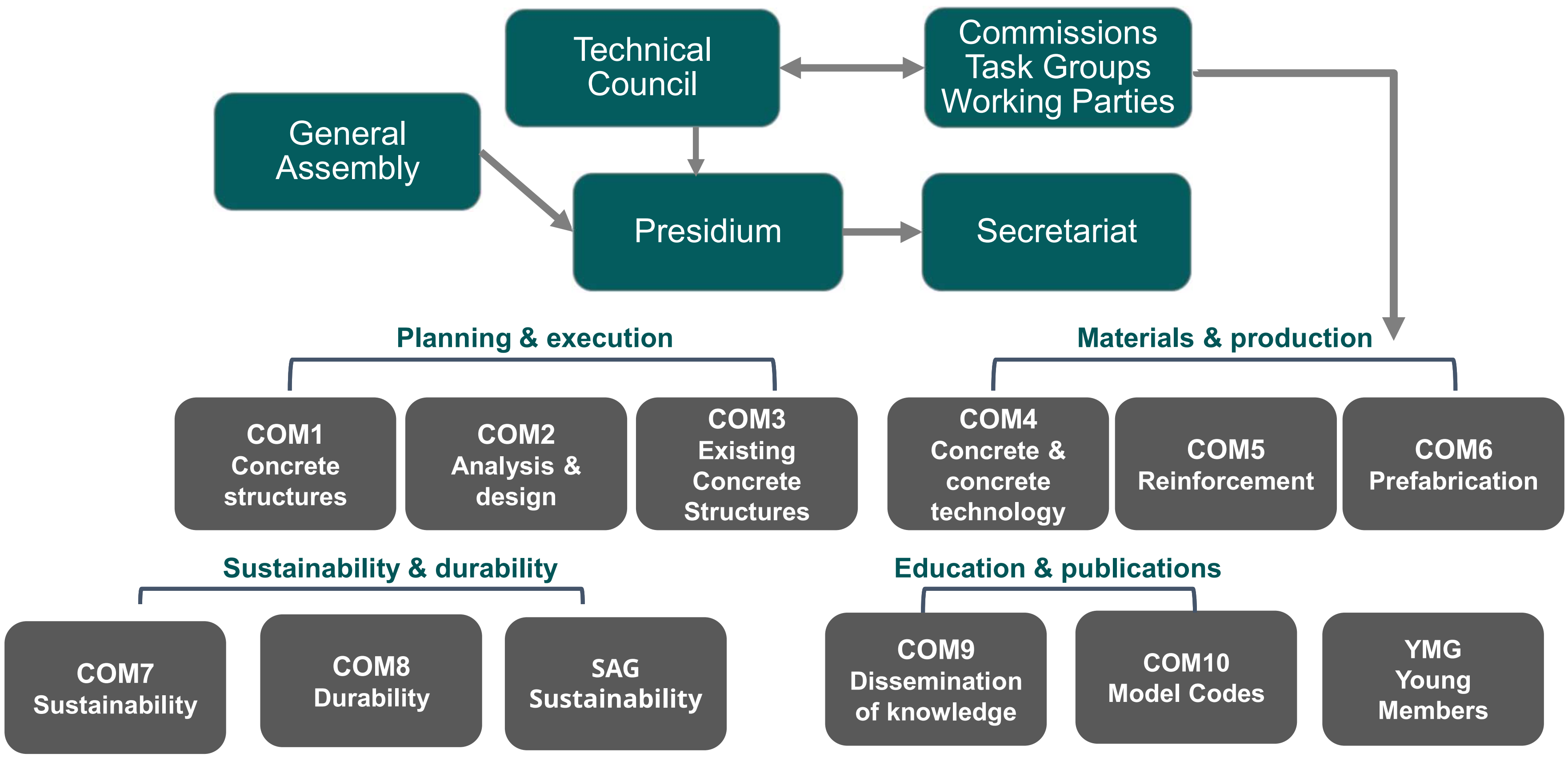
fib members in 104 countries



Mission and Objectives of the *fib*

“To develop at an international level the study of scientific and practical matters capable of advancing the technical, economic, aesthetic and environmental performance of concrete construction.” *Statutes of the fib*

The *fib's* structure



A *B*ridge between *R*esearch and *P*ractice

International Federation for Structural Concrete

2023-24 *fib* Presidium members

Stephen Foster
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Sylvia Keßler
Germany

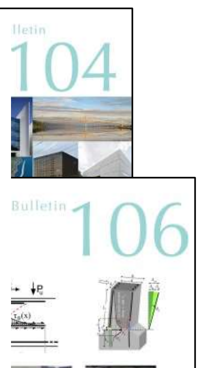
Steve Denton
UK

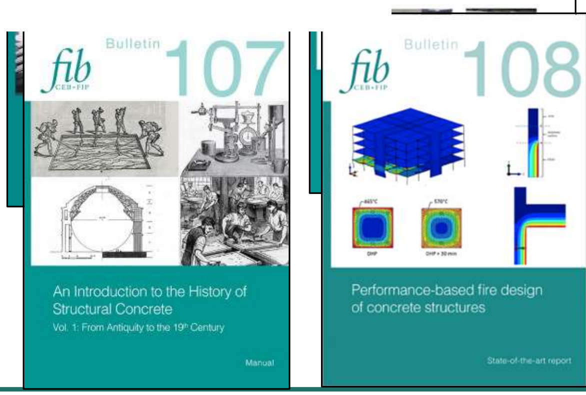
David Fernández-Ordóñez
Secretary General

A *B*ridge between *R*esearch and *P*ractice
International Federation for Structural Concrete

fib Bulletins

- Technical reports
- State-of-the-art reports
- Textbooks
- Manuals or guides
- Recommendations



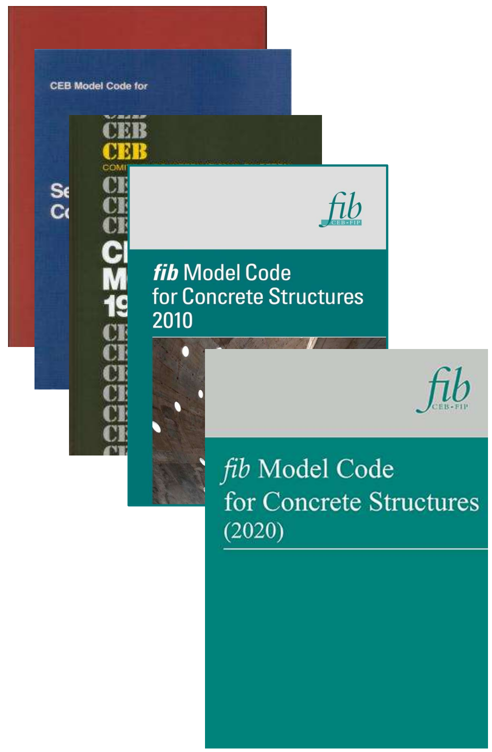


Model Codes

1978

1990

2010



The *fib*'s journal *Structural Concrete*

- Current impact factor: **3.2**
- 6 issues per year

Access to the Publications of the *fib*

PDF viewer

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Rose Fitzgerald Kennedy Bridge

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Winner

Civil Engineering Structures

Rose Fitzgerald Kennedy Bridge
N25, New Ross Bypass, Ireland

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The process of designing the Rose Fitzgerald Kennedy Bridge over the River Barrow spanned over 20 years from concept to completion.

The River Barrow Bridge provides the latest crossing point for the River Barrow which is at least 300 m wide at any point south of the town of New Ross. Located 30 km away from the sea, the bridge has been an engineering target for decades in Ireland. It provides a vital piece of infrastructure in the eastern corridor of the national roads network. Its completion removed a significant proportion of heavy traffic from the town of New Ross, enhancing the quality of life of the local communities while providing a much-needed reduction in long haul journey times in the south-east region.

The project was developed by Transport Infrastructure Ireland and their Technical Advisors Mott MacDonald Ireland in multiple stages. Between late 1998 and 2008, a concept design was developed during the planning and environmental studies stage and several alternatives were considered; from cable stayed to arches and balanced cantilevers, with a final preference for a three-tower extrados bridge which provided the right balance of slenderness and modest height towers. Tender for construction in a Public-Private Partnership (PPP) format took place in 2014, the contract was awarded in 2016 and the road was opened to traffic in January 2020.

The project, which includes a 12km long dual carriageway bypassing New Ross town, was tendered as a PPP Contract and awarded to BAM Iridium PPP Co with a team consisting of Dragados + BAM Ireland as contractors and Arup and Carlos Fernandez Casado S.L. as designers.

The design and value engineering of the structure was constrained by the requirements already established during planning as part of the Environmental Impact Statement and covered in Construction Requirements (critical documents in the Irish planning and tendering process). The following constraints, amongst others, were established as fixed:

- The exact position of the three towers (thus fixing the main spans to 230m).
- The height of the pylons (causing the bridge to be an extrados structure and limiting the cable angle to less than 12 degrees).
- The clear envelope for the navigational river channel (117m wide and 36m high over Mean High-Water Spring).
- The requirement for a full concrete section for the deck and pylons (at least the outside surfaces) and the requirements of a "closed" section with inclined webs without props or ribs.
- The maximum deck depth at the central pylon of 8m and at midspan of 3.5m.
- The position of a central pylon and a central plane of cables in cross section.
- The maximum height of the abutments over ground level of 10m.

With all the above constraints, the number of variables to optimise the design was limited to the cable spacing, number and size, along with the cross-section configuration for the main spans. There was also room to tweak the road design, both in plan and elevation, on the approaches and the configuration of the side spans.

Working within the challenging constraints listed above, the detailed design phase aimed to optimise the preliminary design concept of the structure for structural efficiency and material savings. To achieve a world record span in concrete for an extrados structure with a significant slenderness, the following changes were made:

The cross section was modified from inclined outer webs to two vertical webs 8m apart, substituting the outer webs with precast panels to maintain the appearance of a closed section. The precast panels contribute to the transversal behaviour but there is a gap of 20mm between each panel longitudinally, so they do not contribute to the longitudinal direction.

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The initial proposal of three parallel cables was substituted by a single cable, spaced 6.5m longitudinally and with a maximum size of 127 strands. Saddles were proposed for the cable detail passing on the pylons, allowing the pylon width to be reduced from 2.6m to 1.6m, to enable the minimum possible deck width.

To maintain a relatively light deck, the web and slab thickness were minimised using high strength concrete, where required. C80/95 concrete was used in the main spans and C60/75 in the side spans where the compression required this strength, while the approach spans were designed as C50/60.

Finally, minor adjustments to the side spans were implemented to optimise the longitudinal behaviour. The road alignment was also modified to reduce the bridge width on both ends to achieve a constant width cross section, where possible, and reducing the bridge length from 905m to 887m by changes in the vertical alignment.

The bridge's final configuration, after the minor span changes during tender, resulted in a total length of 887m, as already indicated, with an arrangement of 36 + 45 + 95 + 230 + 230 + 95 + 70 + 50 + 36m. In this way, the structure is characterised by 9 spans with 8 intermediate piers – P1 to P8 – and the 2 abutments – A1 and A2. The plan alignment is straight along 440m located approximately in the central part of the bridge and then curved with a transition from a radius of 720m to the straight alignment at both ends. The height of the deck above the ground or over the river reaches 40m and the height of the towers above the deck is 27.0m for the central tower (P4) and 16.2m for the two lateral ones (P3 and P5). These values imply tower height to span ratios of 0.07L for the side towers and 0.117L for the central tower (with L being the central span length). These are low values which lead to a classic extrados cable arrangement. In addition, the deck is only 3.5m deep at midspan (L/65), 8.5m at the central tower (L/27) and 6.5m at the side towers (L/35). These are quite slender parameters. It is also important to highlight the implication of the different heights of the towers. This leads to an asymmetric distribution of the cables along the main spans (8 from the side towers and 18 from the main tower). This asymmetry on the cable support on the main spans leads to different cantilever lengths during construction, the 8 cables from the lateral towers support approximately 90m while the main tower supports the remaining 140m of each span, resulting in a cantilever length during construction of 140m which would have equated to a 280m equivalent main span.

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This asymmetry and the presence of a central tower also affect the contribution of the cable system under traffic loads, as the central tower provides relatively low contribution when asymmetric spans are loaded.

The Rose Fitzgerald Kennedy Bridge over the River Barrow is a milestone in the design and construction of bridges of this typology. As a world record breaker span with a full concrete deck, its design and construction represented a significant challenge. This was not only due to its size, but also the slenderness achieved and the geometrical constraints derived from the Environmental Impact Statement. The fact that this structure presents a very slender deck affects the load distribution between this element and the cable system. This leads to a behaviour more closely related with cable stayed bridges in comparison with other extrados bridges. From an aesthetic point of view, this bridge is also unique due to the difference in height between the central tower and the side towers. This creates an asymmetry in the cable arrangement in relation to the central spans. Because of the slenderness of the deck, 3.5m deep at the tip with a maximum cantilever of 140m and extremely shallow cables angles (10 degrees with the deck), the geometric deflection control during construction was especially complicated, with the added difficulties of early age properties of the high strength concrete mix used in the project.

OWNER Transport Infrastructure Ireland (TII)
AUTHORITIES' TECHNICAL ADVISOR Mott MacDonald
MAIN AUTHORS Miguel Angel Astiz Suarez & Marcos Sánchez
OTHER PARTICIPANTS Lucia Blanco Martin, Guillermo Ayuso Calle, Borja Martin, Miguel Angel Gil, Raul Gonzalez Aguilar, Cian Long, Claudia Sanroman, Alfonso Ramirez Marchena, Mary Bowe, John Iliff, Fergal Cahill, Pierre O'Loughlin, Joe Shinkwin, John Murphy, Mike Wade & Ron Yee
CONTRACTORS BAM Ireland & Dragados UK Ireland
SUBCONTRACTORS/SUPPLIERS Tensa, Rubrica, Roadstone & Banagher
OPENED TO TRAFFIC January 2020

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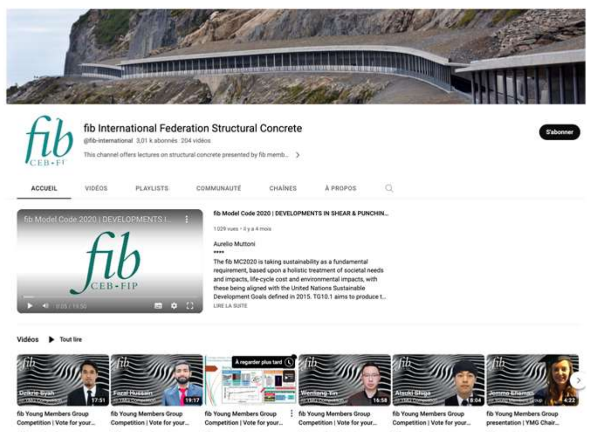
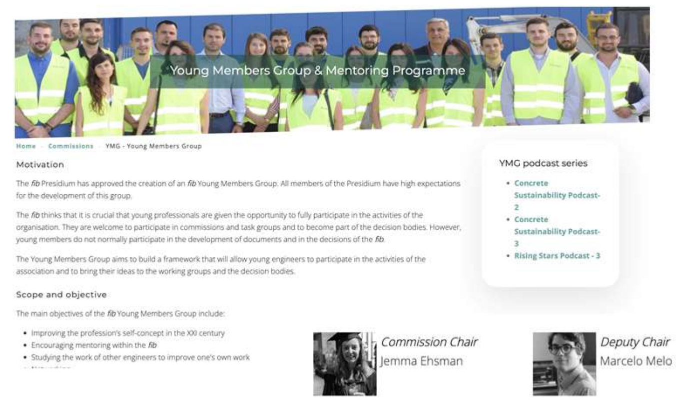
Let's keep in touch

- Social media
- *fib*-news
- e-newsletter

fib YouTube Channel



Join the *fib* Young Members Group!



- Events
- Podcast series
- YMG competition
- And more!

fib Young Members Group!

Home · Commissions · YMG - Young Members Group

Motivation

The *fib* Presidium has approved the creation of an *fib* Young Members Group. All members of the Presidium have high expectations for the development of this group.

The *fib* thinks that it is crucial that young professionals are given the opportunity to fully participate in the activities of the organisation. They are welcome to participate in commissions and task groups and to become part of the decision bodies. However, young members do not normally participate in the development of documents and in the decisions of the *fib*.

The Young Members Group aims to build a framework that will allow young engineers to participate in the activities of the association and to bring their ideas to the working groups and the decision bodies.

Scope and objective

The main objectives of the *fib* Young Members Group include:

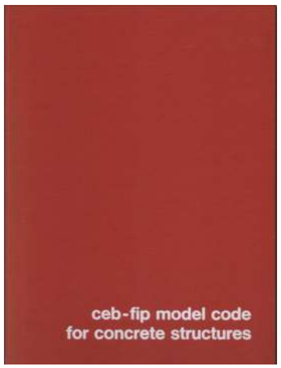
- Improving the profession's self-concept in the XXI century
- Encouraging mentoring within the *fib*
- Studying the work of other engineers to improve one's own work

YMG podcast series

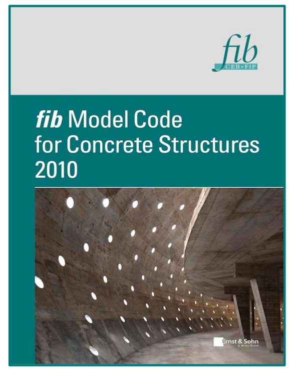
- Concrete Sustainability Podcast-2
- Concrete Sustainability Podcast-3
- Rising Stars Podcast - 3

Deputy Chair
Marcelo Melo

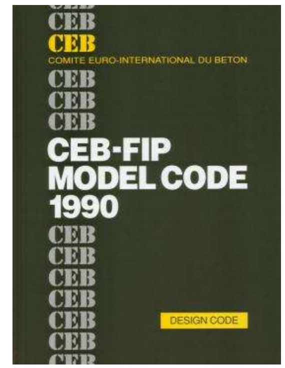
Evolution of Model Codes



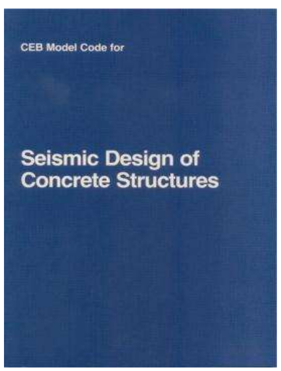
Model Code 1978



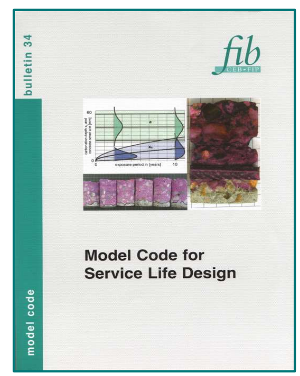
Model Code 2010



Model Code 1990

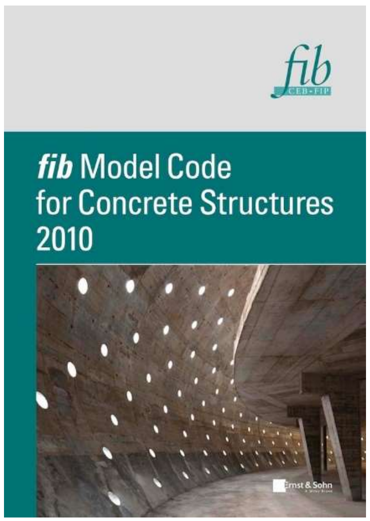


CEB Bull. 165 Seismic Design



fib Bull. 34 Service Life Design

fib Model Code 2010

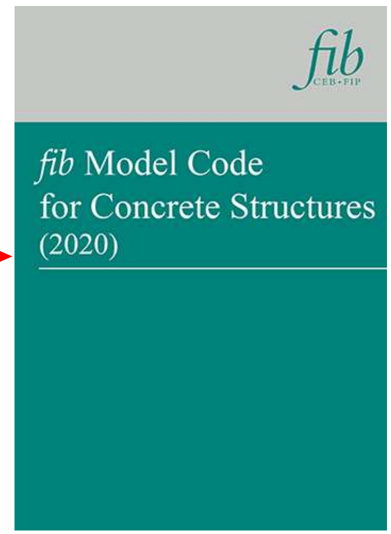


MC2010

5 Parts

10 Chapters

fib Model Code 2020



Greatly extended technical scope and coverage

MC2020

10 Parts

39 Chapters

MC2020

Identified overarching goals for the publication

- MC2020 is a single, merged structural code for new *and* existing structures
- Is an operational model code and oriented towards practical needs
- Includes worldwide knowledge with respect to materials and structural behaviour
- Recognizes the needs of engineering communities around the world

MC2020 Content

- Takes an integrated life cycle perspective
- Provides a holistic treatment of structural safety, serviceability, durability and sustainability
- Defines fundamental principles and a safety philosophy based on reliability concepts and sustainability
- Uses performance-based concept to remove specific constraints for novel types of concrete and reinforcing materials

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PART VII - DESIGN AND ASSESSMENT

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the *fib* Statement on Sustainability (2021)

Received: 18 June 2021 | Accepted: 20 June 2021
DOI: 10.1002/suco.202100396

POSITION PAPER

The *fib* official statement on sustainability

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Sustainability is a key value for today's society and also for the *fib*. In this sense, the whole organization is focused to develop information, documents, and tools to be used by the construction community and the society in general to achieve sustainability goals.

The ambition of the *fib* is that the work developed by the organization creates relevant knowledge in the three pillars of sustainability for the society. The work in the *fib* on the three pillars of sustainability is linked to the United Nations 17 Sustainable Development Goals and the developments of other organizations.

The *fib* is a not-for-profit association formed by 41 national member groups and approximately 1,000 corporate and individual members. The *fib*'s mission is to develop at an international level the study of scientific and practical knowledge capable of advancing the technical, social, economic, and environmental performance of concrete structures.

The knowledge developed and shared by the *fib* (*fib* Model Codes, *fib* Bulletins, *fib* events, *fib* workshops, *fib* courses, etc.) is entirely the result of the volunteering work provided by the *fib* members.

The *fib* was created in 1998 by the merger of the Euro-International Committee for Concrete (the CEB) and the International Federation for Pre-stressing (the FIP). These predecessor organizations existed independently since 1953 and 1952, respectively.

The *fib* is an independent society of professionals working in the field of concrete that includes concrete users, researchers, designers, and engineers from academia, design firms, constructors, and owners.

The *fib* has had a commission dedicated to environmental aspects of structural concrete from the start. Since then, the *fib* has created a Special Activity Group (SAG8) to deal with sustainability and environment in 2010 and created the Commission 7 "Sustainability" in 2015. In the *fib*, there are many Task Groups working on sustainability topics related to structural concepts, resilient structures, precasting, environmentally friendly concrete materials, recycling of materials and components, environmental product declarations, life cycle perspective analysis, etc. And *fib* will introduce some indicators to assess our commission activities in the field of sustainability. These indicators are used for the *fib* value assessment.

Sustainability concepts were already introduced in the Model Code 2010 and are a key part in the elaboration of the Model Code 2020 development. The *fib* Model Code is the only code which has sustainability philosophy as the main concept for the design, construction, and conservation of concrete structures built with concrete which started with MC2010.

Sustainability is a crucial concept for the design, construction, conservation and reuse of concrete structures. The *fib* has had a very intense activity on the environment and sustainability. As an example, we list the past bulletins developed in the *fib* about environmental aspects and sustainability:

- *fib* Bulletin 18. Recycling of offshore concrete structures. 2002.
- *fib* Bulletin 21. Environmental issues in prefabrication. 2003.
- *fib* Bulletin 23. Environmental effects of concrete. 2003.

Discussion on this paper must be submitted within two months of the print publication. The discussion will then be published in print, along with the authors' closure, if any, approximately nine months after the print publication.

Structural Concrete. 2021;22:1909–1910. wileyonlinelibrary.com/journal/suco © 2021 *fib*. International Federation for Structural Concrete | 1909

Sustainability in the Model Code

Received: 11 January 2023 | Revised: 25 February 2023 | Accepted: 26 March 2023
DOI: 10.1002/suco.202300022

ARTICLE

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Sustainability perspective in *fib* MC2020: Contribution of concrete structures to sustainability

Petr Hajek

Open Access:

https://doi.org/10.1002/suco.202300022

Received: 11 January 2023 | Revised: 25 February 2023 | Accepted: 26 March 2023
DOI: 10.1002/suco.202300022

ARTICLE

fib WILEY

Sustainability perspective in *fib* MC2020: Contribution of concrete structures to sustainability

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Funding information
Grantová Agentura České Republiky, Grant/Award Number: 22-14942K

Abstract

Sustainability is a global goal of sustainable development aimed at ensuring a quality life on the Earth for the future generations. Buildings, infrastructure and the entire built environment should be better prepared for the new conditions—they should be sustainable, resilient and adaptable to new situations. This requires new technical solutions for the construction, reconstruction, and modernization of buildings and all other engineering structures. Concrete is gradually becoming a building material with great potential for realizing technical solutions that meet new requirements, leading to the necessary reduction of environmental impacts and consequent improvement of social and economic conditions. The paper presents implementation of sustainability principles in the new fib Model Code 2020 (MC2020). This represents a contribution of the International Federation for Structural Concrete (fib) to the achievements of the Sustainable Development Goals (SDGs), set by the United Nations in 2015 as an action plan for the period up to 2030.

KEYWORDS
concrete, LCA, sustainability

1 | INTRODUCTION

1.1 | Global situation

The world faces an increasing number of environmental damage and/or natural disasters, and constantly growing economic and social problems and challenges. The most critical causes of this situation are population growth and global warming due to the rapidly increasing amount of greenhouse gasses in the atmosphere during last 2 hundred years.

In 2022, the world population has exceeded 8 billion. This represents 3.2× increase since 1950. During the same period, CO_2 emissions increased more than six times, world average temperature increased by 1°C and the number of recorded natural disasters increased 15 times.[1] Entire society, all nations, must take an action to slow down this process and adapt to the new natural and social conditions. To achieve these goals, it is crucial to implement sustainability and resilience as the most important objectives in all human activities and actions.

Discussion on this paper must be submitted within two months of the print publication. The discussion will then be published in print, along with the authors' closure, if any, approximately nine months after the print publication.

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Structural Concrete. 2023;1–10. wileyonlinelibrary.com/journal/suco 1

MC2020. Specific aspects of Sustainability

Chapters related to Sustainability in the MC2020

- Chapter 3. Sustainability perspective
- Chapter 14. Concretes
- Chapter 26. Conceptual design
- Chapter 27. Approach to design
- Chapter 30. Evaluation of structural performance
- Chapter 31. Evaluation of other aspects of social performance
- Chapter 32. Evaluation of environmental performance
- Chapter 33. Evaluation of economic performance
- Chapter 34. Sustainability decision making

MC2020. Specific aspects of Sustainability

3. Sustainability perspective

3.1 Principles of design and assessment with respect to sustainable development

3.2 Social performance

3.3 Environmental performance

3.4 Economic performance

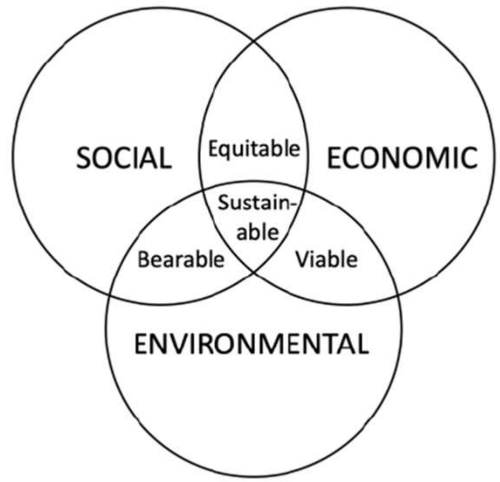


Figure 3.1-1: *Three pillars of sustainability and their interconnections*

MC2020. Specific aspects of Sustainability

14. Concretes

14.5 Environmental performance of concrete

The evaluation of the environmental impact of a concrete structure is highly complex and comprises a great bandwidth of aspects reaching from emissions and resources consumption resulting from the production of the concrete and other building materials, the impact resulting from the building process itself, impacts resulting from the use of the structure (such as heating, cooling etc.) as well as impacts from the demolition of the structure.

Concrete, however, by definition, cannot be sustainable or non-sustainable in itself. It is rather in the responsibility of the designer to use the given material properties in the most sustainable manner during design, execution, and in-service operation of the structure throughout its entire life cycle.

MC2020. Specific aspects of Sustainability

26. Conceptual design

26.1.2 Consideration of sustainability

Sustainability is a holistic concept that involves many aspects that must be satisfied simultaneously and in a balanced way.

At the stage of conceptual design of new structures and interventions in existing structures the evaluation of sustainable performance shall be considered from the perspective of all three pillars of sustainability.

It is essential to consider changes and development of sustainable performance within the entire life of a structure.

MC2020. Specific aspects of Sustainability

27. Approach to design

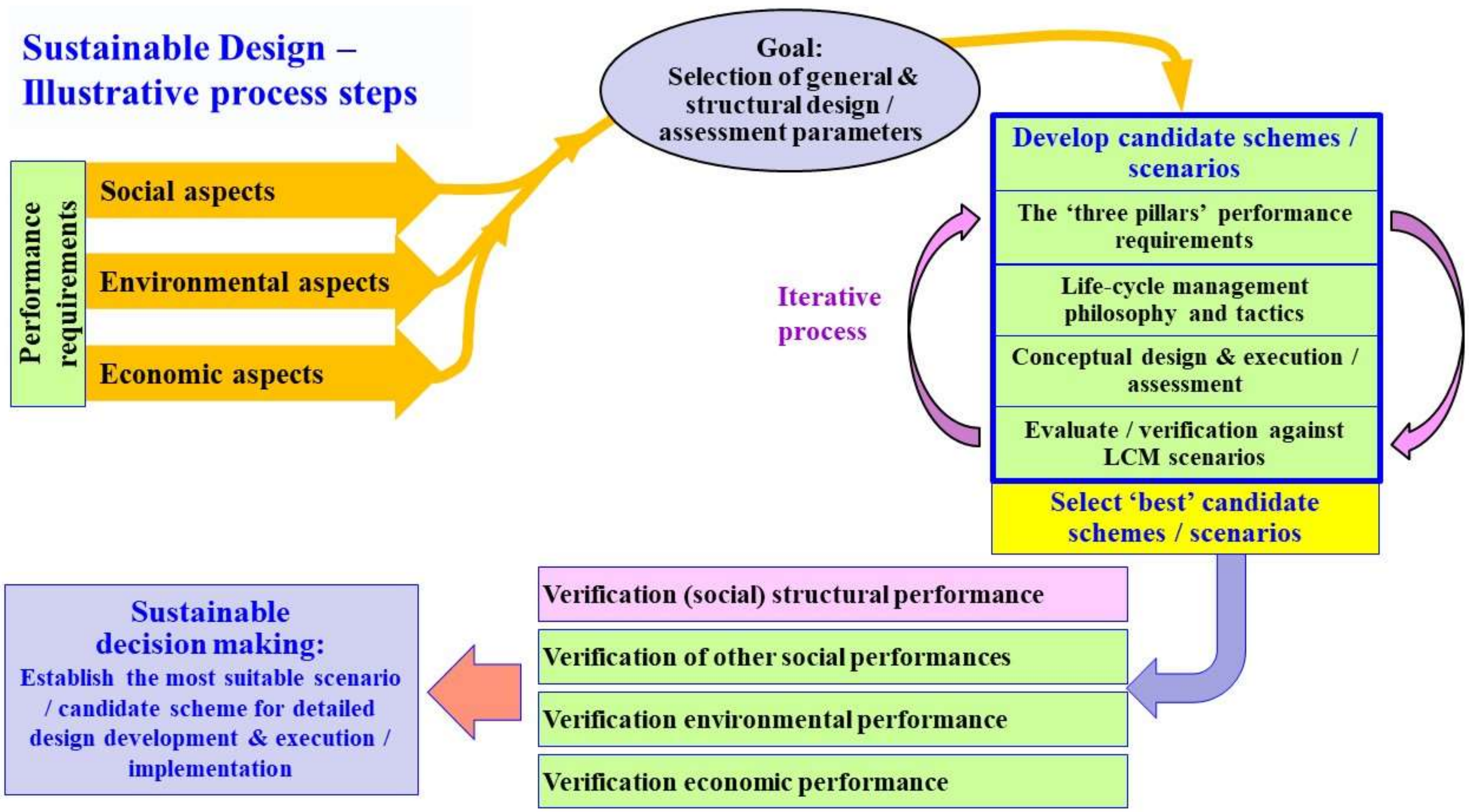
27.2 Consideration of sustainability

Sustainable development is an overarching objective of Model Code 2020 which is defined through three interdependent and mutually reinforcing pillars: namely the objectives and performance requirements established under the pillars of social responsibility, environmental quality and economic efficiency.

Figure 27.2-1 presents illustrative process steps for sustainable design, which are applicable to both general and structural design activities. Appropriately safe and reliable structural performance is a fundamental requirement for the satisfactory societal performance of a concrete structure.

MC2020. Specific aspects of Sustainability

27. Approach to design



MC2020. Specific aspects of Sustainability

31. Evaluation of other aspects of social performance

- 31.1 Introduction
- 31.2 Health and quality of the built environment
- 31.3 Safety and security
- 31.4 Aesthetics and cultural heritage
- 31.5 Impact on local community

MC2020. Specific aspects of Sustainability

32. Evaluation of environmental performance

32.1 General

32.2 Objectives of evaluation of environmental performance

32.3 Principles of environmental impact evaluation

32.4 Life cycle assessment

32.5 Environmental Product Declaration

32.6 EIA – Environmental Impact Assessment

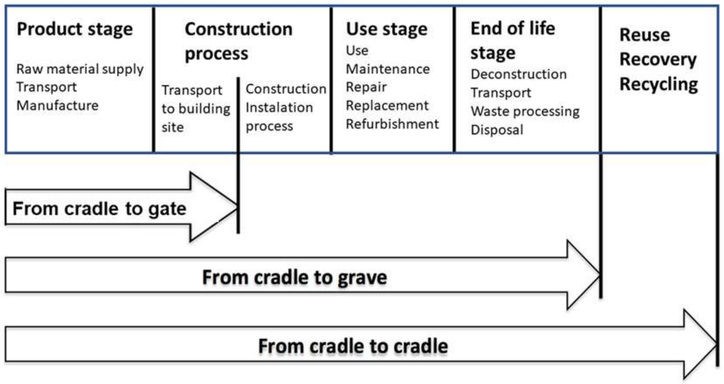


Figure 32.3-2: Different concepts of LCA of concrete structures.

MC2020. Specific aspects of Sustainability

33. Evaluation of economic performance

33.1 Introduction

33.2 Cost categories

33.3 Methodology of LCCA

$$C_{T_d}(\boldsymbol{p}) = C_0(\boldsymbol{p}) + \sum_{n=1}^{N(t_D)} C_{m,n}(\boldsymbol{p})\delta(t_n) + C_D\delta(t_D) \qquad (33.2\text{-}2)$$

where:

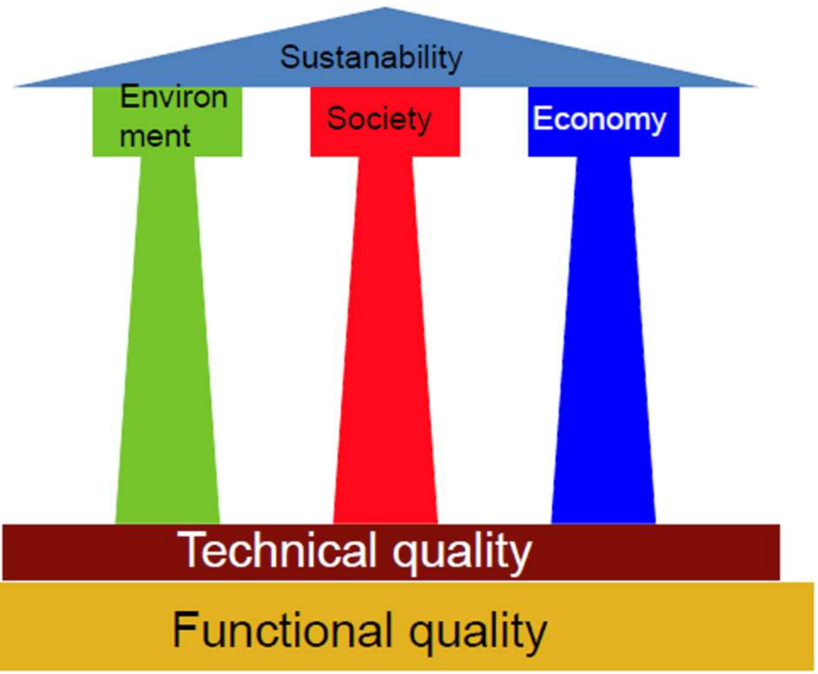
C_0	Design and construction costs (monetary unit);
$C_{m,n}$	Cost of the n^{th} preventive maintenance (monetary unit);
C_D	End-of-service-life costs –Decommissioning costs-(monetary unit);
$\delta(t)$	Discounting function;
t_n	time at which the n-th intervention occurs;
$N(t_D)$	the total number of interventions within time frame t_D;
t_D	end of service life of the system;
$\boldsymbol{p}$	vector parameter of system properties.

MC2020. Specific aspects of Sustainability

34. Sustainability decision making

33.1 Introduction

33.2 Evaluation



MC2020. Specific aspects of Sustainability

34. Sustainability decision making

33.1 Introduction

Each one of the pillars measures a different aspect of sustainability and the criteria and indicators that compose these pillars are generally not combinable. Therefore it is not possible to combine them in a direct way.

Administrations normally have economic limitations but also value specific aspects or ambitions of the project. Normally they will give more preference to solutions that add more value to their requirements if they are in the economic range that is affordable to them. Administrations can be restricted by economic limitations but these should value other requirements and ambitions of the project by properly considering the other pillars.

MC2020. Specific aspects of Sustainability

34. Sustainability decision making

33.2 Evaluation

There are several available approaches oriented to assess sustainability by combining the three pillars. Some of these tools might dismiss the explicit consideration of the ISO regulations for the evaluation of the performance according to the three pillars.

Should the pillars be combined to derive a global sustainability that permits to make decisions, a transparent and consistent procedure has to be followed to establish objective performance for each of the three pillars and the combination of them.

Sustainability-related Task Groups in the *fib*

SPECIAL ACTIVITY GROUP SUSTAINABILITY

TG.SAG.1 Data bases
TG.SAG.2 Low carbon concrete structures and best practices

COMMISSION 7 SUSTAINABILITY

TG 7.1 Sustainable concrete- general framework
TG 7.3 Concrete with recycled materials
TG 7.5 Environmental product declarations
TG 7.6 Resilient structures
TG 7.7 Sustainable concrete masonry components and structures
TG 7.8 Waste materials and industrial by products for high performance reinforced concrete structures

OTHER GROUPS RELATED TO SUSTAINABILITY

TG 1.5 Structural sustainability
TG 4.8 Low-carbon concrete structures
TG 6.3 Sustainability of precast structures

Special Activity Group (SAG). Sustainability

Objective 1: *fib* Database (TG.SAG.1, Costantino Menna)

- Existing database at national or regional level: state-of-the-art and availability
- Main properties/needs of the *fib* Database (sql, no-sql, regional, LCA phases, time representativeness…)
- Source data (manufacturers, associations, literature, …)
- Tools to use the database (online platform, report, specific Bill of Quantity software, BIM, …)

Special Activity Group (SAG). Sustainability

Objective 2: *fib* methodology (TG.SAG.1, Costantino Menna)

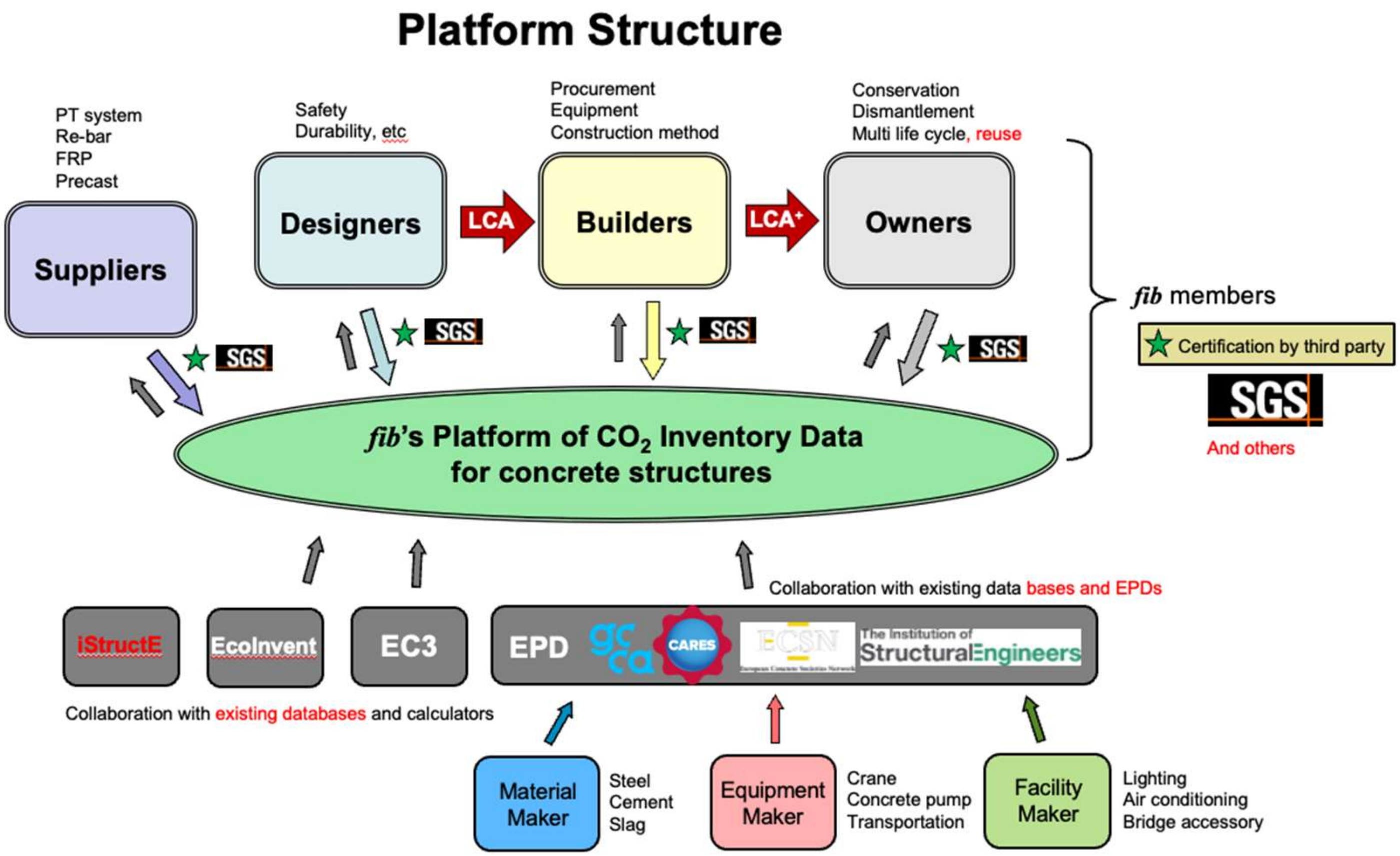
- Existing methodologies and standards: PCR, ISO, …
- Main properties/needs of the *fib* methodology (regional, LCA phases, boundary system, inventory data, Impact categories…)
- Level of application (structural sytems, structural typologies, technological boundaries)
- Tools to use the methodology (online platform, report, specific Bill of Quantity software, BIM, …)
- Methodology certification/standardization (EPD, Model code…)
- Examples and case studies

Special Activity Group (SAG). Sustainability

EN15978

BUILDING LIFE CYCLE INFORMATION																additional information outside the system boundary
A PRODUCT STAGE			A CONSTRUCTION STAGE		B USE STAGE							C END OF LIFE STAGE				D POTENTIAL BENEFITS AND LOADS
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw Material Supply	Transport	Manufacturing	Transport	Construction - Installation process	Use; installed products	Maintenance	Repair	Replacement	Refurbishment	Operational Energy use	Optional Water use	Deconstruction	Transport	Waste processing for reuse, recovery or/ and recycling	Disposal	Reuse - Recovery - Recycling - potential

Special Activity Group (SAG). Sustainability



Special Activity Group (SAG). Sustainability

Objective 3.1: Low carbon concrete structures and best practices (TG.SAG.2, Agnieszka Bigaj):

- Identifying range of **material, structural and technological innovation** to enhance sustainability of concrete structures
  - innovations at material level, structural design level, construction level, maintenance and interventions level, dismantlement and circular use:
    - addressed in ongoing *fib* activities
    - not yet addressed in ongoing *fib* activities

- Identifying **best practices for different innovative solutions**, for various structures, market conditions and geographical areas

Special Activity Group (SAG). Sustainability

Objective 3.2: Low carbon concrete structures and best practices (TG.SAG.2, Agnieszka Bigaj):

- Formulating <u>consistent basis for</u> **performance-based design of sustainable structures in a life cycle perspective** suitable for enhancing the sustainability of concrete structures:
  - consistent safety philosophy for structural design innovative solutions (reliability requirements and uncertainties treatment in verification of structural performance)
  - principles of equivalent performance approach for structural design with innovative (material) solutions
  - framework for performance evaluation based on material and structural testing of innovative solutions

Special Activity Group (SAG). Sustainability

Objective 3.3: Low carbon concrete structures and best practices (TG.SAG.2, Agnieszka Bigaj):

- Identifying methodologies for **decision-making process towards sustainable structural solutions for design, execution and life cycle management including interventions,** optimized in terms of environmental impact, economic and social performance, and satisfying structural and functional performance requirements:
  - optimization objectives
  - effective optimization strategies and procedures

Globe Consensus

http://globe-consensus.com

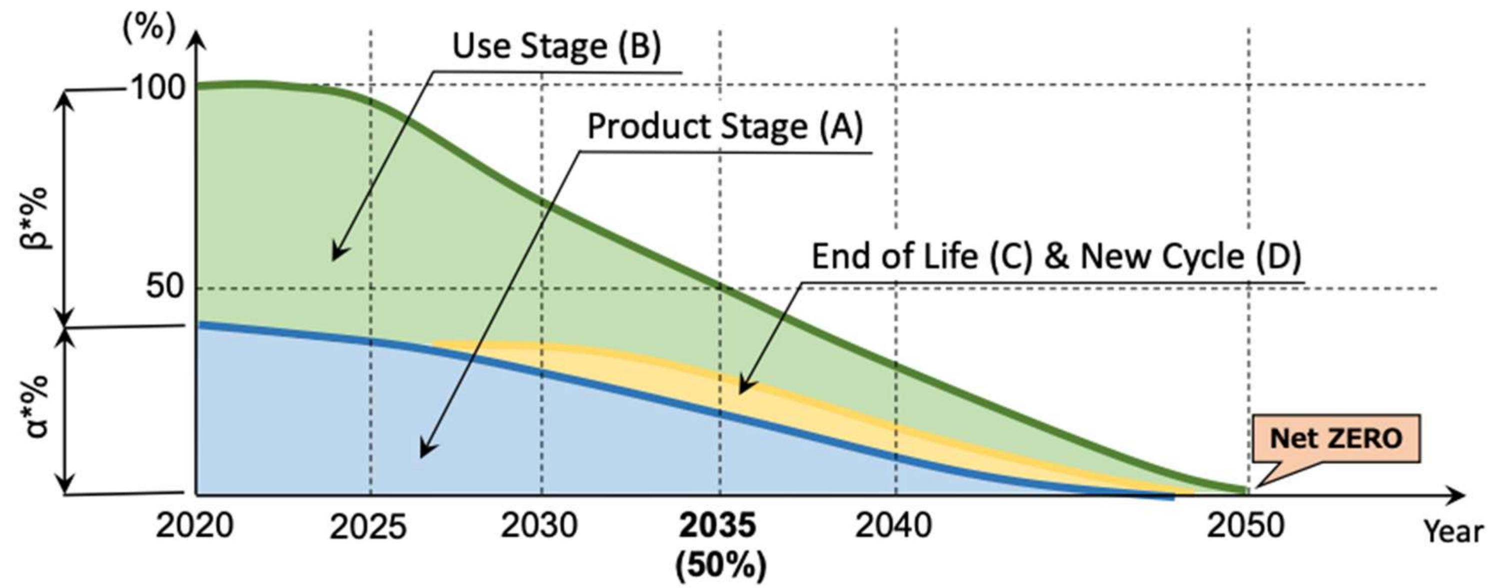
Chair of the Globe:
David Ruggiero EPFL

Globe Consensus

Benchmarking of Resource Use and Embodied CO_2 in Buildings

The objective is to set the foundation for global benchmarks on the carbon footprint of buildings, based on a joint methodology for assessing and reporting embodied impacts in an attempt to generate globally harmonized yet location-specific benchmarks. Measuring and benchmarking is a key strategy to reduce the resource use and CO2 footprints of the global building stock. A global standard will allow to compare and learn from the wide variety global design and construction practices, fostering research and innovation which are crucial to our common climate ambitions.

fib Roadmap

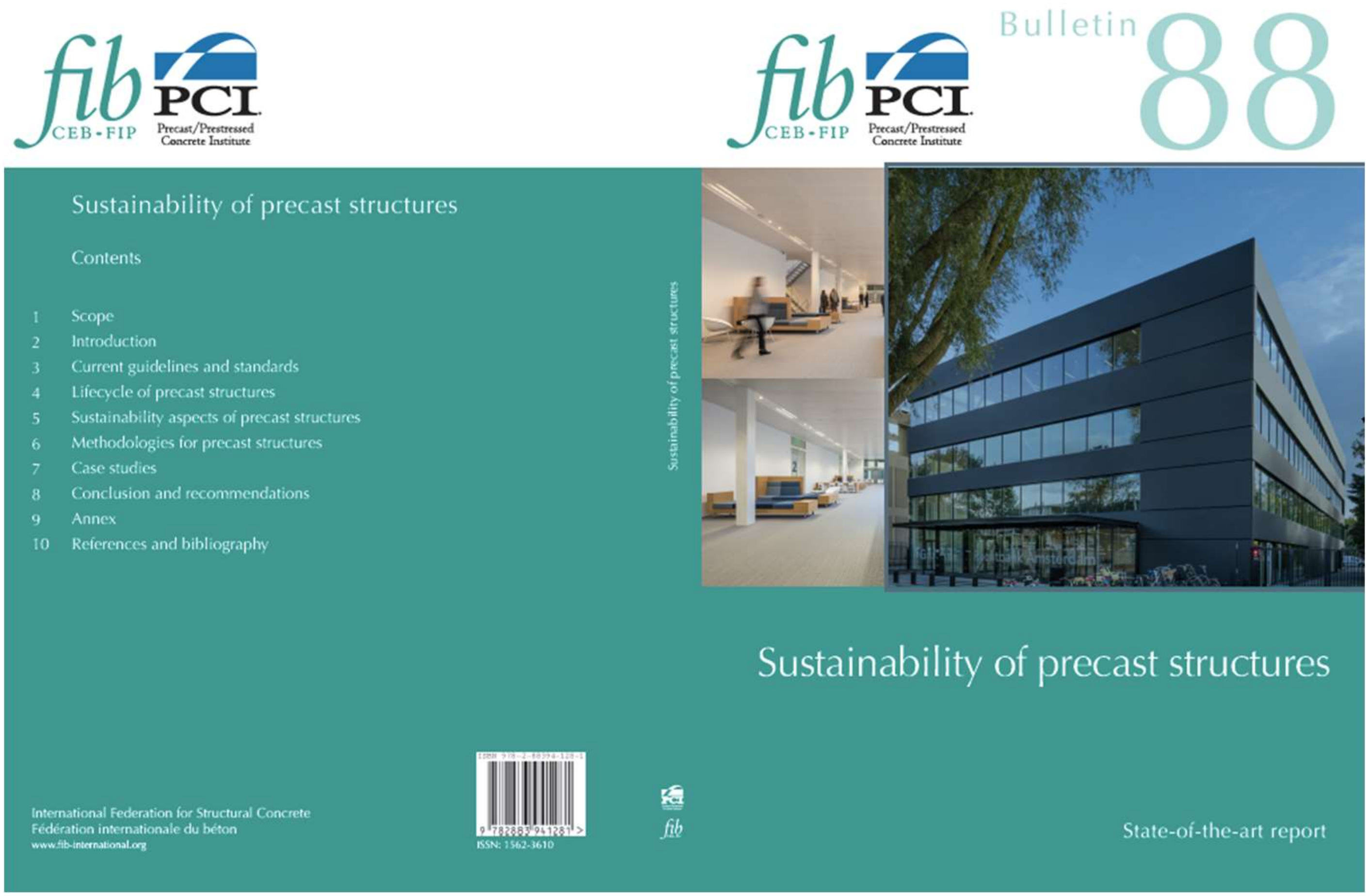


∗ ; α and β might vary depending on the type of structure and the country.

Figure 1. Timeframe for carbon neutrality by 2050.

TG 6.3 Sustainability of structures with precast elements

Conveners: De la Fuente, Josa, Fernández-Ordóñez (Spain)



Sustainability in Housing: EPD

Environmental Declaration ISO/DIS 14025 Type III

CONTIGA

Miljødekke

EPD

Næringslivets Stiftelse for Miljødeklarasjoner

NEPD nr.11N

Godkjent av Stiftelsens Verifikasjonskomité

Gyldig til 31.12.2005

Deklarasjonen er utarbeidet av

Stiftelsen Østfoldforskning

Miljødekke er produsert av:

Contiga AS

Kontaktperson: Jørn Injar

Telefon: 69 24 46 00

E-mail: jorn.injar@contiga.no

Organisasjons nummer: No 917 507 837

EMAS/ISO-14001 reg.No.: -/-

Produktspesifikasjon:

	Andel av total [%]	*Data quality*	*Masse [kg/m2 element]*
Sand	48,5	Stedsspesifikke data	192,3
Pukk	11,5	Stedsspesifikke data	45,6
Miljøpukk	20,4	Stedsspesifikke data	81,1
Sement	12,5	Stedsspesifikke data	49,4
Additiver	0,1	Under cut-off	0,5
Vann	1,8		7,0
Slamvann	3,9	Fra egen produksjon	15,4
Armering	1,3	Generelle data	5,2
Total			**396,6**

Bakgrunns informasjon:

Studien omfatter hele livsløpet.

Funksjonell enhet: 1m² hulldekkelement HD265, basert på element 12 m med 8 spenntau.

Årstall for studien: 2000

Datagrunnlag: Råvaredata fra 1998-01

Antatt levetid: 100 år

Produksjonssted: Contiga AS, Moss

Antatt markedsområde: Østlandsområdet.

Leverandørers miljøstyringssystem

- Contiga har for tiden ingen krav til leverandører om

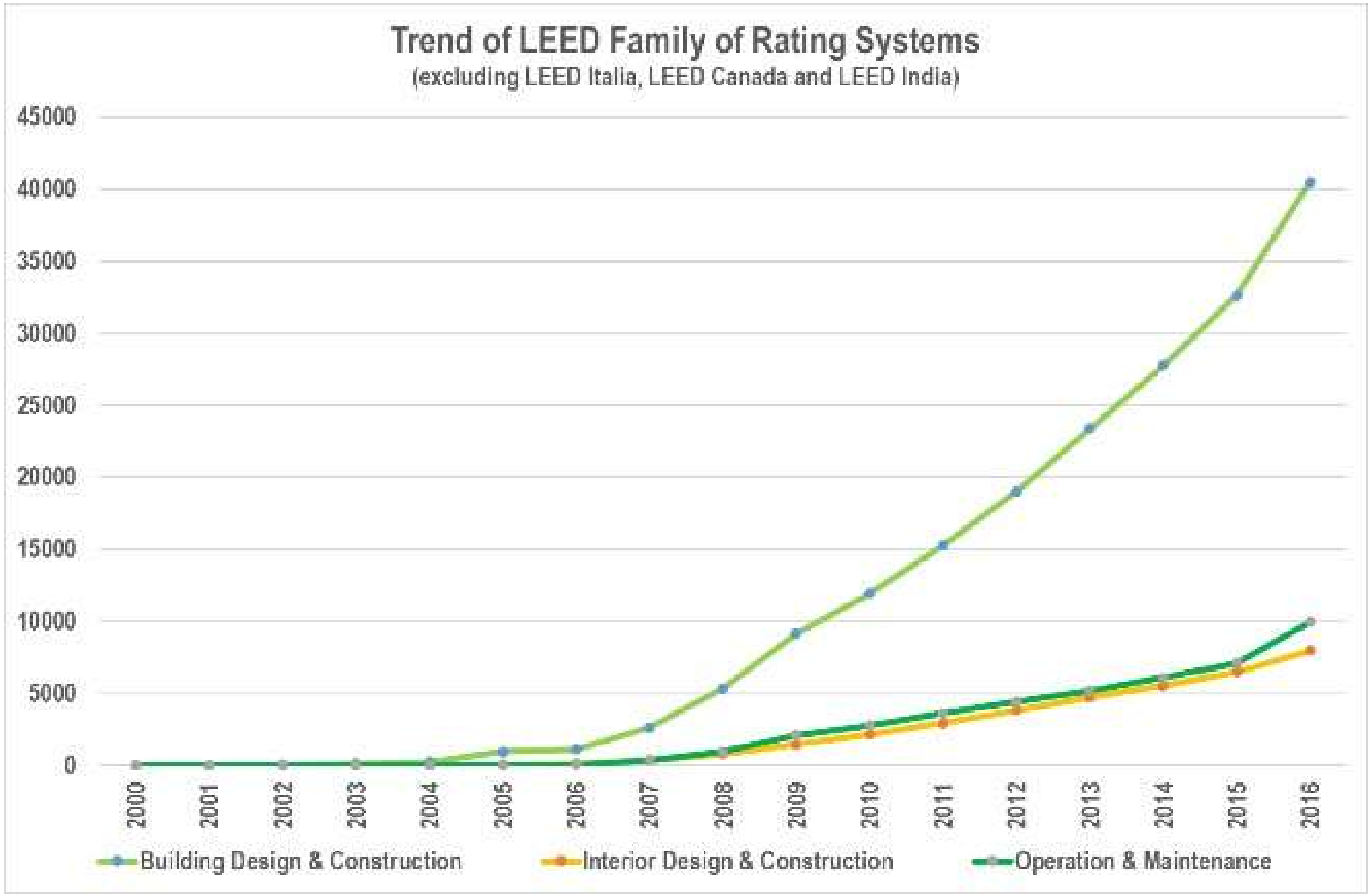
Annen bedriftsspesifikk informasjon

Contiga AS er leverandør av stål- og betongelementer.

Sustainability certification tools for buildings :

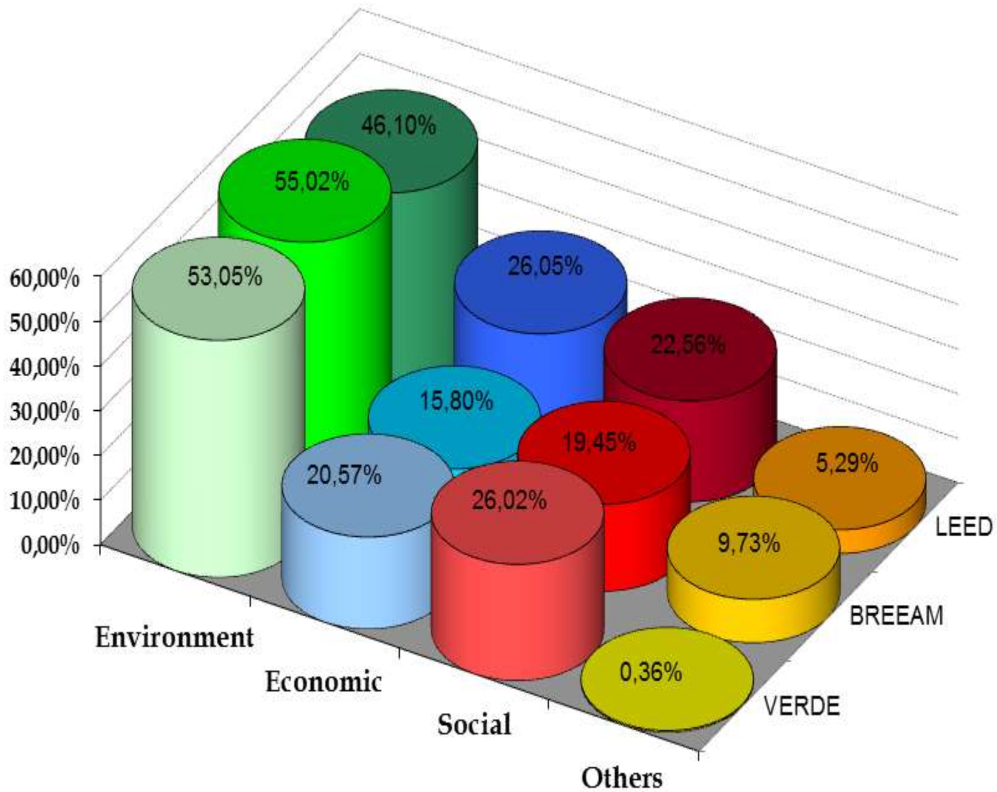
- BREEAM (UK)
- CASBEE (Japan)
- GBTool (International)
- Green Globes TM (Canada)
- LEED (USA)
- Verde (Spain)

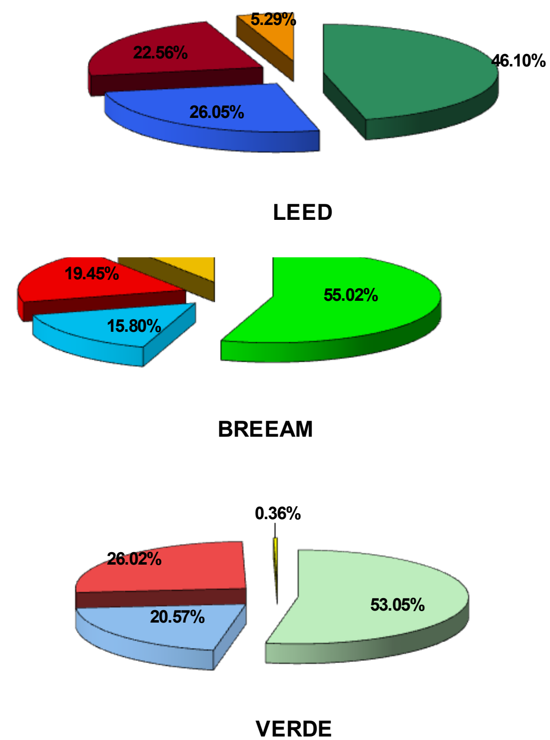
Sustainability certification tools for buildings :



Sustainability certification tools for buildings :

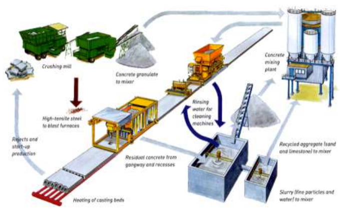
Comparison of parameters between several sustainability tools





Opportunities for prefabrication

Environmentally friendly production



Recycling

New design approach : adaptability
- large spans for interior flexibility
- maximum work in the factory – also for technical equipment

Precast concrete is showing the way

Minimum cement
Thermal mass
Demountability and possible reuse

High strength concrete

Slender components

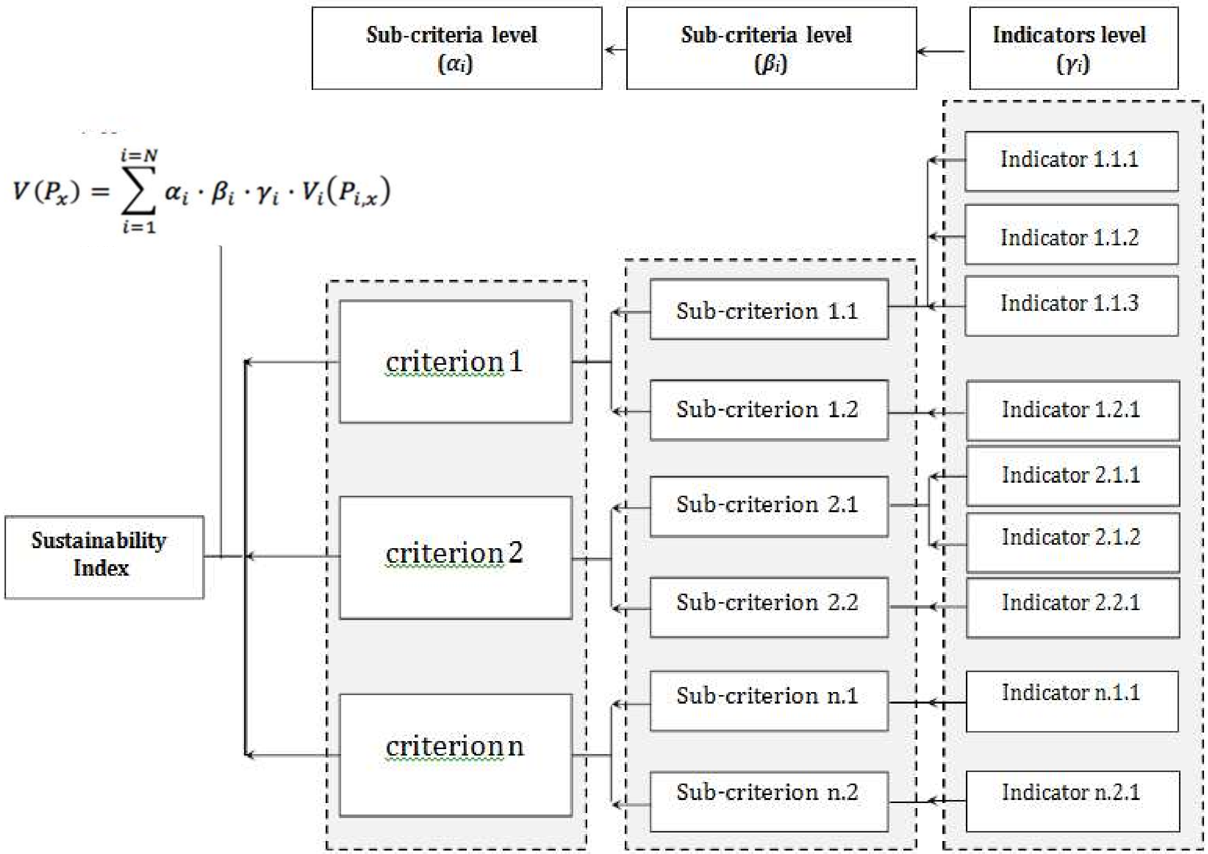
Multi-Criteria Method. General definition:

MIVES is a multi-criteria decision-making method capable of defining specialized and holistic sustainability assessment models to obtain global sustainability indexes.

The method combines:

a) a specific holistic discriminatory tree of requirements;
b) the assignation of weights for each requirement, criteria and indicator;
c) the value function concept to obtain particular and global indexes and
d) seminars with experts using Analytic Hierarchy Process (AHP) to define the aforementioned parts.

Multi-Criteria Method. Requirement tree:



fib TG6.3. Proposed Tree, Criteria and Indicators:

Requirement	Criteria	Indicator	Units	Value Function
R_1 Economic ($\lambda_{R1} = 35\%$)	C_1 Total Costs ($\lambda_{C1} = 42\%$)	I_1 Direct and indirect costs ($\lambda_{I1} = 100\%$)	€	DS
	C_2 Quality ($\lambda_{C2} = 19\%$)	I_2 Non quality costs ($\lambda_{I2} = 100\%$)	Attrib.	
	C_3 Dismantling ($\lambda_{C3} = 9\%$)	I_3 Dismantling costs ($\lambda_{I3} = 100\%$)	€	DS
	C_4 Service Life ($\lambda_{C4} = 30\%$)	I_4 Service costs ($\lambda_{I4} = 61\%$)		
		I_5 Resilience ($\lambda_{I5} = 39\%$)		IS
R_2 Environmental ($\lambda_{R2} = 38\%$)	C_5 Consumption ($\lambda_{C5} = 44\%$)	I_6 Cement ($\lambda_{I6} = 22\%$)	Ton	DS
		I_7 Aggregates ($\lambda_{I7} = 21\%$)		
		I_8 Steel ($\lambda_{I8} = 21\%$)		
		I_9 Water ($\lambda_{I9} = 12\%$)		
		I_{10} Plastics and others ($\lambda_{I10} = 10\%$)		
		I_{11} Reused materials ($\lambda_{I11} = 14\%$)		IS
	C_6 Emissions ($\lambda_{C6} = 32\%$)	I_{12} CO_2 emissions ($\lambda_{I12} = 62\%$)	$TnCO_2$-eq	DS
		I_{13} Total waste ($\lambda_{I13} = 38\%$)	Ton	
	C_7 Energy ($\lambda_{C7} = 24\%$)	I_{14} Materials ($\lambda_{I14} = 37\%$)	MWh	
		I_{15} Construction ($\lambda_{I15} = 26\%$)		
		I_{16} Service ($\lambda_{I16} = 37\%$)		
R_3 Social ($\lambda_{R3} = 26\%$)	C_8 Third parties ($\lambda_{C8} = 37\%$)	I_{17} Comfort ($\lambda_{I17} = 52\%$)	Attrib.	
		I_{18} Noise pollution ($\lambda_{I18} = 15\%$)	Db.	
		I_{19} Particles pollution ($\lambda_{I19} = 20\%$)	Ton	
		I_{20} Traffic disturbances ($\lambda_{I20} = 13\%$)	Attrib.	
	C_9 Health and Safety ($\lambda_{C9} = 63\%$)	I_{21} Risks. Production ($\lambda_{I21} = 23\%$)		
		I_{22} Risks. Construction ($\lambda_{I22} = 23\%$)		
		I_{23} Risks. Service life ($\lambda_{I23} = 55\%$)		

fib TG6.3. Proposed Tree, Comparison with other tools:

In terms of comparison with other sustainability or certification tools for buildings, this table gathers the weights' distribution proposed in these alternative sustainability assessment approaches.

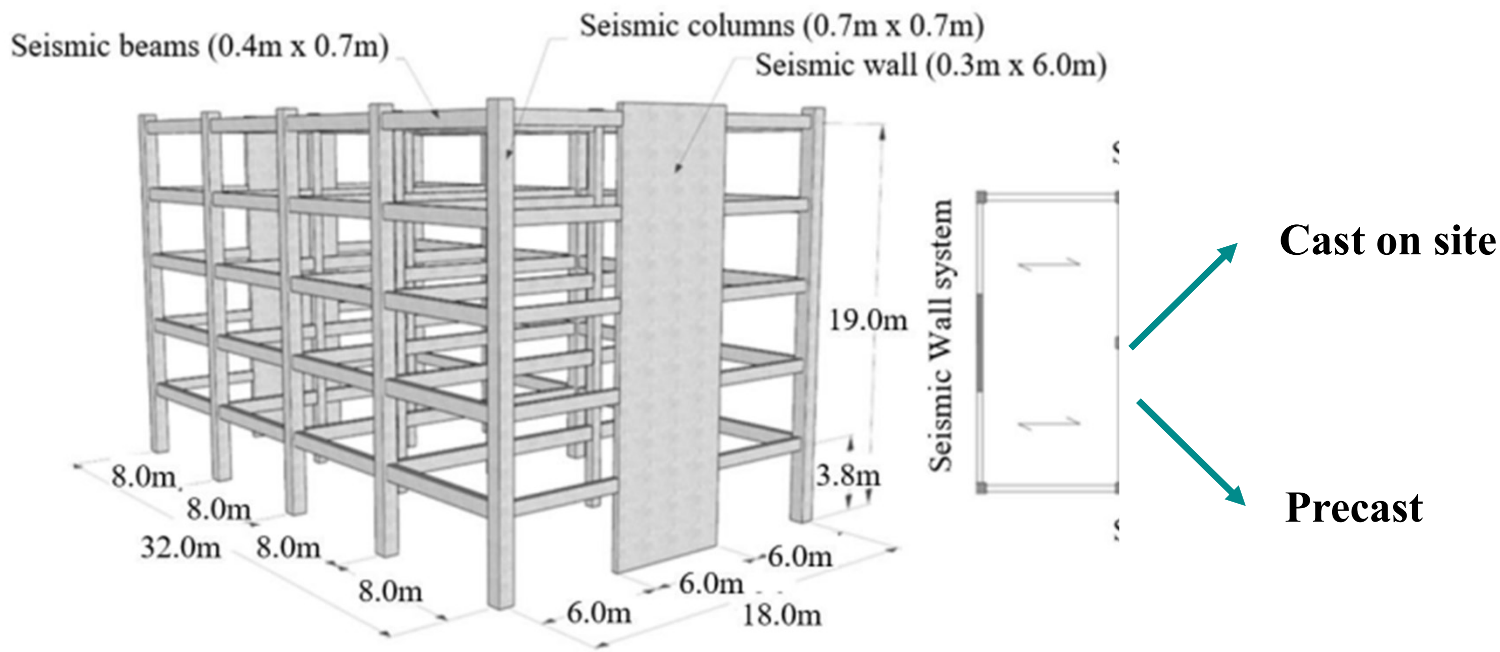
	fib TG 6.3	LEED	BREAM	VERDE	DGNB	LEnSE	SBToolCZ	λ_{Rim}	$CV_{\lambda R}$	$\lambda_{Ri,min}$	$\lambda_{Ri,max}$
Economic (R_1)	35%	26%	16%	21%	33%	19%	15%	24%	34%	15%	35%
Environmental (R_2)	38%	46%	55%	53%	33%	44%	50%	46%	17%	33%	55%
Social (R_3)	26%	23%	20%	26%	33%	37%	35%	29%	22%	20%	37%
Others (R_4)	0%	5%	10%	0%	0%	0%	0%	2%	-	0%	10%

Table 4. Weights' distributions for various sustainability/certification tools for buildings

The data gathered reflect that the average value of the economic requirement weight is reduced to 24% respect to the 35% agreed in the *fib* TG 6.3 whilst the environmental requirement weight increases up to 46% in contrast the 38% assumed in the *fib* committee. Finally, average values between 25%-30% for the social requirement weight seems to be well-accepted.
It is important to note that the environmental sensitivity is high independently of the assessment method since values ranging from 33% to 55%, with variation coefficient 17%, have been found.

fib TG6.3. Second document: Application to a precast concrete building

Case study



fib TG6.3. Second document: Application to a precast concrete building

Model developed: decision-making tree

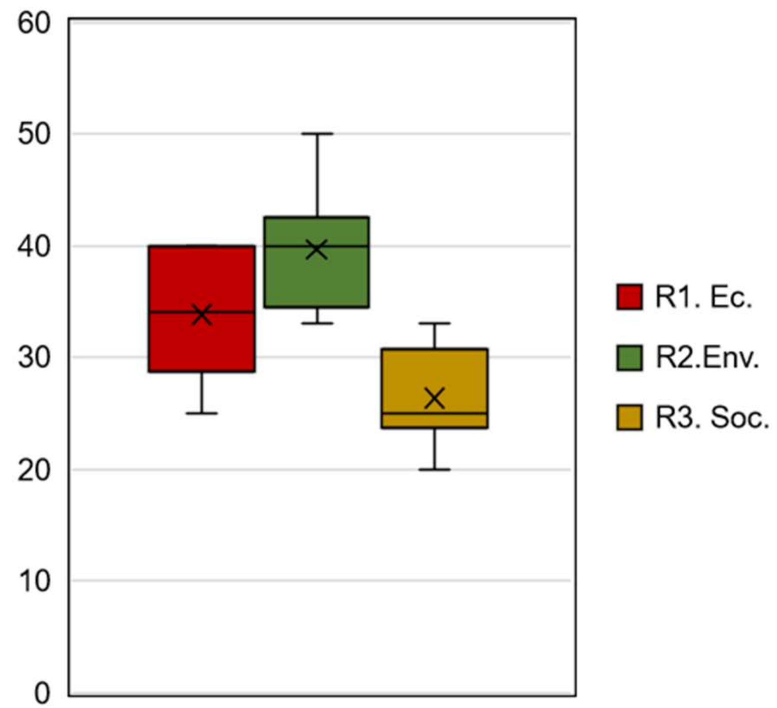
Requirement		Criteria		Indicators	
R1. Economic	36%	C1. Cost	61%	I1. Direct	61%
				I2. Indirect	6%
				I3. Rehabilitation	11%
				I4. Dismantling	21%
		C2. Time	39%	I5. Production & Assembly	100%
R2. Environmental	39%	C3. Emissions	55%	I6. Emissions of CO2-eq	100%
		C4. Energy	19%	I7. Energy consumption	100%
		C5. Materials	26%	I8. Index of Efficiency	100%
R3. Social	25%	C6. Safety	60%	I9. Index of Risk	100%
		C7. Third parties' affectations	40%	I10. Social Benefits	55%
				I11. Disturbances in construction	45%

fib TG6.3. Second document: Application to a precast concrete building

Model developed: weights

Requirement	
R1. Economic	36%
R2. Environmental	39%
R3. Social	25%

Participatory approach

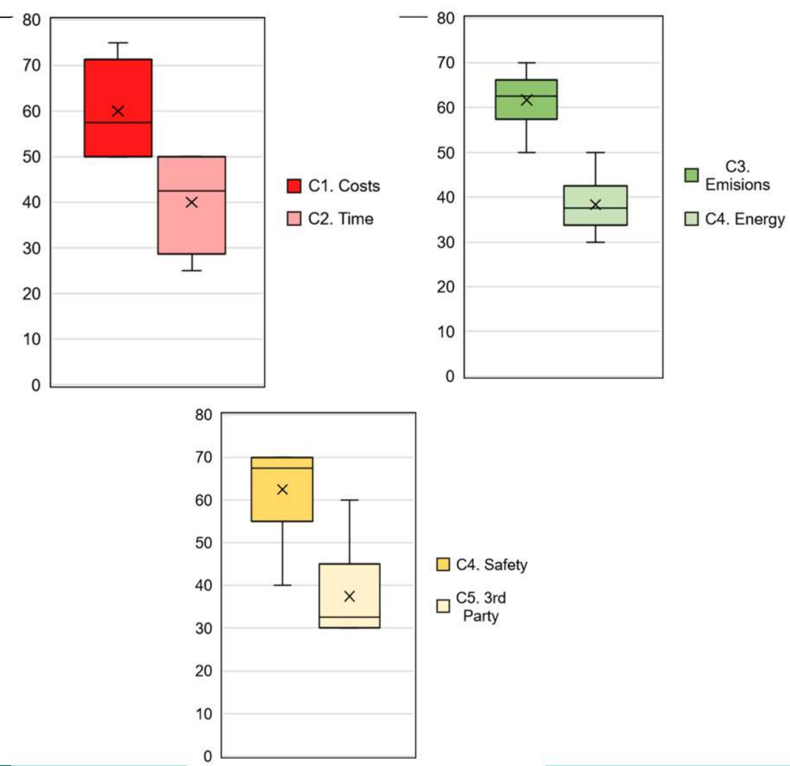


fib TG6.3. Second document: Application to a precast concrete building

Model developed: weights

Participatory approach

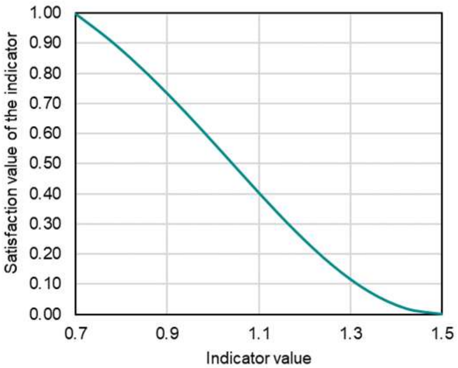
Requirement		Criteria	
R1. Economic	36%	C1. Cost	61%
		C2. Time	39%
R2. Environmental	39%	C3. Emissions	55%
		C4. Energy	19%
		C5. Materials	26%
R3. Social	25%	C6. Safety	60%
		C7. Third parties' affectations	40%



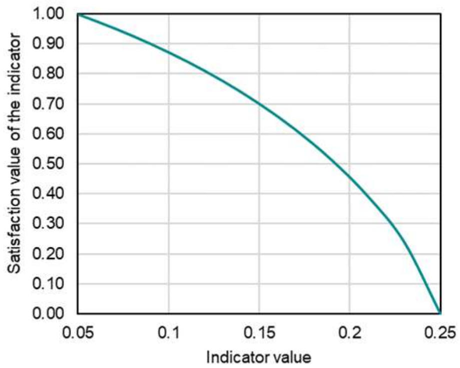
fib TG6.3. Second document:
Application to a precast concrete building

Model developed: indicators

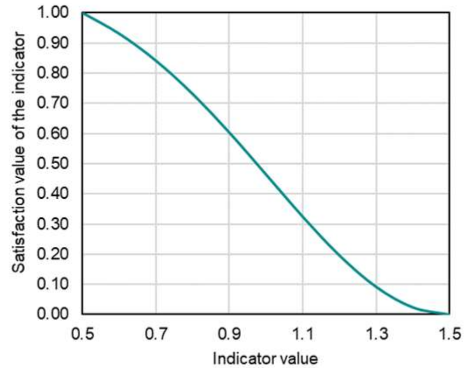
Direct costs



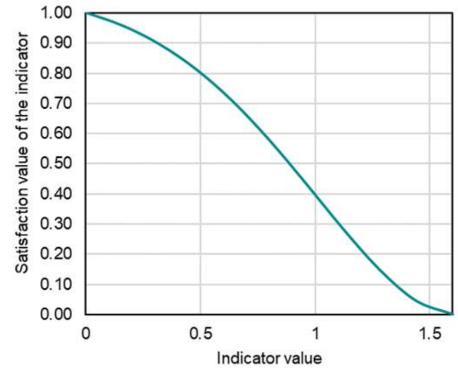
Indirect costs



Rehabilitation costs
Dismantling costs



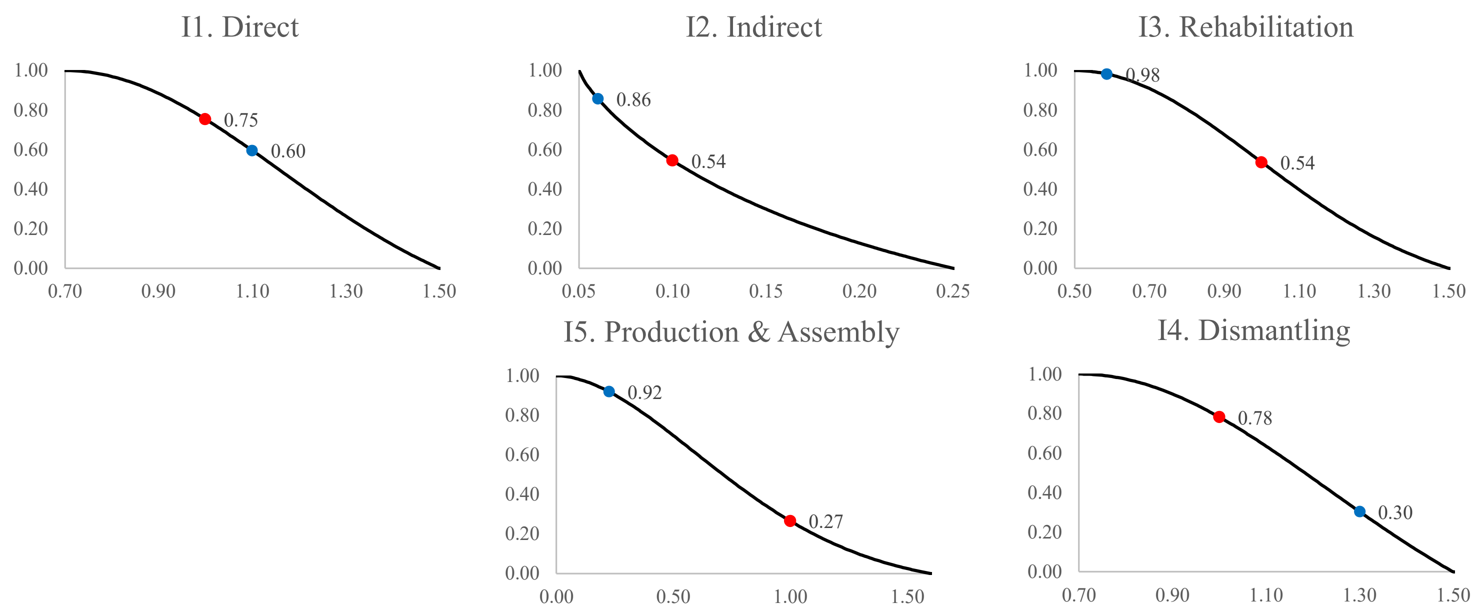
Production and assembly time



fib TG6.3. Second document:
Application to a precast concrete building

Model developed: indicators

ECONOMIC

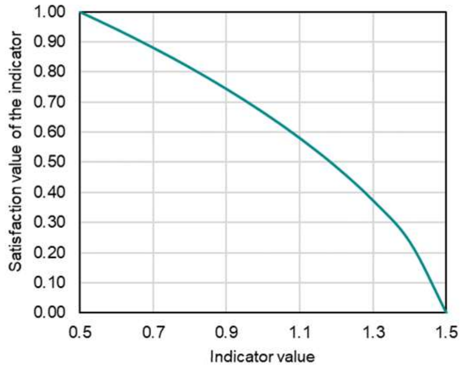


fib TG6.3. Second document:
Application to a precast concrete building

Model developed: indicators

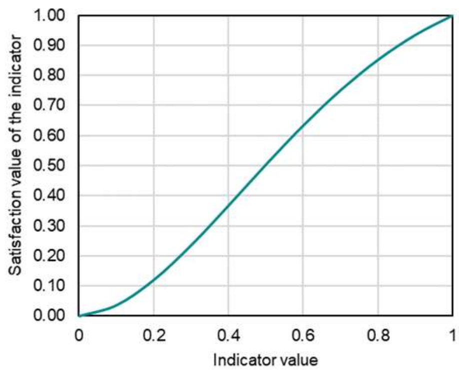
ENVIRONMENTAL

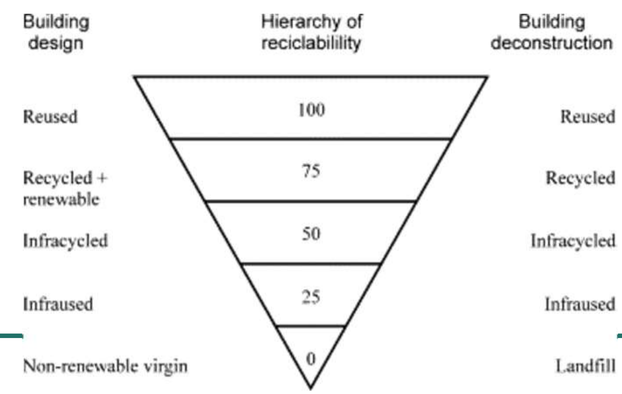
Equivalent CO_2 emissions
Energy consumption



Derived from LCA

Material efficiency index

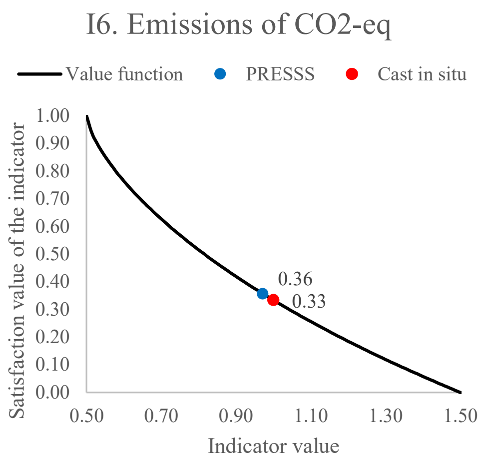


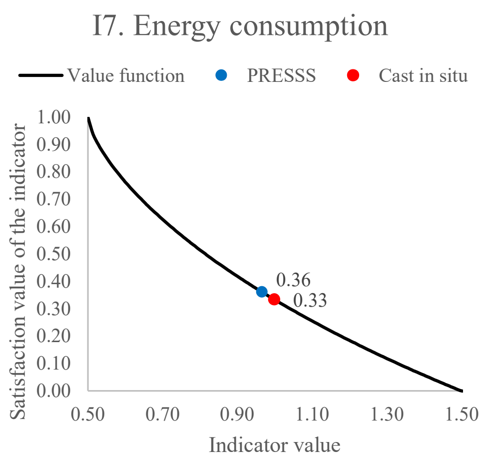


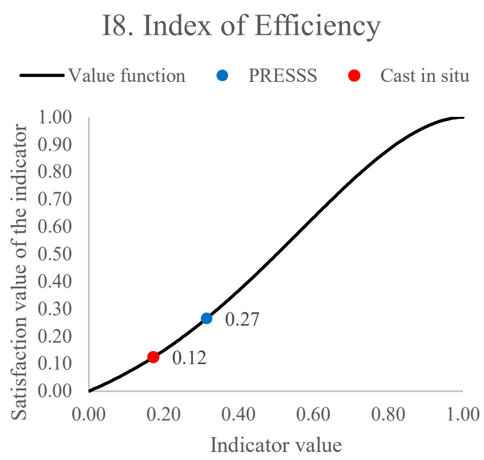
fib TG6.3. Second document:
Application to a precast concrete building

Model developed: indicators

ENVIRONMENTAL





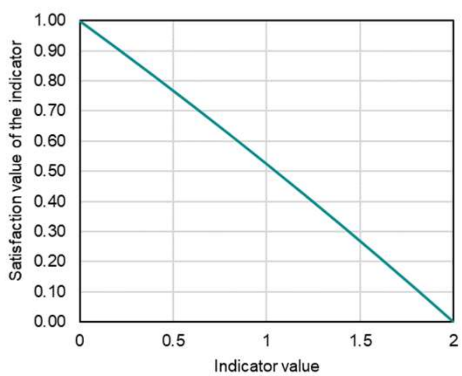


fib TG6.3. Second document:
Application to a precast concrete building

Model developed: indicators

SOCIAL

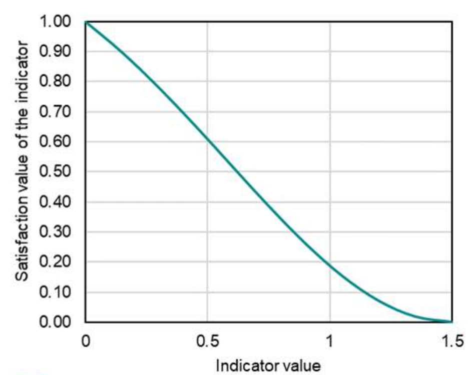
Safety



Calculated using the Occupational Risk Index (ORI)

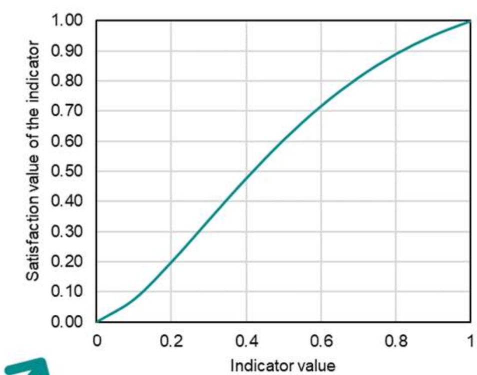
Risk - ACTIVITY - Sub-activity	Weight Exposure	Nº workers	Total Exposure
	h	-	
R.1 Fall to lower levels - working at height or depths of more 2m	152	33	463.1
R.8 Collision with or entrapment by moving loads	79	38	481.1
R.9 Blo[illegible] lower limbs	16	0	0.0

Social benefits



Calculated considering services downtime

Disturbances in construction

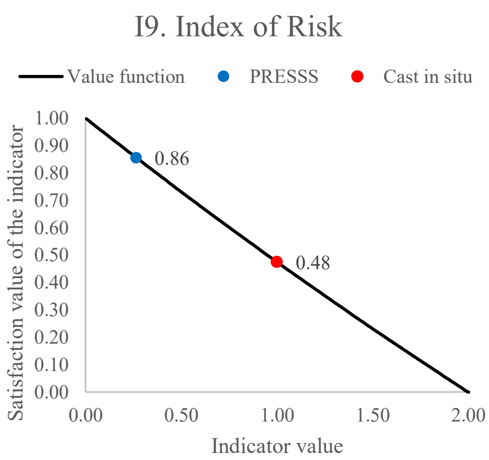


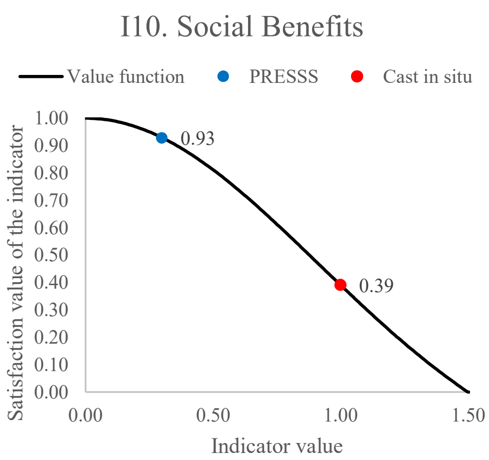
Calculated considering noise pollution and transit/traffic disturbance

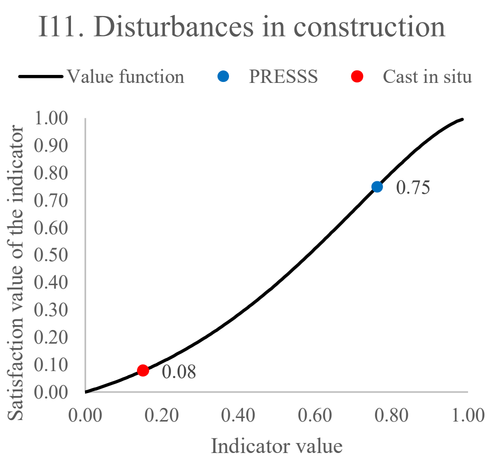
fib TG6.3. Second document:
Application to a precast concrete building

Model developed: indicators

SOCIAL

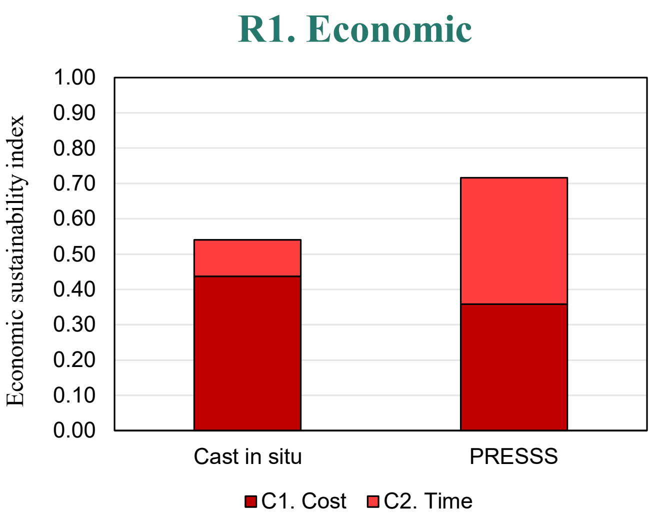


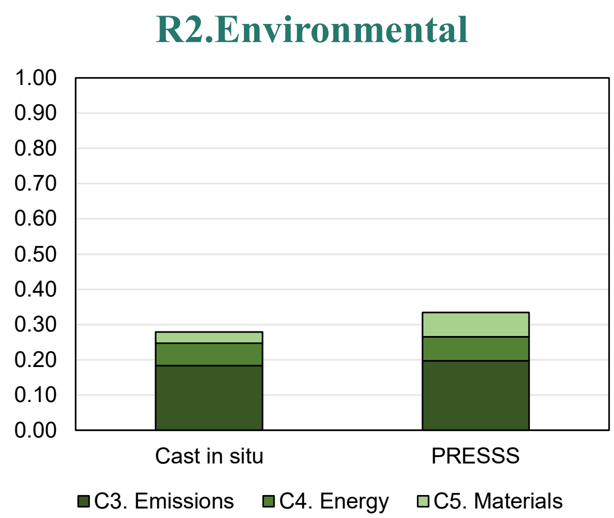


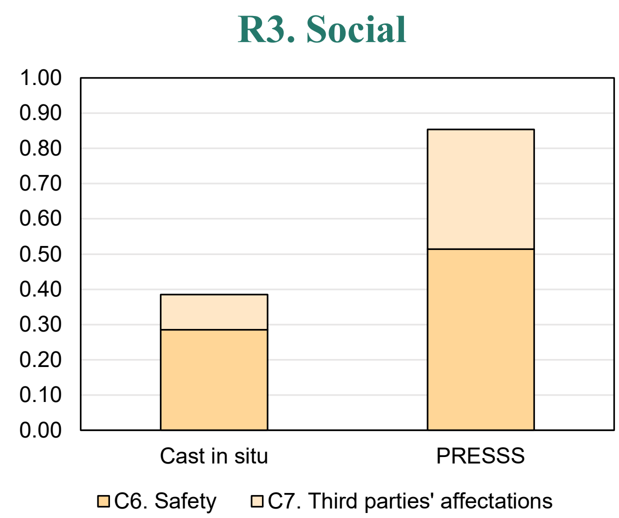


fib TG6.3. Second document:
Application to a precast concrete building

Case study: results

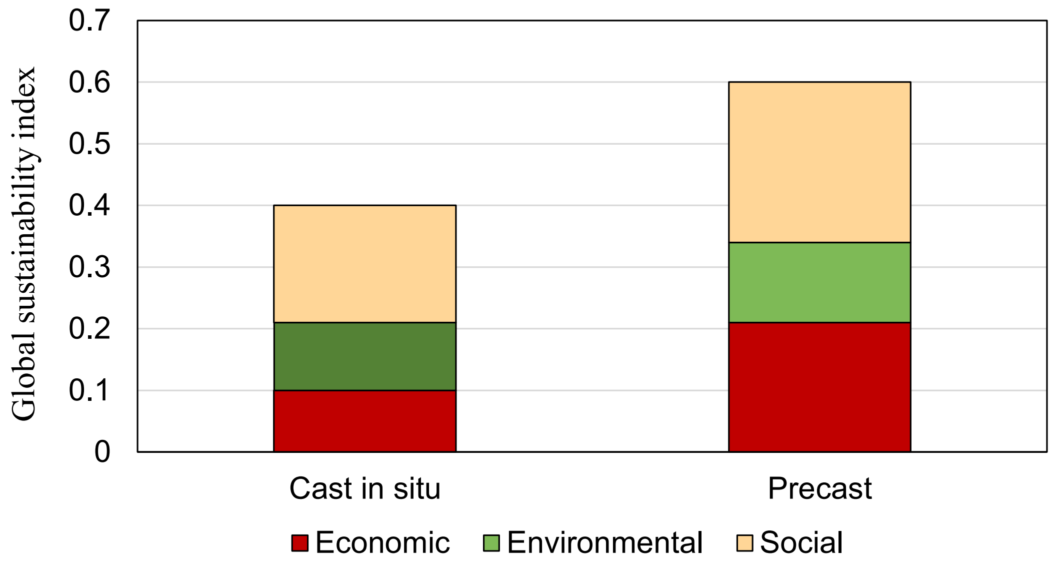






fib TG6.3. Second document: Application to a precast concrete building

Case study: results



fib TG6.3. Second document:
Application to a precast concrete building

Conclusions:

- In this case study, the results obtained showed that the **prefabricated solution** was **more sustainable** than the on-site one.
  - From an **economic** point of view, although the traditional solution has lower overall costs, the prefabricated solution is characterized by faster construction and repair times.
  - Regarding **environmental** aspects, results showed the convenience of precast concrete especially from the point of view of the efficiency of materials that can be more easily recycled or reused.
  - From a **social** point of view, the precast solution proved to be far superior to the one cast in place due to the lower exposure to the risks and disturbances caused in the construction phase.

International Federation for Structural Concrete
Fédération internationale du béton

David Fernández-Ordóñez

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