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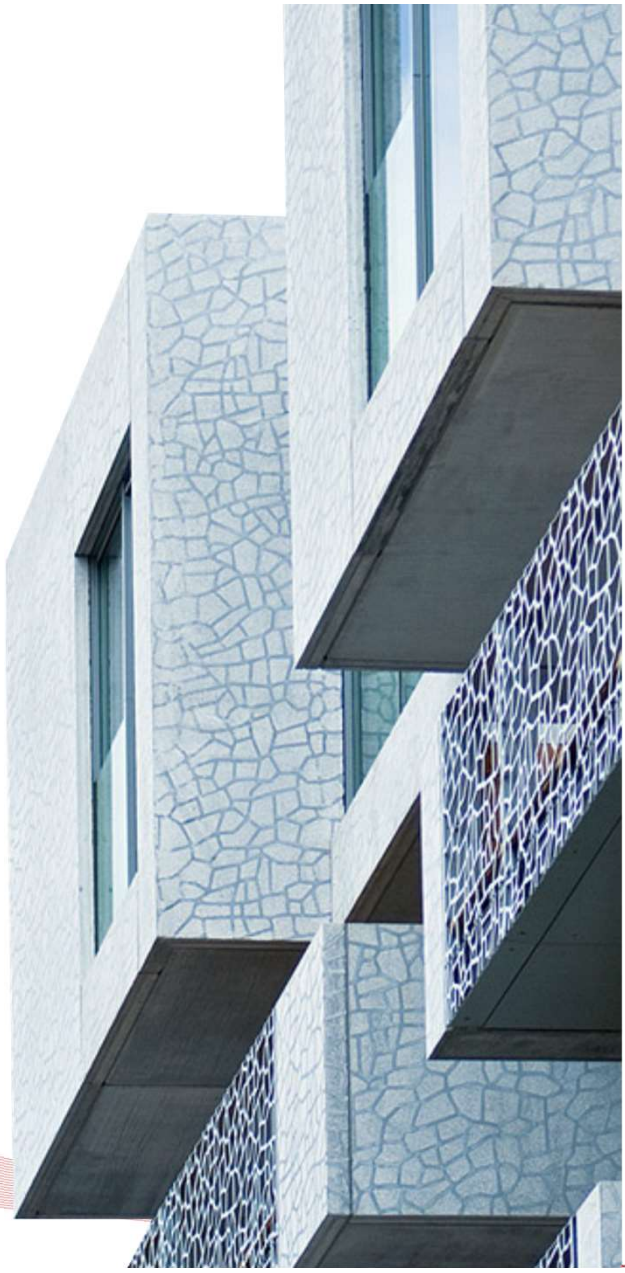
fib/CNI International Seminar on

Precast Concrete in Seismic Regions and International Perspectives



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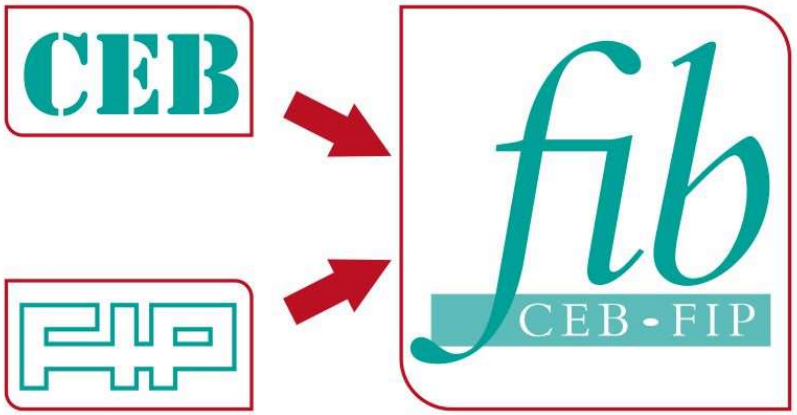
History

- International Federation for Structural Concrete
  - created in 1998 by merger of :
    - CEB, the Euro-International Committee for Concrete (Comité Euro-international du Béton, founded 1953);
    - FIP, the International Federation for Pre-stressing (Fédération Internationale de la Précontrainte, founded 1952);



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Objectives

- To develop at international level the study of scientific and practical matters in order to advance the technical, economic, aesthetic and environmental performance of concrete construction by :
  - stimulation of research and synthesis of findings;
  - transfer into design and construction practice;
  - dissemination by publications, congresses, courses, etc.;
  - production of recommendations, guidance documents, etc.;
  - informing of members through relevant publications;

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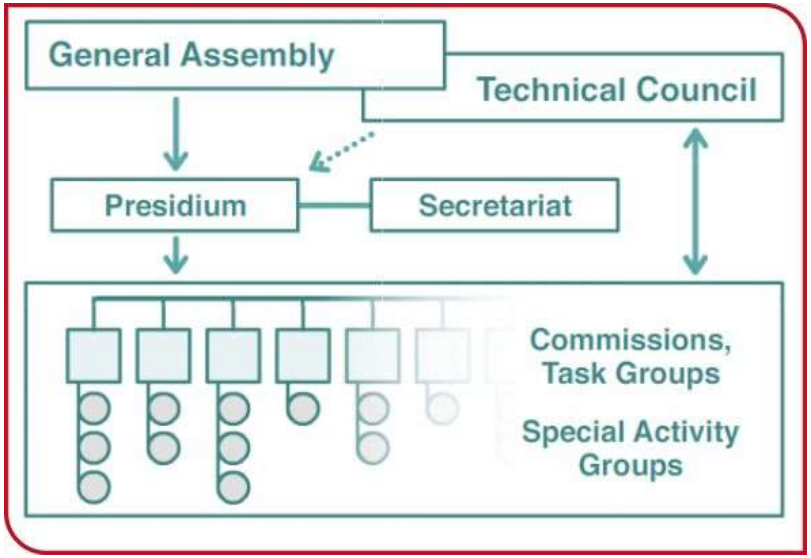
Structure

- General Assembly
- Technical Council
- Presidium (President)
- Secretariat
- Commissions,
  Task Groups,
  Special Activity Groups



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Commissions

- COM 1 Concrete structures
- COM 2 Analysis and design
- COM 3 Existing Concrete Structures
- COM 4 Concrete and concrete technology
- COM 5 Reinforcements
- **COM 6 Prefabrication**
- COM 7 Sustainability
- COM 8 Durability
- COM 9 Dissemination of knowledge
- COM 10 Modelcodes
- YMG
- Databases

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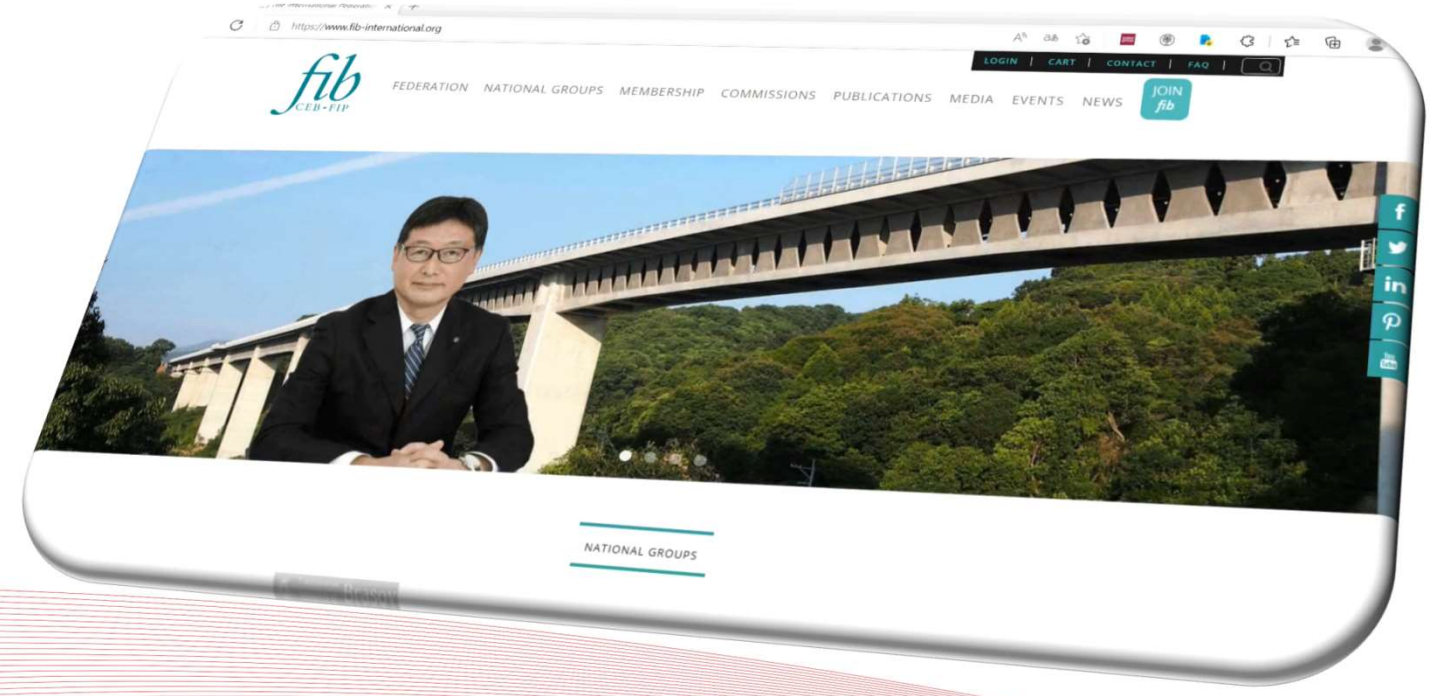
More information…

- Website ***www.fib-international.org***
- Facebook
- Twitter
- LinkedIn
- Pinterest
- **YouTube**



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Overview

- Approximately **60 delegates** (Italy 6)
  - **Balanced** composition (academics, designers, producers, suppliers, contractors)
  - Representing **25 countries**
- Approximately **150 experts** (Italy 13) active in task groups
  - Representing **32 countries**
- **Italy** is an important partner
  - **Prof. M. Menegotto** - Past Chairman
  - **A. Ronchetti** - Secretary

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Overview

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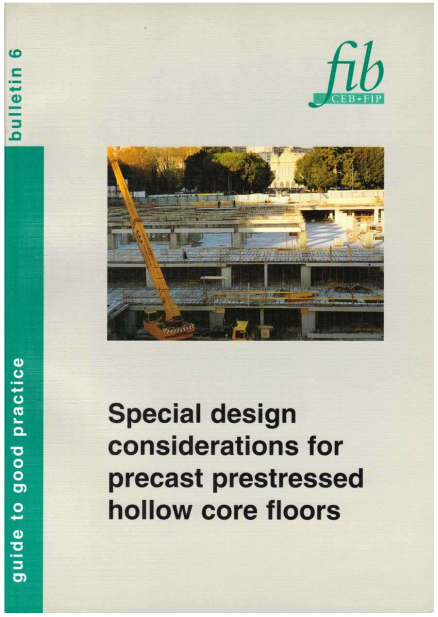
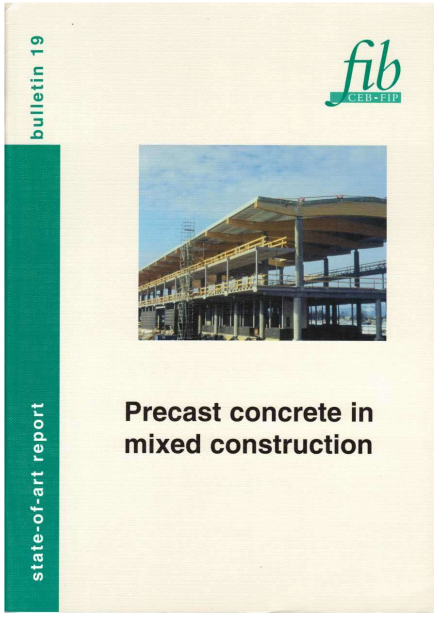
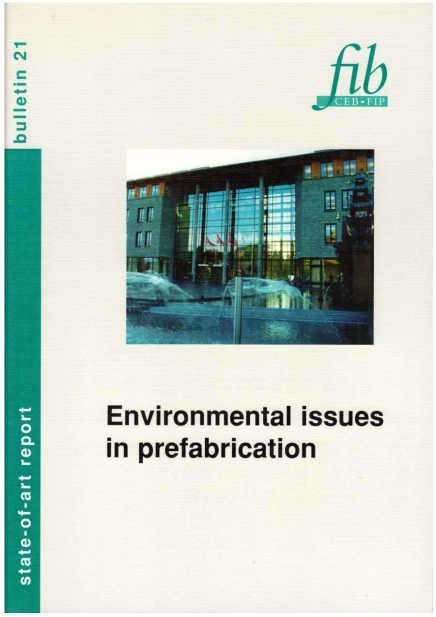
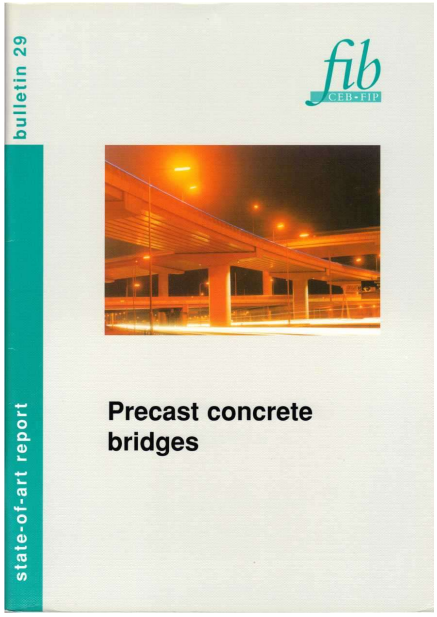
Publications









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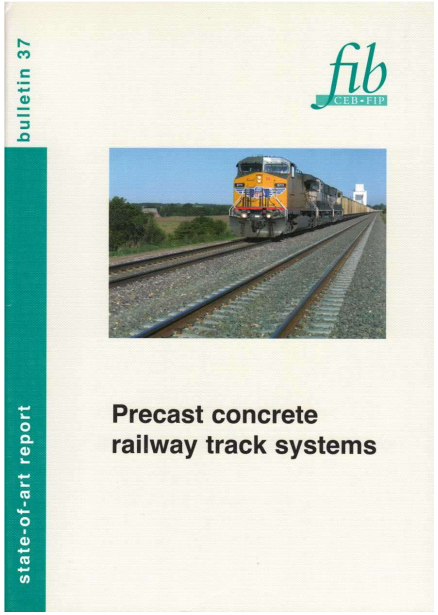
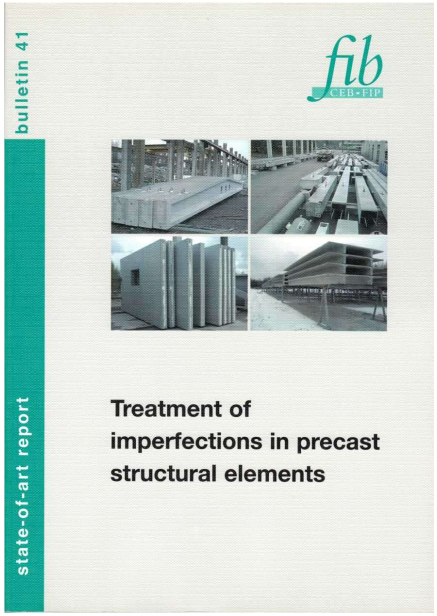
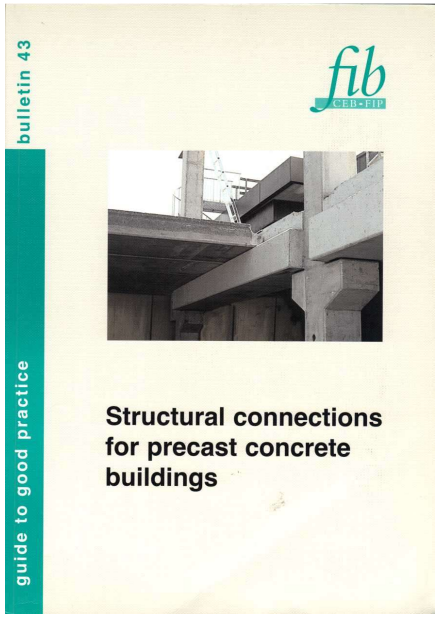
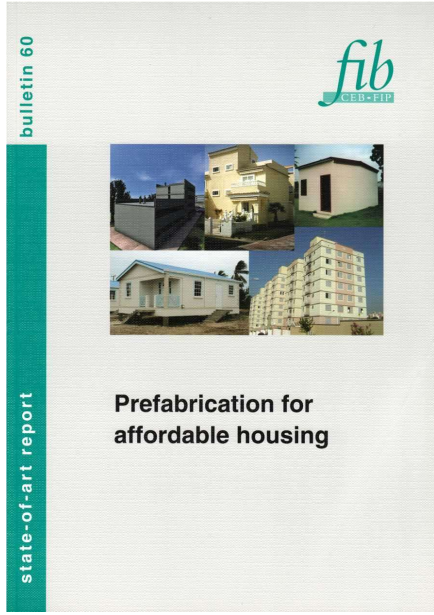
Publications









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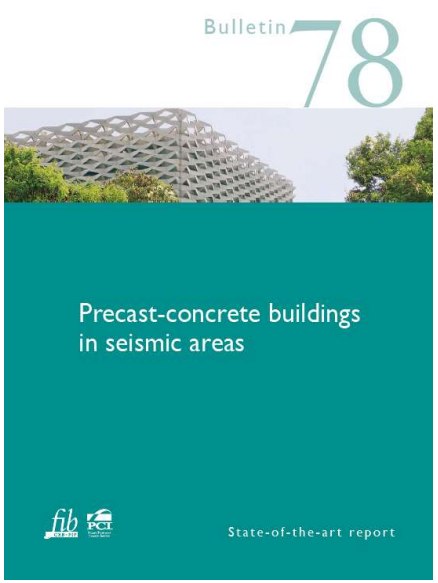
Publications



COM 6 - PREFABRICATION

fib bulletin 74

Handbook

phase of study, precasting cannot be ignored any longer, either as a solution for the whole structure or for parts of it.

In this chapter information is given concerning the possibilities precast concrete offers, its advantages and limitations, and the principles of quality assurance and plant certification.

1.2 Advantages and limitations

Most buildings are suitable for precast concrete construction. Buildings with an orthogonal plan are, of course, ideal for precasting because they exhibit a degree of regularity and repetition in their structural grid, spans, member size, and so forth. When designing a building, one should always strive for standardisation and repetition to ensure economical construction while still attempting to respect the individuality of the architectural design. This rule applies to all design and not only to precast concrete construction. The concourse structure shown in Figure 1.2, where a set of nearly identical concrete columns, beams and slabs, illustrates this philosophy. Figure 1.2, where a set of nearly identical concrete elements was configured to create a challenging solution in exposed, grit-blasted concrete columns, beams and slabs, illustrates this philosophy.

Fig. 1.2: Precast elements consisting of circular columns, beams and vaulted roof panels provide the finished structure to the concourse of Paddington station, London

On many occasions irregular ground layouts are, if not totally then certainly partially, suitable for precasting. It is a misunderstanding that precast concrete offers no flexibility. Modern precast concrete buildings can be designed safely and economically, with a variety of plans (see figures 1.1 to 1.5) and with considerable variation in the treatment of the elevations, generally to heights of about twenty to thirty metres but also up to forty floors high.

Fig. 1.3: Flexibility in design and construction enables this oval shape building in Brussels, Belgium, to be prefabricated with mainly rectangular concrete elements

Figures 1.3 and 1.4 illustrate market trends in the architectural layout of all kinds of non-orthogonally shaped floor plans, for example, ones that are elliptic, rounded and have sharp edges. This is now possible in the precast industry thanks to great flexibility in the production technique.

Fig. 1.4: Freedom in design of the floor layout of the conference building of the European Union, Brussels, with its 7 large conference rooms

Figure 1.5 shows the example of an entirely precast car park with 2.500 places in Bologna, Italy. Despite the large number of different units, most of the elements were cast in the same basic moulds. This enabled not only economical production, but also flexibility in the casting.

a. Plan view

b. View of façades

Fig. 1.5: Layout of the floor and a view of the façades of an entirely precast car park with 2.500 places in Bologna, Italy

Precast concrete offers considerable scope for improving structural efficiency. Longer spans and shallower construction depths can be obtained by using prestressed concrete for beams and floors. For industrial and commercial halls, roof spans can be up to forty metres in length or even longer. When precast concrete is used in parking garages, more cars can be fit into the same construction space because of the large span possibilities and slender column sections. If precast units were used to their full potential, office buildings could have even larger open spaces divided only with partitions. Using such units leads to greater flexibility as well as an extended lifetime because of a building's greater adaptability. Thus, a building can retain its commercial value over a longer period.

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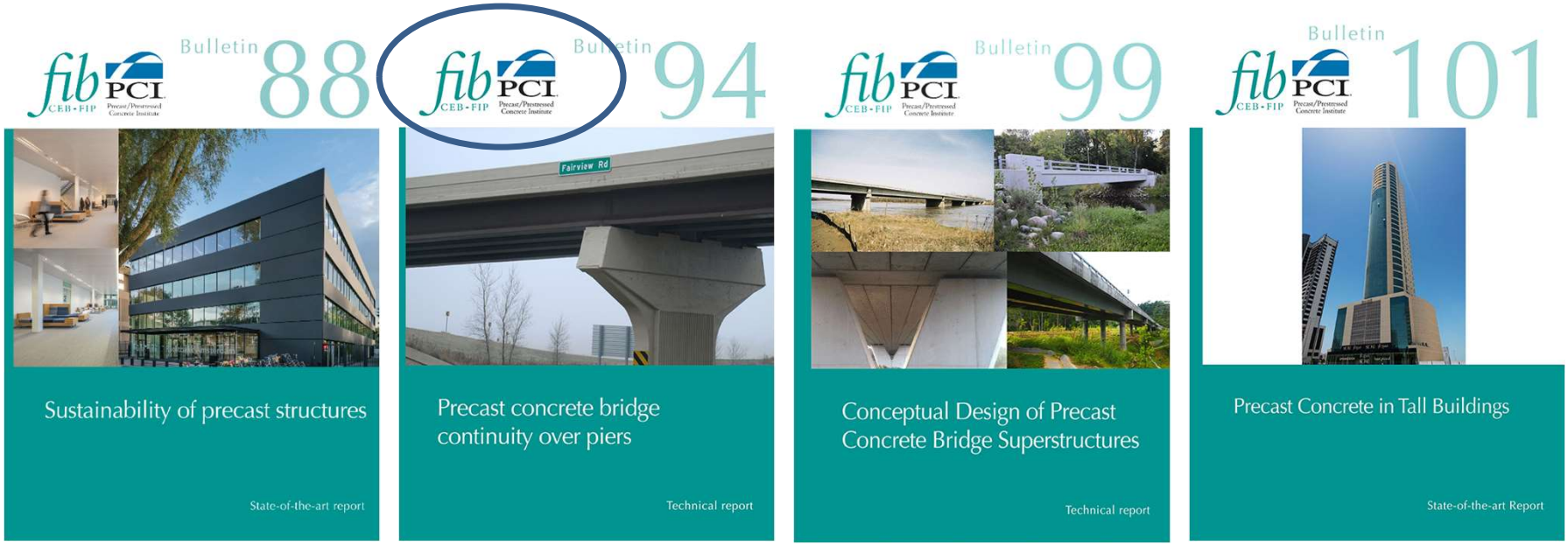
Publications



fib COM6
and PCI

- Joint work since 2008
- Initially two separate meetings were held
  - *fib* COM 6 - plenary
  - *fib* COM6/PCI
- Today 1 integrated plenary meeting
- On task group level :
  - PCI member attend fib TG's
  - *fib* COM6 members attend PCI-committees
- Common publications

fib COM6

Active Task Groups

- TG6.1 Prestressed hollow core floors
- TG6.2 Quality control for precast concrete
- TG6.3 Sustainability of structures with precast elements
- TG6.4 Precast concrete towers for wind power generators
- TG6.5 Precast concrete bridges
- TG6.6 Retrofitting of precast seismic structures
- TG6.7 Precast concrete in tall buildings
- TG6.8 Terminology for precast concrete
- TG6.9 Precast parking structures
- WG Modelcode

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6.1

Source: echobel.com

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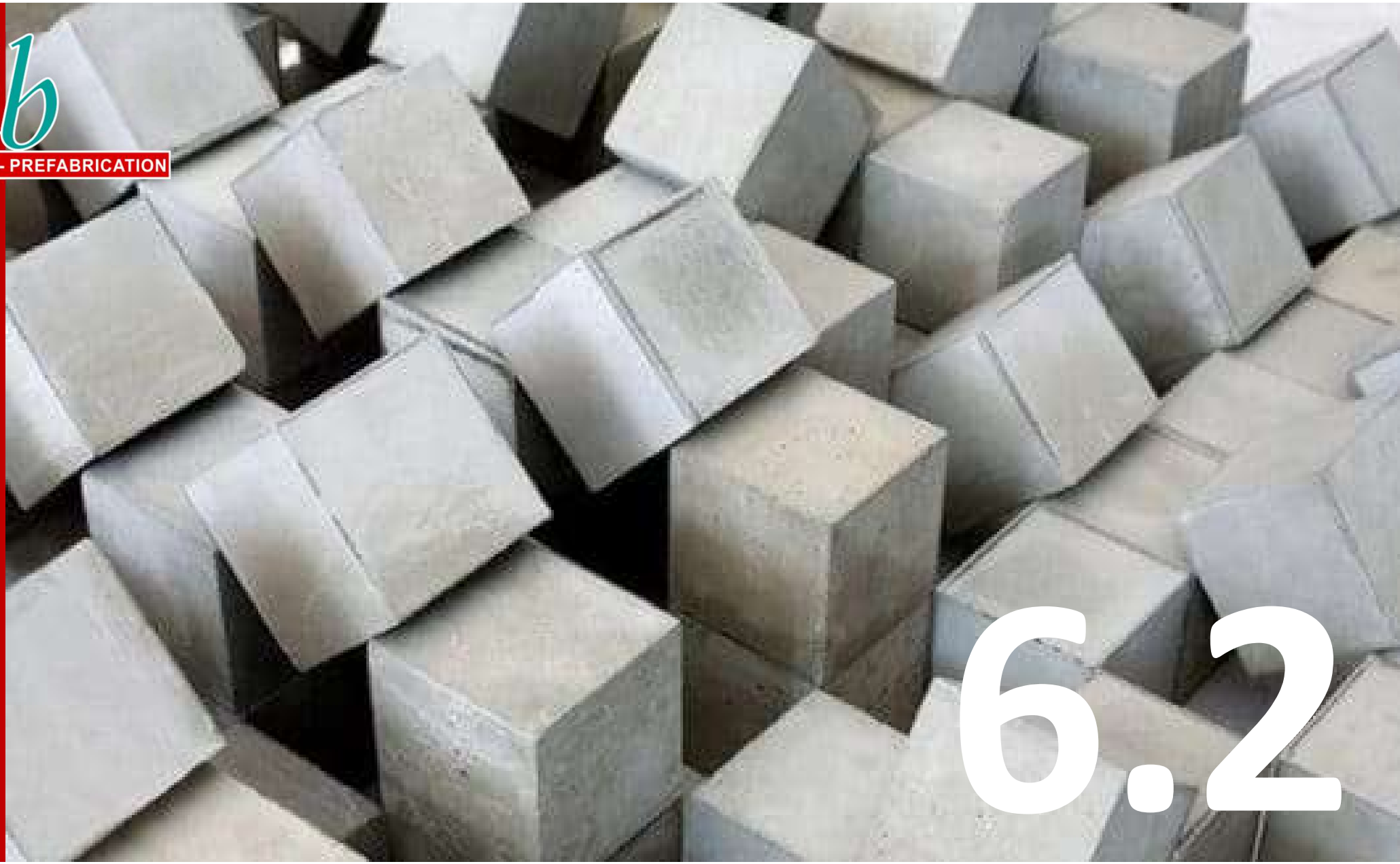


6.2

fib COM 6 - PREFABRICATION

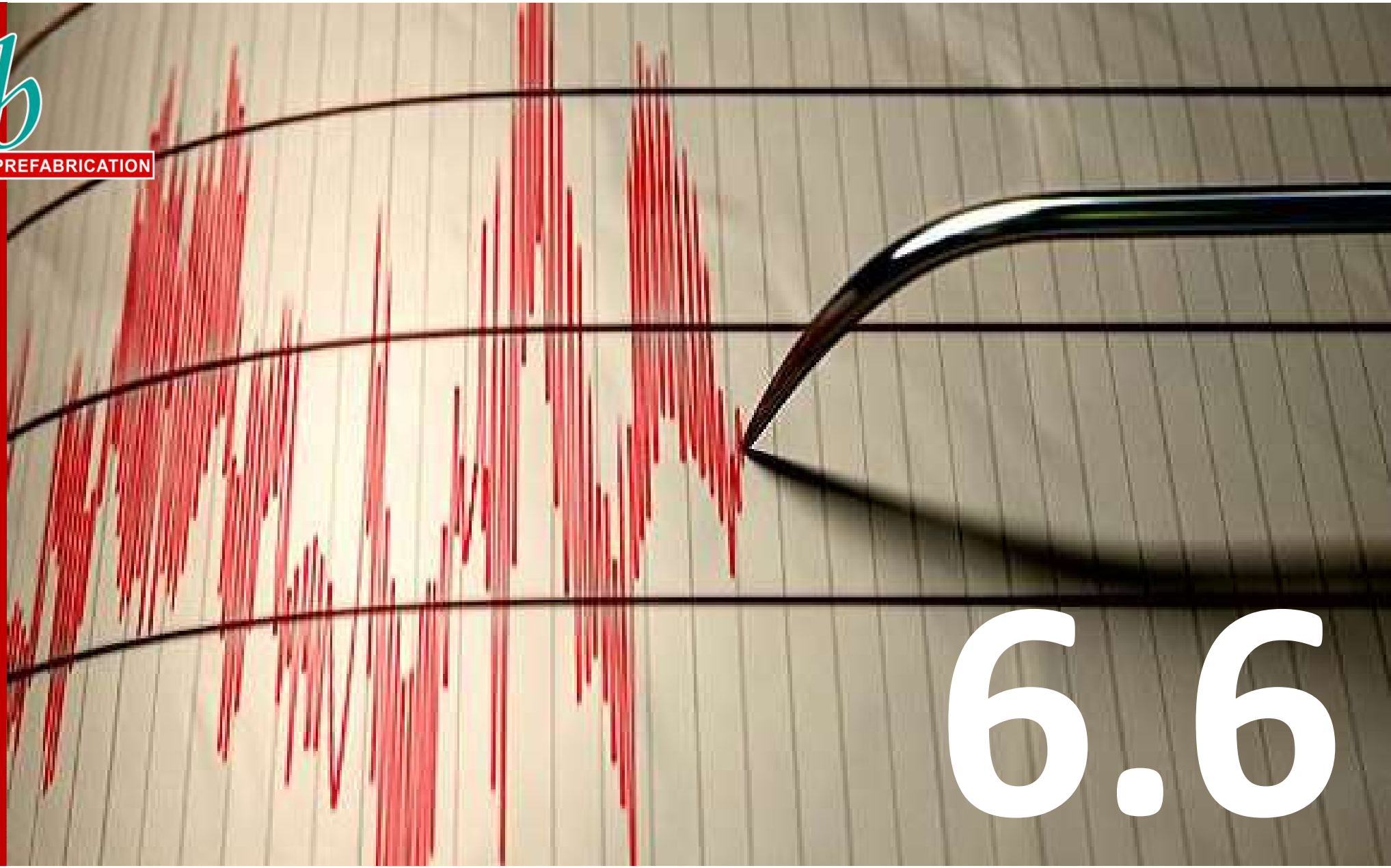
6.3

6.4

Source: www.sunwindenergy.com

6.5

Source: Pieter van der Zee (COM6)



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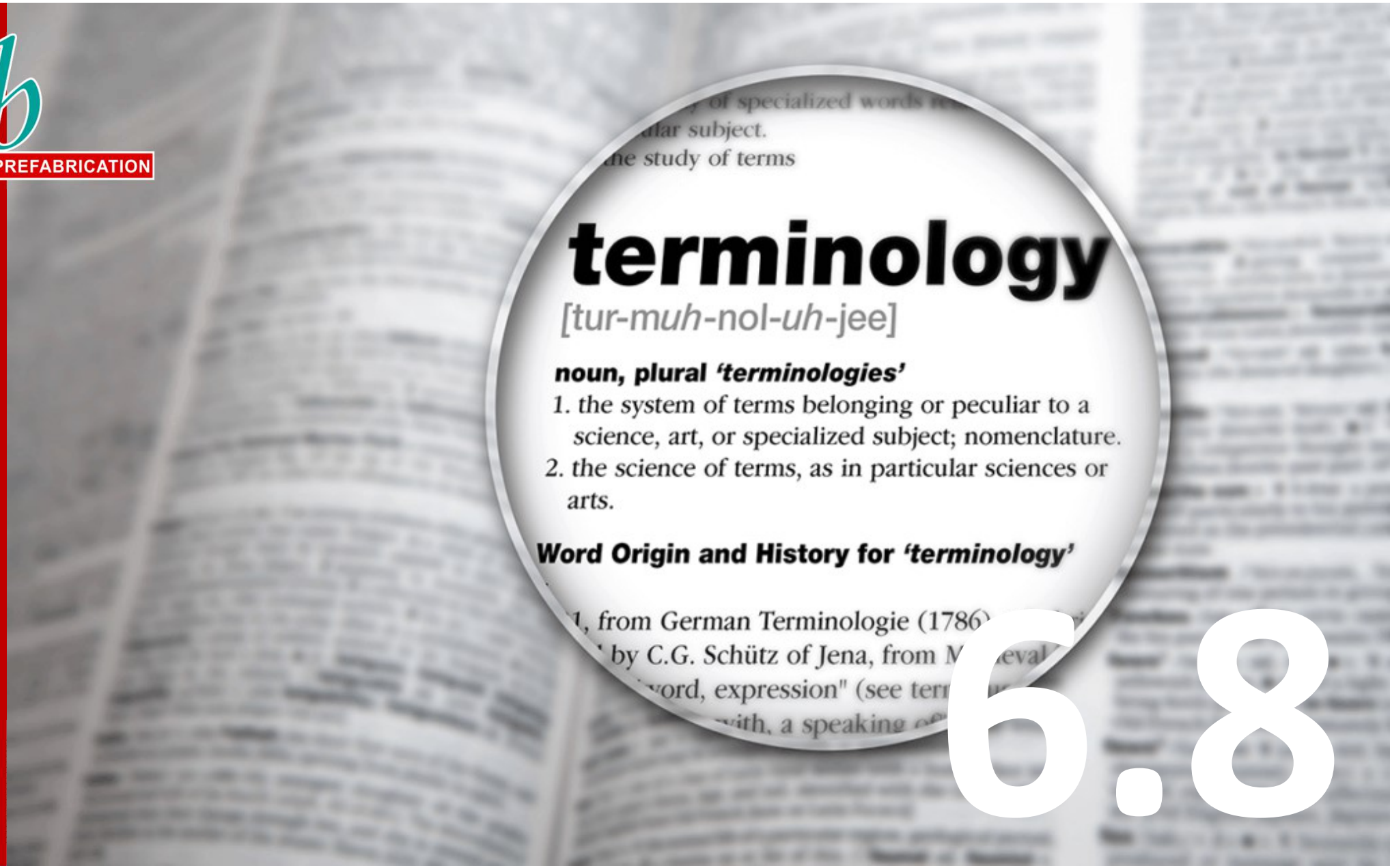
6.7


terminology
[tur-muh-nol-uh-jee]
noun, plural 'terminologies'
1. the system of terms belonging or peculiar to a science, art, or specialized subject; nomenclature.
2. the science of terms, as in particular sciences or arts.
Word Origin and History for 'terminology'

6.8

6.9

Source: VBI

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TG6.1 Prestressed hollow core floors

New design recommendations

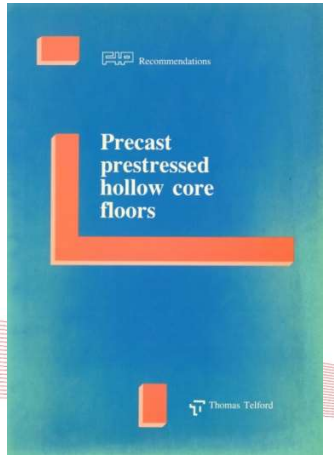
for precast prestressed hollow core floors

COM 6 - PREFABRICATION

fib C6 – TG 6.1

Prestressed Hollow Core floors

- ….
- 1988 Precast prestressed hollow core floors (Thomas Telfort)
- 2000 Special design recommendations for precast prestressed hollow core floors
- 2022 New design recommendations



New recommendations

Chapter 1: introduction

- Why this update
  - 25 000 000 m²/y annual production
    - 40-60 % EU precast flooring
  - Evolutions over last decades
    - Introduction of Eurocodes
    - Introduction CEN Product standard EN 1168
    - Experiences by commission members
    - International studies
      - Holcotors
      - Holcofire
      - …
    - International publications
      - PCI, manual for the design of Hollow Core Slabs

New recommendations

Chapter 1: introduction

- Why this update
  - Relevant information
    - Partially covered in bulletin 6
    - Actual state of the art in this document
- Scope
  - Prestressed hollow core slabs/floors
  - Depth ≤ 500 mm
  - Width ≤ 1200 mm

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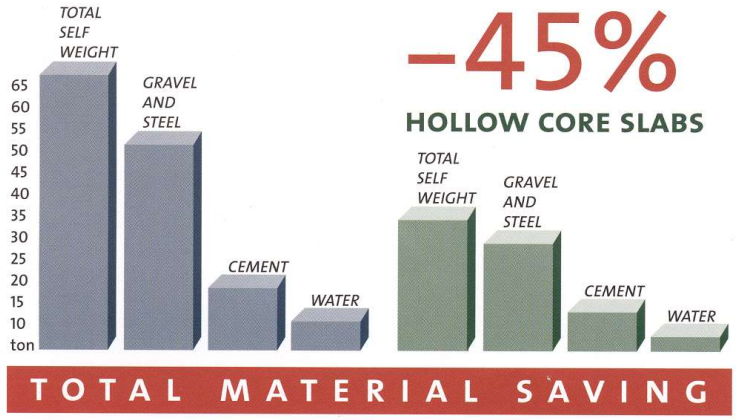
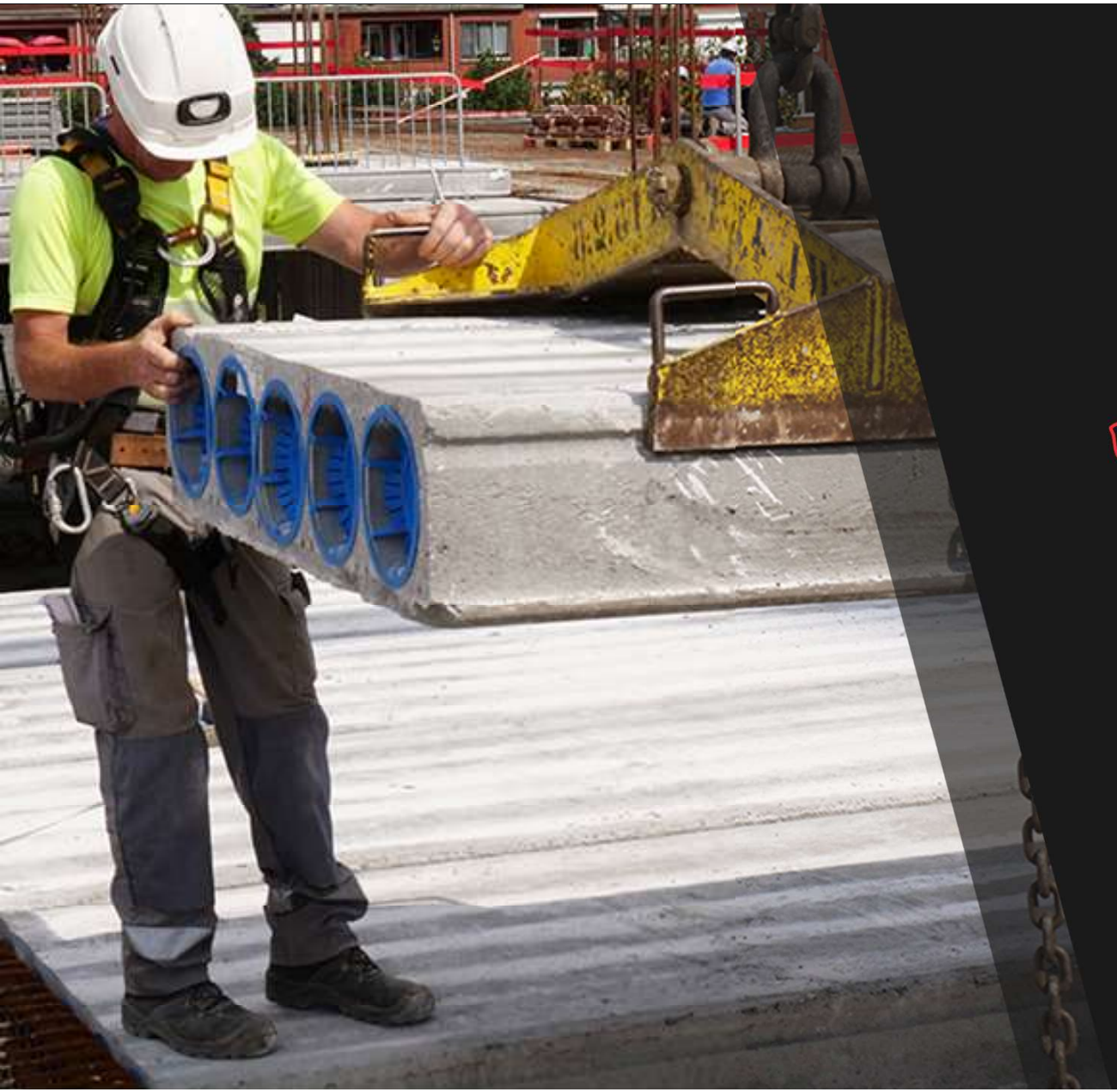
New recommendations

New or improved topics

- Extruded + slipform products
- Transfer of prestressing
- Calculation of shear and anchorage capacity
- Shear and bending interaction
- Shear and torsion interaction
- Protruding strands
- Camber design and deflection
- Composite action
- Restrained composite supports
- Non-rigid supports
- Horizontal actions
- Dynamic actions and vibrations
- Shear resistance at fire
- HC floors under seismic action

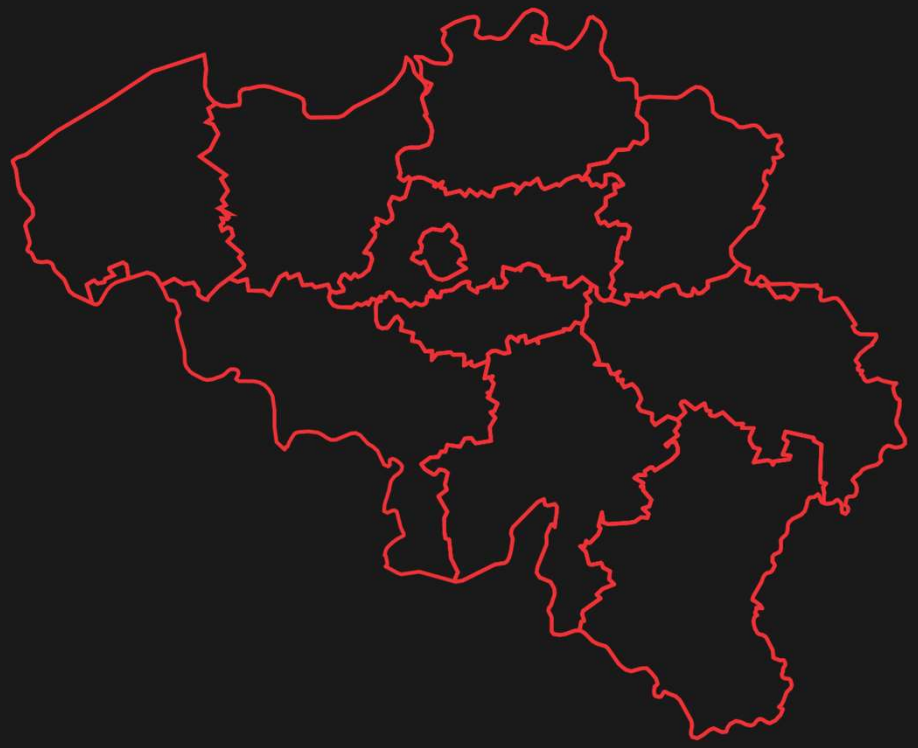
- Openings
- Building physics
- Environmental issues
- Testing

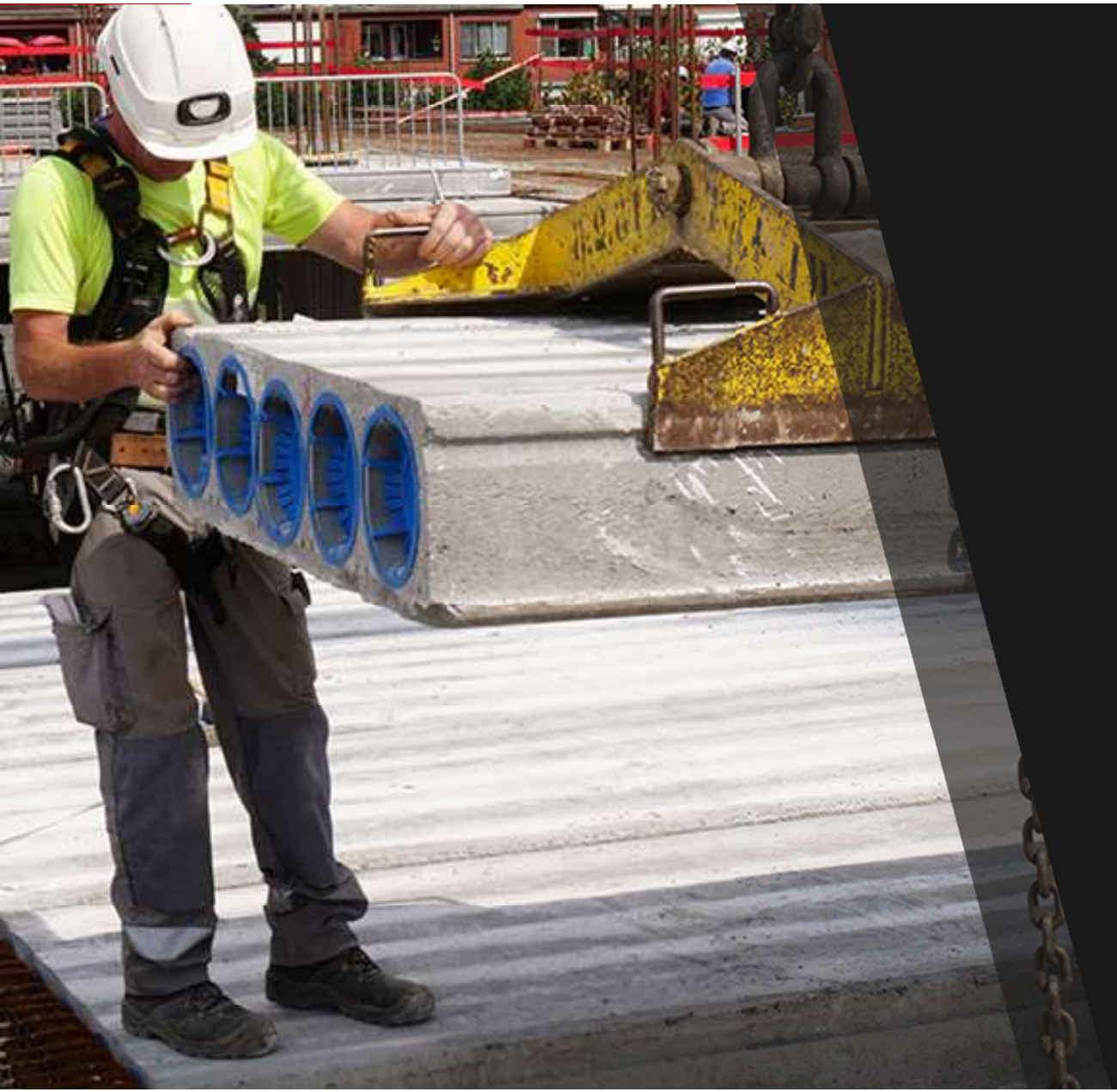




Belgium

known for...





Welcome

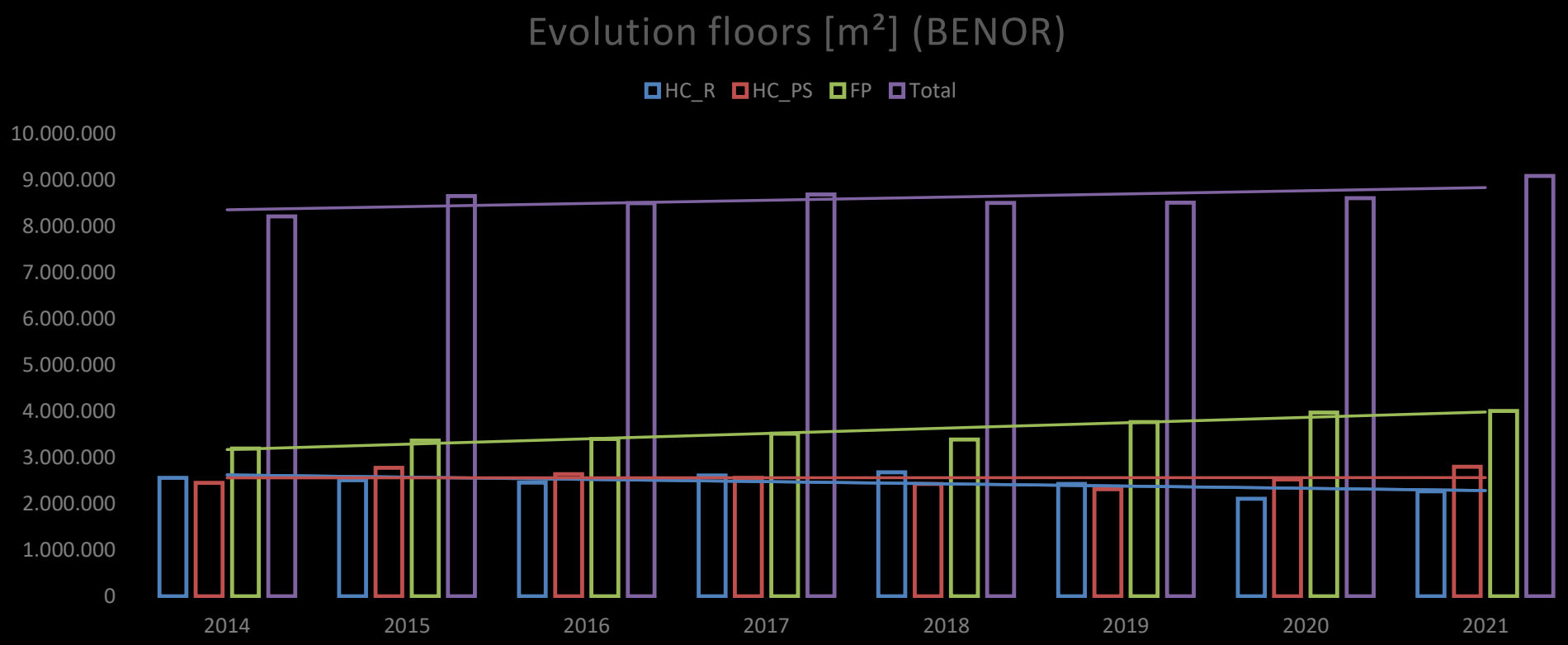
to Belgium

- 11,5 million inhabitants
- Surface area : 30 688 km²

- Annual HC production
  - Total: 5 080 000 m² [29]
  - Prestressed: 2 806 000 m² [18]
  - Reinforced: 2 274 000 m² [13]

HC in Belgium

Market evolution



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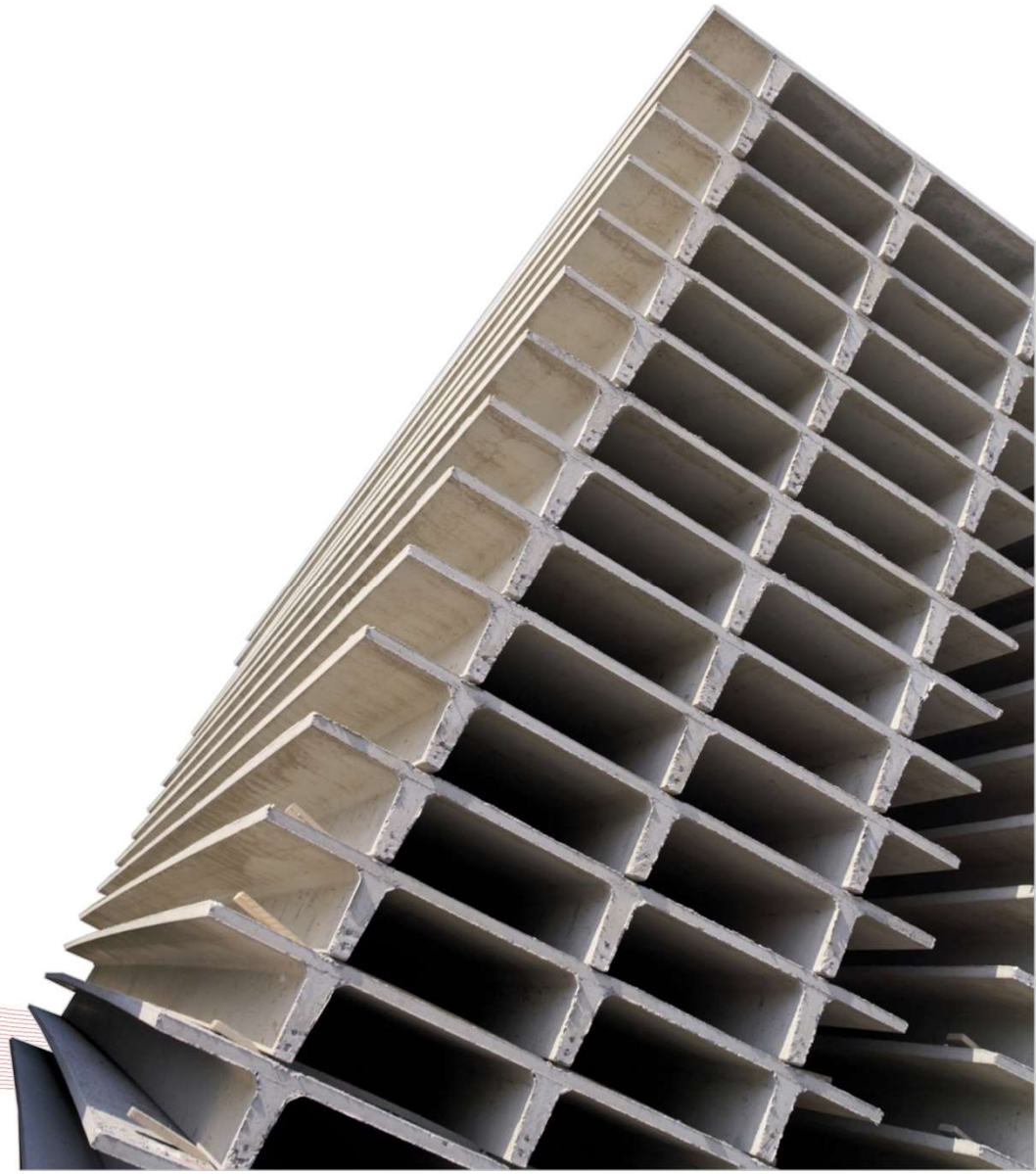
TG6.2 Quality control

for precast concrete

[FRANK/FERNANDEZ]

State-of-art report



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Quality control

Obvious?

PRECAST

- Building components (other than masonry)
- Railways, roads and landscaping
- Sewers, drains and separators
- Masonry

CONCRETE

STEEL

CONSTITUENTS FOR CONCRETE

- Cement
- Mixing water
- Aggregates
- Fly ash
- Silica fume
- Slag
- Lightweight aggregates
- Admixtures
- Fibres
- Pigments

AAC, GRC & other

- Autoclaved aerated concrete (AAC) and prefabricated reinforced components of lightweight aggregate concrete with open structure
- Glass-fibre reinforced cement (GRC)
- Other

DESIGN

WORKS

RETROFITTING

BUILDING PHYSICS & FIRE

QUALITY, SUSTAINABILITY AND SAFETY MANAGEMENT

Standards for Precast Concrete –

Overview of standards relevant for precasters. For education purposes only

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This poster is a joint initiative by FEBE and PROBETON

PRECAST

Building components (other than masonry)

EN 13369	Common rules for precast concrete products
EN 1168	Precast concrete products - Hollow core slabs
EN 12737	Precast concrete products - Floor slats for livestock
EN 12794	Precast concrete products - Foundation piles
EN 12839	Precast concrete products - Elements for fences
EN 12843	Precast concrete products - Masts and poles
EN 13224	Precast concrete products - Ribbed floor elements
EN 13225	Precast concrete products - Linear structural elements
EN 13693	Precast concrete products - Special roof elements
EN 13747	Precast concrete products - Floor plates for floor systems
EN 13978-1	Precast concrete products - Precast concrete garages - Part 1: Requirements for reinforced garages monolithic or consisting of single sections with room dimensions
EN 14843	Precast concrete products - Stairs
EN 14844	Precast concrete products - Box culverts
EN 14991	Precast concrete products - Foundation elements
EN 14992	Precast concrete products - Wall elements
EN 15037-1	Precast concrete products - Beam-and-block floor systems - Part 1: Beams
EN 15037-2	Precast concrete products - Beam-and-block floor systems - Part 2: Concrete blocks
EN 15037-3	Precast concrete products - Beam-and-block floor systems - Part 3: Clay blocks
EN 15037-4	Precast concrete products - Beam-and-block floor systems - Part 4: Expanded polystyrene blocks
EN 15037-5	Precast concrete products - Beam-and-block floor systems - Part 5: Lightweight blocks for simple formwork
EN 15050	Precast concrete products - Bridge elements
EN 15258	Precast concrete products - Retaining wall elements
EN 1857	Chimneys - Components - Concrete flue liners
EN 1858	Chimneys - Components - Concrete flue blocks
EN 12446	Chimneys - Components - Concrete outer wall elements
EN 490	Concrete roofing tiles and fittings for roof covering and wall cladding - Product specifications
EN 492	Fibre-cement slates and fittings - Product specification and test methods
EN 491	*Concrete roofing tiles and fittings for roof covering and wall cladding - Test methods*
EN 14437	*Determination of the uplift resistance of installed clay or concrete tiles for roofing - Roof system test method*

Railways, roads and landscaping

EN 13230-1	Railway applications - Track - Concrete sleepers and bearers - Part 1: General requirements
EN 13230-2	Railway applications - Track - Concrete sleepers and bearers - Part 2: Prestressed monoblock sleepers
EN 13230-3	Railway applications - Track - Concrete sleepers and bearers - Part 3: Twin-block reinforced sleepers
EN 13230-4	Railway applications - Track - Concrete sleepers and bearers - Part 4: Prestressed bearers for switches and crossings
EN 13230-5	Railway applications - Track - Concrete sleepers and bearers - Part 5: Special elements
EN 13481-2	Railway applications - Track - Performance requirements for fastening systems - Part 2: Fastening systems for concrete sleepers
EN 1317-1	Road restraint systems - Part 1: Terminology and general criteria for test methods
EN 1317-2	Road restraint systems - Part 2: Performance classes, impact test acceptance criteria and test methods for safety barriers including vehicle parapets
EN 1317-3	Road restraint systems - Part 3: Performance classes, impact test acceptance criteria and test methods for crash cushions
EN 1317-4	Road restraint systems - Part 4: Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers
EN 1317-5	Road restraint systems - Part 5: Product requirements and evaluation of conformity for vehicle restraint systems
EN 14388	Road traffic noise reducing devices - Specifications

CONSTITUENTS FOR CONCRETE

Cement

EN 197-1	Cement - Part 1: Composition, specifications and conformity criteria for common cements
EN 197-2	Cement - Part 2: Conformity evaluation
EN 14216	Cement - Composition, specifications and conformity criteria for very low heat special cements
EN 14647	Calcium aluminate cement. Composition, specifications and conformity criteria.
EN 15743	Supersulfated cement - Composition, specifications and conformity criteria
EN 413-1	Masonry cement - Part 1: Specifications
EN 196-1	*Methods of testing cement - Part 1: Determination of strength*
EN 196-2	*Methods of testing cement - Part 2: Chemical analysis of cement*
EN 196-3	*Methods of testing cement - Part 3: Determination of setting times and soundness*
EN 196-5	*Methods of testing cement - Part 5: Pozzolanicity test for pozzolanic cement*
EN 196-6	*Methods of testing cement - Part 6: Determination of fineness*
EN 196-7	*Methods of testing cement - Part 7: Methods of taking and preparing samples of cement*
EN 196-8	*Methods of testing cement - Part 8: Heat of hydration – Solution method*
EN 196-9	*Methods of testing cement - Part 9: Heat of hydration – Semi-adiabatic method*
EN 196-10	*Methods of testing cement - Part 10 : Determination of the water-soluble chromium (VI) content of cement*
EN 413-2	*Masonry cement - Part 2: Test methods*

Mixing water

EN 1008	Mixing water for concrete - Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete

Aggregates

EN 12620	*Aggregates for concrete*
EN 932-1	*Tests for general properties of aggregates - Part 1: Methods for sampling*
EN 932-2	*Tests for general properties of aggregates - Part 2: Methods for reducing laboratory samples*
EN 932-3	*Tests for general properties of aggregates - Part 3: Procedure and terminology for simplified petrographic description*
EN 932-5	*Tests for general properties of aggregates - Part 5: Common equipment and calibration*
EN 932-6	*Tests for general properties of aggregates - Part 6: Definitions of repeatability and reproducibility*
EN 1744-1	*Tests for chemical properties of aggregates - Part 1: Chemical analysis*
EN 1744-3	*Tests for chemical properties of aggregates - Part 3: Preparation of eluates by leaching of aggregates*
EN 1744-4	*Tests for chemical properties of aggregates - Part 4: Determination of water susceptibility of fillers for bituminous mixtures*
EN 1744-5	*Tests for chemical properties of aggregates - Part 5: Determination of acid soluble chloride salts*
EN 1744-6	*Tests for chemical properties of aggregates - Part 6: Determination of the influence of recycled aggregate extract on the initial setting time of cement*
EN 1744-7	*Tests for chemical properties of aggregates - Part 7: Determination of loss of ignition of Municipal Incinerator Bottom Ash Aggregate (MIBA Aggregate)*
EN 1744-8	*Tests for chemical properties of aggregates - Part 8: Sorting test to determine metal content of Municipal Incinerator Bottom Ash (MIBA) Aggregates*
EN 933-1	*Tests for geometrical properties of aggregates - Part 1: Determination of particle size distribution - Sieving method*

AAC, GRC & OTHER

Autoclaved aerated concrete (AAC) and prefabricated reinforced components of lightweight aggregate concrete with open structure

EN 1520	Prefabricated reinforced components of lightweight aggregate concrete with open structure with structural or non-structural reinforcement
EN 12602	Prefabricated reinforced components of autoclaved aerated concrete
EN 678	*Determination of the dry density of autoclaved aerated concrete*
EN 679	*Determination of the compressive strength of autoclaved aerated concrete*
EN 680	*Determination of the drying shrinkage of autoclaved aerated concrete*
EN 989	*Determination of the bond behaviour between reinforcing bars and autoclaved aerated concrete by the "Push-Out" test*
EN 990	*Test methods for verification of corrosion protection of reinforcement in autoclaved aerated concrete and lightweight aggregate concrete with open structure*
EN 991	*Determination of the dimensions of prefabricated reinforced components made of autoclaved aerated concrete or lightweight aggregate concrete with open structure*
EN 992	*Determination of the dry density of lightweight aggregate concrete with open structure*
EN 1351	*Determination of flexural strength of autoclaved aerated concrete*
EN 1352	*Determination of static modulus of elasticity under compression of autoclaved aerated concrete or lightweight aggregate concrete with open structure*
EN 1353	*Determination of moisture content of autoclaved aerated concrete*
EN 1354	*Determination of compressive strength of lightweight aggregate concrete with open structure*
EN 1355	*Determination of creep strains under compression of autoclaved aerated concrete or lightweight aggregate concrete with open structure*
EN 1356	*Performance test for prefabricated reinforced components of autoclaved aerated concrete or lightweight aggregate concrete with open structure under transverse load*
EN 1521	*Determination of flexural strength of lightweight aggregate concrete with open structure*
EN 1737	*Determination of shear strength of welded joints of reinforcement mats or cages for prefabricated components made of autoclaved aerated concrete or lightweight aggregate concrete with open structure*
EN 1738	*Determination of steel stresses in unloaded reinforced components made of autoclaved aerated concrete*
EN 1739	*Determination of shear strength for in-plane forces of joints between prefabricated components of autoclaved aerated concrete or lightweight aggregate concrete with open structure*
EN 1740	*Performance test for prefabricated reinforced components made of autoclaved aerated concrete or lightweight aggregate concrete with open structure under predominantly longitudinal load (vertical components)*
EN 1741	*Determination of shear strength for out-of-plane forces of joints between prefabricated components made of autoclaved aerated concrete or lightweight aggregate concrete with open structure*
EN 1742	*Determination of shear strength between different layers of multilayer components made of autoclaved aerated concrete or lightweight aggregate concrete with open structure*
EN 12269-1	*Determination of the bond behaviour between reinforcing steel and autoclaved aerated concrete by the beam test - Part 1: Short term test*
EN 12269-2	*Determination of the bond behaviour between reinforcing steel and autoclaved aerated concrete by the beam test - Part 2: Long term test*
EN 15304	*Determination of the freeze-thaw resistance of autoclaved aerated concrete*
EN 15361	*Determination of the influence of the corrosion protection coating on the anchorage capacity of the transverse anchorage bars in prefabricated reinforced components of autoclaved aerated concrete*

Glass-fibre reinforced cement (GRC)

EN 1170-1	*Precast concrete products - Test method for glass-fibre reinforced cement - Part 1: Measuring the consistency of the matrix "Slump test" method*
EN 1170-2	*Precast concrete products - Test method for glass-fibre reinforced cement - Part 2: Measuring the fibre content in fresh GRC, "Wash out test"*
EN 1170-3	*Precast concrete products - Test method for glass-fibre reinforced cement - Part 3: Measuring the fibre content of sprayed GRC*
EN 1170-4	*Precast concrete products - Test method for glass-fibre reinforced cement - Part 4 : Measuring bending strength, "Simplified bending test" method*
EN 1170-5	*Precast concrete products - Test method for glass-fibre reinforced cement -*

Quality control

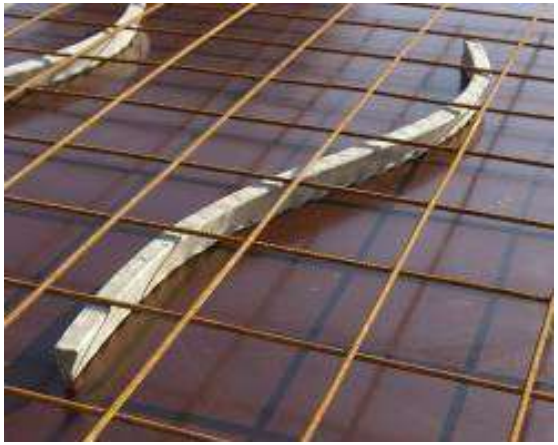
why this state-of-the-art report?

1. Quality (product conformity) is one of the main advantages of precast concrete
2. Sound quality control is a prerequisite for the introduction of precast concrete in new markets.

Quality control

Content

1. Introduction
2. Quality Control System
3. Materials and accessories
4. Production
5. Transport and erection
6. Equipment
7. Quality Control Operations

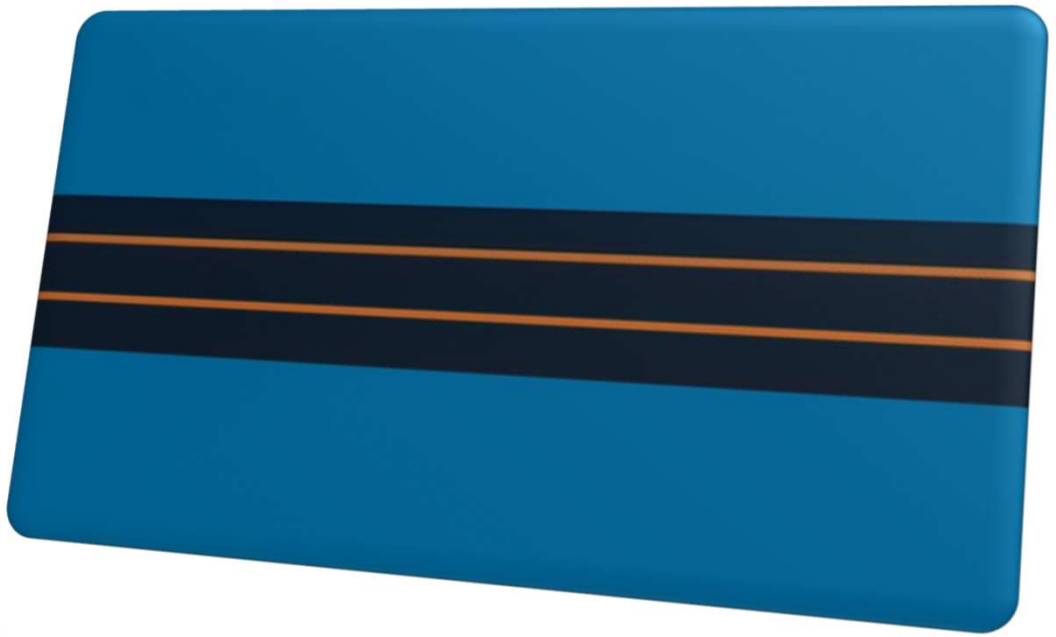


Quality control

Sources

Gathered information from:

- Europe
- USA
- Japan
- Brazil
- Canada
- …



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Active Task Groups

- TG6.1 Prestressed hollow core floors *[MAAS]*
  - Part 1 - recommendations
    - Content is complete
      - Request IPHA : new chapter sesimic design
    - Editorial work
    - Review
  - Part 2 – worked examples
    - Editorial work

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Active Task Groups

- TG6.2 Quality control for precast concrete
  [FRANK/FERNANDEZ]

  - Master table completed
    - Summarizing world wide experiences
  - TG proposes ‘recommended’ values
  - Work on tolerances
  - Quality insurance

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Active Task Groups

- TG6.3 Sustainability of structures with precast elements
  [FERNANDEZ-ORDOÑEZ / DE LA FUENTE]
  - Bulletin 88 published;
    - State-of-the-art report
  - Work on the next bulletin (full example based on a real building) started.

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Active Task Groups

- TG6.4 Precast concrete towers for wind power generators
  [ARROYO - LANCHA]
  - TG Chair restarted the work
    - MS Teams meeting on April 1 2021
  - TG Chair stopped the work
    - Search for solution

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Active Task Groups

- TG6.5 Precast concrete bridges *[WAIMBERG]*
  - Published
    - continuity of bridges
    - conceptual design
  - In preparation
    - lateral stability

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Active Task Groups

- TG6.6 Retrofitting of precast seismic structures
  [PAMPANIN & TSOUKANTAS†]

  – 'Seismic assessment and retrofit';
  – Collecting experiences in different countries;
  – Presentation of the bulletin to COM6 in 2022 (ROME);
  – Joint publication with PCI.

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Active Task Groups

- TG6.7 Precast concrete in tall buildings *[JONES]*
  - Document is published
    - State-of-the-art document
    - Bulletin 101
    - Joint publication
    - Videos online

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Active Task Groups

- TG6.8 Terminology for precast concrete
  [KROHN]
  - The Group closed the work;
  - Final review is needed;
    - In the future, terms could be translated into other languages with the help of *fib* National member groups;
    - COM6 or fib-international?
  - Work on 'hold'

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Active Task Groups

- TG6.9 Precast Parking Structures
  [SENNOUR/DONIAK]
  - State-of-the-art report
  - Last meeting: 18/11/2021
  - Next meeting: TBD
  - Table of contents
  - Sub-groups

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Active Task Groups

- WG MC 2020
  [FERNANDEZ-ORDOÑEZ / PAMPANIN/DERKOWSKI]
  - ‘key-chapters’ related to PC determined
  - Comments gathered
  - Compiled document to be finished

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Future work

- Website
  - Avoid overlap with fib website
    - Organisation of TG work – *fib*-website
  - Promotion
- Workshop for TG Convenors (2022)
  - Reporting
    - *fib* rules (new form)
  - How to use the new *fib*-website
  - How to draft a bulletin
    - Experiences TG 6.7
    - *fib* rules

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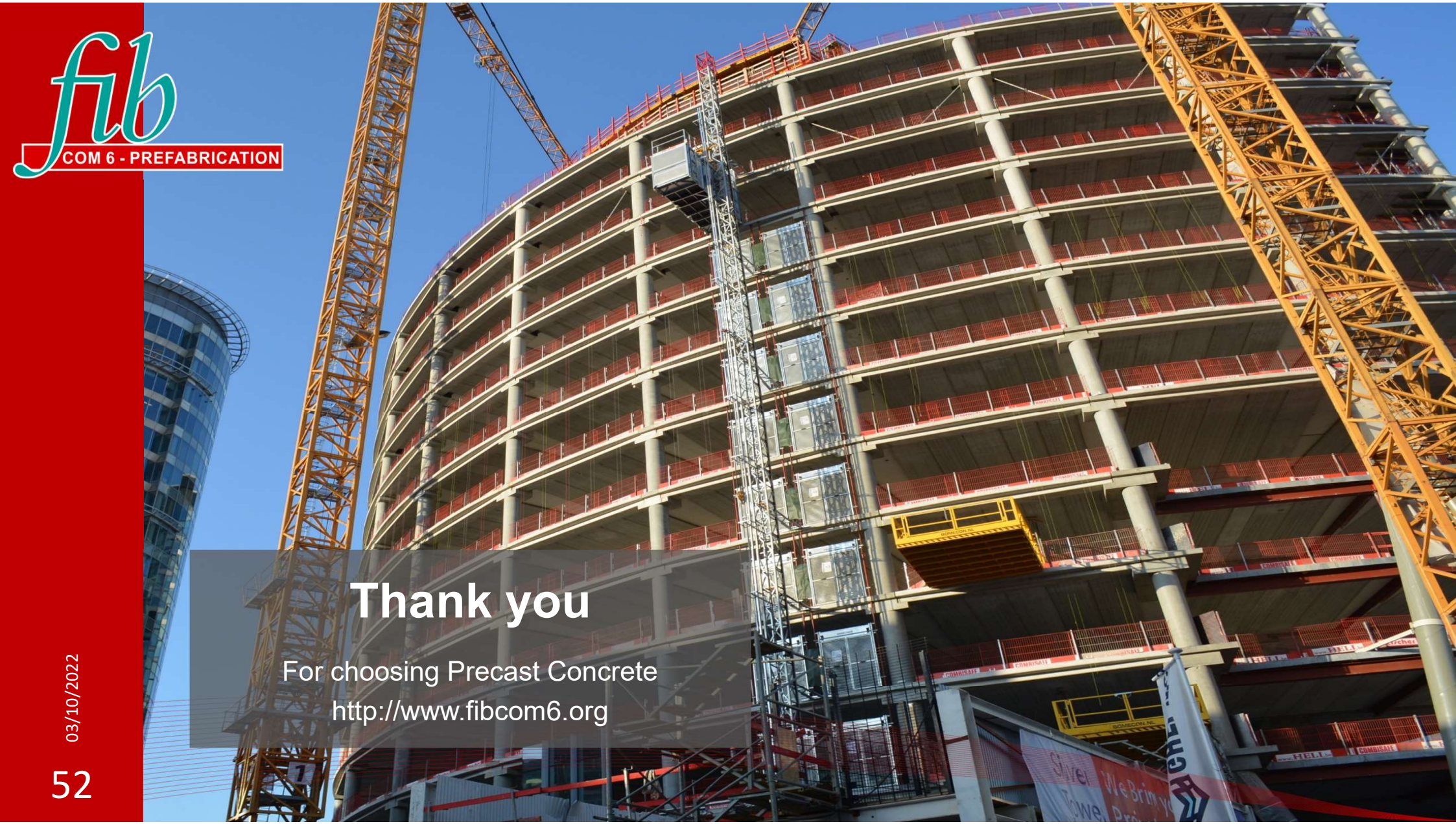
Future work

- Key points (needs)
  - How to use precast concrete to meet today's challenges!
    - E/C – Footprint
    - Circularity
  - Other:
    - Sustainability
    - Design
    - Erection
    - Technology
    - Promotion
    - Existing structures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