Model Code 2020: conceptversie ter becommentariëring

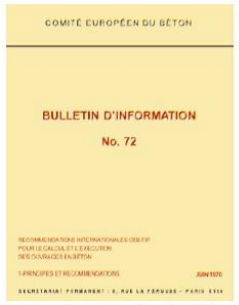
Agnieszka Bigaj-van Vliet (TNO)

Co-convenor fib Task Group 10.1: MC2020

Inhoud

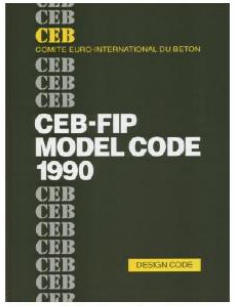
- Evolutie van fib Model Codes
- Ambitie en uitdaging fib Model Code 2020
- Fundamentele principes en concepten in fib Model Code 2020
  - sustainability-driven & performance-based : prestatiegerichte benadering in ontwerp, uitvoering en levenscyclusbeheer van betonconstructies
  - beginselen van prestatie-evaluatie bij ontwerp en beoordeling (PPP)
  - beginselen en concepten in toetsing van constructieve veiligheid en bruikbaarheid
- Levenscyclus-perspectief in fib Model Code 2020
- MC2020 TOC (Delen & Hoofdstukken)
- ACTIE : conceptversie ter becommentariëring

Evolutie van fib Model Codes

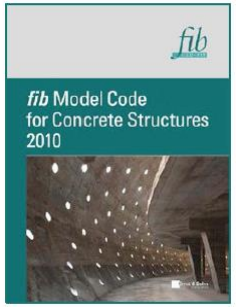


Model Code 1970

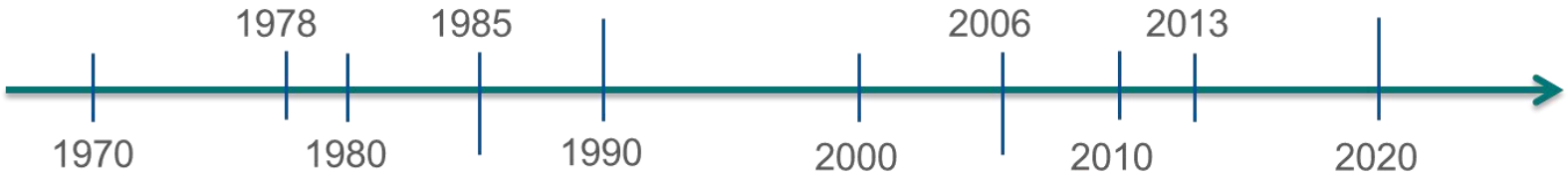
Model Code 1978



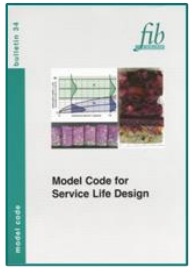
Model Code 1990



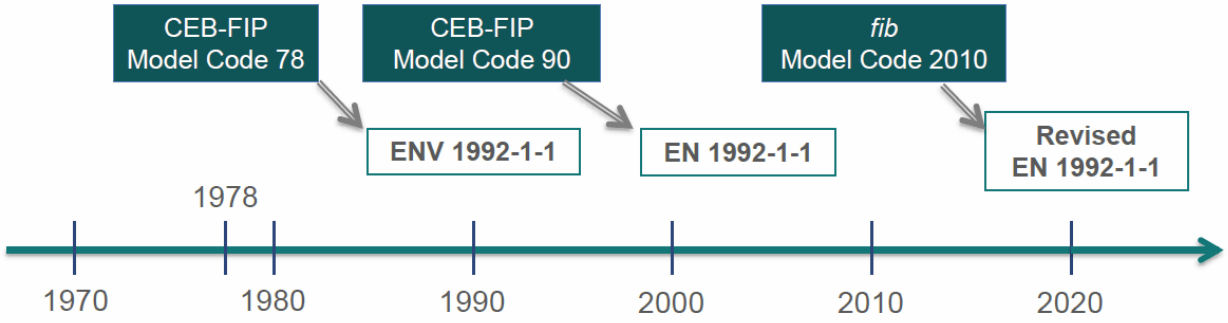
Model Code 2010



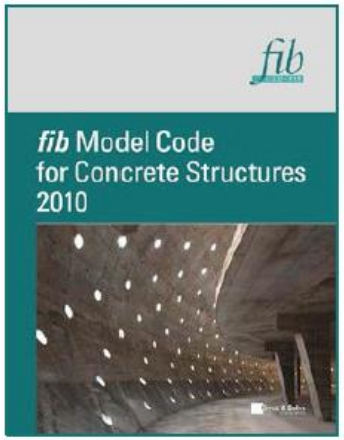
CEB Bull. 165
Seismic Design



fib Bull. 34
Service Life Design



Ambitie en uitdaging fib Model Code 2020



Model Code 2010

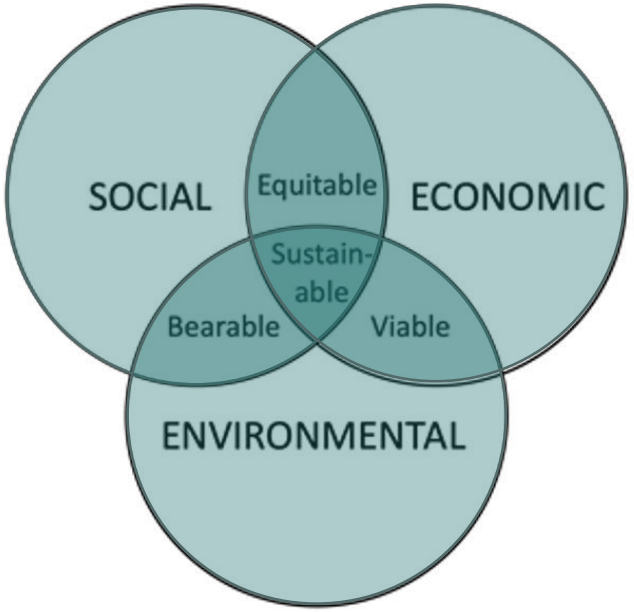
- All ‘Engineering works’ are undertaken to **meet established societal needs and goals**. MC2020 adopts a **sustainability-driven approach** to design, execution and life-cycle management of concrete structures.
- The vision on MC2020 is for it to be **future oriented and capable to accommodate and not hinder technological progress**, thereby facilitating the ongoing evolution of concrete and reinforcement materials, associated technologies and the structural forms which might potentially be created using them.
- MC2020 consistently deals with **new and existing concrete structures, incl. structures after interventions**, applying fundamental principles of performance-based approach to design and assessment, safety philosophy based on risk and reliability concepts, and consistent treatment of safety, serviceability and durability verification

Ambitie en uitdaging fib Model Code 2020

MC2020 adopts a **sustainability-driven performance-based approach to design, execution and life-cycle management of concrete structures**.

The sustainability-driven performance-based approach to design and assessment, seeks to ensure that the **structure fulfills the performance requirements** it is expected to meet **throughout its full / extended service life cycle**.

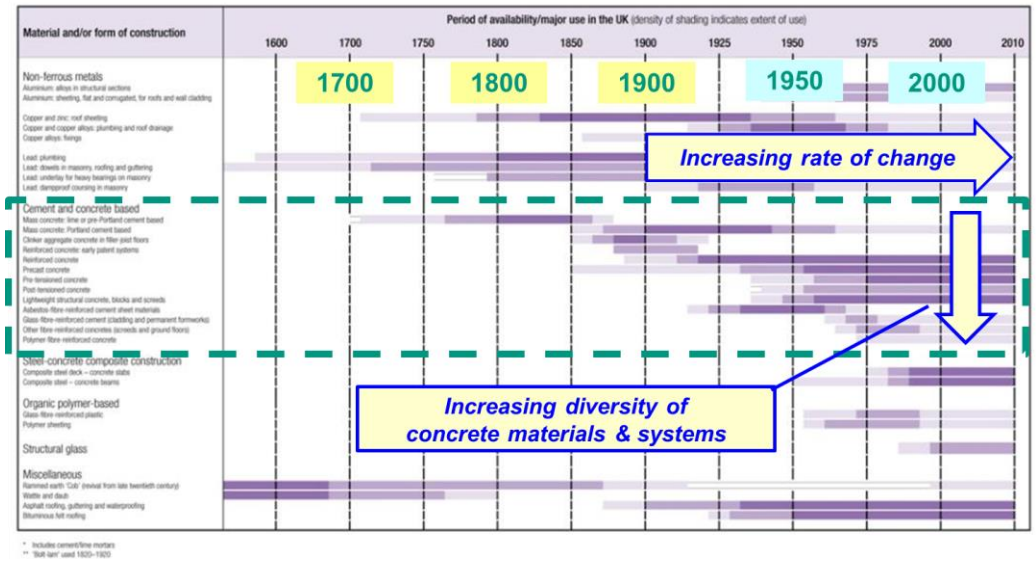
The essence of the concept of the performance-based approach is that the requirements which have to be met should be defined, but not the manner in which this should be done



Sustainability is described by means of the three interdependent pillars on which sustainable development depends:

- **social pillar**
- **environmental pillar**
- **economic pillar**

Aspiration and challenge fib Model Code 2020



Criterion	MC 1990	MC 2010	MC 2020
concrete strength	20 … 60 (90) MPa	20 … 130 MPa	20 … 130 MPa
concrete type	normal strength	■ normal strength ■ high strength ■ lightweight (10 … 90 MPa) ■ self-compacting ■ green (eco-concrete) → concretes comply largely with the provisions of EC2 and EN 206, resp.	■ normal strength ■ high strength ■ lightweight (10 … 90 MPa) ■ self-compacting ■ green (eco-concrete) ■ UHPC (…. 250 MPa) ■ intervention materials ■ old concrete **desired**
concrete loads	different ranges of applicability, depending on the related load (static, impact etc.); temperature range: mainly 0 ° C < T < 80 ° C		
tailor-made concrete			reference to test standards or recommendations

The fib MC2020 covers wide range of traditional and non-traditional solutions and includes provisions for **various types of concrete** and concrete structures (reinforced, prestressed, both pretensioned and post-tensioned, as well as steel-concrete composite structures). Provisions cover **static and non-static conditions such as fatigue, seismic excitations, impact and explosions, and an extreme range of thermal exposure including fire and cryogenic conditions, in full range of environmental exposure conditions.**

Duurzaam beton in fib Model Code 2020

Evaluation of environmental performance – approach given in MC2020

- MC2020 provides the designer with a simple procedure/formula of how to evaluate and compare the potential of a certain concrete to be used in a sustainable manner:

$$\text{concrete sustainability potential (CSP)} = \frac{\text{performance} \cdot \text{service life}}{\text{environmental impact}} = \frac{f_{ck} \cdot t_{SL}}{GWP}$$

- Provisions rely on generally accepted input parameters already introduced in the MC2020 or available in international standards:
  - concrete performance, f_{ck} – measured/represented by compressive strength
  - concrete service life (durability), t_{SL} – determined by SLA
  - environmental impact, *GWP* – determined by applying a LCA based on ISO 14040

Duurzaam beton in fib Model Code 2020

Problem: Green concrete properties and future developments

- New types of green concretes, beyond provisions of today's standards will enter the market

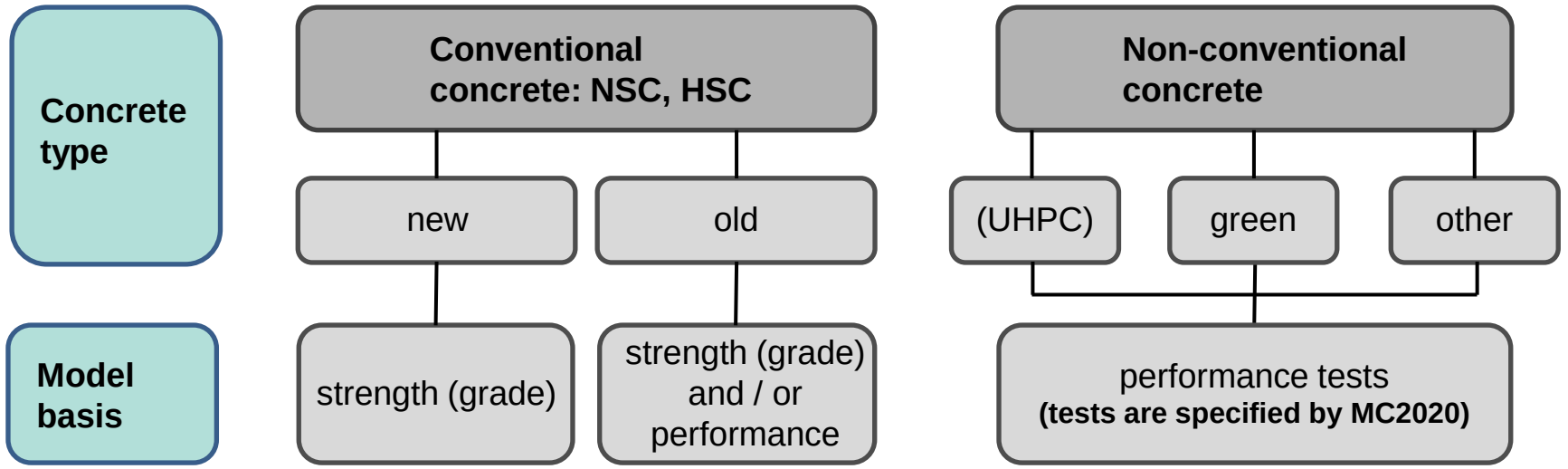
  (new binders, low binder content, new types of aggregate, …)

→ **concrete models are not available**

MC2020 compressive strength-based concepts/models may not be applied!

→ performance-based modelling is required (testing is mandatory)

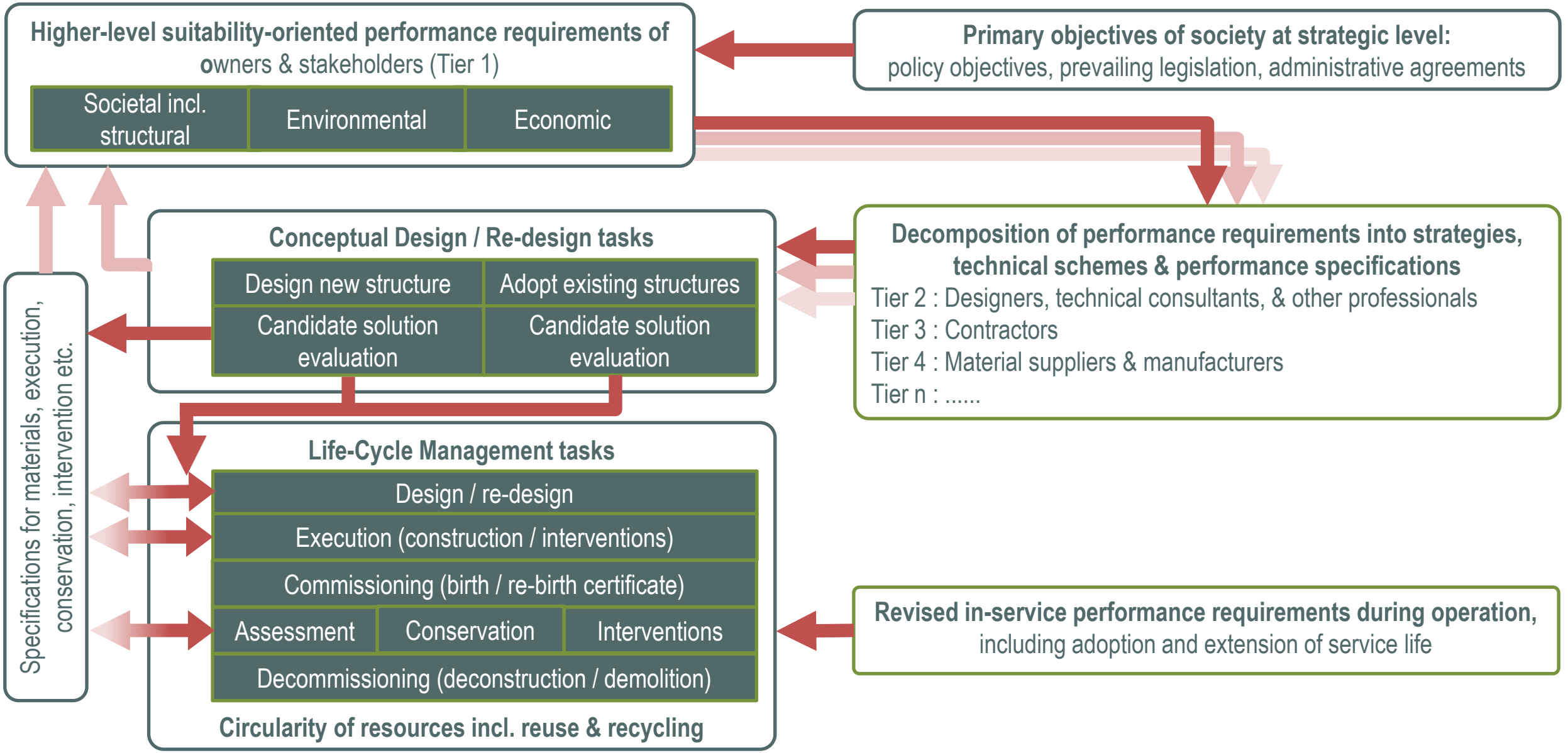
Approach: Distinction in conventional and non-conventional concrete



Duurzaam beton in fib Model Code 2020

- **Green concrete is explicitly addressed** in MC2020. Particular design provisions on the material level and the structural level are indicated.
- The **classical strength-based approach for modelling/predicting** concrete behaviour can not be kept for green concrete. Therefore, **performance-based modelling approaches** have to be used.
- A distinction between **conventional concrete** and **non-conventional concrete** is introduced; for non-conventional concrete, i.e. **new green concretes**, guidance is given for tests in order to derive design relevant characteristics.
- Provisions given in the chapter “Concrete” of MC2020 are **intended to facilitate the adoption of advances** in the fields of concrete materials and engineering, so seeking that MC2020 may even be applied when future progress in these technological areas occurs.
- **Background information** will be given in a fib Bulletin (under preparation).

Prestatiegerichte benadering in fib Model Code 2020



Prestatiegerichte benadering in fib Model Code 2020

Society and stakeholders give **demands for the objectives** of a structure during its life cycle and **the functions to achieve the objectives**, and that these demands **should reflect the role(s) that a structure should have** under the intended conditions of **construction, service life and dismantlement**.

Categories of performance requirements to be consider :

- **Structural performance requirements**, associated with structural safety, serviceability, durability, robustness and structural resilience,
- **Requirements for other aspects of societal performance**, associated with effects on stakeholders, quality of the built environment (aesthetics, cultural heritage, movements of traffic /other items etc), asset attributes (buildability, maintainability, circular resource flows) etc.,
- **Environmental performance requirements**, associated with demand regarding the resources, energy and land use, emissions to air, water and soil, noise and vibration, preservation of species and ecosystems; wastes arising etc.,
- **Economic performance requirements**, associated with asset creation, operation, maintenance, adaptation, refurbishment and repurposing, dismantlement, reuse & recycling, the cost of capital; support of the local economy etc.

Prestatie-evaluatie bij ontwerp en beoordeling in fib Model Code 2020

fib MC2022 recommends that the **stakeholders have to give demands for the objectives of a structure** during its life cycle and **for the functions to achieve the objectives**, and that these demands should reflect the role(s) that a structure should have under the intended conditions of construction, service life and dismantlement

Evaluation of performance requirements :

- performance requirements should be established by means of the **performance criteria**:
- for **performance requirements of a quantitative nature** (e.g. structural reliability, LC costs, CO_2 emissions) performance criteria are expressed by **quantitative limits** associated with a performance requirement, defining the boundary between desired and adverse performance.
- for **performance requirements of a qualitative nature** (e.g. aesthetics, social functions) performance criteria are expressed by **qualitative limits** associated with a performance requirement, defining the boundary between desired and adverse performance.

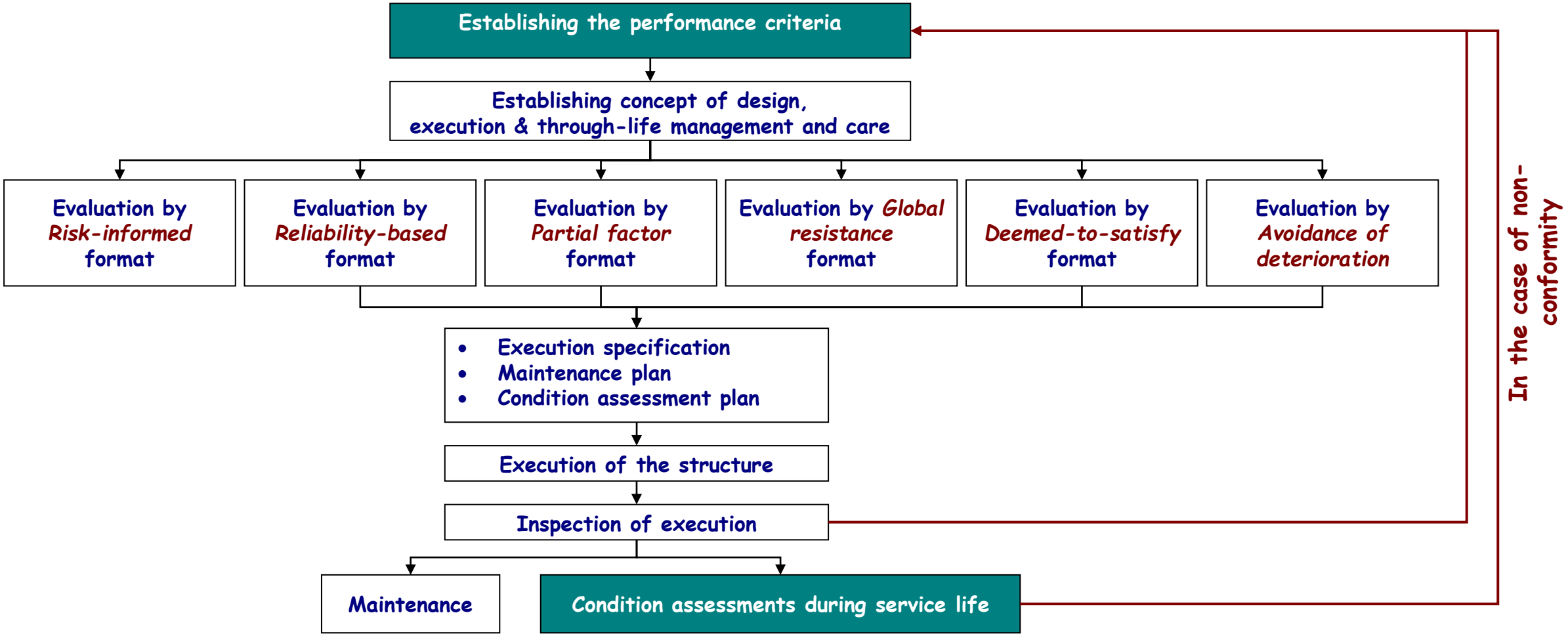
Defining the required performance / outcome in terms of performance **criteria** with associated metrics (and/or tests) might be used:

- to evaluate if performance requirements are satisfied

- to effectively monitor the progress achieved towards the desired performance goals.

Toetsing constructieve veiligheid en bruikbaarheid in fib Model Code 2020

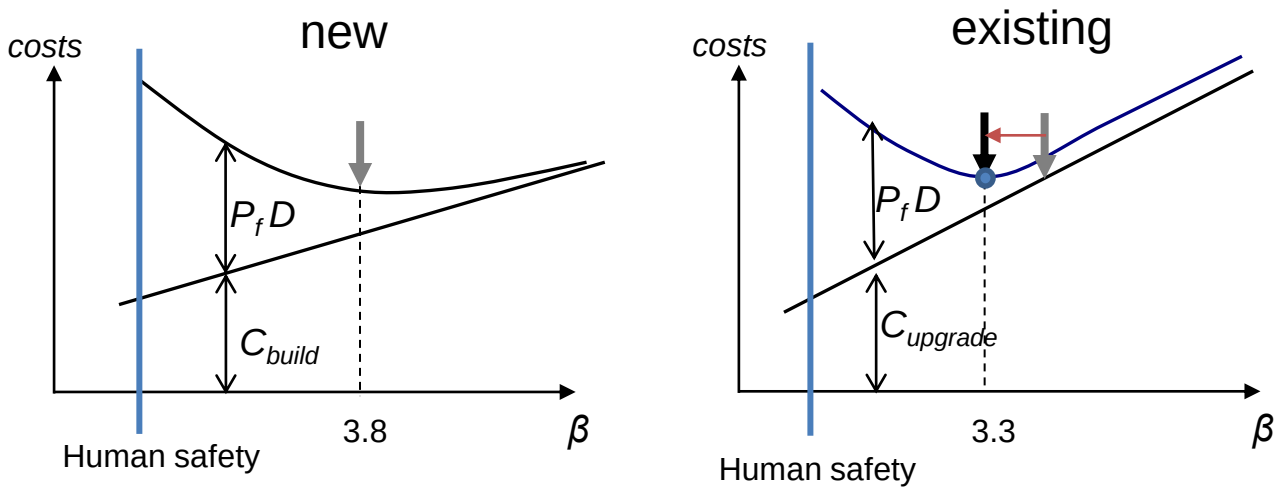
Consistent approach to new and existing structures:



Toetsing constructieve veiligheid en bruikbaarheid in fib Model Code 2020

Consistent approach to new and existing structures:

- **safety philosophy based on risk and reliability concepts**



Substantial costs of interventions on existing structures to increase performance levels

Remaining working life and reference period often smaller than design life of 50 years

- **differentiation of target performance levels to be considered** : the relative maintenance cost of existing structures increases which justifies a **lower β target value for in assessment of existing structures**
- **adjusted reference period in assessment to be considered** : taking reference period equal to 1 year allows to take into account the reducing resistance for deteriorating structures and is fit for use in data-informed assessment (e.g. SHM)
- the new partal factors and $\alpha_{R,E}$ factors and fib MC2020 proposals for both design (t_{ref} = 50y) and assessment (t_{ref} = 1y) are calibrated for reinforced concrete structures

Toetsing constructieve veiligheid en bruikbaarheid in fib Model Code 2020

			CC1	CC2	CC3
EN1990 Design	γ_c		1.5	1.5	1.5
	γ_s		1.15	1.15	1.15
	γ_G		1.22	1.35	1.49
	γ_Q		1.35	1.5	1.65
MC2020 Design t_{ref} = 50 y	γ_c		1.4	1.5	1.6
	γ_s	Normal uncertainty*	1.1	1.15	1.175
		Higher execution quality**	1.05	1.075	1.1
		Measurements executed***	1.0	1.05	1.05
	γ_G	V_g = 0.04 (self-weight)	1.2	1.25	1.25
		V_g = 0.1 (other loads)	1.3	1.35	1.4
	γ_Q	Imposed****	1.3	1.5	1.7
		Wind	1.6	1.85	2.1
		Road traffic	1.25	1.3	1.4
		Snow	1.75	1.95	2.2
MC2020 Assessment t_{ref} = 1 y Cost of safety measure: Large (A)	γ_c	V_{fc} = 0.08 (core tests executed)	1.1	1.125	1.15
		V_{fc} = 0.15 (no core tests)	1.1	1.15	1.2
	γ_s	Normal uncertainty*	1.075	1.075	1.1
		Measurements exec.***	0.975	1.0	1.0
	γ_G	V_g = 0.04 (self-weight); $V_{\theta E}$ = 0.025****	1.125	1.125	1.15
		V_g = 0.04 (self-weight); $V_{\theta E}$ = 0.075	1.2	1.225	1.25
		V_g = 0.1 (other loads); $V_{\theta E}$ = 0.025****	1.25	1.275	1.3
		V_g = 0.1 (other loads); $V_{\theta E}$ = 0.075	1.3	1.325	1.375
	γ_Q	Imposed*****	1.0	1.075	1.25
		Wind	1.05	1.15	1.3
		Road traffic	1.05	1.075	1.15
		Snow	1.05	1.15	1.35

Toetsing constructieve veiligheid en bruikbaarheid in fib Model Code 2020

Evaluation of performance requirements :

- evaluation of performance seeks to **demonstrate that a desired balance of the needs and the demands** of the stakeholders is achieved **throughout the life cycle** of a structure.
- performance is evaluated using **appropriate methodologies to verify or validate the behaviour, quality or impact** of a structure or a structural component against the **specified performance requirements** by means of the **associated performance criteria**

Verification by models
i.e. **verification by modelling or simulating performance** of element, component, or system within the structures, followed by a review or analysis of the modelling results

Verification by testing
i.e. **verification supported by testing (field and lab)** of material, element, component, or system followed by a review or analysis of the testing results

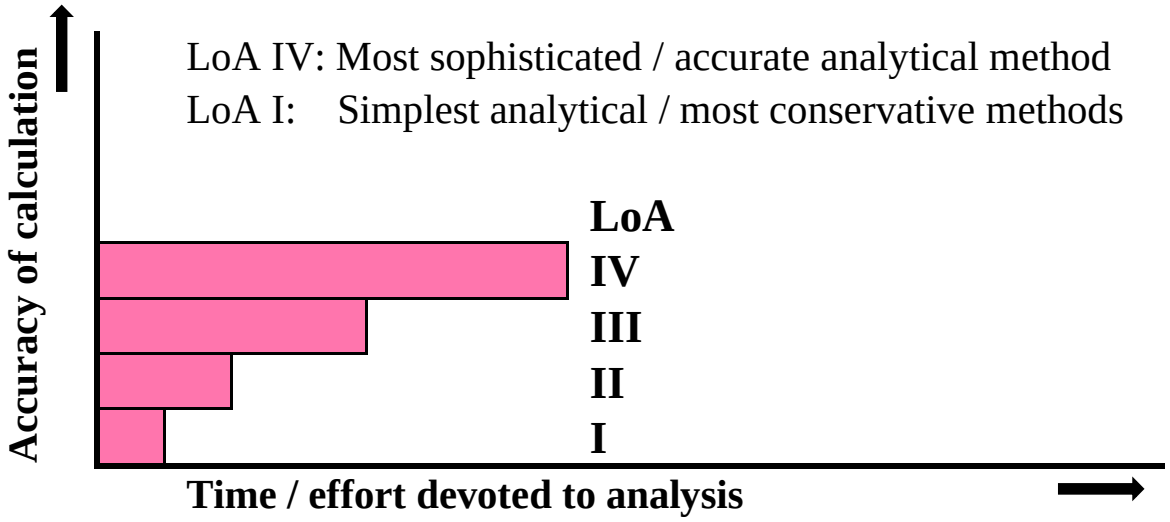
- performance-based **design** is completed when it has been **shown that the relevant performance requirements are adequately satisfied**
- performance-based **assessment** is completed when it has been **identified whether all relevant performance requirements are satisfied or not** (in the latter case the performance is qualified as inadequate)

Validation
i.e. establishing evidence that provides a high degree of assurance that of element, component, or system within the structures accomplishes its intended performance

Toetsing constructieve veiligheid en bruikbaarheid in fib Model Code 2020

Level of Approximation approach:

A strategy to model the behavior of structures where the accuracy of the estimate of a structural member's response (e.g. resistance, deformation or deterioration) can be, if necessary, progressively refined through a better representation of the phenomena and/or a better estimate of parameters involved in the analysis by models . **Higher LoA models might require more accurate information to assess model parameters. Therefore, when selecting LoA level for the analysis the minimum demands for the information should be elaborated.**



- LoA IV : fit for the assessment of critical existing structures & design of special cases
- LoA III : fit for in-depth elemental evaluation of existing structures & design of special cases
- LoA II : fit for typical elemental design & assessment
- LoA I : fit for preliminary design & assessment, non-governing limit state

fib Model Code 2020 - Accuracy on the estimate of the actual behaviour as a function of time devoted to the analysis for various levels-of-approximation

Toetsing dwarskracht in fib Model Code 2020

Reasons for change

- To ensure consistency with new provisions for steel fibre reinforced concrete
- To account for new findings since MC2010
- To account for the influence of reinforcement ductility classes
- To avoid misunderstandings related to the aim of Level of Approximation I provisions
- Implementing a new consistent model for loads carried directly to a support through strut or arch action
- To explain the similarities of strain-based approaches with closed-form solutions
- To provide statistical data for detailed assessment of existing structures
- To provide some additional guidance for higher levels of approximation (non-linear analysis for instance)

Toetsing dwarskracht in fib Model Code 2020

Aim of LoA I provisions (shear and punching shear)

- The level I equations are derived from the more general level II approximations with the assumption that the longitudinal reinforcement has reached the yield strength.
- This simplification, useful for design and assessment, is based on the assumption that the longitudinal reinforcement has been designed to resist the bending moment associated to the shear resistance (same load-carrying capacity for flexural and shear failure).
- For this reason, level I should not be used for a comparison to test results to check model accuracy, unless the experiments were designed to fail simultaneously in shear and flexure.

Toetsing dwarskracht in fib Model Code 2020

Approaches for shear and punching in members without shear reinforcement

	Strain based approaches according to MC2020 (unchanged from MC2010)	Closed-form solutions derived from simplifications of the strain-based approaches (prEN 1992-1-1:2021)
Shear in members without shear reinforcement	$V_{Rd,c} = \frac{0.4}{1+1500\cdot\varepsilon_x}\cdot\frac{1300}{1000+k_{dg}\cdot z_v}\frac{\sqrt{f_{ck}}}{\gamma_C} b_w \cdot z$ $\varepsilon_x = \frac{1}{2\,E_s A_s}\left(\frac{M_{Ed}}{z_v}+V_{Ed}+N_{Ed}\left(\frac{1}{2}\mp\frac{\Delta e}{z_v}\right)\right)\geq 0$	$V_{R,c} = 0.07\cdot\left(\rho_l\cdot E_s\cdot f_c\cdot\frac{d_{dg}}{\sqrt{a_{cs}\cdot d}}\right)^{1/3}\cdot b_w\cdot d$
Punching of slabs without shear reinforcement	$V_{Rd,c} = \frac{1}{1.5+0.9k_{dg}\psi d}\frac{\sqrt{f_{ck}}}{\gamma_c} b_0\ d_v$ $\psi = 1.5\cdot\frac{r_s}{d}\frac{f_{yd}}{E_s}\cdot\left(\frac{m_{Ed}}{m_{Rd}}\right)^{1.5}$	$V_{Rc} = 0.16\cdot\sqrt{\frac{d}{b_0}\cdot a}\cdot\left(\rho\cdot E_s\cdot f_c\cdot\frac{d_{dg}}{\sqrt{d\cdot r_s}}\right)^{1/3}\cdot b_0\cdot d$

Background document: Muttoni et al., 2018, Cavagnis et al. 2020

Toetsing dwarskracht in fib Model Code 2020

Approaches for shear in members with shear reinforcement

- Navigation clause added to provide overview of approaches
- Levels of approximation modified to improve consistency

Level of approximation	*Concrete contribution*	*Minimum compressive stress field inclination*	*Strength reduction factor for $V_{RD,max}$*
I	$V_{Rd,c} = 0$	$\cot\theta_{\min} = \text{fixed}$	$k_\varepsilon = \text{fixed}$
			Eq. (27.1-37)
IIa	$V_{Rd,c} = 0$	$\cot\theta_{\min} = f(\varepsilon_x)$	$k_\varepsilon = f(\varepsilon_x, \theta)$
		Eq. (27.1-39)	Eq. (27.1-40)
IIb	$V_{Rd,c} = f(\varepsilon_x)$	$\cot\theta = f(\varepsilon_x)$	$k_\varepsilon = f(\varepsilon_x, \theta)$
	Eq. (27.1-43)	Eq. (27.1-39a)	Eq. (27.1-40)

LoA IIa (II according to MC2010) is based on a stress field approach consistent with strut-and-tie models where the compression field inclination q may be selected between $q_{\min}$ and 45°

$$V_{Rd} = V_{Rd,s} \le V_{Rd,\max}$$

LoA IIb is consistent with the Simplified Modified Compression Field Theory where the inclination q refers to the assumed crack plane angle which depends directly on the longitudinal strain.

$$V_{Rd} = V_{Rd,c} + V_{Rd,s} \le V_{Rd,\max}$$

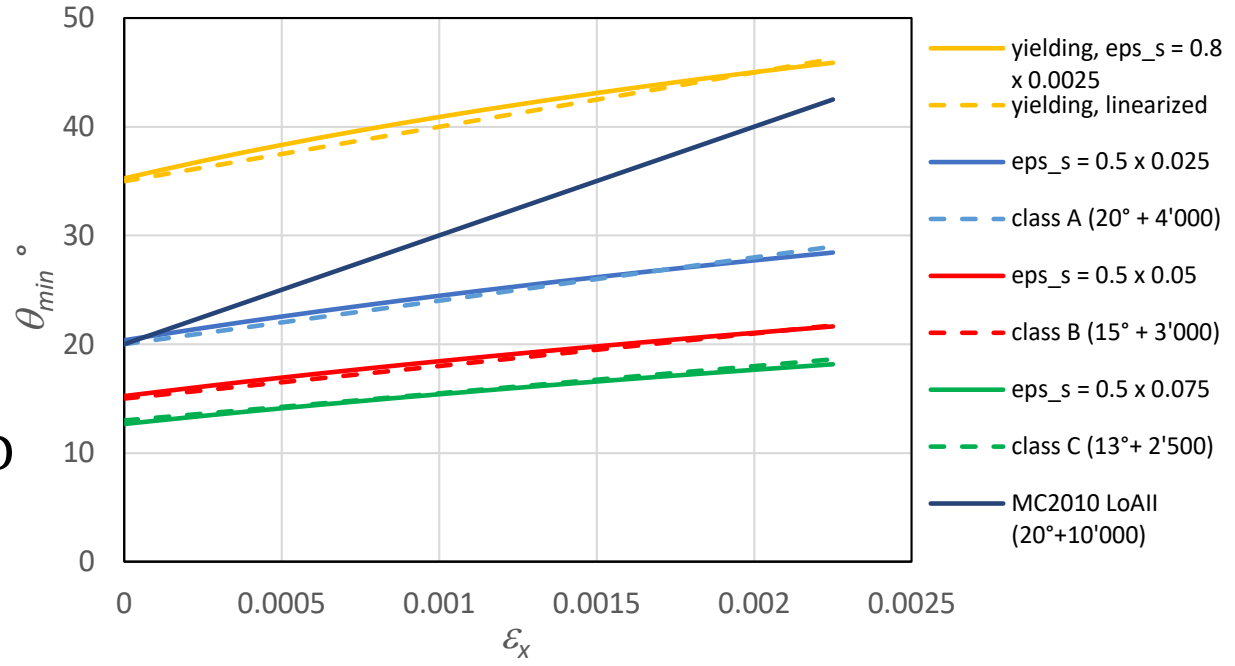
Approaches for shear in members with shear reinforcement

- Modified minimum compression field inclination for LoAIIa

$$\cot\theta_{\min} = \cot\left(20° + 4000\varepsilon_x\right) \quad \text{Ductility Class A}$$

$$\cot\theta_{\min} = \cot\left(15° + 3000\varepsilon_x\right) \quad \text{Ductility Class B}$$

$$\cot\theta_{\min} = \cot\left(13° + 2'500\varepsilon_x\right) \quad \text{Ductility Class C-D}$$



Background document: Sigrist 2011

Toetsing dwarskracht in fib Model Code 2020

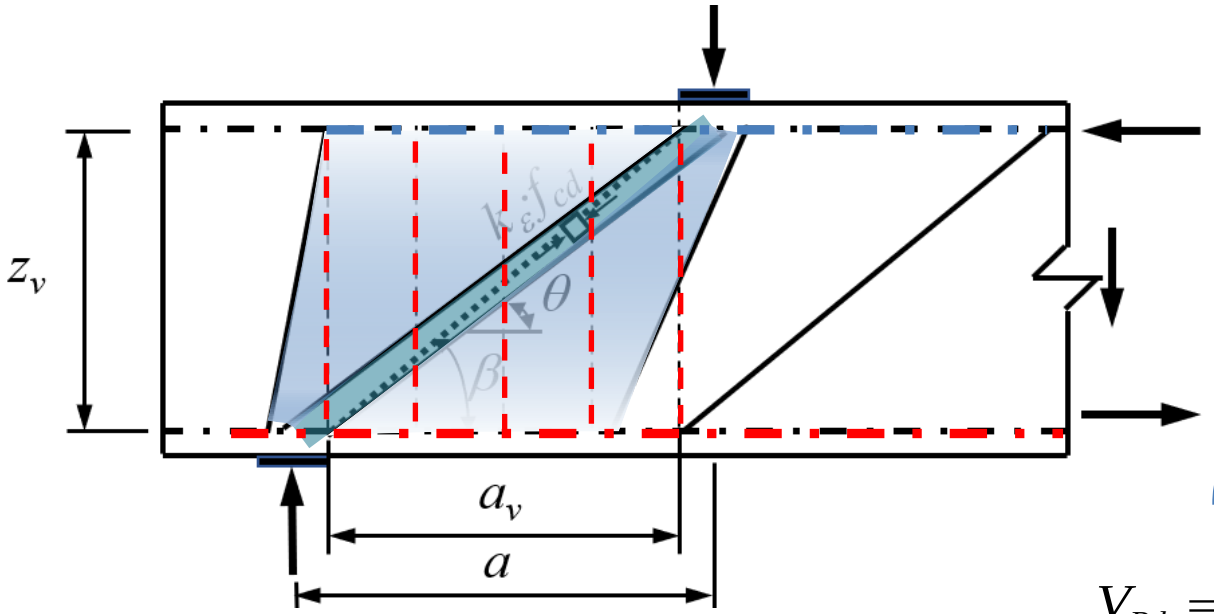
Minimum shear reinforcement: may be reduced for higher ductility

- Same minimum shear reinforcement as MC2010 for Ductility Class A shear reinforcement
- may be reduced by 10% for ductility class B shear reinforcement
- may be reduced by 20% for ductility class C or D shear reinforcement

Toetsing dwarskracht in fib Model Code 2020

New model for loads carried directly to a support

Empirical formula in MC2010 replaced by a mechanical model consistent with stress fields and strut&tie models



Shear force carried by direct strutting

Shear force carried by shear reinforcement

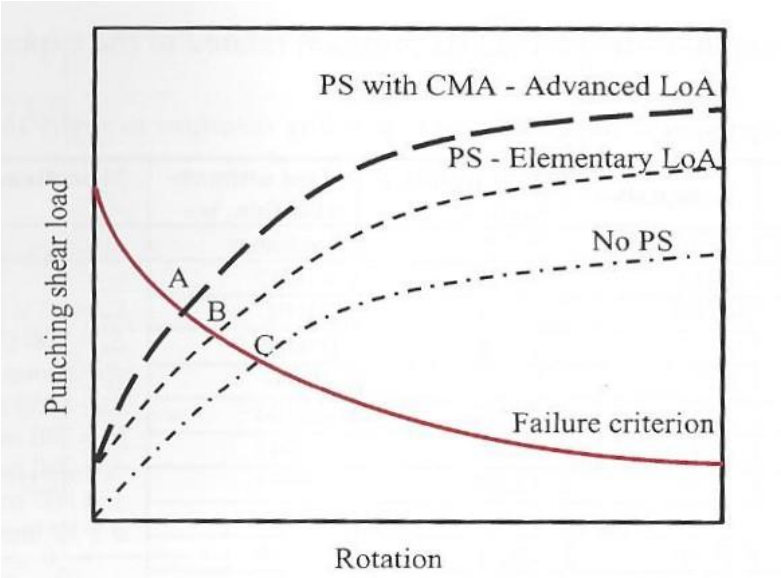
$$V_{Rd} = k_\varepsilon f_{cd} \frac{\cot\theta - \cot\beta}{1+\cot^2\theta} \cdot b_w \cdot z_v + \frac{A_{sw}}{s_w} z_v \cdot f_{ywd} \cot\beta \le V_{Rd,\max}$$

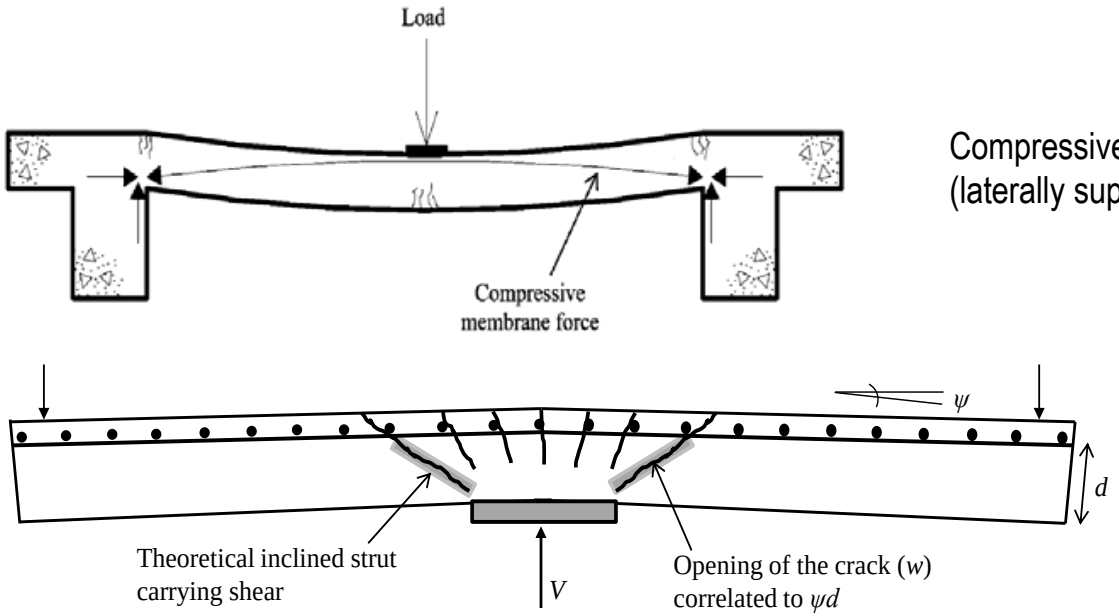
Background document: Pejatovic et al., 2022

Toetsing pons in fib Model Code 2020

Unaccounted behavior upon structural resistance :

- effect of prestressing & compressive membrane action on the punching shear capacity





Compressive membrane action
(laterally supported slab)

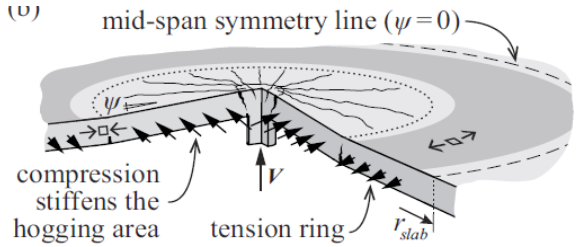
Role of the rotation angle ψ in the determination of the punching shear capacity

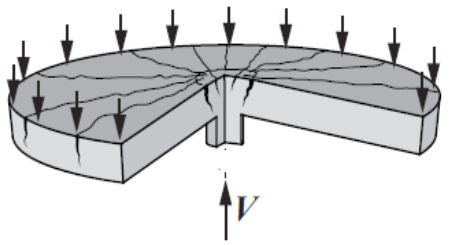
Coronelli, Walraven, Zandi & Matthews,
fib Model Code 2020 - Structural models for existing concrete structures, fib Congress 2018, Melbourne, Australia

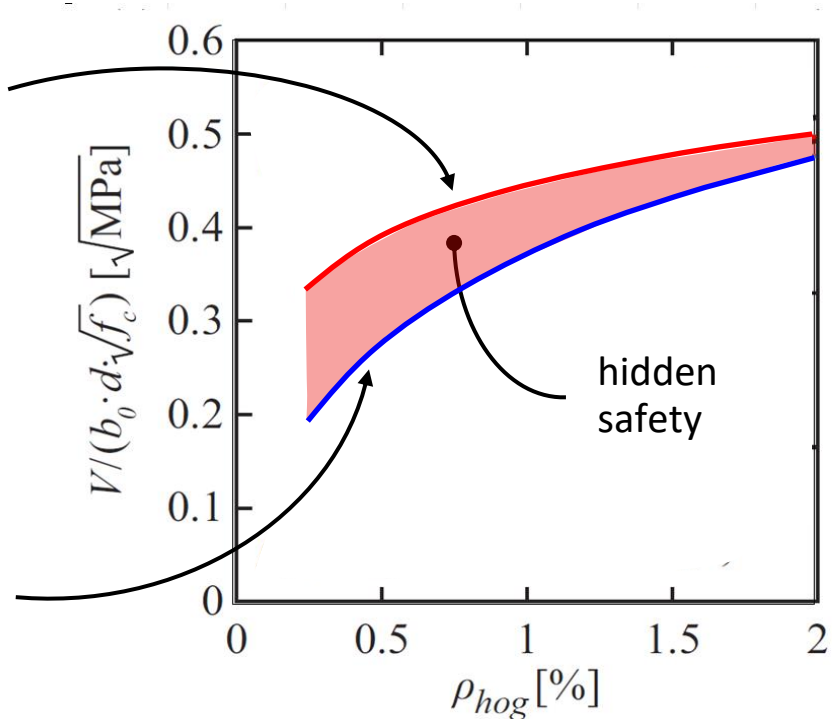
Toetsing pons in fib Model Code 2020

New punching shear provision to account for compressive membrane action

The beneficial effects of compressive membrane action and redistribution of internal forces in continuous slabs may be considered for internal columns by reducing the rotation y by coefficient







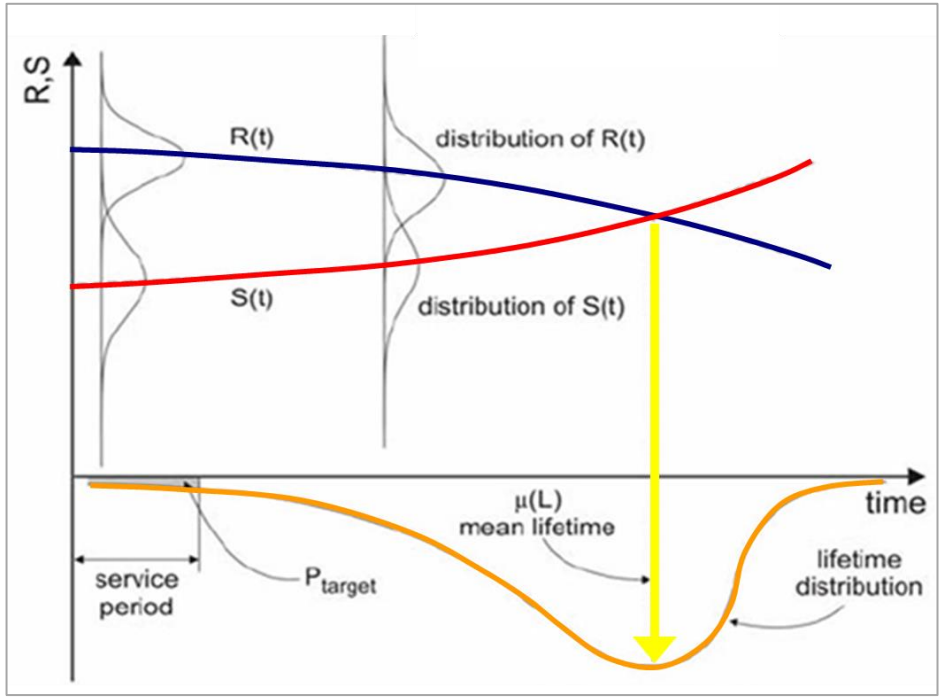
where m_{cr} is the cracking moment of the slab calculated with concrete tensile strength f_{ctm}
This beneficial effect may be considered provided that there are no openings in the slab in a distance ≤5d_v from the control perimeter.

Background document: Einpaul et al., 2016

Beoordeling bestaande constructies in fib Model Code 2020

Assessment of structures with deteriorated or damaged components :

- consideration time-depended degradation in assessment
- data-informed approach to assessment of residual service life
- improved modelling of the capacity of corroded structures



$$V_{Rd,det} = V_{Rdc,det} + V_{Rds,det}$$

Design shear resistance of corroded member

Concrete contribution

Contribution of shear reinforcement

Reduced cross-section by corrosion

$$V_{Rd,c} = k_v \frac{\sqrt{f_{ck}}}{\gamma_c} z b_w$$

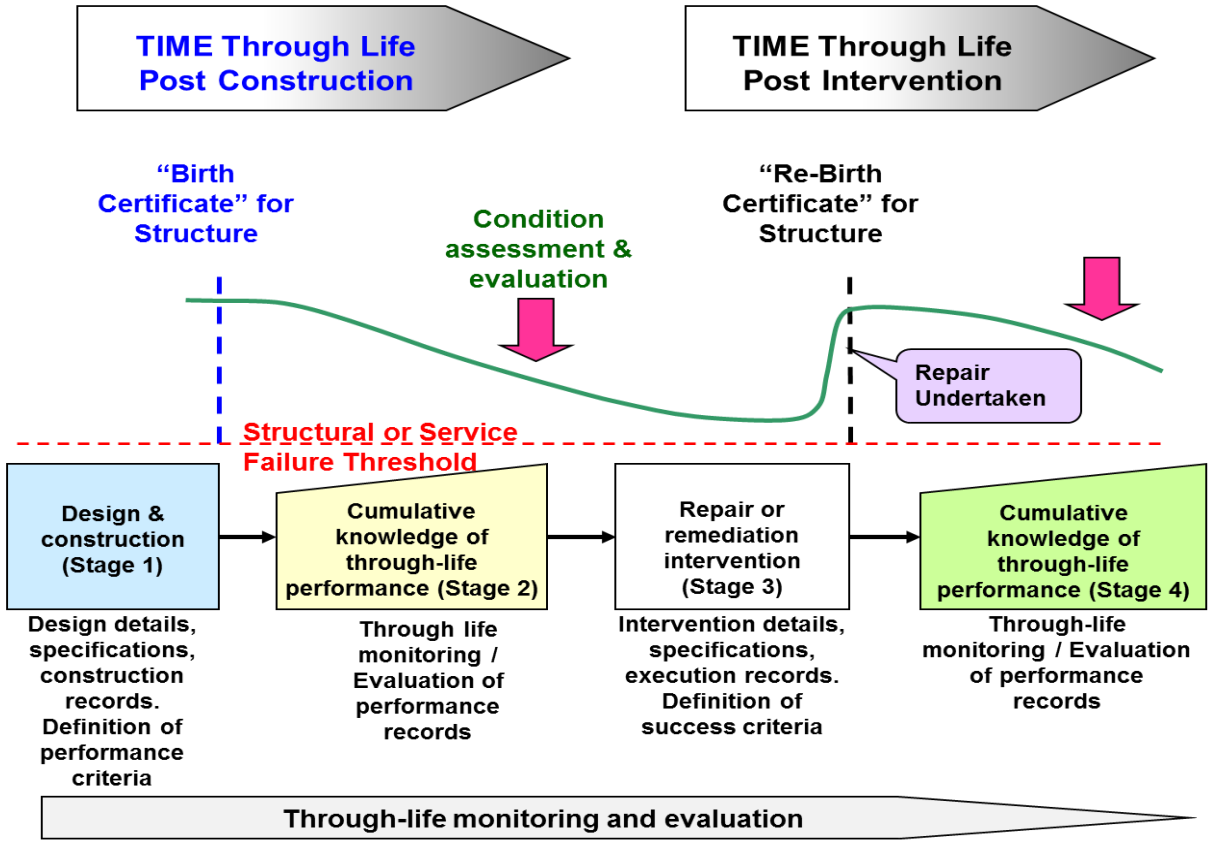
Include bond Reduction factor

$$V_{Rds,det} = z \cdot \cot\theta \cdot \frac{A_{sw,red} \cdot f_{ywd}}{s}$$

Strut angle to be limited because of reduced ductility

fib Model Code 2020 - Assessment of the shear capacity of structures with corroded reinforcement

Levenscyclus-perspectief in fib Model Code 2020



Life-cycle management (LCM) is the **overall philosophy / strategy to be used in managing a concrete structure through its life-cycle,** particularly during its operation and use phase.

LCM facilitates informed choices being made between various design, construction, use, conservation, adaptation and end of life options on the basis of formulating appropriate LCM scenarios at the planning stage, as a means of ensuring the performance requirements are attained

LCM involves :

- 'Durability Planning' as a component part of life-cycle management and the Concept Design process
- condition survey, condition assessment & performance evaluation
- decision-making for LCM activities and interventions
- execution of LCM activities and/or preventative interventions or remedial works

Levenscyclus-perspectief in fib Model Code 2020

Intervention works as LCM activities – Selection of intervention methods

- Selection with consideration of cause of deterioration (or deterioration mechanism) and level of deterioration

Case of steel corrosion due to salt attack

Stage 1: No change in appearance: Chloride ion concentration at depth of reinforcing bar below corrosion threshold			Stage 2: No change in appearance: Chloride ion concentration at depth of reinforcing bar above corrosion threshold			Stage 3: Concrete exhibiting cracking, spalling and rust staining			Stage 4: Rebar corrosion having caused a reduction in load capacity (strength) of affected members		
Deterioration / distress phenomena	**Intervention principle / remedy**	**Intervention method examples**	**Deterioration / distress phenomena**	**Intervention principle / remedy**	**Intervention method examples**	**Deterioration / distress phenomena**	**Intervention principle / remedy**	**Intervention method examples**	**Deterioration / distress phenomena**	**Intervention principle / remedy**	**Intervention method examples**
Before initiation of rebar corrosion: No change in external appearance of concrete members	Moisture control	Keeping concrete dry	Early-stage propagation of rebar corrosion: Rebar corrosion underway, but no cracking of concrete	Moisture control	Keeping concrete dry ®	Mid- stage propagation of rebar corrosion: Rebar corrosion underway, cracking of concrete has developed	Moisture control	Keeping concrete dry ®	Advanced / late-stage propagation of rebar corrosion: Rebar corrosion underway, cracking of concrete and with loss of structural strength of affected concrete members	Moisture control	Keeping concrete dry Ω
		Dehumidify concrete			Dehumidify concrete®			Dehumidify concrete®			
	Protection against ingress	Apply surface impregnation		Protection against ingress	Apply surface impregnation®		Protection against ingress	Apply surface impregnation®		Protection against ingress	Apply surface impregnation Ω
	Protection against ingress	Apply surface coating		Protection against ingress	Apply surface coating ®		Protection against ingress	Apply surface coating ®		Protection against ingress	Apply surface coating Ω
	Preserve / restore passivity	Chloride extraction		Preserve / restore passivity	Make patch repair		Preserve / restore passivity	Make patch repair		Preserve / restore passivity	Make patch repair Ω
	Prevention of rebar corrosion	Use cathodic protection			Chloride extraction			Chloride extraction			Chloride extraction Ω
				Prevention of rebar corrosion	Use cathodic protection		Prevention of rebar corrosion	Use cathodic protection		Prevention of rebar corrosion	Use cathodic protection Ω
								Apply corrosion inhibitors			Apply corrosion inhibitors Ω
							Prevention of delamination	Use anchorage reinforcement, Jacketing		Prevention of delamination	Use anchorage reinforcement, Jacketing
							Concrete restoration	Make patch repair	Scaling, delamination	Concrete restoration	Make patch repair
									Severe rebar corrosion	Rebar reinstatement	Rebar replacement
									Inadequate structural capacity	Structural strengthening	Strengthening, rebuilding

Key: ® If a patch repair is made, implement after that activity completed. Ω Repair shall be conducted after cracks have been properly repaired (eg. by crack injection or patch repair).
Anti-crack reinforcement (mesh or bar), which is placed in the jacketing concrete, is not for structural strengthening, but primarily for prevention of cracking / delamination of cover concrete, etc

Levenscyclus-perspectief in fib Model Code 2020

Intervention works as LCM activities – Design of interventions

- The design can be conducted according to **the method for new structures**, which is provided in MC2020
- However, the following points should be considered:
  - the **difference in properties** between intervention materials and ordinary concrete / steel
  - the **difference in structural details** between intervention methods and ordinary concrete structures

Intervention works as LCM activities – Materials and systems for interventions

- Different from ordinary concrete and steel
  - Inorganic materials, organic materials (polymers, etc), metal, FRPs
- Different from ordinary structural details
  - External bonding by adhesives, shear keys, mechanical anchors
- Necessary properties
  - Depending on **intervention purpose**
  - **Durability** of materials/systems themselves
  - **Compatibility** under variation of temperature and moisture

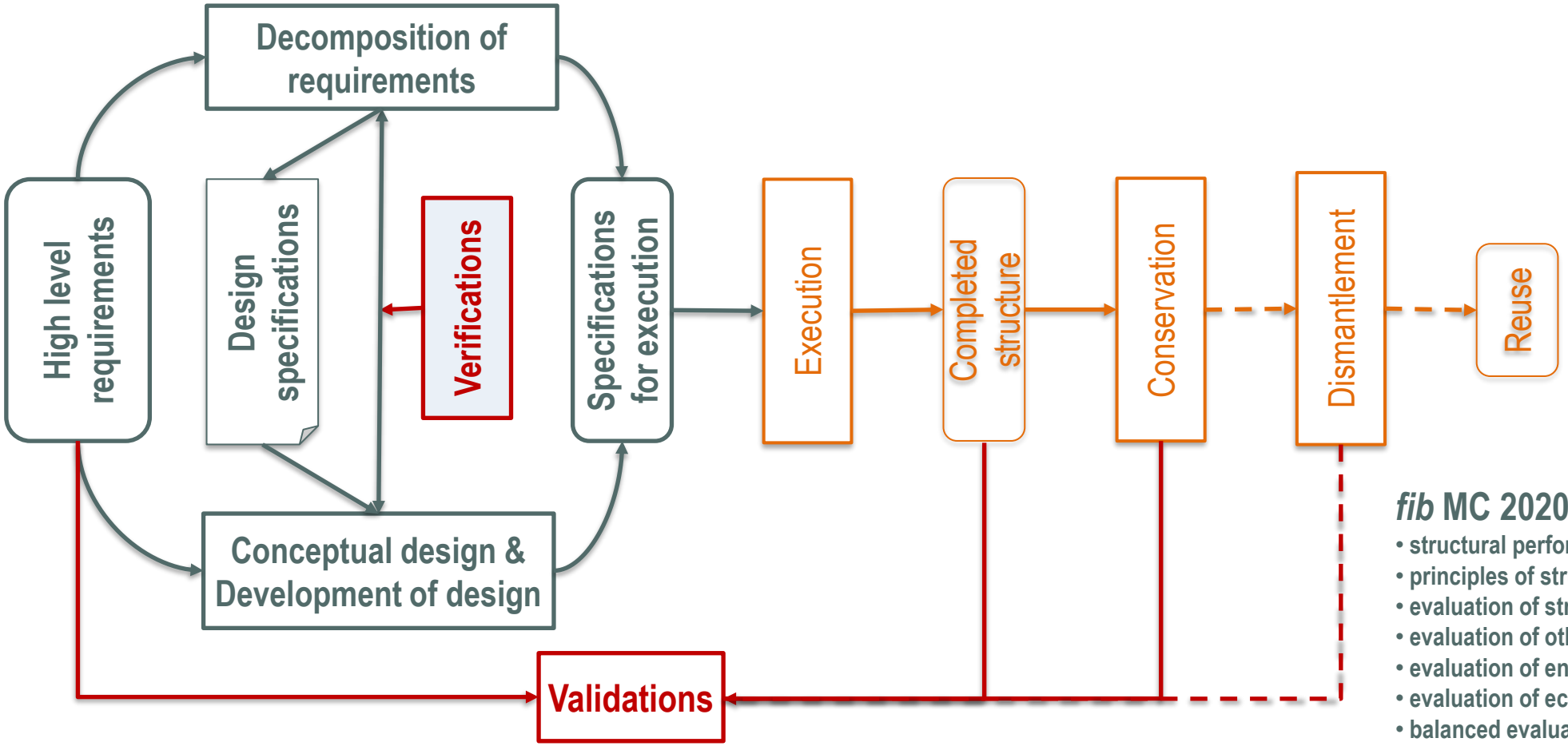
Levenscyclus-perspectief in fib Model Code 2020

Intervention works as LCM activities – Execution of interventions

- **The space and time constraints are significant and potentially severe** in comparison with those for the execution of new structures
  - The execution plan should be well prepared
- **The parts of the existing structure**, where the material and/or system for intervention is connected / attached, **should be prepared in advance to achieve the intended integration**
  - The concrete surface layer of an existing structure should be pre-treated by removing / repairing deteriorated zones and/or roughening for reliable bonding
- Reinforcing / cementitious materials works may require special care as some **intervention materials need more specific conditions**

Conservation, including intervention, is the main part of life cycle management since longer service life is often now expected for sustainability reasons. The conservation plan should include a plan for interventions, such as undertaking maintenance interventions. The importance of intervention has become clearer in this century. **The development of reliable interventions** is still a sought for goal. For this purpose, **the standardization of intervention methods** is necessary, after narrowing down the many methods available to the most suitable methods.

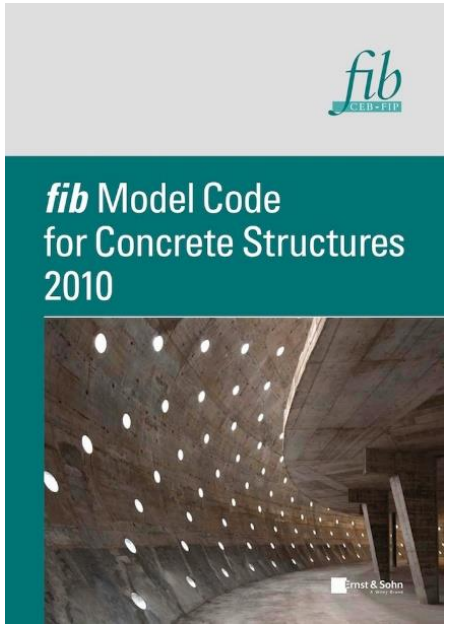
Levenscyclus-perspectief in fib Model Code 2020



***fib* MC 2020:**

- structural performance evaluation framework – Ch.11
- principles of structural design and assessment – Ch.12
- evaluation of structural performance - Ch.30
- evaluation of other aspects of social performance – Ch.31
- evaluation of environmental performance – Ch,.32
- evaluation of economic performance – Ch.33
- balanced evaluation of performance of a structure for three pillars of sustainability as a whole – Ch.34
- execution management – Ch.35
- construction works management – Ch.36
- performance management through life cycle – Ch.37

MC2020 TOC (Parts & Chapters) - 0



MC2010

5Nr Parts
10Nr Chapters
Pages ≈ 400 pages

MC2020

10Nr Parts
39Nr Chapters
Pages ≈ 800

Greatly extended technical scope and coverage:

- new & existing structures
- novel materials
- technical developments since MC2010

MC2020 TOC (Parts & Chapters) - 1

MC2020 TOC (Parts & Chapters) - 2

PART IV - ACTIONS ON STRUCTURES

13. Actions on structures

PART V - INPUT DATA FOR MATERIALS

14. Concretes → incl. **Green Concrete Rules**
15. Reinforcing steel
16. Prestressing steel & prestressing systems
17. Non-metallic reinforcement
18. Fibre reinforced concrete → incl. **FRC design**
19. Protective materials & systems

PART VI - INPUT DATA FOR INTERFACES

20. Bond of embedded steel reinforcement → incl. **Bond of corroded reinforcement**
21. Bond of embedded non-metallic reinforcement
22. Bond of externally applied reinforcement
23. Concrete to concrete
24. Concrete to steel by mechanical interlock
25. Anchorages in concrete

MC2020 TOC (Parts & Chapters) - 3

PART VII -DESIGN AND ASSESSMENT PROCEDURES – MAIN TECH CONTENT

26. Conceptual design
27. Approach to design
28. Approach to assessment
29. Structural analysis
30. Evaluation of structural performance → Shear, Punching & Torsion, Fatigue, FRC, FRP etc.
    → Existing structures
    → Novelties in Seismic Approaches
    → Serviceability Limit States
31. Evaluation of other aspects of social performance
32. Evaluation of environmental quality
33. Evaluation of economic efficiency
34. Sustainable decision making

MC2020 TOC (Parts & Chapters) - 4

PART VIII - EXECUTION

31. Execution management
32. Construction works
33. Execution of interventions

PART IX – CONSERVATION (LIFE-CYCLE MANAGEMENT)

38. Conservation

PART X - CIRCULARITY - DISMANTLEMENT AND REUSE

39. Circularity - Dismantlement and reuse

Many of these Bulletins are being developed as the MC2020 work progresses

fib Bulletin 100 - Design and assessment with strut-and-tie models and stress fields: from simple calculations to detailed numerical analysis
fib Bulletin 102 - Protection and repair of concrete structures
fib Bulletin 103 - Guide for Strengthening of Concrete Structures
fib Bulletin 105 - Fibre Reinforced Concrete

Outlook

Future aspiration :

- Enabling performance-based approaches which may require more advanced engineering skills but enable possibilities to optimise design solutions to better fit needs of the stakeholders and remove constraints for novel types of concrete, reinforcing materials and design concepts.
- In the future standards / codes of practice there will be still a place for prescriptive approaches, such as in specifications using closely defined procedures which need to be applied consistently to be useful but provide good and easy to prove solutions in particular circumstance.

Future work :

- to enable methods to define performance requirements in terms of accurately measurable / verifiable factors
- to enable methods to verify or to validate that defined performance requirements will be achieved
  - enable methods to demonstrate compliance with longer-term performance requirements (e.g. by combination of testing and performance modelling)
- to educate the engineering community to master the processes and procedures involved in performance-based approaches, in which the standards / specifications will have to play a necessary supporting role
- to develop the supportive forms of contracts and relationship that will be required for the successful use of performance-based approaches and implementation of innovative solutions (e.g. novel types of materials)

Conclusies

MC2020 outcomes include:

- **Improved technical guidance for:**
  - Design / execution / conservation of new concrete structures
  - Assessment / adaptation / conservation of existing structures (including interventions)
- **These capabilities**, combined with improved abilities to undertake appropriate interventions upon deteriorating structures, **are critical to extending the useful life of concrete structures and/or upgrading them to satisfy existing or revised (increased) performance requirements**

MC2020 innovations and improvements can :

- **Assist the creation of durable low carbon structures (new / adapted / upgraded etc)**
- **Provide better tools and techniques for the design of new structures and the assessment / adaptation / alteration of existing buildings & constructed assets**

Aspiration : *fib* Model Code for Concrete Structures which is better suited to future demands and the circumstances encountered in the years ahead

Acties

In januari/februari 2023 wordt de volledige conceptversie voor ModelCode 2020 voorgelegd aan fib Commissies en nationale leden groepen voor commentaar.

Om goed en afgewogen commentaar te geven vanuit het representatief deel van de Nederlandse ingenieurspraktijk wordt Stufib gevaagd om een bijdrage te leveren op de becommentariëring van de conceptversie voor ModelCode 2020.