ASPIRATIONS FOR FIB MC2020

GENERAL INTRODUCTION

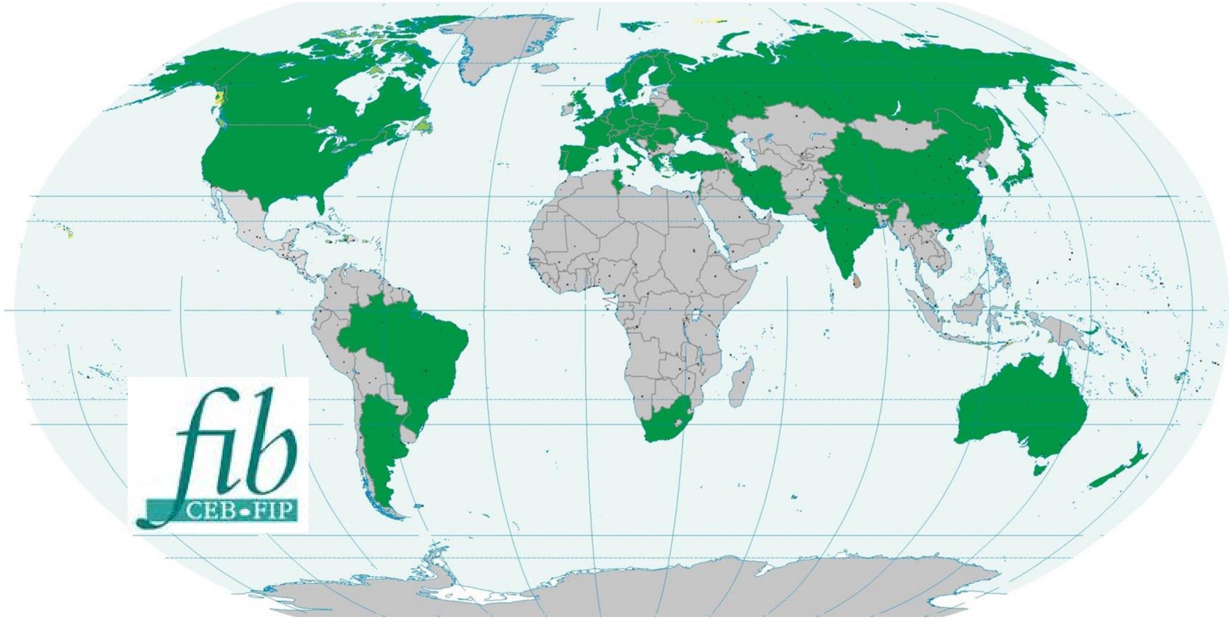
Agnieszka Bigaj-van Vliet

CONTENT

- ***Looking for global involvement***
- ***Evolution of Model Codes***
- ***Aspiration and challenge***
- ***Developing fib MC2020***
  - *Organization framework for fib MC2020*
  - *Timeline for fib MC2020*
  - *Proposed content of fib MC2020*
  - *TC10.1 way of working*
- ***Questions & discussion***

LOOKING FOR GLOBAL INVOLVEMENT

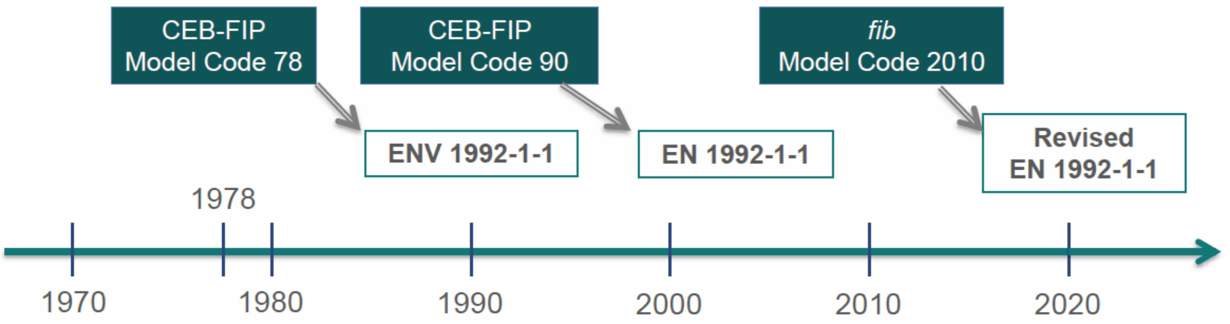
- *World-wide spread of 44 national member groups and app. 1,000 individual or corporate members*



EVOLUTION OF MODEL CODES

- *Impact of fib* (CEB-FIP) *Model Codes*

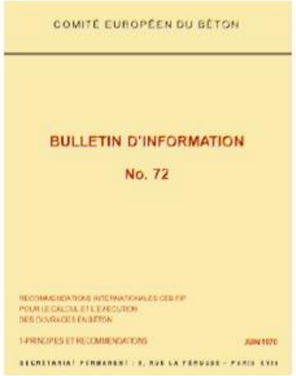
Strong influence on CEN Eurocodes (36 countries, 600 million people)



Pronounced influence on Asian and African Model Codes

Model Codes are used as reference documents
both in research and in design

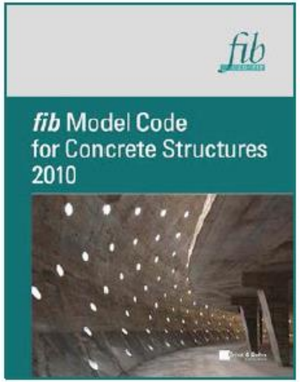
EVOLUTION OF MODEL CODES



Model Code 1970

Model Code 1978

Model Code 1990



Model Code 2010

LOOKING BACK AT *fib* MC2010

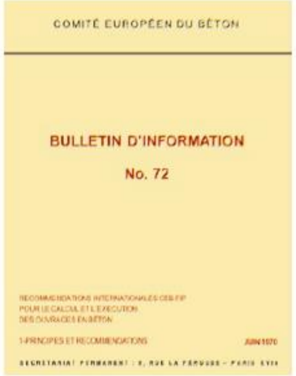
11th fib General Assembly voting on Model Code 2010, Lausanne, 29 October 2011

MC2010 FOR CONCRETE STRUCTURES

What has been achieved?

- A code, basically, for new and old structures
- Introduction of "conceptual design" to stimulate creativity
- Design with due regard to service life of structures
- First introduction of sustainability
- Improved safety formats for new and existing structures
- Improved constitutive relations for old and new types of concrete, with due attention to durability aspects
- Steel fibres and non-metallic reinforcement as new alternatives for reinforcing concrete structures
- Wide scope of loading types (static, fatigue, impact, explosion, seismic, fire, cryogenic)
- Scientifically based models, with simplified versions for lower level approximations (daily practice)
- Introduction of reliability concepts in numerical analysis
- Introduction of maintenance strategies for through-life care

EVOLUTION OF MODEL CODES



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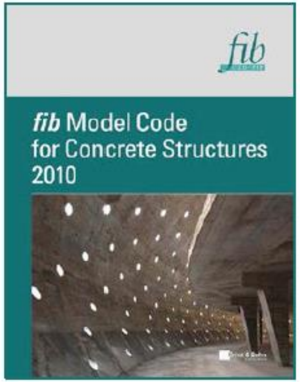


Model Code 2010

fib MC2020: The journey so far - 1

Background and motivation

Need to extend MC2010 to fully address matters concerning existing concrete structures

Initiative launched by COM3 for *fib* MC for existing concrete structures

Vigorous debate at TC Meeting in Copenhagen May 2015

Outcomes - The Technical Council endorsed :

- **The vision of preparing a *single combined code for both new and existing concrete structures*   [*fib* Model Code 2020]**
- **Holding a workshop in The Hague to develop MC concepts**

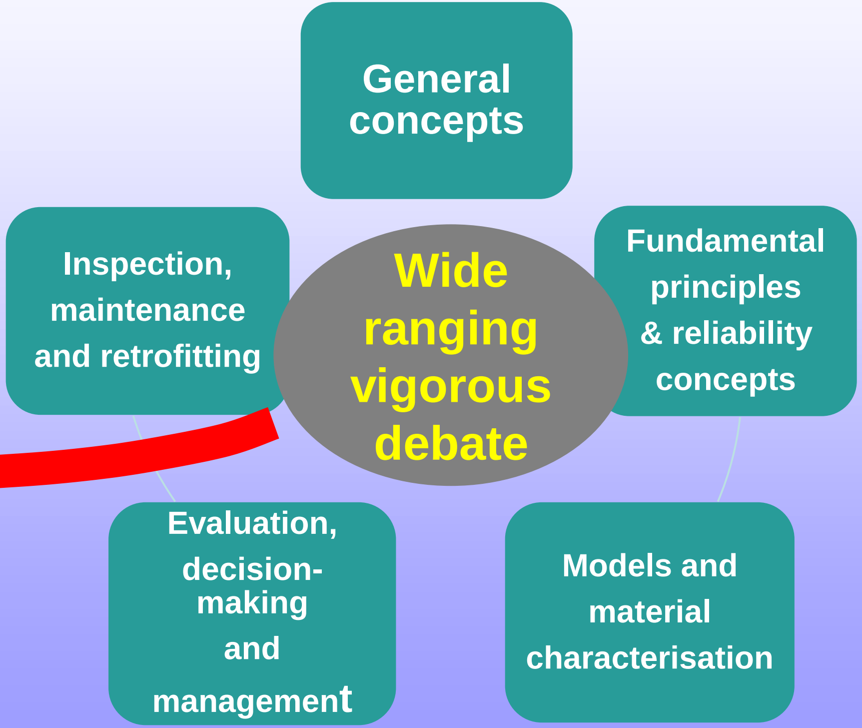
fib MC2020: The journey so far - 2

MC2020 Workshop in The Hague

- Hosted in June 2015 by TNO
- Invited speakers from *fib* commissions and other organisations
- Over 40 participants

Workshop Output:

Identified possible ways forward and confirmed the aspiration for developing integrated provisions for both new and existing



LOOKING FORWARD AT *fib* MC2020

A Core Group was established in autumn 2015 to develop a ***Roadmap for advancing the fib Model Code for Concrete Structures towards MC2020***

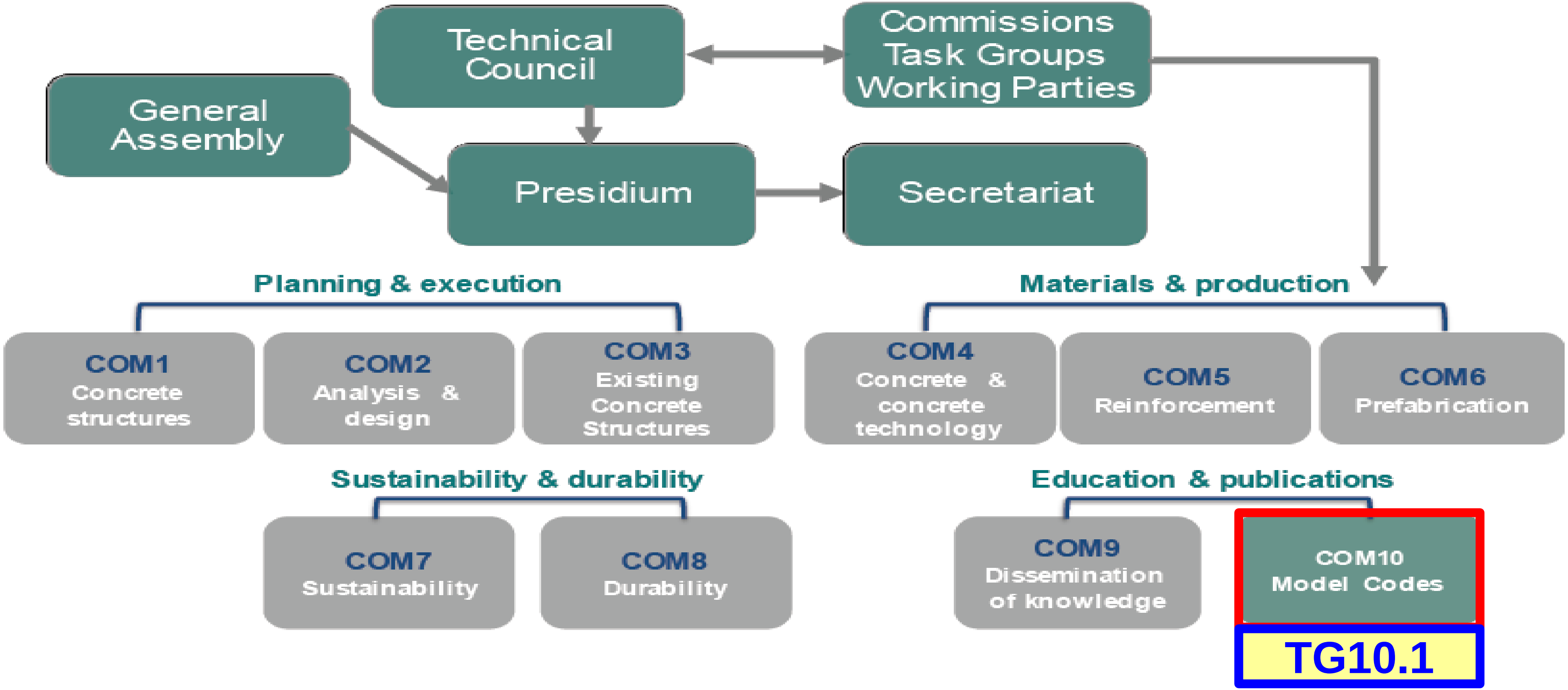
Joost Walraven, Frank Dehn, Aurelio Muttoni, Agnieszka Bigaj-van Vliet, Giuseppe Mancini, Stuart Matthews, Gerrie Dieteren, Tamon Ueda, Hugo Corres

LOOKING FORWARD AT *fib* MC2020

Considerations of fib Presidium

- *The fib recognises the **need** and the **possibility**, to provide ideas for single merged structural code for both new and existing concrete structures,*
- *The advancement of Model Code must be addressed with **clear objectives** and **well defined deadlines**.*
- *The advancement of Model Code must include **worldwide knowledge** with respect to materials and structural behaviour, must recognize the needs of engineering communities in different regions of the world, and thus must aim for strong international (world) perspective,*
- *The advancement of Model Code should be supported by **the whole fib community**, and thus shall involve all fib Commissions and all national groups,*

The *fib's* structure



DEVELOPING *fib* MC2020

T10.1 Model Code 2020 : co-ordinating & drafting body for MC2020 activated Oct 2016 (Lausanne)

Chair:	**Stuart Matthews**	(BRE, UK)
Co-Chair:	**Giuseppe Mancini** **Joost Walraven**	(Politecnico di Torino, Italy) (Delft University of Technology, Netherlands)
Deputy-Chair:	**Agnieszka Bigaj-van Vliet**	(TNO, Netherlands)
Technical Secretary:	**Gerrie Dieteren**	(TNO, Netherlands)
Other core group members:	**Hugo Corres Peiretti, Frank Dehn, Aurelio Muttoni, Tamon Ueda**	

Chairs of **all fib Commissions**

Regional contacts : **Africa, Asia, Europe, North America & South America**

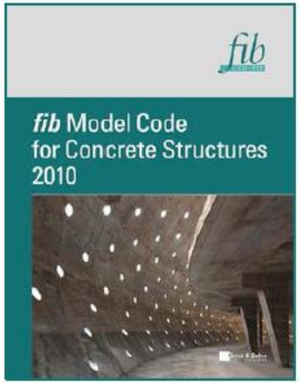
Contacts for international organisations inc. bodies such as **CEN, ISO, JCI, ACI, PCI, JCSS & RILEM**

Other invited fib members incl. representaives of MC2020 Action Groups

MC2020 FOR CONCRETE STRUCTURES

Aspiration and challenge

- *Single merged structural code based on sound and consistent basic principles*
- *Including worldwide knowledge with respect to materials and structural behaviour*
- *Recognizing the needs of engineering communities in different regions of the world*
- *Developing operational model code oriented towards practical needs*



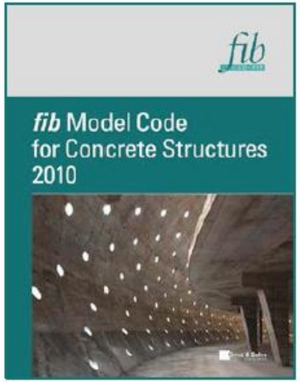
Model Code 2010

fib
Mode Code
2020

MC2020 FOR CONCRETE STRUCTURES

Scope and basic principles:

- *dealing with new and existing concrete structures, and removing constraints for novel types of materials*
- *reflecting the importance of sustainability and through-life management of structures*
- *implementing fundamental principles and a safety philosophy based on reliability concepts*
- *implementing consistent treatment of safety, serviceability, durability by performance based concepts*



Model Code 2010

fib
Mode Code
2020

TIMELINE OF *fib* MC2020

June 2015	*fib* workshop Advancing the *fib* Model Code for Concrete Structures, The Hague, Netherlands: - to identifying needs and possibilities for provisions for existing concrete structures
Dec 2015	Core Group meeting to identify topics, the desired contents and roadmap for MC2020
Feb 2016	Submission of the roadmap for M2020 to the *fib* Presidium
Mar 2016	Decisions on the roadmap for M2020 by the *fib* Presidium
June 2016	Approval of COM 10 / MC2020 project at fib Technical Council meeting in Madrid
Oct 2016	T10.1 MC2020 Kick-off meeting, Lausanne, Switzerland : - to establish a shared vision on specific tasks, to set draft contents for MC2020 & identify (main)authors / contributing groups, to formulate final timetable proposal etc

- **Kick-off meetings of *fib* Commission 10: & TG10.1: MC2020 in Lausanne, Switzerland, 14 -15 October 2016**

- ***fib* Commission 10: & TG10.1: MC2020 in Delft, Nederland 10 - 11 March 2017**
- ***fib* Commission 10: & TG10.1: MC2020 in Barcelona, Spain 11 - 12 December 2017**

TIMELINE OF *fib* MC2020

Sept 2016	MC2020 JCI-fib Joint Workshop on Codes for Existing Structures, Tokyo, Japan : - to stimulate participation of Japan / Asia
Nov 2016	MC2020 regional workshop on Advancing fib Model Code for Concrete Structures - link to the fib Symposium in Cape Town, Republic of South Africa - to stimulate participation of Africa
June 2017	MC2020 Intercative session on Advancing fib Model Code for Concrete Structures on fib Symposium in Maastricht
Sept 2017	MC2020 fib-Abcic-ABECE Joint Workshop on Developments in Codes for New and Existing Concrete Structures: to stimulate participation of South America
Oct 2017	MC2020 special session on Durability - link to Concrete 2017 and ICDC 2017 in Adelaide, Australia - to stimulate participation of Australia
2018	MC2020 regional workshop in USA: to stimulate participation of North America
2018	MC2020 regional workshops in India and in China: to stimulate participation of Asia

MC2020 Initiative – Global involvement

T10.1 ACTION GROUPS

AG1: Databases	*Bayrak*
AG2: Shear, punching & other combined actions	*Muttoni*
AG3: Bond	*Plizzari*
AG4: Durability (under auspices of COM8)	*Papworth*
AG5: Detailing	*COM2 to advise*
AG6: Fire	*Taerwe*
AG7: Seismic Design & Assessment	*Fardis*
AG8: Numerical analysis (NLFEM)	*Hendriks & Monti*
AG9: Testing & SHM:	*Bergmeister & Strauss*
AG10: Robustness / Accidental actions:	*Caspeele & Mancini*
AG11: Fatigue	*Ueda*
AG12: Impact & Explosion	*Di Prisco*

MC2020 FOR CONCRETE STRUCTURES

Part I: General	Development / Change
1. Scope	Shared
2. Terminology	Shared - Extended
3. Basic principles	Shared - Extended
Part II: Design & Assessment Input Data	
4. Principles and processes • Design principles • Principles of assessment / service life aspects • Principles of through-life management & interventions	Greatly extended • MC2010 • New • Extended
5. Materials • Contemporary materials • Other / previous materials / forms of construction • Forms of damage and deterioration	Greatly extended • MC2010 • New • New
6. Interface characteristics • Contemporary materials • Other / previous materials / forms of construction • Forms of damage and deterioration	Greatly extended • MC2010 • New • New

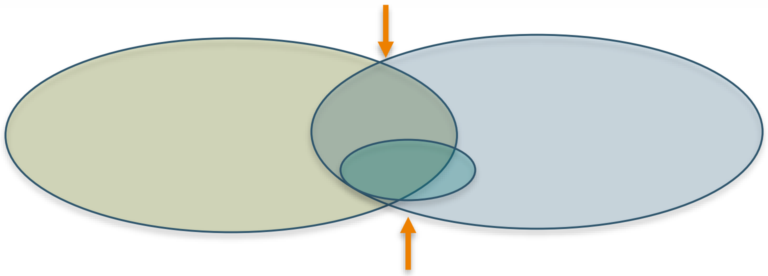
MC2020 FOR CONCRETE STRUCTURES

Part III: Design & Assessment	Development / Change
7. Design • **Design verification** • **Assessment verification / re-design procedure** **Verification addresses: structural safety, serviceability, durability & sustainability**	Greatly extended • MC2010 • New
Part IV: Construction	
8. Construction • **New works** • **Works on existing structures**	Extended • MC2010 • New
Part V: Conservation	
9. Conservation • **Conservation by through-life management** • **Conservation by interventions – Physical works**	Extended • Changed / Extended • Changed / Extended
Part VI: Dismantlement	
10. Dismantlement	Greatly extended • Extended

5.1 Concrete Frank Dehn 5.1.1 Scope definition and range of applicability 5.1.2 Classification by strength 5.1.3 Classification by density	**Revise & update, and expand** • Introduce levels of knowledge maturity for materials • Include conventional materials, old, novel and deteriorating materials incl. materials for interventions (repair mortars etc.) • Include lightweight concrete, aerated autoclaved material • Include concrete with recycled aggregates • Future new binder materials • Existing concrete materials not previously included in Model Code eg, shotcrete • Include aspects relevant for interaction between old (subtracts) and new (overlay/repair) concrete	COM1 [T1.6] COM1 COM3 [T3.1] [T3.2] [T3.4] COM4 [T4.5?] [T4.6?] COM8 [T8.1] [T8.6] **Action Group Durability & Service Life Prediction** (Frank Papworth ?/ COM8 ?, Carmen Andrade, Christoph Gehlen, Steiner Helland, Giuseppe Mancini, Joost Walraven, Robby Caspeele?, Tamon Ueda) Liaison RILEM Liaison JCSS
5.1.4 Classification of novel types of cementitious materials	• Addition of new types of cementitious materials, if possible • Concrete with supplementary binding materials, novel types of aggregates etc.	
5.1.5 Provisions for quality control	•	
5.1.6 Concrete properties 5.1.6.1 Compressive strength 5.1.6.2 Tensile strength and fracture properties 5.1.6.3 Strength under multiaxial states of stress 5.1.6.4 Modulus of elasticity and Poisson's ratio 5.1.6.5 Stress-strain relations for short-term loading 5.1.6.6 Time effects 5.1.6.7 Temperature effects 5.1.6.8 Properties related to non-static loading 5.1.6.8 Transport of liquids and gases in hardened concrete 5.1.6.9 Properties related to durability	**Revise & update, and expand :** COM4, COM8, COM3, **Action Group Durability & Service Life Prediction** • Revise parts concerning relation of strength parameters, to account for possible difference of new material combinations compared to regular material behavior. • Add for old concrete mixtures different creep and shrinkage models (due to usage of different materials). • Include assessment of concrete properties not only on the basis of concrete strength [T3.2] • Create framework for testing concrete and evaluation of results for assessment [T3.1] + [T3.2] • Concrete strength in-situ vs concrete strength on-site • Model accuracy • Define testing methods, if needed (seeking cooperation with RILEM) • Data for verification of structural performance in respect to durability • Improve coordination between chapter on materials and chapter on verification • Precision requirements • Extension of creep models for concrete under increased temperature (not only fire conditions to be included). • Include new materials for interventions (polymer cement mortar etc.) [T3.4] • Need for a framework with respect to durability	

MC2020 FOR CONCRETE STRUCTURES

- ***Single merged structural code dealing with both new and existing concrete structures***



New structures and existing structures are not always easy to distinguish (overlap region is very important for engineer's activity)

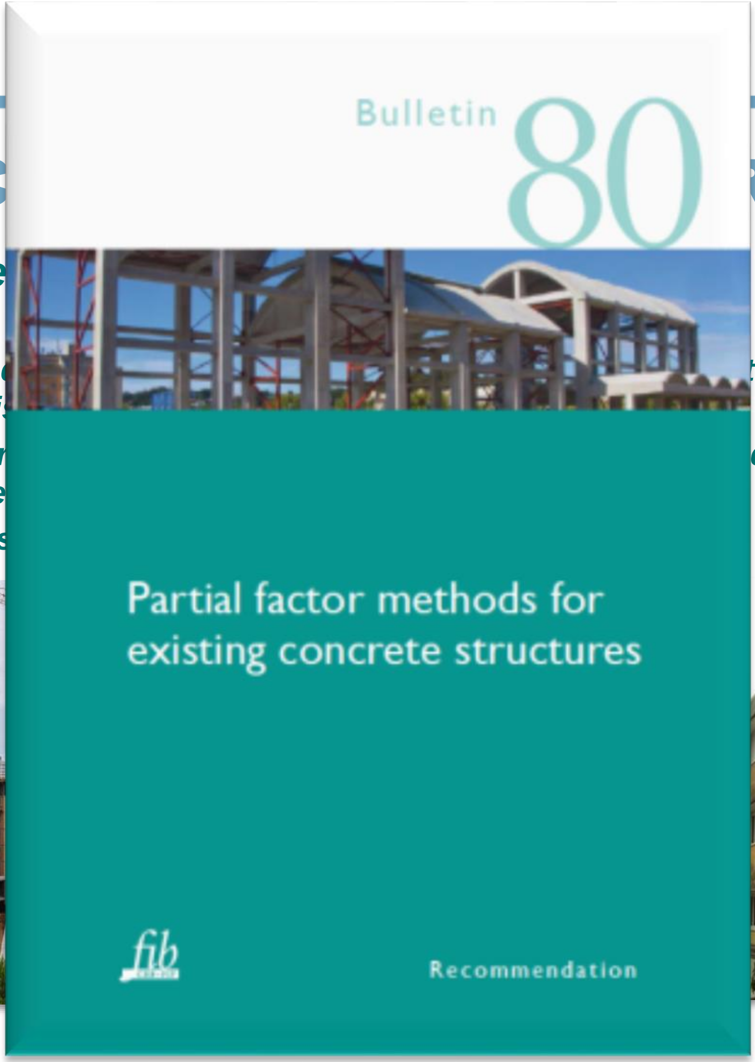
MC2020 FOR CONCRETE STRUCTURES

- ***Safety philosophy based on reliability concept***
  - ***Reliability concepts extended and updated to cover new and existing structures, considering risk and reliability differentiation to distinguish between :***
    - ***new and existing structures - where different safety levels are adopted due to economics but with minimum levels due to human safety requirements***
    - ***countries'/regions' specific economic conditions***

The target reliability values (β) may be reduced in existing structures compared to the new ones

MC2020 FOR C… …RES

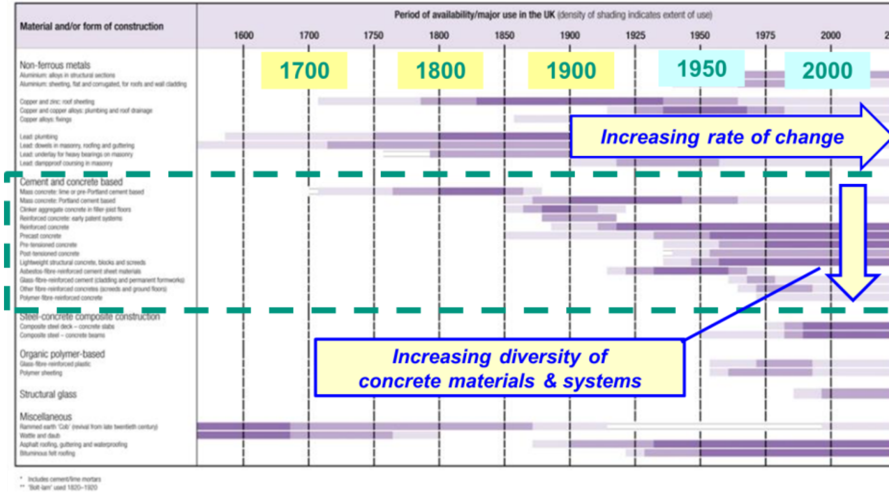
- *Safety philosophy base…*
  - *Reliability concepts exten… …tures, considering risk and reliability differentiation to distingui…*
    - *new and existing str… …d due to economics but with minimum levels due…*
    - *countries'/regions' s…*



MC2020 FOR CONCRETE STRUCTURES

Structural materials

- *Scope definition and range of applicability:*
  - *conventional materials, old, novel and deteriorating materials incl. materials for interventions (repair mortars etc.)*
- *Assessment of material properties*
  - *assumptions for design and assessment*
- *Taking advantage of information acquired by testing and monitoring*
  - *tests methods to enable defined performance material design*
  - *evaluation framework*
  - *provisions for quality control*



MC2020 FOR CONCRETE STRUCTURES

- ***Reinforcing steel***
- ***Prestressing steel***
- ***Prestressing systems***

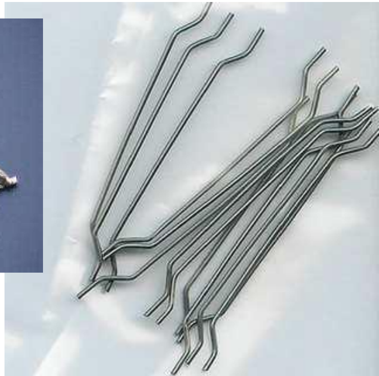
  - ***Scope definition and range of applicability:***
    - ***include old reinforcing materials and systems, corrosion resistant reinforcement***
  - ***Assessment of material and system properties***
    - ***effect of deterioration on the properties of reinforcing steel & prestressing steel***
    - ***behaviour of reinforcing steel after cooling***
    - ***time dependent losses for old materials***
  - ***Taking advantage of information acquired by testing and monitoring***
    - ***evaluation framework for assessment***
    - ***situ measuring techniques to determine present prestressing level***

MC2020 FOR CONCRETE STRUCTURES

- ***Non-metallic reinforcement***
  - ***Scope definition and range of applicability:***
    - ***include FRP rebars and externally applied reinforcement, include textile reinforcement***
  - ***Assessment of material properties***
    - ***properties related to durability of non-metallic reinforcement***
  - ***Design and execution guidance***
    - ***Include assumptions used for design incl. stochastic approach and treatment/determination of safety factors***

MC2020 FOR CONCRETE STRUCTURES

- *Fibres/Fibre Reinforced Concrete*
  - *Scope definition and range of applicability:*
    - *include UHPFRC (consistent design recommendations for all FRC's)*
  - *Assessment of properties of fibre reinforced concrete*
    - *taking advantage of information acquired by testing and monitoring*
    - *test methods for the determination of FRC properties*
    - *durability of steel fibres in concrete*
    - *constitutive laws incl. creep and fatigue*
  - *Behaviour in shear without conventional reinforcement (incorporation in shear model for ordinary RC)*



MC2020 FOR CONCRETE STRUCTURES

- ***Concrete to concrete***
- ***Concrete to steel***

  - ***Scope definition and range of applicability:***
    - ***include new material for interventions***
    - ***interaction of new concrete to old concrete***
    - ***include mechanical interlock not fulfilling current provisions***

MC2020 FOR CONCRETE STRUCTURES

- ***Bond of embedded steel reinforcement***
- ***Bond of prestressing rebars***
- ***Bond of non-metallic reinforcement***

  - *Scope definition and range of applicability:*
    - *bond provisions for existing structures and structures under severe conditions*
      - *bond of old and of new materials, bond of post-installed rebars, bond of externally applied reinforcement*
      - *effect of deterioration on bond*
      - *bond in case of repair action*
      - *bond in seismic joints of existing and new structures*
      - *interaction of bond-corrosion-fatigue*
      - *long term performance*
  - *Performance specifications for laps and anchorages*
    - *attention for simplified provisions (level of approximation)*

MC2020 FOR CONCRETE STRUCTURES

7. DESIGN AND ASSESSMENT

- ***Conceptual approach to design and assessment***

Scope definition :

- ***consider implications of conceptual approach for assessment,***
- ***Treatment of sustainability and through-life care***
- ***Strategies for design and assessment (incl. reasoning in applying surveys, testing and monitoring) and consequences of those for verification strategies***

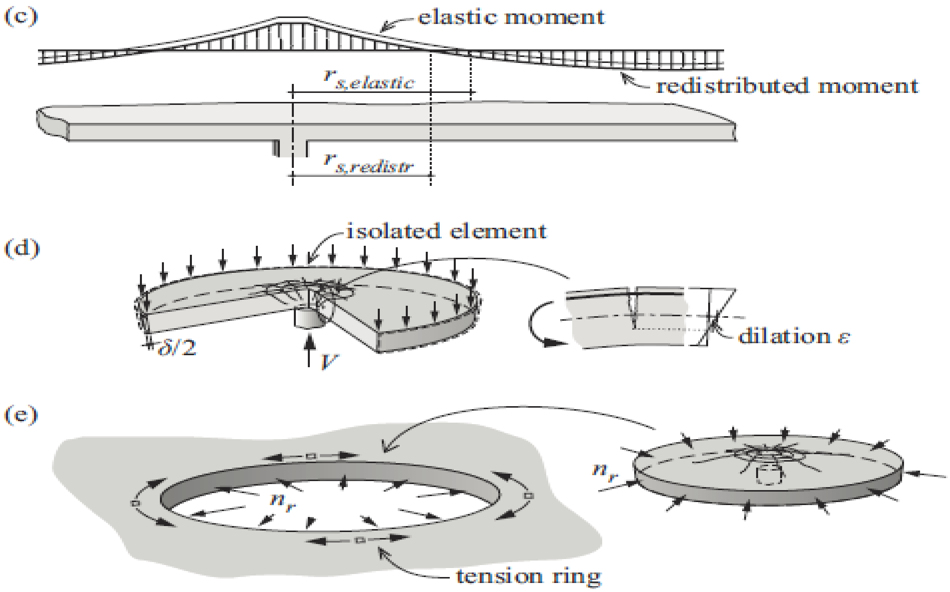
MC2020 FOR CONCRETE STRUCTURES

7.3 VERIFICATION/DESIGN OF/FOR STRUCTURAL SAFETY (ULS) FOR PREDOMINANTLY STATIC LOADING

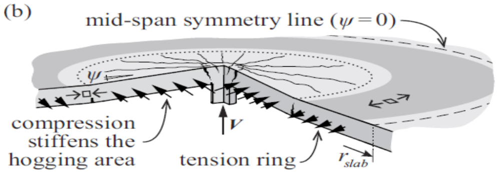
Shear and Punching

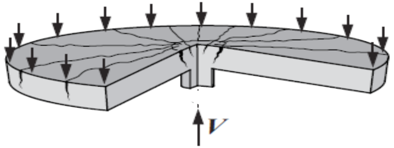
- *Improved models for shear and punching:*
- *Differentiation of shear level I-III models for different types of structures*
- *Shear capacity of circular cross-sections*
- *Influence of fatigue in shear and punching behaviour*
- *Implementation of compressive membrane action in punching resistance*
- *Influence of type of steel (A, B, C, D), plain or ribbed on shear behavior, old types of reinforcement, alternative types of concrete, deteriorated materials*
- *Effect of insufficient reinforcement*
- *Shear resistance models in presence of external prestressing*
- *Verification methods need to be generalized to accommodate not only steel reinforcement but also non-metallic reinforcement, steel fibre reinforcement as far as appropriate*

Influence of slab continuity on punching shear strength

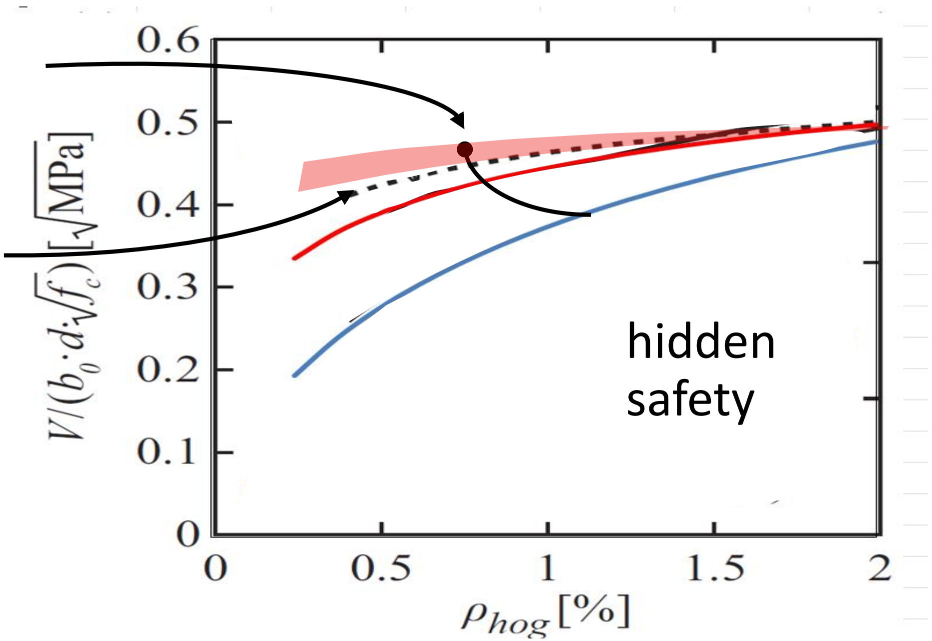


Hidden reserves are relevant for assessment, but wat about new structures?





$$V_{R,c} \approx \text{proportion al to } (\rho)^{\frac{1}{3}}$$



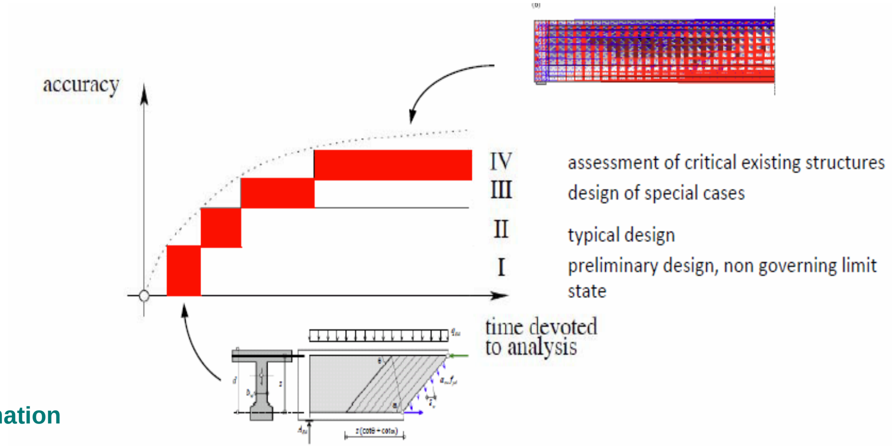
Einpaul, J. , Fernández Ruiz, M., Muttoni, A., *Influence of moment redistribution and compressive membrane action on punching strength of actual flat slabs*, Engineering Structures, 2015

Einpaul, J. , Ospina C. E., Fernández Ruiz, M., Muttoni, A., *Punching Shear capacity of Continuous Slabs*, ACI Structural Journal , 2016

MC2020 FOR CONCRETE STRUCTURES

Levels of approximation approach

- *Provisions based on generalized models and level of approximation approach*



Levels of approximation

IV System assessment of critical existing structures & design of special cases e.g. by FEM
III In-depth elemental evaluation of existing structures & design of special cases
II Typical elemental design & assessment
I Preliminary design & assessment, non governing limit state

MC2020 FOR CONCRETE STRUCTURES

7.4 VERIFICATION OF STRUCTURAL SAFETY (ULS) FOR NON-STATIC LOADING

- *Fatigue*
  - *Fatigue strength (life) of members subjected to shear: shear strength beam without shear reinforcement, shear strength of slab, shear strength of beam with shear reinforcement, effect of travelling loads, effect of moisture, effect of freeze thaw cycles*
  - *Fatigue in combination with corrosion*
  - *Fatigue for new materials*
- *Impact and explosion*
- *Seismic*
  - *Seismic design and assessment incl. seismic retrofitting*
  - *Seismic resistance of precast concrete structures*
  - *Design for resilience*

MC2020 FOR CONCRETE STRUCTURES

7.5 VERIFICATION OF STRUCTURAL SAFETY (ULS) FOR EXTREME THERMAL CONDITIONS

- *Fire*
- *Cryogenic conditions*

  - *Scope definition :*
    - *Include non-metallic reinforcement and new cementitious materials*
    - *Include post-fire assessment and repair after fire*

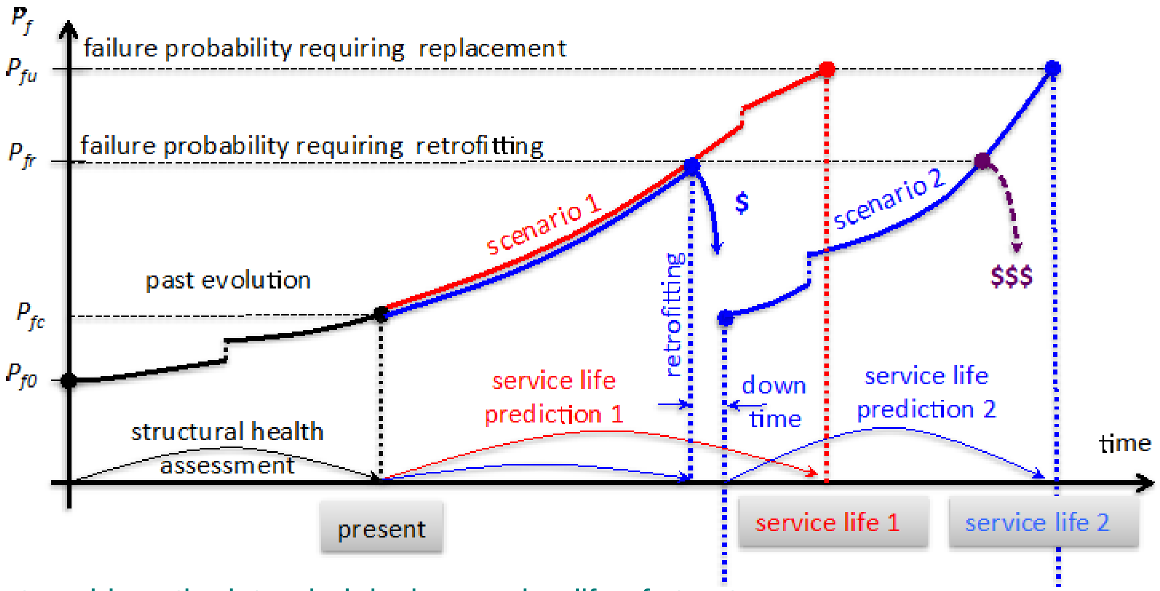
MC2020 FOR CONCRETE STRUCTURES

7.8 VERIFICATION OF LIMIT STATES ASSOCIATED WITH DURABILITY

Durability and Service Life Prediction

- *Change approach from design by avoidance (proxi limit states criteria) to evaluation or design for (residual) life time (new limit state criteria)*
- *Introduce of new limit state concept for existing structures with damages beyond limit state of new structures, which can be based on structural performance rather than material condition*
- *Introduce propagation models (need for models or tests with reproducible results) including the effects of interventions Introduce evaluation of reliability and durability for deteriorating structures*
- *Include updating of reliability and durability for deteriorating structures by use of information from in-situ testing and monitoring Include durability assessment after intervention / repair*
- *Extension of models for durability to various forms of deterioration*
  - *carbonation-induced corrosion*
  - *chloride-induced corrosion*
  - *freeze-thaw attack*
  - *acid attack*
  - *sulphate attack*

MC2010 FOR CONCRETE STRUCTURES



- to achieve the intended design service-life of structure
- to facilitate an extension of life / change of use of structure
- to minimise through-life cost and environmental impacts

MC2020 FOR CONCRETE STRUCTURES

- *Robustness*

  - *Clear definition of the concept of robustness and its limitations*
  - *Introduction of redundancy as a design criterion*
  - *Difference between assessment and design*

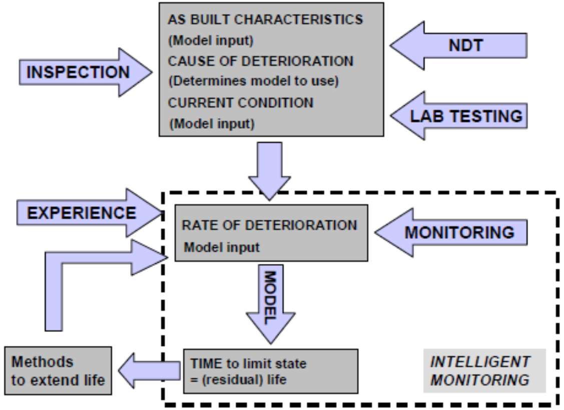
MC2020 FOR CONCRETE STRUCTURES

- ***Sustainability verification***

  - ***Scope:***
    - ***Impact on environment***
    - ***Impact on economy***
    - ***Impact on society***
  - ***Include effect of avoiding replacement or reduction of interventions***
  - ***Show concept to seek for best scenario for sustainability (saving resources and energy) through-life maintenance management***

MC2020 FOR CONCRETE STRUCTURES

- *Verification assisted by monitoring and testing*
  - *Monitoring of durability and performance*
    - *Locations for surveys, testing and monitoring activities*
    - *Condition survey and monitoring activities*
    - *Tools and techniques for surveys and monitoring*
    - *Gathering data for condition control purposes*
    - *General flow of condition survey process*
    - *Automated monitoring of concrete structures*
    - *Automated monitoring and updating of service life prediction*
  - *Data evaluation and incorporation of a priori knowledge*
  - *Consideration of past performance as evidence of suitability for future performance*
  - *Provisions for proof loading of structures*
  - *Monitoring systems related to service life*
  - *Value of information*



MC2020 FOR CONCRETE STRUCTURES

- *Detailing*

  - *Improved background for detailing provisions and provide more rational detailing models*

  - *Scope extension:*
    - *structures after intervention and/or with special structural details / special materials*
    - *detailing of connections between new concrete and old concrete*
    - *behaviour and strength of badly detailed existing structures*

MC2020 FOR CONCRETE STRUCTURES

8. CONSTRUCTION

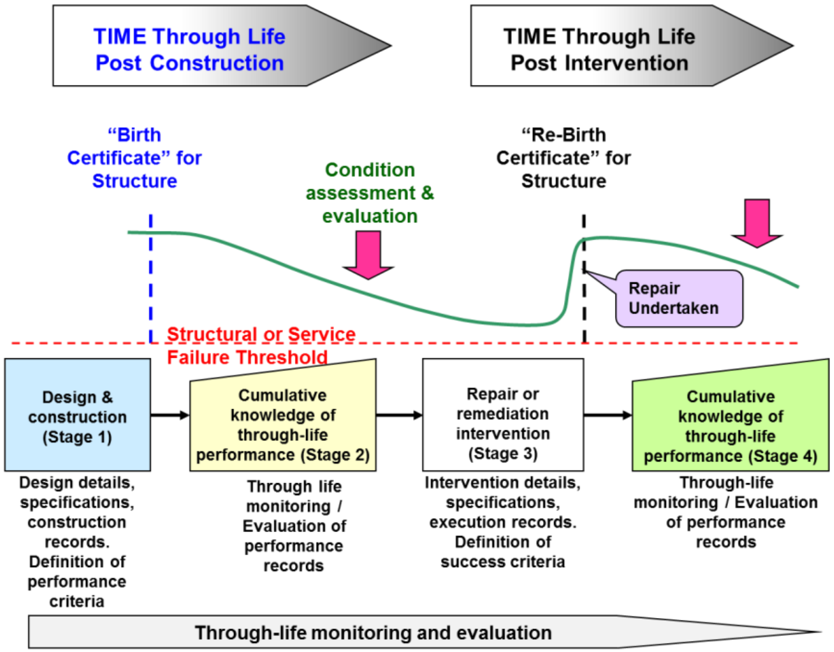
Construction works: new works and works on existing structures

- ***Scope***
  - ***include maintenance and interventions***
  - ***include post casting treatments***
  - ***include provision for FRC & UHPC, new cementitious materials***
  - ***consider implications of BIM and relation with Quality and Information Management***

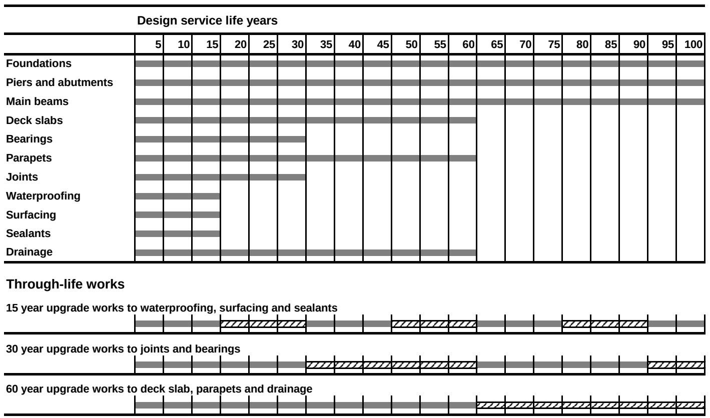
- ***Reference to ISO Execution Standard as far as appropriate***

MC2020 FOR CONCRETE STRUCTURES

9. THROUGH-LIFE MANAGEMENT & CARE



A design service life performance plan for elements of a bridge



MC2020 FOR CONCRETE STRUCTURES

10. DISMANTLEMENT

Dismantlement, repurposing, reuse and recycle

- *Scope*
  - *Include safety level / safety management for dismantling*
  - *Elaborate structural aspects of dismantlement (dismantlement of parts, dismantlement of prestressed structures, repair of accidently cut tendons)*
  - *Include reflective thinking approach / review of proposed dismantlement concept and approach*

TIMELINE OF *fib* MC2020

2016-2019	Delivery of *fib* Bulletins from the supporting work program of commissions
2017	Dissemination of the vision on advancing *fib* MC2020 in *Structural Concrete*
Oct 2018	Report of drafting of MC2020 presented at *fib* Congress in Melbourne
May 2019	Report of drafting of MC2020 presented at *fib* Symposium in Krakow
	First compete draft of fib MC2020 presented at fib Symposium for review and comment by fib Technical Council, fib Commissions, fib National Groups, fib members, etc.
	Final draft of MC2020 presented at fib Symposium / Congress & voting by fib General Assembly

Final timetable will be established in interaction with the TC and all Commission Chairs, involved in this particular task

THANK YOU FOR YOUR ATTENTION