Commission 7 – Sustainability

Chair:

Hájek	Czech Technical University in Prague	Czech Republic

Co-Chair:

Noguchi	University of Tokyo	Japan

Members:

Borg	University of Malta	Malta
Choi	Hankyong National University	South Korea
Desmyter	Belgian Building Research Institute	Belgium
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Kawai	Hiroshima University	Japan
Kohoutková	University of Prague	Czech Republic
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Prota	University of Naples	Italy
Sakai	Japan Sustainability Institute	Japan
Štepánek	Brno University of Technology	Czech Republic
Tamura	Kogakuin University	Japan

Corresponding members:

Hisada	Tohoku University	Japan
Piscaer	Univerde Agencies	Netherlands

(*fib* members are listed in **bold**)

Recent meetings:

Copenhagen (May 2015); Prague (Nov 2015); Madrid (June 2016)

Terms of reference

Motivation/background (in brief)

Concrete is the most used material for the construction of buildings and civil structures. Concrete and concrete structures should contribute to the development of a sustainably built environment in a socially, environmentally and economically responsible manner. There is no general methodology for sustainability design and assessment of concrete structures covering all important sustainability aspects and all life cycle phases from acquisition of materials, through production of concrete and concrete components, construction, operation of structure, up to demolition and recycling.

Scope and objective of technical work

The main scope of Commission 7 (COM7) is to develop a strategy as to how to incorporate sustainability issues into the design, construction, operation and demolition of concrete structures. Design concepts of concrete structures should be based on a sustainability framework considering environmental, economic and social aspects. The main focus should be on: the reduction of CO_2 emissions from concrete production, the reduction of energy use for construction and the operation of buildings (incl. thermal mass effect), an improvement in the performance quality of the internal environment (acoustics, thermal well-being, etc.), the reduction of waste to landfill, the development of sustainability metrics and data requirements needed for EPDs and other quality assessment, recycling and use of recycled materials (incl. recycled concrete), resiliency of structures, etc. The goal is to prepare a framework and data for the sustainable design of concrete structures to be implemented in a new model code.

Description of workflow and timeline

COM7 will start activity in January 2015. It will incorporate existing task groups which existed under the former *fib* structure (prior to 2015) with T7.2, *Application of environmental design to concrete structures*, T7.3, *Concrete made with recycled materials – life cycle perspective*, T7.4, *Sustainable civil structures*,and T7.5, *Environmental product declarations (EPD) and equivalent performance for concrete product*s. New task group T7.1, *Sustainable concrete - general framework* will start in January 2015 and other new task groups Sustainable concrete buildings and Resilient concrete structures will be proposed for start during 2015 or 2016.

Collaboration with other groups

COM7 will collaborate with COM6, *Prefabrication,* and COM8, *Durability*

COM7 will liaise with ANNEX 57 Evaluation of Embodied Energy and Carbon Dioxide Emissions for Building Construction and with iiSBE - International initiative for Sustainable Built Environment

Target Audience

Academia, designers, consultants, producers, contractors, authorities/governmental institutes

Expected outcome and delivery dates

Task groups will prepare reports to be published in *fib* bulletins.

Task Group 7.1: Sustainable concrete structures – general framework

Convener:

Hájek	Czech Technical University in Prague	Czech Republic

Members:

Borg	University of Malta	Malta
Chira		Romania
Desmyter	Belgian Building Research Institute	Belgium
Fiala	Czech Technical University in Prague	Czech Republic
Lamikova	Brno University of Technology	Czech Republic
Sakai	Japan Sustainability Institute	Japan
Štěpánek	Brno University of Technology	Czech Republic

(*fib* members are listed in **bold**)

Other members for this new task group are invited.

Terms of reference

Motivation/background (in brief)

There is no general framework for the design and assessment of concrete structures considering a complex sustainability approach. This framework should follow developments in standardization in the field of sustainability (CEN, ISO). The work of T7.1 will be based on previous work of *fib* task groups prior to 2015, which produced the following bulletins: Environmental design of concrete structures - general principles (*fib* Bulletin 47), Guidelines for green concrete structures (*fib* Bulletin 67) and Integrated life cycle assessment of concrete structures (*fib* Bulletin 71).

Scope and objective of technical work

Definition of a basic framework of sustainable concrete design and an assessment considering environmental, economic and social aspects. The framework will focus on different types of concrete structures - buildings, bridges, roads, water structures etc. and their construction and operation in various specific regional conditions. The entire life cycle will be considered.

Description of workflow and timeline

T7.1 will start activity during 2015. The detailed workflow will be defined based on a discussion in the new COM7. The technical report is expected to be finished by the end of 2018.

Collaboration with other groups

T7.2, T7.3, T7.4, T7.5

Target Audience

Academia, consultants, authorities/governmental institutes

Expected outcome and delivery dates

Technical report (expected by the end of 2016)

Task Group 7.2: Application of environmental design to concrete structures

Convener:

Kawai	Hiroshima University	Japan

Members:

Asprone	University of Naples	Italy
Hájek	Czech Technical University in Prague	Czech Republic
Prota	University of Naples	Italy
Sakai	Japan Sustainability Institute	Japan
Sukontasukkul	King Mongkut Institute of Technology	Thailand
Tamura	Kogakuin University	Japan

Corresponding Members:

Choi	Hankyong National University	South Korea
Desmyter	Belgian Building Research Institute	Belgium

(*fib* members are listed in **bold**)

Terms of reference

Motivation/background (in brief)

fib Bulletin 47, "*Environmental design of concrete structures - general principles*", prepared by a former task group, covers the life cycle of concrete structures including manufacturing of materials, transportation, execution, maintenance, demolition, disposal and recycling. In an actual concrete structure, however, the requirements for structural performance and durability performance in addition to environmental performance must be satisfied in a well-balanced manner.

Scope and objective of technical work

The scope of the activities of the task group is to show application procedures of environmental design to concrete structures to promote sustainable construction. Since the quantitative evaluation method of environmental aspects in the design and construction of concrete structures is still under development, a document to facilitate it, such as a manual, will be required to foster the incorporation of environmental aspects into the design and construction. Based on the document, various case studies will be conducted.

In Bulletin 47, environmental design is conducted with the performance-based design method. Performance parameters associated with environmental aspects are verified and inspected in the planning stage and implementation stage. The verification and inspection, however, should be essentially carried out in terms of structural and durability aspects together with environmental aspects. In cases where criteria for low environmental impact conflict with performance or durability requirements, methodologies of optimization will be investigated. From these viewpoints, environmental design methodologies for the whole design of concrete structures should be also investigated.

Description of workflow and timeline

Several case studies regarding the environmental design of concrete and concrete structures have already been collected. The details of these case studies will be investigated before preparing the first draft of the TG's report. The report will have several revisions and be finalized within two or three years.

Target Audience

Academia, consultants, authorities/governmental institutes, producers (concrete, admixtures, concrete additions/extenders, cement, aggregates), contractors.

Expected outcome and delivery dates

The output of the T7.2 activities will be a manual for environmental design of concrete structures to be published in 2017. Topics addressed will include:

- concept of environmental design within the design as a whole;
- general methodologies to harmonize structural, durability and environmental performance of concrete structures;
- procedure for environmental impact evaluation of concrete structures;
- inventory analysis including data collection for evaluation of environmental impact;
- Integrated evaluation of environmental impact;
- case studies on environmental design of concrete structures.

Regarding the procedure for the environmental impact evaluation, inventory analysis and integrated evaluation, examples will be shown together with the general concepts.

Task Group 7.3: Concrete made with recycled materials – Life cycle perspective

Convener:

Noguchi	University of Tokyo	Japan

Members:

Akbarnezhad	The University of New South Wales	Australia
Choi	Hankyong National University	South Korea
de Larrard	Lafarge LCR	France
Desmyter	Belgian Building Research Institute	Belgium
Dunne	AECOM	United Kingdom
Moriconi	Università Politecnica della Marche	Italy
Poon	The Hong Kong Polytechnic University	China
Tamura	Kogakuin University	Japan
Ulsen	Polytechnic School at the University of Sao Paulo	Brazil
Vazquez	Universitat Politècnica de Catalunya	Spain
Xiao	Tongji University	China
Zhang	Southeast University	China

Corresponding Members:

Ajdukiewicz	Silesian Technical University	Poland
Hájek	Czech Technical University in Prague	Czech Republic
John	Polytechnic School, University of Sao Paulo	Brazil
Kliszczewicz	Silesian Technical University	Poland
Pileggi	Polytechnic School, University of Sao Paulo	Brazil

(*fib* members are listed in **bold**)

Terms of reference

Motivation/background (in brief)

The concrete sector is already facing the problems of resource recycling in some regions or will definitely face them in the future all over the world. That is, huge amounts of natural resources are consumed at present to produce a large amount of concrete and their amounts will greatly increase in the future, and a large amount of concrete waste from demolished structures is generated at present and its amount will also increase in the future. Additionally, there are some regions where they are suffering from a lack of final disposal site for concrete waste, or where good natural resources, e.g. natural river sand, are almost scarce. Other sectors expect concrete to utilize their waste and by-products as constituent materials. In these contexts, the concrete sector has to establish a resource recycling society similar to steel and aluminium, taking the utilization of by-products from other industries into consideration.

Scope and objective of technical work

The objective of T7.3 is to collect statistical data on concrete production, waste generation and those related to resource recycling in the world. The objective also includes an investigation of:

- the properties of recycled materials for concrete made from waste and by-products,
- the properties of concrete with recycled materials and their applications
- concrete recycling technologies, and
- the environmental impact caused during recycling of concrete waste.

Finally, T7.3 will publish a state-of-the-art report on concrete with recycled materials such as demolished concrete, ceramics, glass, ashes, organic waste, etc. and to propose the ideal future for recycling concrete resources taking into account aspects of durability and recyclability of concrete, and minimizing the environmental impact in the life cycle.

The area of T7.3's technical work and interest includes:

- statistical data for recycling of C&D waste in the world
- technologies and environmental aspects in producing recycled cement, supplementary cementitious materials made from waste and by-products, recycled aggregate, recycled fibre and recycled water
- properties of recycled cement, supplementary cementitious materials made from waste and by-products, recycled aggregate, recycled fibre and recycled water
- properties of concrete with recycled cement, supplementary cementitious materials, recycled aggregate, recycled fibre and recycled water
- utilization of demolished concrete in applications other than concrete
- reuse of members in existing structures
- design of reusable/recyclable concrete structures
- system for promoting concrete made with recycled materials.

Description of workflow and timeline

The scope and objective, membership, and the content of publications have been under discussion since 2010. T7.3 began to draft the state-of-the-art report on concrete with recycled materials in 2014. The report is expected to be published in 2017 at which time T7.3 will be disbanded.

Collaboration with other groups

T7.1, T7.2, T7.4, T7.5

RILEM TC-EEC (Environmental evaluation of concrete structures toward sustainable construction)

ACI TC-555 (Concrete with recycled materials)

Target Audience

Academia, consultants, authorities/governmental institutions, producers (concrete, concrete additions/extenders, cement, aggregates), contractors

Expected outcome and delivery dates

State-of-the-art report on concrete with recycled materials will be published in 2017.

Task Group 7.4: Sustainable civil structures

Convener:

Kohoutková	University of Prague	Czech Republic

Members:

Akbarnezhad	The University of New South Wales	Australia

Corresponding Members:

Weglorz	Silesian Technical University	Poland

(*fib* members are listed in **bold**)

Other members for this new Task Group are invited.

Terms of reference

Motivation/background (in brief)

The objective of the task group is to develop a methodology for optimising the design process leading to lower life cycle cost and more environmentally friendly civil structures. The way of doing this is to apply life cycle costs and life cycle assessment tools in the civil structure design process.

The different phases of a civil structure project from planning to end of service life demand different methodologies. The phases include the feasibility phase, conceptual design, detailed design, construction, operation and maintenance and end of life/re-use. In the feasibility phase, for instance, different alignments are possible as well as different structural solutions (different tunnel and bridge solutions). The possibility of influencing the construction costs and environmental impact lies mainly in this feasibility phase.

In the conceptual and detailed design phases codes and standards are used with predefined service life requirements. This service life is related to durability of the structure itself, however does not take operation and maintenance of the structure into account. For instance, if stainless steel reinforcement is used, no operation and maintenance of the structure is expected as concerns reinforcement corrosion. However the selection will have an impact on the construction costs and the environmental impact, which is not evaluated in the design phase today. Also aspects in relation to indirect costs and environmental impacts can be taken into account in the early design phase. In an urban environment, traffic interruptions during construction and operation and maintenance activities may well be the decisive parameter when selecting the construction method and design.

By applying life cycle cost and environmental tools into design life calculations e.g. for

- different durabilty strategy options,
- different materials (steel, concrete, wood) or
- different structure types (arch bridge, suspension bridge, tunnels, etc)

The information achieved can be used by the owners in order to take decisions on a rational basis.

The owners will hence have a possibility to optimise fund allocations and minimise environmental impact for the benefit of society over the service lifetime of the structure

Scope and objective of technical work

Draft table of contents

1. Executive summary

2. Screening for available LCC and LCA tools and methods for optimising integrated bridge design taking cost and environmental impact into account

3. Stages in bridge design

4. LCC including operations, maintenance and repair plan

5. LCA including operations, maintenance and repair plan

6. Proposed methodology

Description of workflow and timeline

Commencement in 2013

June 2014: Rev 0.1 for COM members review

June 2014 to September 2014. Under review

Feb. 2015 Rev. 1.0 for *fib* review and possible approval

Collaboration with other groups

Coordination with:

- T7.5 Environmental Product Declarations (EPD) and equivalent performance of concrete
- COM5 on service life aspects and LCC

Subject to approval:

- The road authorities in Denmark, Sweden, Norway and Finland
- Czech Technical University in Prague
- KTH in Stockholm, Sweden
- NTNU in Trondheim, Norway
- DTU in Lyngby, Denmark
- Danish Technological Institute, in Tåstrup, Denmark

Target Audience

Owners, Planners and Designers

Expected outcome and delivery dates

State-of-the-art report, 2018

Task Group 7.5: Environmental product declarations (EPD) and equivalent performance of concrete

Convener:

Mathiesen	Danish Technological Institute	Denmark

Members:

Asprone	University of Naples	Italy
Brankley	CARES	United Kingdom
Choi	Hankyong National University	South Korea
Dehn	MFPA Leipzig GmbH	Germany
Desmyter	Belgian Building Research Institute	Belgium
Fosberg	COWI A/S	Denmark
Haas	Delft University	Netherlands
Henriksen	Danish Technological Institute	Denmark
Hodková	Czech Technical University in Prague	Czech Republic
Jäger	Peter Jäger Bauingenieure AG	Switzerland
Moriconi	Università Politecnica della Marche	Italy
Müller	Karlsruhe Institute of Technology	Germany
Noguchi	University of Tokyo	Japan
Piscaer	Univerde Agencies	Netherlands
Prota	University of Naples	Italy
Reiners	VDZ	Germany
Rodriguez Valenzuela	AIDICO	Spain

Corresponding Members:

Ajdukiewicz	Silesian Technical University	Poland
Pade	Danish Technological Institute	Denmark

(*fib* members are listed in **bold**)

Terms of reference

Motivation/background (in brief)

The objective of the task group will be two-fold:

1. To recommend preferred approaches (road maps) for establishing "equivalent performance" of low environmental impact concrete typically containing high contents of supplementary cementitious materials and therefore in terms of composition falls outside the prescriptions found in existing standards/regulations. By equivalent performance is understood that the concrete has acceptable production, structural and durability properties for its intended use. Clear road maps for establishing equivalent performance are a prerequisite and will likely act as a catalyst for increased use of such lower environmental impact concrete compositions to the benefit of the global community.

2. To establish best available technologies for Environmental Product Declarations (EPDs) on concrete compositions (mix designs). EPDs are an emerging means, which, if performed on a common basis, allow a comparison of the environmental impact of different concrete compositions/products. As such, EPDs may be used by the consumer (end-user) to make a qualified decision concerning the choice of concrete, e.g. as requirements to the environmental performance can be verified and therefore also specified.

The combination of a clear, unambiguous road map for establishing “equivalent performance” of a concrete composition and an equally clear and unambiguous EPD showing an advantageous environmental impact of the concrete composition could prove a valuable set of tools in promoting the use of greener concrete compositions in the interest of mankind.

Scope and objective of technical work

Draft table of contents

1. Executive summary

2. Screening for available concepts of establishing equivalent performance - European, Asian, North American status

3. Guideline with recommended methodology

Description of workflow and timeline

Commencement in 2013

June 2014: Rev 0.1 for COM7 member review

June 2014 to September 2014. Under review

Feb. 2015 Rev. 1.0 for *fib* review and possible approval

Collaboration with other groups

Coordination with COM4 T4.22 on Supplementary Cementitious Materials (Tor Arne Martius-Hammer)

Subject to approval:

- BIBM
- ERMCO
- RILEM - TC-SCM

Target Audience

Owners, Specifiers, Concrete producers, Raw materials suppliers

Expected outcome and delivery dates

BAT Guideline, end of 2015

Task Group 7.6: Resilient structures

Convener:

Asprone	University of Naples Federico II	Italy

Members:

To be invited

Terms of reference

Motivation/background (in brief)

Since the UN Summit on Sustainable Development in 2002 the linkage between resilience and sustainability of urban systems has been highlighted. The capacity of society and urban systems to manage natural hazards and mitigate their impact, that is resilience, represents a basic condition for the social sustainability of the development. Thus, to boost the sustainability of the future cities, the resilience of the physical systems and infrastructures should be addressed.

A growing number of structural systems are clustered in disaster-prone areas worldwide, making cities ever more exposed in time and space. Keeping with this, whenever a catastrophic event occurs, buildings and infrastructures have to be not only capable to withstand it but they have to be resilient too.

A resilient structure can effectively prevent from collapse and life safety of occupants and, in addition, it can absorb external stresses and restore its basic functionality and structural capacity in a timely manner. Particularly, a robust structural system is a key feature for a structure to be resilient, ensuring an advanced bouncing back capacity when extreme natural or man-made events occur. Besides, abnormal loads from extreme events have to be considered within the design process and also within the buildings' maintenance and retrofit actions. In fact, exceptional loads are often not considered in current engineering practice, whereas they need to be integrated to ensure restraining damages spreading and incipient collapse.

A resilient structure plays a critical role within the urban environment also enhancing the resilience of the local community, and its sustainable development. This is because of its capability to ensure essential services, emergency response and shelter for deallocated citizens. Furthermore, severe economic and human losses are expected from buildings' damage and collapse in the face of shocking events. Hence, designing and erecting disaster-resilient buildings and infrastructures has a positive outcome, allowing to address social and economic sustainability related issues.

In this context, resilience can be regarded as a fundamental prerequisite to strengthen modern societies and enhance their sustainability, through a multiscale approach: from the single building scale to the urban environment scale.

Advanced structural engineering and strategic disaster management methodologies can be developed through the implementation of resilience concepts in traditional practice.

When considering the matter from a hazard perspective, several potential disasters should be taken into account, including terrorist attacks, hurricanes, nuclear power plant accidents, earthquakes, tsunamis. As a result, multihazard approaches need to be used to compute diverse risks along with structural performances. Performance-based methodologies can then be implemented to assess resilience within a multiscale approach, from the single structures to the whole urban system, also considering interrelations between infrastructure and citizens.

The knowledge of the structural resilience is fundamental as a support to disaster managers for the choice of the best recovery strategy to be implemented soon after a catastrophe occurrence. Diverse strategies can be hypothesised and resilience can be assessed for each of them to recognise the most efficient one to be implemented.

Resilience concepts and assessment methodologies have to be integrated within international building codes and guidelines to provide stakeholders with recommendations about performance-based design, structural retrofit techniques and resilience assessment methods.

Scope and objective of technical work

The objective of the task group is to highlight criticalities in current structural design practice and to provide fundamentals to address the design, the maintenance and the retrofit principles towards resilient structures in sustainable urban systems, and more in general, in view of smart cities.

The task group aims at developing guidelines to help diverse stakeholders involved within such processes, in order to face resilience issues through a multiscale approach.

Multihazard performance-based methodologies are developed and integrated within the current standards.

Guidelines approach resilience issues according to a multiscale approach, starting from the single building scale. Structural design principles are rethought from the point of view of the practicality, repairability, robustness and serviceability in the aftermath of a catastrophe. Particularly, performance goals are recognised to define new resilience-based limit states, in order to enhance disaster preparedness and response of urban structures. Innovative and novel standards and metrics are implemented within the guidelines, as a support to the development of post-event strategic intervention, protection and response technologies and recovery strategies.

Further recommendations are also given at the higher scale of urban system to identify the most critical structures and infrastructure networks that determine the disaster resilience of the overall urban environment.

In other words, resilience is approached in a systemic manner by extending the performance-based standards from the level of the single building to those of interconnected infrastructures and, finally, to the urban system.

Advanced engineering methods are also proposed to define methodologies and metrics for damage assessment of cities and best practises for structural strengthening and design are advised to create resilient buildings and improve community life-safety and sustainability.

Description of workflow and timeline

End 2016: Kick-off Meeting

June 2017: First draft available

December 2017: Final draft to be reviewed and approved

Collaboration with other *fib* Commissions and task groups

To be defined

Target audience

Designers, stakeholders, disaster managers

Expected outcome

Publication expected in December 2017