Commission 7

# Seismic design

| | |
|---|---|
| Chair: | Pinto (Univ. di Roma La Sapienza, Italy) |
| Deputy-Chair: | Watanabe (Takenaka Corp., Japan) |
| Members: | Bonelli (Facultad de Ingenieria, Valparaiso, Chile), Calvi (Univ. degli Studi di Pavia, Italy), Carvalho (Gapres SA, Portugal), Elnashai (Univ. of Illinois at Urbana, USA), Fardis (Univ. of Patras, Greece), Franchin (Sapienza Università di Roma, Italy), Garcia (Univ. de Los Andes, Colombia), Hiraishi (Ministry of Construction, Japan), Kahan (Setec Industries, France), Kappos (Aristotle Univ. of Thessaloniki, Greece), Kawashima (Tokyo Institute of Technology, Japan), Kowalsky (North Carolina State Univ., USA), Mitchell (McGill Univ., Canada), Moehle (Univ. of California, Berkeley, USA), Mosalam (Univ. of California, Berkeley, USA), Nakano (Univ. of Tokyo, Japan), Pampanin (Univ. of Canterbury, New Zealand), Pantazopoulou (Demokritus Univ. of Thrace, Greece), Priestley (Rose School, Pavia, Italy), Rodriguez (National Univ. of Mexico), Tanaka (Kyoto Univ., Japan) |
| Recent Meetings: | (The Commission membership being largely identical to the membership in Task Groups, an official Commission meeting will only be called for if formal decisions need to be taken) |
| Recent Bulletins: | ***fib*** Bulletin 24: ***Seismic assessment and retrofit of reinforced concrete buildings*** (State-of-art report prepared by former TG7.1, published 2003)<br>***fib*** Bulletin 25: ***Displacement-based seismic design of reinforced concrete buildings*** (State-of-art report prepared by former TG7.2, published 2003)<br>***fib*** Bulletin 27: ***Seismic design of precast concrete building structures*** (State-of-art report prepared by former TG7.3, published 2004)<br>***fib*** Bulletin 39: ***Seismic bridge and retrofit - structural solutions*** (State-of-art report prepared by former TG7.4, published 2007) |

## Terms of reference

### Scope

The general scope of the work is the promotion of the use and improvement in safety of concrete structures in seismic regions worldwide.

### Areas of interest

The Commission will contribute:

- to the development of new concepts and rules for the seismic design of new concrete structures and for the improvement of seismic safety of existing ones;
- to the harmonisation and improvement of seismic design standards worldwide.

### Working programme

High-priority topics of the Commission are the following:

- *Seismic assessment and retrofit of existing concrete structures:* elaboration of available procedures for the seismic assessment of existing structures and development and calibration of new ones; collection and compilation of information on available strengthening techniques, including guidance and recommendations on their design and application, as well as pertinent examples.
- *Displacement-based or, in general deformation-controlled seismic design and assessment:* advancement of new concepts for the design of new concrete structures and the assessment of existing ones directly on the basis of seismic displacement demands and of serviceability or ultimate limit states expressed in terms of member deformation limits.
- *High strength materials in earthquake-resistant concrete structures:* compilation and elaboration of available information on the behaviour of concrete members with high strength concrete, steel or FRP reinforcement under large-amplitude post-elastic cyclic loading, focusing on the effect of the inherent brittleness of high strength materials on the deformability and the energy-dissipation

capacity of concrete members; adaptation of member dimensioning and detailing rules and of overall seismic design concepts to the use of high strength materials.

- *Earthquake-resistant prefabricated concrete structures (in collaboration with **fib** Commission 6, Prefabrication):* compilation and elaboration of data on the behaviour of connections of precast elements under large-amplitude cyclic loading; development of recommendations and proposals for code rules for the dimensioning and detailing of connections for earthquake resistance; assessment and rating of common precast concrete construction types of configurations in terms of earthquake resistance and robustness and recommendations for their improvement.
- *Earthquake-resistant prestressed concrete structures:* compilation and elaboration of available experimental data on the behaviour of prestressed concrete members under large-amplitude post-elastic load cycles, focusing on the effect of prestress on energy dissipation capacity and ultimate deformation; development of recommendations and proposals for code rules for the dimensioning and detailing of earthquake-resistant prestressed members, and of design concepts of prestressed concrete structures.
- *Wall systems in seismic regions:* study of the seismic behaviour of structural systems which depend mainly on structural walls for resistance against horizontal actions, with emphasis on the cost-effectiveness of large lightly-reinforced walls; development of recommendations and of code rule proposals for earthquake-resistant dimensioning and detailing of walls with complex cross-sectional shapes, including coupled walls.
- *Moment resisting frame systems in seismic regions:* study of the seismic design provisions of major codes of countries with a view to comparing capacity design approaches and detailing provisions for moment resisting frames for a range of levels of seismic design forces corresponding to various structure ductility demands; particular emphasis to be placed on appropriate capacity design and detailing procedures for structural elements and joints.
- *Seismic isolation:* development of criteria and methods for the design of seismically isolated buildings and bridges. Main topics to be covered include: definition of performance levels, calibration of the safety elements needed to achieve given performance objectives, modelling of the behaviour of different categories of isolating / dissipating devices, determination of the respective fields of applicability of equivalent linear and non-linear analysis methods, assessment of the effect of non synchronous motion in the case of bridges.
- *Concrete silos, tanks and chimneys:* development of criteria and methods for the design of concrete containment or similar special structures against seismic action. Main topics to be covered include: definition of performance levels, interaction between contained material and structure, non conventional shapes, inelastic response and design for ductility, seismic isolation.
- *Tall buildings:* development of criteria and methods for the design of tall buildings against seismic action. Main topics to be covered include: structural systems (including mixed ones comprising concrete cores and steel or composite frames), definition of performance levels, appropriate methods of analysis, definition of input ground motion for long-period structures, definition of input ground motion for structures with significant embedded portions, seismic isolation of tall buildings.
- *Performance-based seismic design:* development of a document for direct design of buildings aimed at ensuring compliance with specified probabilistically-defined performance objectives. The design methods will be of the displacement-based type and will account explicitly for uncertainties in the seismic action, the structural system, the foundation medium, etc.

The Commission is expected to follow the worldwide developments and needs and identify additional topics of interest and priorities.

In addition to the Task Groups described below, the establishment of two further groups dealing with seismic design of silos/tanks and tall buildings is planned in the near future.

Task Group

## TG 7.5 Seismic design of buildings incorporating high performance materials

Conveners: Watanabe (Takenaka Corp., Japan), Pampanin (Univ. of Canterbury, New Zealand)

Secretary: Nishiyama (Kyoto Univ., Japan)

Members: Christopoulos (Univ. of Toronto, Canada), Dazio (ETH Zürich, Switzerland), Elnashai (Univ. of Illinois at Urbana, USA), Franchin (Univ. di Roma La Sapienza, Italy), Fukuyama (Building Research Institute, Japan), Kelly (Univ. of California at Berkeley, USA), Komuro (Taisei Corporation, Japan), Konstantinidis (Egnatia Odos SA, Greece), Li (Nanyang Technological Univ., Singapore), McSaveney (Golden Bay Cement, New Zealand), Mitchell (McGill Univ., Canada), Moehle (Univ. of California at Berkeley, USA), Noguchi (Univ. of Tokyo, Japan), O'Leary (Sinclair Knight Merz Ltd., New Zealand), Pantazopoulou (Demokritus Univ. of Thrace, Greece), Parra-Montesinos (Univ. of Michigan, USA), Paultre (Univ. of Sherbrooke, Canada), Rodriguez (National Univ. of Mexico, Mexico)

Recent Meetings: Naples (June 06)

### Terms of reference

The use of high strength concrete and high strength reinforcement has been widespread for the precast and the cast-in-situ construction of building structures. In some cases special response control materials are incorporated to reduce the drift during the earthquake. On the other hand new precast structural seismic systems incorporating several types of high performance materials are being developed for the damage-controlled design. Task Group 7.5 will summarize the state of the art of these high performance materials and devices. The output of the task group will give engineers a guide for the seismic design of buildings incorporating high performance materials and promote the future development of high performance materials. (Modifications still possible.)

Task Group

## TG 7.6 Critical comparison of major seismic design codes for buildings

Conveners: Tanaka (Kyoto Univ., Japan), Watanabe (Takenaka Corp., Japan)

Secretary: Kuramoto (Toyohashi Univ. of Technology, Japan)

Members: Calvi (Univ. degli Studi di Pavia, Italy), Carvalho (Gapres SA, Lisbon, Portugal), Fardis (Univ. of Patras, Greece), Fenwick (Univ. of Canterbury, New Zealand), Garcia (Univ. de Los Andes, Colombia), Kappos (Aristotle Univ. of Thessaloniki, Greece), Kolias (DENCO Ltd., Greece), Li (Nanyang Technological University, Singapore), Lupoi (Univ. of Rome "La Sapienza", Italy), Maffei (Rutherford & Chekene, USA), Mitchell (McGill Univ., Canada), Moehle (Univ. of California, USA), Pampanin (Univ. of Canterbury, New Zealand), Pantazopoulou (Demokritus Univ. of Thrace), Paultre (Univ. of Sherbrooke, Canada), Rodriguez (National Univ. of Mexico), Shiohara (Univ. of Tokyo, Japan)

Recent Meetings: Naples (June 06)

### Terms of reference

A critical comparison of current seismic codes for the design of new concrete building structures in Europe, Japan, New Zealand and North America will be conducted. The comparison will include the demand side (design seismic forces, capacity design actions, design seismic displacements and associated design ductilities; and the capacity side (member and joint strengths - flexure, shear and anchorage); hierarchies of strength attainment; deformation capacity of mechanisms of inelastic

deformation; and the detailing of members and connections for the required strength and ductility. The focus will be on some of the controversial aspects of the use of the capacity design approach (e.g., amplification factors for column bending moments and shears for strong column-weak beam design), the detailing of beams, columns and walls for ductility, and the detailing of beam-column joints for shear, confinement and the limitation of bond slip. Buildings of reinforced concrete, prestressed concrete, and combinations of both will be considered. The report will emphasise the outcomes of the major differences between the current seismic codes. (Modifications still possible)

Task Group

# TG 7.7 Direct probability-based seismic design of buildings

Convener: Pinto (Univ. di Roma La Sapienza, Italy)
Members: List to be finalised

## Terms of reference

The well-known PEER project is about to conclude a long-term effort to develop a methodology for the explicit evaluation of seismic performance of buildings, measured in terms of probability of exceeding a selected measure of damage/cost of use for decision makers. A procedure for direct design of a building to ensure desired performances with specified probabilities, a much more challenging problem, is still not available. On the other hand, much progress has been made towards deterministic performance-based seismic design through the development of displacement-based approaches, which start from a chosen inelastic deformed shape of the structure to apportion stiffness and strength of members. The group will strive to progress along these directions in order to produce a guidance document with a proposal for direct design of buildings aimed at ensuring compliance with specified probabilistically-defined performance objectives.