

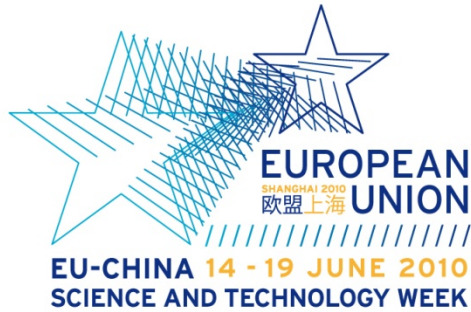
Standards in Construction

Artur Pinto

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Joint Research Centre

Institute for Protection and Security of the Citizen
European Laboratory for Structural Assessment



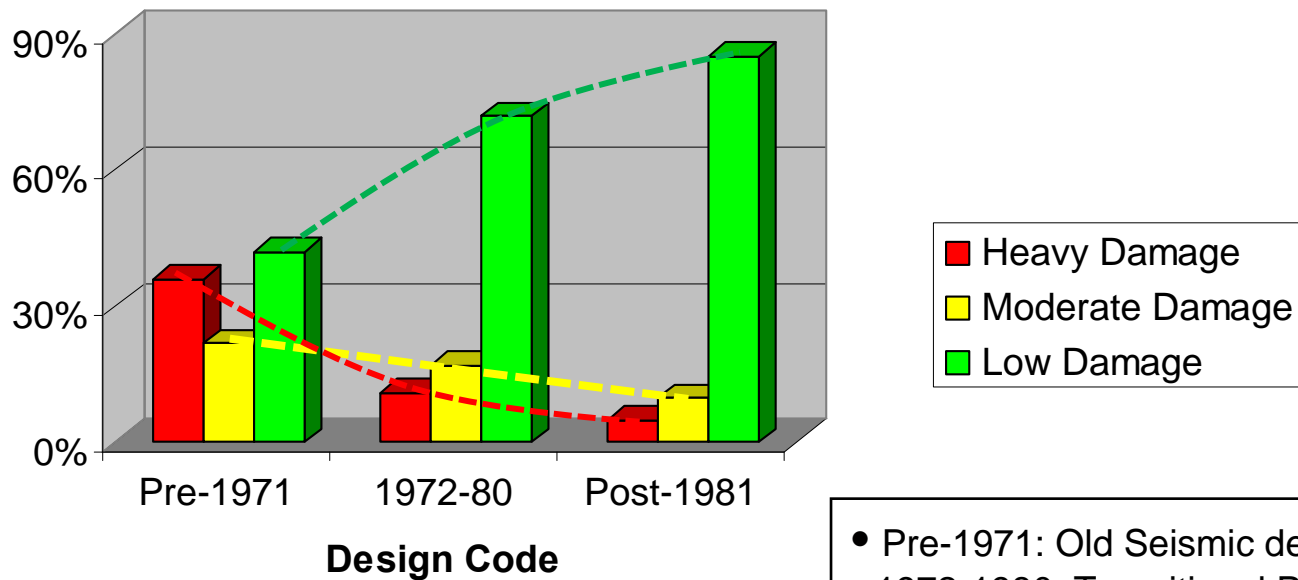


Outline

- Role of standards (Safety, Risk Mitigation, ...)
- European Legislation and Standardization
- The Eurocodes (present and future)
- EU Standards for Building Design addressing: Safety, Health, Energy and Env. Sustainability

Role of the Design Code (Standards) in Earthquake Building Performance

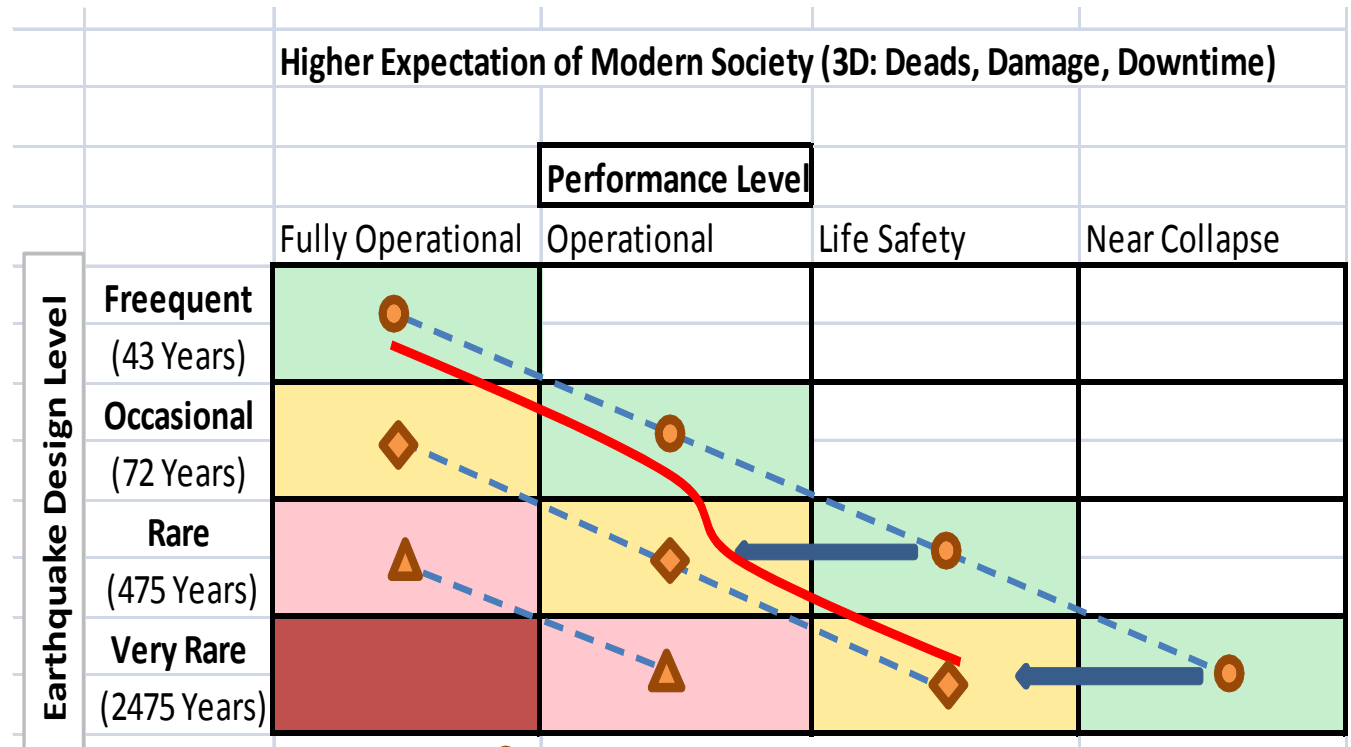
Performance of buildings constructed in Kobe by Ohbayashi Corporation (Kobe earthquake, 1995]



- Pre-1971: Old Seismic design Code
- 1972-1980: Transitional Period
- Post -1981: New Seismic Design Code

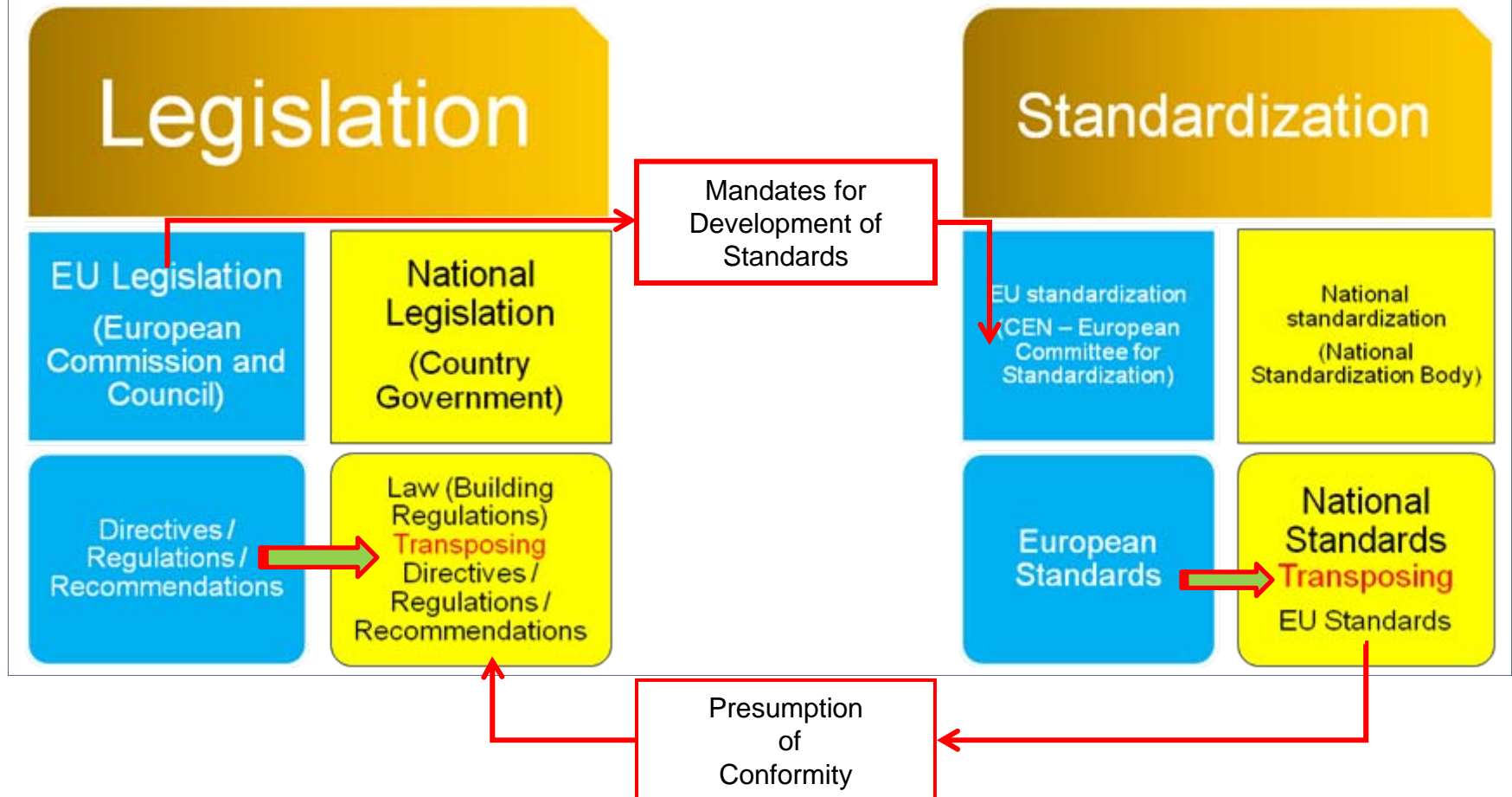


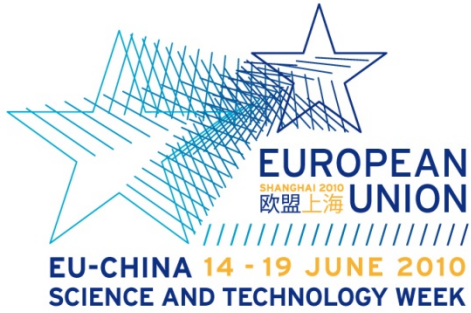
Performance-Based Design (Multi-Objective Approach)



- Ordinary structures
- ◇ Important structures
- △ Critical structures

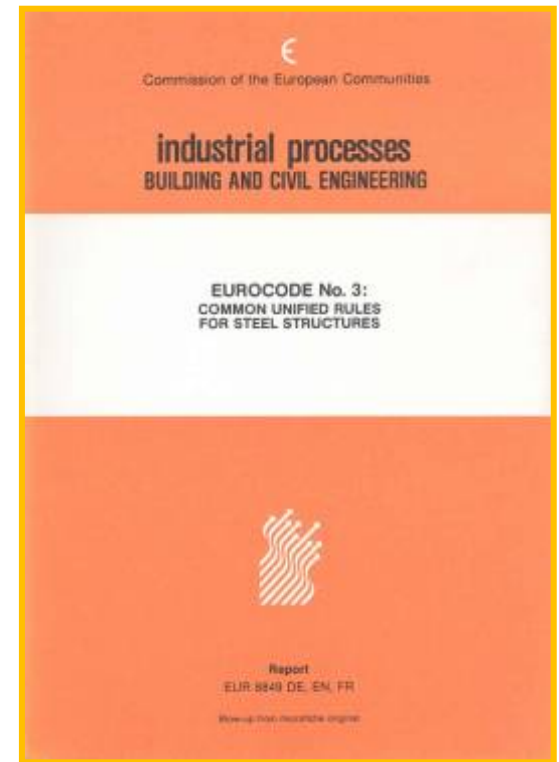
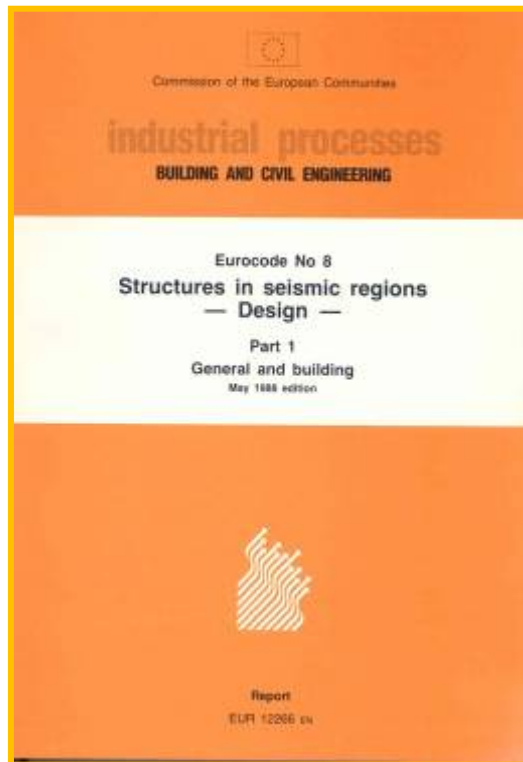
Legislation and Standards (EU and National levels)





European Standardization

RESEARCH (PRE-NORMATIVE) IN SUPPORT OF THE EUROCODES [1995-2005]





Seismic testing of a 4-storey building at the JRC

Reference tests for Eurocodes development and calibration



Tests on Large-scale Bridge models at the JRC

□ Concrete Bridges designed to EC2 and EC8

- The first bridges designed to EC8 part 2
- Rectangular Hollow cross-section (most common in Europe)
- Ductile capacity of bridge Piers
- Irregularity in bridges, Alternative design methods
- Non-synchronous earthquake motions
- Seismic Isolation

□ Consequences:

- ✓ EC8 design accepted for regular bridges
- ✓ Deformability in detriment of strength for irregular bridges (isolation – a suitable and economical solution)





The Eurocodes

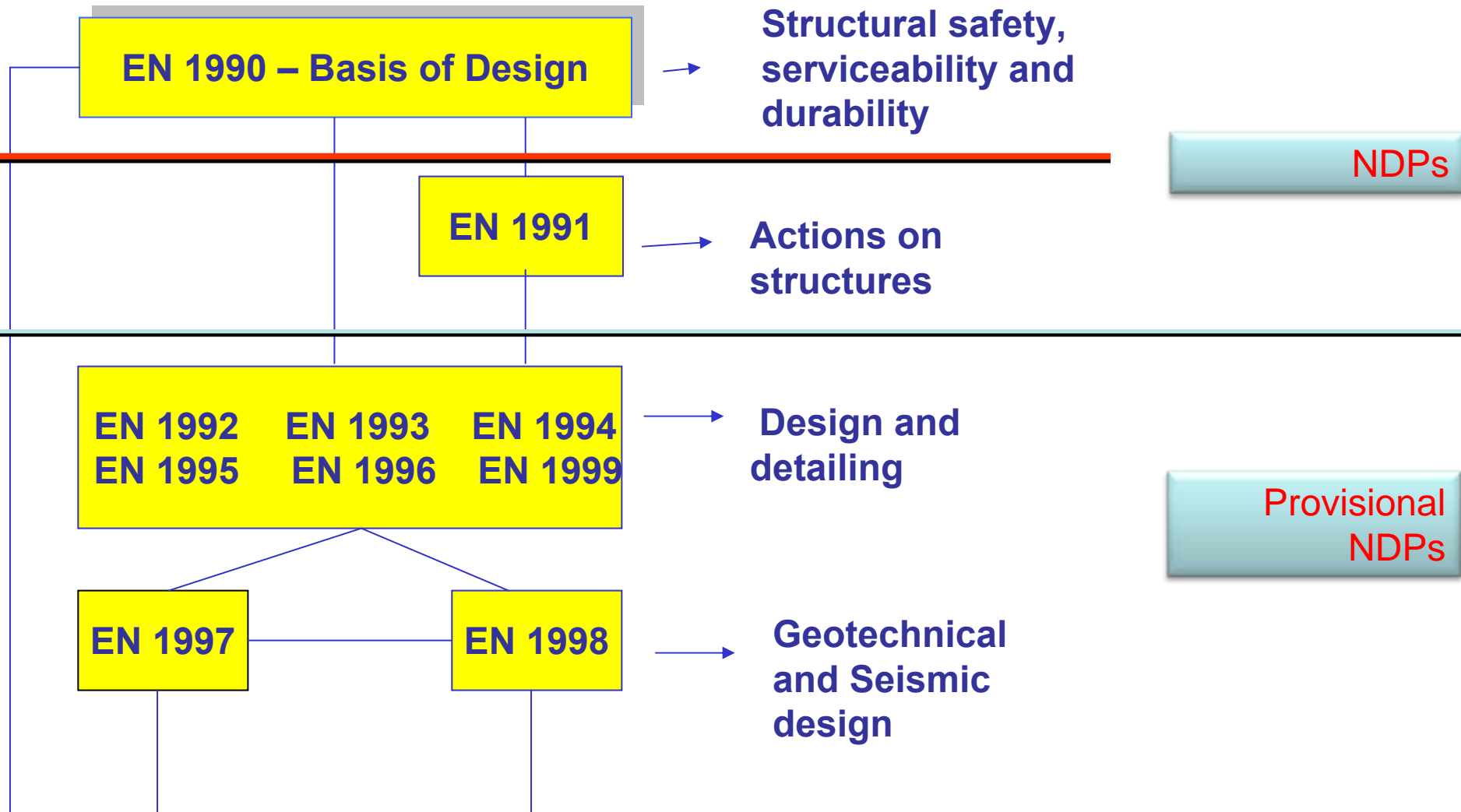
- European Standards (EN) for the design of buildings, construction works and products (58 Parts)
- Since **March 2010**: the only design standards in EU and EFTA (31 countries, > 500 million citizens)

EN 1990	Eurocode: Basis of structural design
EN 1991	Eurocode 1: Actions on structures
EN 1992	Eurocode 2: Design of concrete structures
EN 1993	Eurocode 3: Design of steel structures
EN 1994	Eurocode 4: Design of composite steel and concrete structures
EN 1995	Eurocode 5: Design of timber structures
EN 1996	Eurocode 6: Design of masonry structures
EN 1997	Eurocode 7: Geotechnical design
EN 1998	Eurocode 8: Design of structures for earthquake resistance
EN 1999	Eurocode 9: Design of aluminium structures

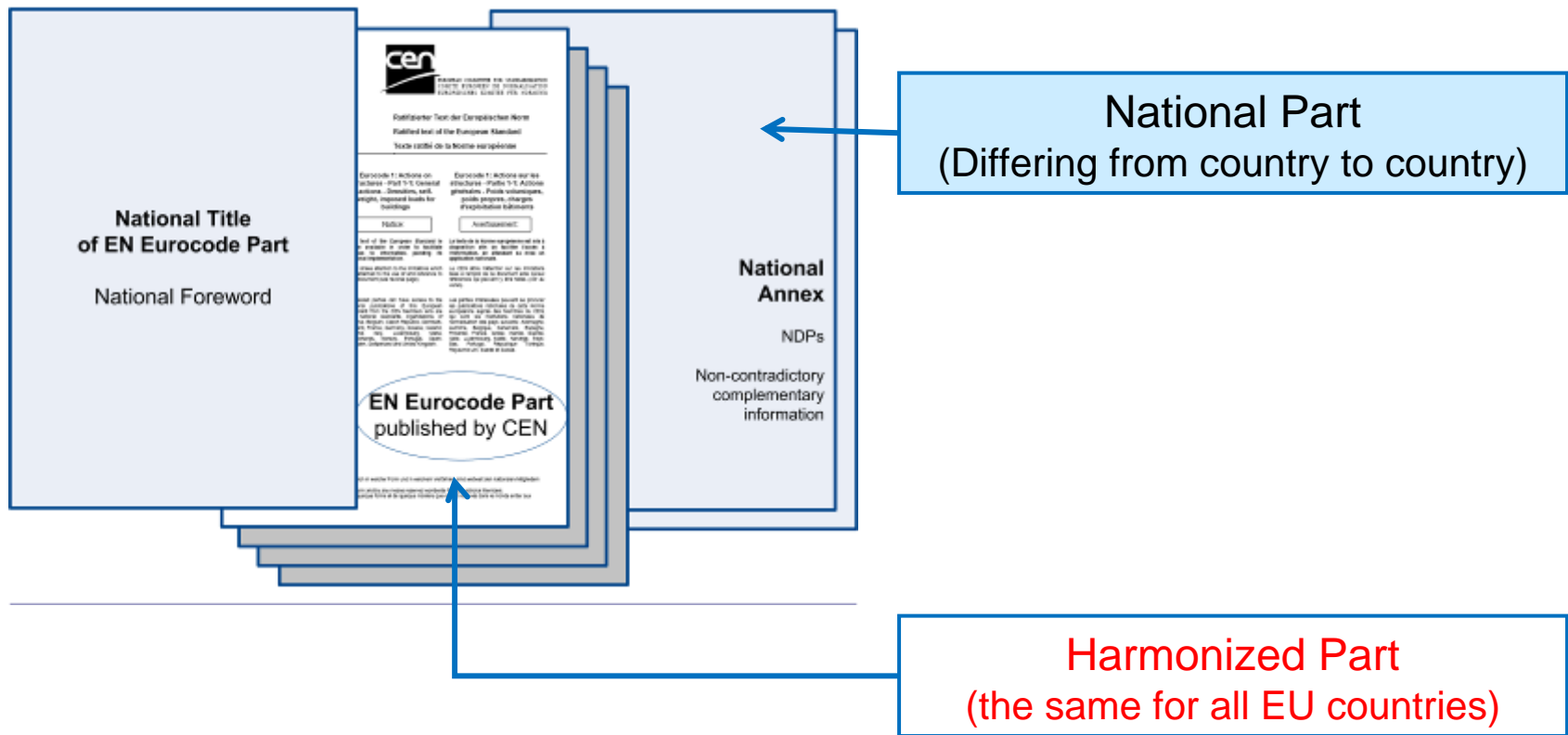
THE EN EUROCODES and the Nationally Determined Parameters (NDPs)

[...EUROPEAN STANDARDS (EN)...]

[..National Annexes..]



Country Standard Transposing a European Standard



BSI EN 1992

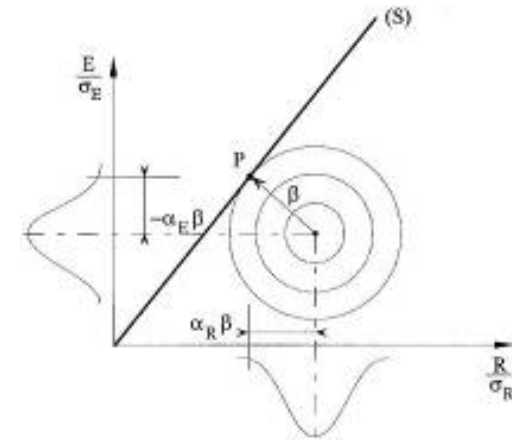
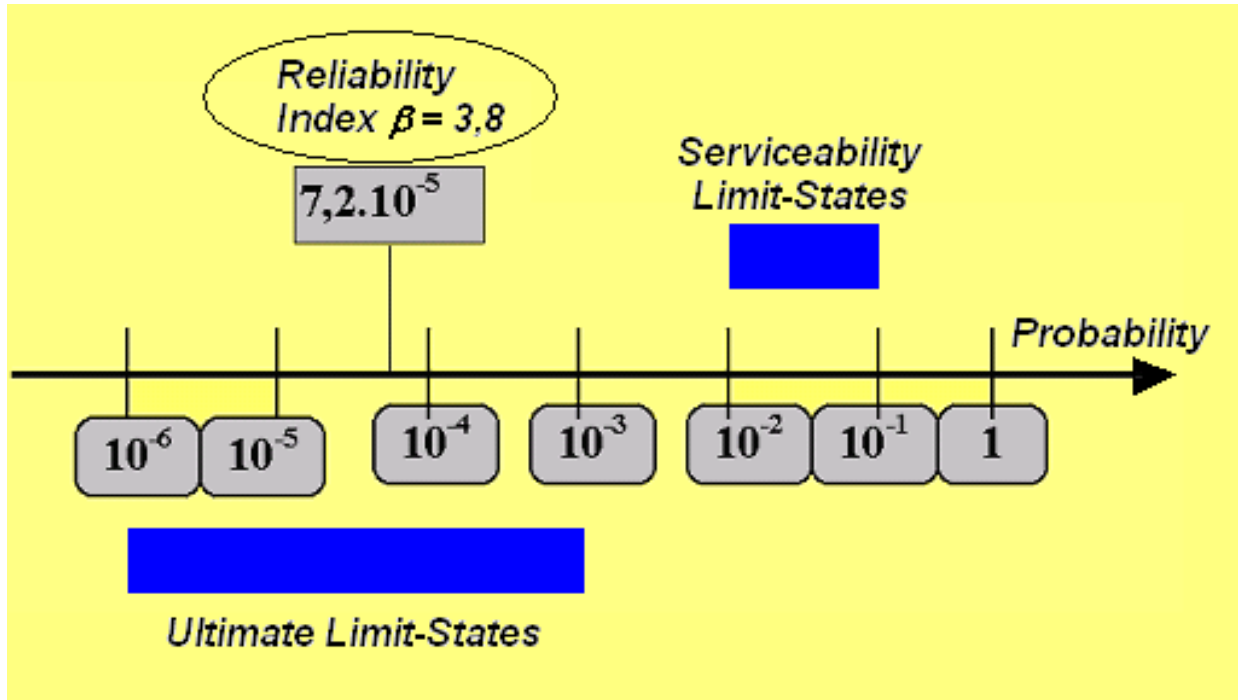
DIN EN 1992

AFNOR EN 1992

UNI EN 1992

PROBABILITY ASSOCIATED TO LIMIT STATES

Reliability Index ($\beta = ?$)

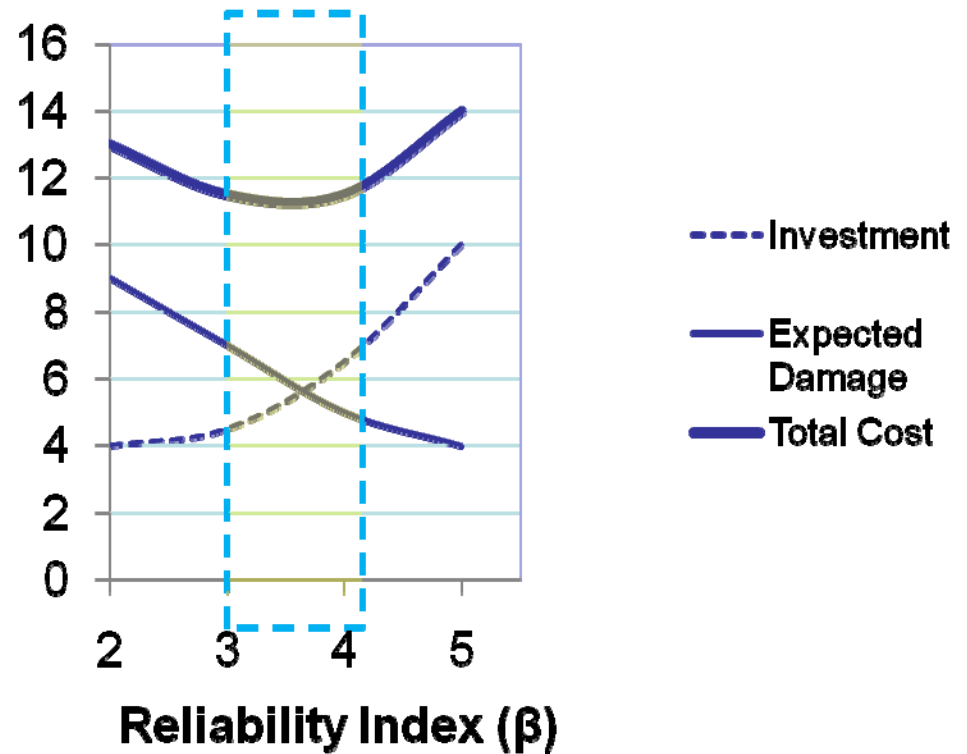


Indicative (Recommended) Values for Probability of failure in 50 years (ULS)

Average number of endangered people	Economical consequences		
	Low	Considerable	Very great
Low ($< 0,1$)	10^{-3}	10^{-4}	10^{-5}
Medium	10^{-4}	10^{-5}	10^{-6}
High (> 10)	10^{-5}	10^{-6}	10^{-7}

National Calibration for ULS

Cost





PROMOTION

- **Strategy for international promotion**
- EU-Russia regulatory dialogue
- TAIX workshops in Candidate countries, Potential Candidates and Neighbour countries



FURTHER DEVELOPMENT

- New **materials**: FRP, glass, ...
- New **fields of design**: robustness, existing structures, membrane structures, ...
- Increased protection against **fire** and **earthquakes**
- **Sustainability**: recyclability, durability, use of environmentally compatible materials



Standards Revision/ Upgrade

Calgaro: The European technical culture in Civil Engineering: the Eurocodes – Present and Future

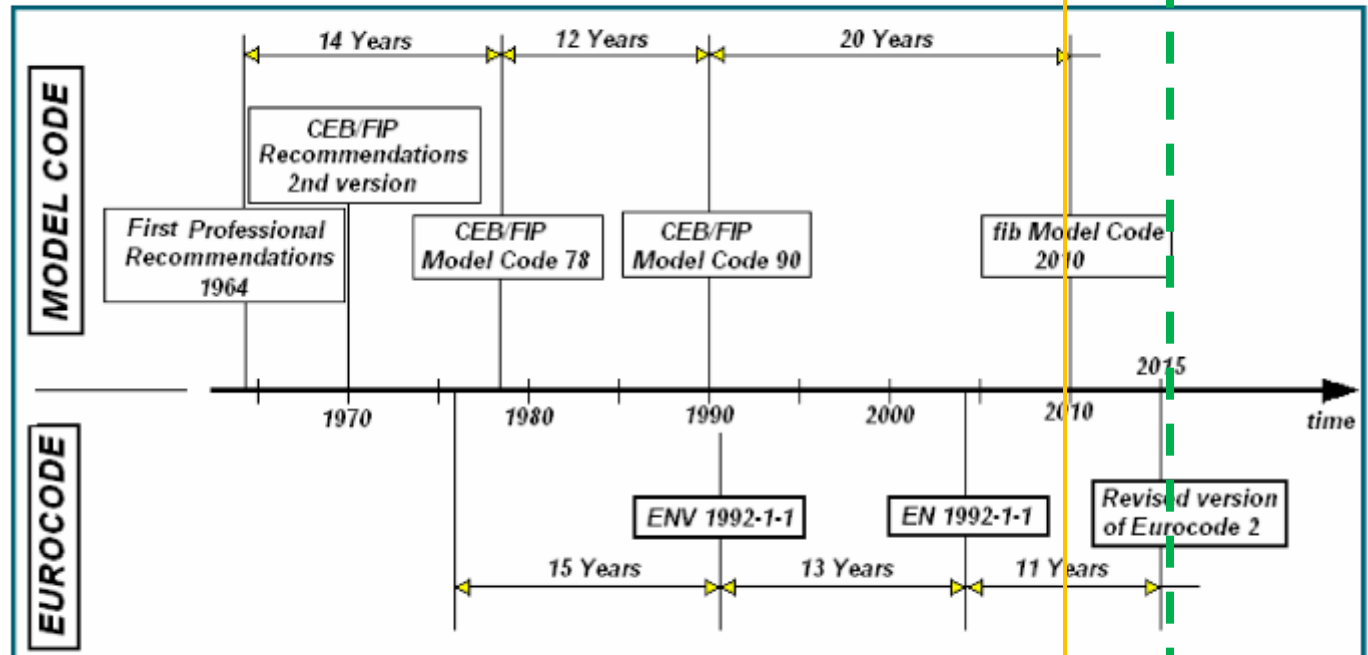


Figure 1: A brief history of the publication of some recent concrete Codes

Today

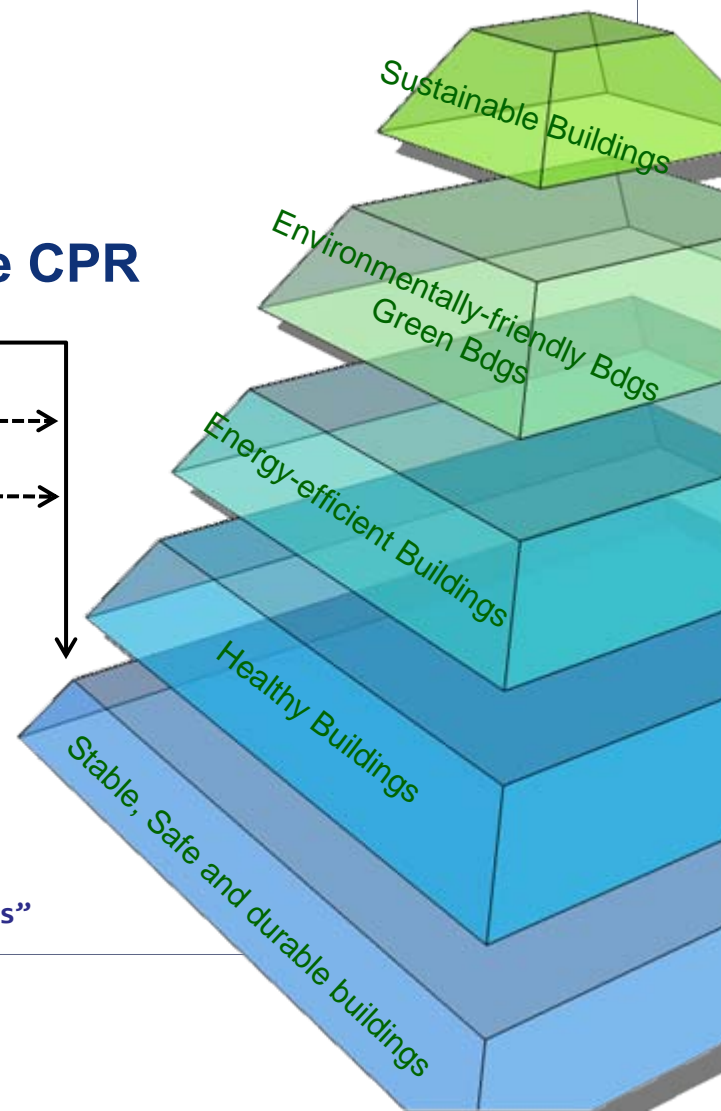
Tomorrow
W

Basic Works Requirements (BWRs) of the CPR

- BWR1 - MECHANICAL RESISTANCE AND STABILITY
- BWR2 - SAFETY IN CASE OF FIRE
- BWR3 - HYGIENE, HEALTH AND THE ENVIRONMENT
- BWR4 – SAFETY IN USE
- BWR5 – PROTECTION AGAINST NOISE
- BWR6 – ENERGY ECONOMY AND HEAT RETENTION
- BWR7 – SUSTAINABLE USE OF NATURAL RESOURCES

Goal:

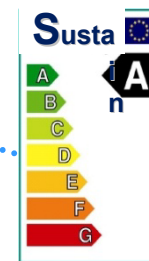
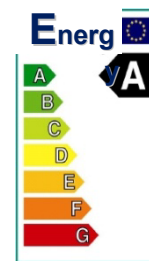
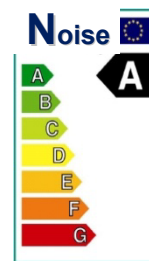
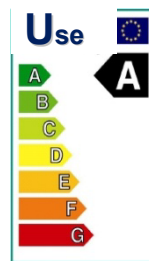
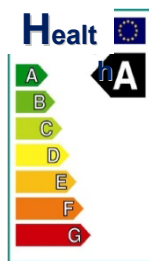
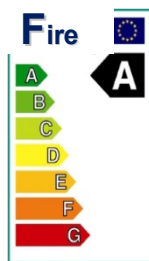
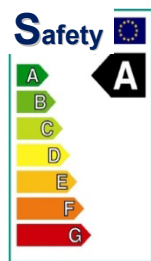
“A set of Interoperable European Standards addressing all BWRs”



Head-Standards

For each Basic Works Requirement:

- ✓ Basic principles
- ✓ Performance assessment methodology
- ✓ Minimum performance requirements
- ✓ Performance classes (**Labeling Buildings !!!**)



How to achieve it ?



Get together !





Increasing scientific cooperation

14th World Conference on Earthquake Engineering
October 12-17, 2008, Beijing, China



RECENT COLLABORATIVE RESEARCH ACTIVITIES BETWEEN EUROPE AND CHINA ON THE SEISMIC BEHAVIOUR OF PRECAST STRUCTURES

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ABSTRACT:

With the support from both European Commission and Chinese Government, a series of collaborative activities on the seismic behaviour of precast reinforced concrete structures have been carried out. The European Laboratory for Structural Assessment (ELSA), Joint Research Centre, European Commission, and the State Key Laboratory for Disaster Reduction in Civil Engineering (SKLDRCE), Tongji University, Shanghai, China. The seismic behaviour of this worldwide used structural system is discussed, based on the experimental activity. It is concluded that well-conceived and designed precast reinforced concrete structures have almost the same seismic capacities as the cast-in-situ reinforced concrete structures. Further ongoing activities are discussed.

KEYWORDS: Precast structures, testing, connections



Field investigation on the performance of building structures during the 12 May 2008 Wenchuan earthquake in China

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Codes in Structural Engineering Developments and Needs for International Practice

Joint IABSE – fib Conference

Dubrovnik, Croatia, May 3-5, 2010

Topic 1.2: Comparison of Codes

SEISMIC DESIGN OF RC BUILDINGS ACCORDING TO CHINESE STANDARDS AND EUROCODE 8

Georgios Tsionis *, Bin Zhao **, Fabio Taucer * & Artur Pinto *

* Joint Research Centre, European Laboratory for Structural Assessment, Ispra, Italy

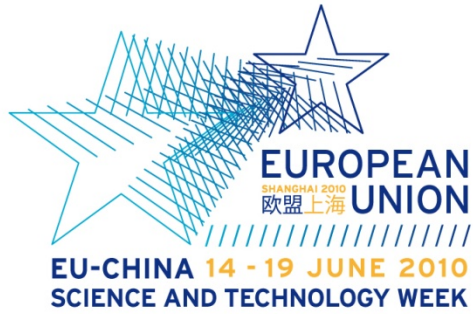
** Tongji University, State Key Laboratory for Disaster Reduction in Civil Engineering, Shanghai, China (formerly at Joint Research Centre)

EEFIT mission after Wenchuan earthquake (July 2008)

Increase
Scientific and
Technical
Cooperation



“Disaster Risk Mitigation and Response”



Thank you for your attention

<http://eurocodes.jrc.ec.europa.eu>

