Appendix 9

Section 9 *Safety Assessment for Earthquake Risk Reduction: An EU Research and Training Network*

presented by F. Taucer

Safety Assessment for Earthquake Risk Reduction: An EU Research and Training Network

Mid-Term Review Meeting
24 May 2002, JRC Ispra

Overview

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Reduction of Seismic Risk

Background PREC8 ICONS SAFERR Closure

Aims:

To mitigate seismic risk through European collaboration for:

- Training of young researchers Furthering research and development of innovative concepts
- Integration of earthquake geophysics, structural engineering, engineering seismology and geotechnical engineering
- Increasing awareness through outreach activities, training and education
- Introducing appropriate seismic provisions in traditional design and construction practices

Means:

- Research and training networks funded by the EC and national agencies
- Establishment of a permanent core European research and development group with experience in research and networking

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International Efforts

Background PREC8 ICONS SAFERR Closure

Centralised earthquake risk mitigation networks

USA

Four centres of excellence in earthquake engineering:

- NCEER, PEER, MAE, MCEER
- Formed by consortia of universities
- Funded by NSF, industry and/or State sources

Japan

Nationally-organised networks in earthquake engineering:

- Topic-specific and of short life-span
- Funded by government
- Recently adopted US model

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European Networks Philosophy

Background PREC8 ICONS SAFERR Closure

Topical philosophy:

Holistic approach to choice of research topics

- Consideration of Demand, Supply and their interaction
- Contribution from organisations with required expertise

Managerial philosophy:

Clear framework

- To maintain a balance between research development and training within networks
- Consideration of EC proposal requirements

Foresight and global framework

- To integrate the different networks towards the maintenance of a core European earthquake engineering community

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Prenormative Research in Support of Eurocode 8 (PREC8) – Co-ordinators : UPAVIA

Background → PREC8 → ICONS → SAFERR → Closure

Aims:

Furthering European earthquake engineering design

- Investigation of weaknesses in the pre-standard for EC8 using both experimental and analytical techniques
- Recommendations for Code revision

Areas of research:

Task 1	Task 2	Task 3	Task 4	Task 5
Seismic Behaviour of RC Frames	Infill Models & Effects on Response	Reinforcing Steel Properties	Seismic Behaviour of RC Bridges	Foundations & Retaining Structures

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Participation in PREC8

Background → PREC8 → ICONS → SAFERR → Closure

Institution	Responsible Scientist
1. University of Liege (B)	A.Plumier
2. Geodynamique et Structure (F)	A.Pecker
3. GRECO (F)	J.Mazars & J.M.Reynouard
4. Darmstadt University of Technology (D)	J.Woerner
5. University of Patras (GR)	M.N.Fardis
6. University of Basilicata (I)	M.Dolce
7. Politecnico di Milano (I)	E.Faccioli
8. Universita di Pavia (I) - Co-ordinator	G.M.Calvi
9. Universita di Roma "La Sapienza" (I)	P.E.Pinto
10. Universidad Politecnica de Madrid (E)	E.Alarcon
11. Imperial College (UK)	A.S.Elnashai
ECOEST I	
1. National Technical University of Athens (GR)	G.Gazetas & P.Carydis
2. ISMES, Bergamo (I)	M.Casirati
3. Joint Research Centre, Ispra (I)	A.V.Pinto
4. National Laboratory of Civil Engineering, Lisbon (PT)	E.C.Carvalho
5. University of Bristol (UK)	R.Severn

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Deliverables of PREC8

Background → PREC8 → ICONS → SAFERR → Closure

Title	Editor
Vol. 1: Standardisation of shaking tables	A.Crewe
Vol. 2: Seismic behaviour and design of foundations and retaining structures	E.Faccioli , R.Paolucci
Vol. 3: Large scale shaking tests of geotechnical structures	R.Severn , C.Taylor
Vol. 4: Experimental and numerical investigations on the seismic response of bridges and recommendations for code provisions	G.M.Calvi , P.E.Pinto
Vol. 5: Pseudo-dynamic and shaking table tests on RC bridges	A.V.Pinto
Vol. 6: Experimental and numerical investigations on the seismic response of RC infilled frames and recommendations for code provisions	M.N.Fardis
Vol. 7: Numerical investigations on the seismic response of RC frames designed in accordance with Eurocode 8	E.Carvalho , E.Coelho
Vol. 8: Shaking table tests of RC frames	
Vol. 9: European activities for the development of Eurocode 8	P.Carydis, T.Severn, G.M.Calvi

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Innovative Concepts in Seismic Design of New and Existing Structures (ICONS) - JRC

Background → PREC8 → ICONS → SAFERR → Closure

Aims:

- Advancement of existing knowledge and development of innovative techniques in earthquake engineering
- Provide a framework for training young researchers

Research topics and participants:

Task 1	Task 2	Task 3	Task 4	Task 5
Seismic Action	Assessment, Repair & Strengthening	Innovative Design Concepts	Composite Structures	Shear-wall Structures
GDS, POLIMI, UPAVIA, ICSTM	ULIEGE, GEO,TUD, UPATRAS,UPAVIA, UROMA, UMADRID, ICSTM	UPATRAS, GDS, POLIMI UPAVIA, GEO, UROMA	ULIEGE, TUD, UMADRID, ICSTM	GEO, UPATRAS, UROMA

ECOEST II – (LNEC, NTUA, JRC, ISMES, CEA, UBRISTOL)

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Large-Scale Testing – Walls and Dual Frame

Background PREC8 ICONS SAFERR Closure

- Shake table tests on selectively repaired walls (LNEC)
- PSD tests on dual frame-shear wall RC structure (JRC)

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ICONS - Achievements

Background PREC8 ICONS SAFERR Closure

- **Technical developments**
  - Displacement-based design and assessment methodologies
  - Displacement demand spectra
  - Selective repair techniques, guidelines for composite structures
- **High quality training of young researchers**
  - More than 50 YRs appointed for a total of 427 training-months
  - Exchange of researchers between institutions
  - YRs participation in 11th ECEE and 12th WCEE
- **Publications**
  - More than 40 publications, including scientific reports, journal and conference papers
  - Report series published jointly with ECOEST II
- **Industrial interest**
  - Awareness of earthquake risk-related problems raised
  - Industrial involvement in experimental programme

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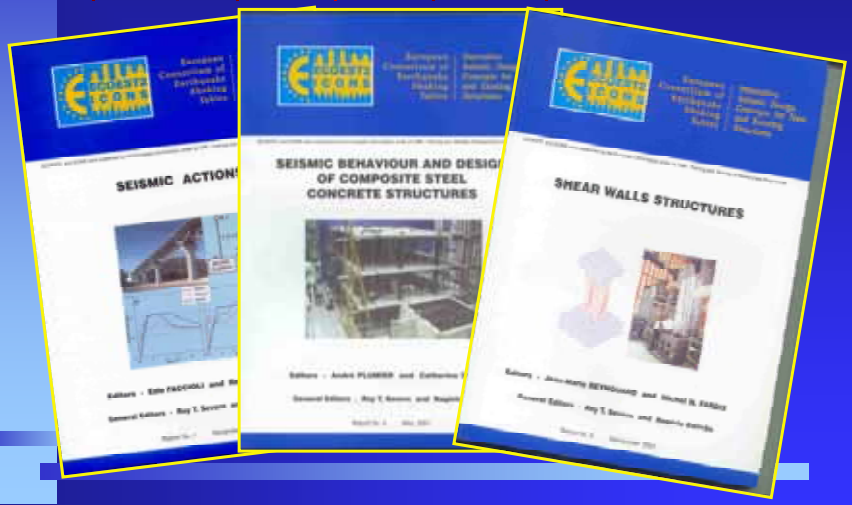
ICONS - Publications

Background → PREC8 → **ICONS** → SAFERR → Closure



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Safety Assessment for Earthquake Risk Reduction (SAFERR) – Coordinators ICSTM

Background → PREC8 → ICONS → **SAFERR** → Closure

Aim:

- Advancement, application & dissemination of seismic risk mitigation measures
- Combination of research with technical training of YRs
  - → Specialist equipment training
  - → Development of communication and management skills

Features:

- Greater participation
- Ambitious scope of research

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Research Topics and Participants

Background PREC8 ICONS SAFERR Closure

Coordinator ICSTM

Task 1	Task 2	Task 3	Task 4
Characterisation of Seismic Hazard	Assessment and Design for Low-Seismicity	Strategies for Risk Reduction	Risk Assessment Systems
GDS ICSTM, POLIMI, GEO, ULIEGE	ULIEGE ULJ, GEO, UKASSEL UROMA, UPATRAS	UROMA GEO, GDS, UKASSEL UPATRAS, UPAVIA UMADRID, ICSTM	ULJ UPATRAS ICSTM, POLIMI, UPAVIA, UMADRID

ECOLEADER – (LNEC, NTUA, JRC, ISMES, CEA, UBRISTOL)

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Partners

Background PREC8 ICONS SAFERR Closure

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Training of Young Researchers

Background → PREC8 → ICONS → SAFERR → Closure

Partner	Pre-Doc	Post-Doc	Total	To Date
1. ICSTM	26	4	30	20
2. POLIMI	24	3	27	17
3. LNEC	18	8	26	15
4. JRC	18	4	22	12
5. UROMA	24	12	36	24
6. UPATRAS	17	11	28	17
7. UPAVIA	20	10	30	18
8. GEO	0	24	24	16
9. UMADRID	25	3	28	12
10. ULIEGE	28	4	32	20
11. UKASSEL	30	0	30	0
12. GDS	19	8	27	15
13. ULJ	21	6	27	23
Total	270	97	367	209

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Non-SAFERR Researchers

Background → PREC8 → ICONS → SAFERR → Closure

Partner	Other Sources - Contract	Other Sources – To Date	No. of Researchers - Contract	No. of Researchers – To Date
1. ICSTM	36	22	7	8
2. POLIMI	27	12	6	6
3. LNEC	14	5	6	6
4. JRC	14	6	7	4
5. UROMA	46	22	7	7
6. UPATRAS	29	14	5	5
7. UPAVIA	30	5	6	6
8. GEO	18	8	5	5
9. UMADRID	34	15	8	5
10.ULIEGE	14	7	2	2
11.UKASSEL	38	0	7	0
12.GDS	13	4	4	3
13.ULJ	27	25	8	10
Total	340	145	78	67

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Training of Young Researchers

Background PREC8 ICONS SAFERR Closure

- Technical training
- Training in communications skills
- Management skills
- Training on specialist equipment
- Training through visits and secondments

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Technical Achievements

Background PREC8 ICONS SAFERR Closure

Achievements (T1):

- A simple procedure has been developed to account for vertical earthquake ground motion in seismic design codes. It is under consideration by the EC8 drafting panels and US guidelines committees. (T1 – S2)
- A robust formulation for extending available design spectra from three seconds to ten seconds has been developed and verified. The displacement spectra in the newest draft of EC8 are based on this work. (T1-S3)
- Important advancements on modelling the effect of geological features on the definition of hazard. The work is pioneering and will be further developed to derive simple and accurate methods to account for the effect of surface geology on ground motion and design spectra. (T1-S4)

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Technical Achievements

Background PREC8 ICONS SAFERR Closure

Achievements (T2):

- Non-seismically designed reinforced concrete and masonry structures have been extensively studied to establish quantitatively unintentional seismic resistance. This will lead to possibly exempting populations of structure in Europe from seismic design and great economies whilst retaining an acceptable level of safety. (T2-S1,2)
- Extensive experimental and analytical work has lead to new and verified guidance on the seismic resistance of large lightly reinforced concrete walls. This has had a direct effect on code provisions in France as well as the EC8 RC design chapters. (T2-S3)

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Technical Achievements

Background PREC8 ICONS SAFERR Closure

Achievements (T3):

- Isolation-dissipation systems for bridges have been comprehensively assessed leading to new insight into the conditions under which isolation-dissipation may not mitigate the expected damage. This work is most significant to the protection and development of the Pan-European road network. (T3-S1)
- The largest database of experimental observations on non-seismically detailed RC members available worldwide has been assembled. This provides a unique opportunity to accurately assess the seismic resistance of RC buildings not designed for seismic loading, which constitutes the majority of structures in Europe. (T3-S2)
- Novel analytical approaches have been developed to model repaired structures while taking into account the existing damage state and the specific behaviour of new repair member/material response, such as FRP and added RC walls. These developments lead to quantitatively-supported decisions on repair and strengthening of the existing built infrastructure. (T3-S3)

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Technical Achievements

Background PREC8 ICONS SAFERR Closure

Achievements (T3):

- Detailed modelling and analysis of a number of flat stab RC structures lead to the quantification of the level of seismic resistance of this important structural form. Noting that flat slab structures are widespread and are indeed the preferred form in many southern European countries, this is a most significant development. (T3-S4)
- Studies on long and short bridges subjected to coherent and incoherent motion have broken new ground and have yielded valuable information on the risk level to which these structures are subjected. Guidance on the additional risk to which bridges are subjected on short span (high speed train-type) has been derived. (T3-S5)
- Advances have been achieved in understanding the dynamic behaviour of inclined piles and pile groups. The extensive analytical results, obtained at this level of detail for the first time, are being simplified to arrive at code-type design expressions taking into account the inelastic structure and soil behaviour, as well as interaction effects. (T3-S6)

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Technical Achievements

Background PREC8 ICONS SAFERR Closure

Achievements (T4):

- A new method of mapping seismic risk using displacements has been developed, using a dual probabilistic-deterministic approach for intermediate and long periods. This is of great significance for the derivation of European hazard maps applicable to deformation-based seismic design. (T4-S1)
- Major advances in characterising fragility of RC buildings based on a very large observational database and experiments on full-scale structures have been made. Also, analytical fragility relationships for bridges have been derived. This allows the assessment of seismic damage before and after earthquakes and aid in decision-making and disaster mitigation planning. (T4-S2)
- A recently-developed integration procedure for hazard and vulnerability is being implemented and applied to a number of cities in Greece, including advanced fragility formulations and hazard definition. The potential significance of this work lies in its ability to make direct use of dynamic demand prediction whilst retaining practical applicability. (T4-S3)

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Publications

Background PREC8 ICONS SAFERR Closure

- Six papers authored by researchers from more than one SAFERR partner institution
- Thirteen papers from SAFERR work authored by researchers from one SFAERR partner institution
- Plans for ten papers in journals and international conferences from SAFERR work

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Dissemination and Publicity

Background PREC8 ICONS SAFERR Closure

- Publications – Papers and Reports
- Web Sites – SAFERR and Partners'
- Industrial Contacts
- International Contacts

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International Collaboration

Background → PREC8 → ICONS → SAFERR → Closure

- Joint MSc and PhD programmes for YRs with a number of international institutions
- Joint Workshop with MAE and GNDT – 23 May 2002
- Joint Coordination Group and Web Site
- Joint Research and Development
- Joint Conference in June 2003 – Erice, Italy
- Workshop with Japanese Researchers, May 2002

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Closure

Background → PREC8 → ICONS → SAFERR → Closure

- A coherent group of researchers with long experience and track record in seismic risk assessment and mitigation
- Established a system for delivery of both high quality training of young researchers and significant technical advancements towards earthquake risk reduction
- Training undertaken on a wide range of transferable skills in a multi-disciplinary environment combining engineering seismology, geotechnical and earthquake structural engineering
- SAFERR expertise recognised by European industry and academia

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