

# Short information on recent initiatives (Eol's) in Earthquake Engineering - Assessment of seismic risk of important civil structures

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## 1. Integrated Seismic Risk Assessment of Important Existing Civil Structures (ISRECS)

The proposed project is oriented towards priority thematic area 1.1.6.3/ Global Change and ecosystems/ natural disasters/ improved disaster preparedness and mitigation.

Much work in Earthquake Engineering was devoted to the improvement of earthquake resistant design of new structures. The European main effort into this direction is EC 8, which will be in several years the main seismic code for all European countries. But existing structures caused in many large earthquakes of the past the greater part of casualties and damages. **Hence, the assessment of the earthquake capacity of existing structures and prioritisation for retrofit will be a central task within the next decades (e.g. see resolution of the WS *Mitigation of Seismic Risk – Support to Recently Affected European Countries* in Belgrade/ Italy Nov. 2000, <http://elsa.jrc.it/workshop2000/>).**

This workshop was an initiative of the Joint Research Centre on the grounds of informal discussions between M. Papayannakis, MEP, and M. Busquin, Commissioner for Research, just after the Earthquakes that struck Turkey and Greece in 1999. The workshop was jointly organized by the Joint Research Centre, Safety in Structural Mechanics Unit and DG-Environment, Civil Protection Unit with collaboration from DG Research, DG Enterprise, the European Consortium of Earthquake Engineering Research Infrastructures and several European Associations, institutions and experts. Hence, in the resolution the way is pointed out, now we need initiatives to start the work!

The main goal of the proposed project is to build common strategies and to create "easy to use" analytical tools for assessing and redesign of important existing vulnerable and hazardous civil engineering systems to meet performance limits set for different levels of earthquakes. First, a building stock database consisting of vulnerable civil engineering systems from all participating countries will be established taking into account their environmental and social importance. Each of these structures will be assessed to a certain amount. It will be the first and most important step in the project to select a sufficiently large number of structures covering the most relevant structural types. Second, several structures will be investigated in a very detailed way, using also sophisticated experimental tests and integrated concepts for long term monitoring. At least one of the selected structures will be a bridge.

The objectives of the project are given in what follows:

Objective 1 is the elaboration of Guidelines for the practical application of "easy to use" tools. There is a need to provide information for the practitioners, concerning which degree of sophistication (of the models of excitation, structure+ foundation + subsoil and analysis procedure) is necessary in a certain case. Especially limits of applicability of certain simplifications have to be formulated. The Guidelines will be elaborated at the working step *interpretation of results* (see Fig. 1).

Objective 2: In order to achieve the main goal, performance limits for the class of important structures have to be agreed and established. Some basic ideas could be taken from VISION 2000 which is a study by SEAOC and the U.S. Federal Emergency Management Agency. It shows graphically a relationship developed between the performance objective, type of facility, and probability of earthquake occurrence. The method still needs to indicate what performance parameters to consider (drift, stress, plastic hinge rotation, acceleration, etc). and what limits are to be imposed to achieve a particular performance objective. Some information on performance parameters was provided in Vision 2000 for basically the first

time, but it was for the most part based on consensus rather than on test data or quantitative field observation. The performance limits will be elaborated from working steps *performance limits* and *interpretation of results* (see Fig. 1). Hence, the overall goal is a new performance –based design- and re-design approach.

Objective 3 is the elaboration of Guidelines for retrofit. Retrofitting covers the whole structure- foundation- subsoil system, e.g. liquefaction, lateral spreading, vertical displacements, etc can be the governing problem in a certain case. For some of the assessed structures also retrofit solutions will be elaborated. In each case several solutions (“classical” as well as “innovative”) will be studied: comparison of several variants of retrofit methods for certain structures; application of innovative energy dissipating devices, comparison between ductility concepts and capacity design.

Base isolation and other innovative energy dissipating devices are more and more used in areas of high seismicity outside of Europe. In Europe base isolation is mainly used for the retrofit of bridges. But nowadays also examples of solutions for buildings using dissipative devices appear slowly in Europe (e.g. Italy: headquarters of fire brigade, center of telecommunication, etc.). As far as reliability, the civil engineering field is very conservative and reluctant in adopting mechanical devices as the main protection line against earthquakes, especially for devices based on friction or composed of many “moving parts”. In this sense a strong effort in disseminating results is needed. Unfortunately the relevant codes do not allow the designers the application of these devices in an economical manner. But simple and/or clear guidelines on how to analyse structures protected by mechanical devices would encourage their adoption in seismic codes and therefore their use by the designer.

Objective 4: The building stock database of a sufficiently large number of structures from at least 10 European countries, which is necessary to achieve the *main goal*, will be used in addition for dissemination. There is a great need to provide examples of application for the practical engineers. Further, it will reflect the safety status of important building structures like schools, public buildings and important bridge structures in all participating countries. The *building stock database* will consist of a description of the objects, of modelling of excitation and structure, of the selected analysis method, of the applied performance limits and of the results.

Objective 5: For the investigations the appropriate models to describe the earthquake loading as a function of the performance objective and type of assessment method will be used. Hence, for some of the sites in different European countries, special earthquake time histories and response spectra, considering source, path and local effects will be calculated. Further, the project will enter into the so-called “Nonlinear seismology- the seismology of the XXI century”.

Objective 6 is the comparison of PSD tests versus shaking table tests. Such comparisons are very important, since both methods have their limitations. New methods of control and nonlinear substructuring techniques are now more or less available for both methods. Several buildings (number depending on complexity of the selected structures) will be investigated very detailed, using both experimental methods. Besides the direct use of the experimental result in order to achieve the *main goal*, advantages and disadvantages of both methods will be elaborated via direct comparison of the results.

Objective 7 is the elaboration of Guidelines for the assessment. Experimental in-situ methods are an essential part of the assessment procedure. A lot of experience on the methodologies and practical application will be collected during the project.

The workplan consists of 7 “vertical” tasks (WP 1 – WP 7), and 2 “horizontal” tasks (WP 8 – WP 9), see Fig. 1. The necessary working tools are provided in WP 1 – WP 6. They will be applied within the framework of the “horizontal” tasks. WP 7 covers dissemination, exploitation and training.

The horizontal tasks start with an assessment of the selected structures from all participating countries (WP 8). Later, several structures will be selected from the above building stock for very detailed investigations including also shaking table tests and PSD – tests (WP 9).

Many leading industrial and academic European research institutions have expressed their readiness and availability to cooperate within the project ISRECS. This means a

considerable integration of European researchers. There are some institutions from candidate countries, which means a further “level” of integration. Further, it will be necessary to disseminate the new ideas and results to the potential end- users. Before a broader application can start, the involved persons will also need “integration” provided by training.

In order to disseminate the ideas and results in the right way, the project will need new tools of Information Technologies for communication and visualization by electronic networking. There is need for new distributed databases and for linking with data bases from other projects (EU-MEDIN, SAMCO, etc.) from the very beginning.

The core of the consortium worked together very successfully during the years 1998 – 2001 in the VAB project (Advanced methods for assessing the seismic vulnerability of existing motorway bridges – ENV4-CT97-0574). Additional partners are welcome!

**Partner 1 (ARS)** arsenal research/ Vienna (A) has the role of the coordinator. The institution is active in Structural Dynamics and Earthquake Engineering. ARS has a very well developed in-situ test technique. Also the new reaction mass exciter VICTORIA will be used. Since many years it is the strategy of ARS to combine in-situ testing with FE modelling. ARS will act also as TL of WP 8.

**Partner 2 (AUT)** Aristotele University of Thessaloniki, Lab. Soil Mech. and Found. Eng. (EL) is active in many fields of Earthquake Engineering and specialized on soil dynamics and soil – structure – interaction. AUT will act as Sub TL 2.2. Further Structural Engineering from the same University is willing to participate. AUT will be also responsible for the selection of structures in Greece for WP 8.

**Partner 3 (BRI)** University of Bristol, EERC (UK) will mainly contribute by its large facility shaking table.

**Partner 4 (CIM)** Int. Center for Numerical Methods in Engineering (E) is the specialist for probabilistic approaches. CIM will consider the uncertainties of structural models and of the earthquake load. CIM will act as Sub – TL 2.6. CIM will be responsible for the selection of structures in Spain for WP 8. CIM was also partner in the VAB project.

**Partner 5 (CLS)** Central Laboratory for Seismic Mechanics and Earthquake Engineering/ Bulgarian Academy of Sciences (BG) is active in seismic hazard assessment and seismotectonics and will contribute to several WP’s. CLS will be also responsible for the selection of structures in Bulgaria for WP 8.

**Partner 6 (GKG)** Gerling – Konzern Globale Rückversicherungs AG (GER) is the enduser in the group. GKG is a reinsurance company interested in the development of simple but efficient assessment techniques. GLK will be responsible for the selection of structures in Germany. The firm operates world-wide, hence eventually further structures will be contributed by GKG.

**Partner 7 (ICTP)** The Abdus Salam International Centre for Theoretical Physics (INT) is the specialist for the earthquake input. ICTP generates deterministic time histories considering source, path and local site soil conditions. ICTP will act as TL of WP 4. ICTP was also partner in the VAB project.

**Partner 8 (ISM)** ENEL-HYDRO/ ISMES (I) is active in Structural Dynamics and Earthquake Engineering. ISM will be TL of WP 5. ISM has also a subcontractor, an industrial partner – ALGA – which is the producer of antiseismic bearings. ALGA will be active on “innovative” energy dissipating devices. In addition, ISM will be responsible for the selection of structures in Italy for WP 8. ISM was also partner in the VAB project.

**Partner 9 (JRC)** Joint Research Center ISPRA/ ELSA Lab (EU) is active in many fields of Earthquake Engineering and will mainly carry out the Pseudo - Dynamic Test. JRC will act as TL for WP 3. JRC was also partner in the VAB project.

**Partner 10 (NIE)** National Institute of Research and Development for Earth Physics (RO) is active in many fields of Earthquake Engineering and will contribute to several WP’s. Further, NIE will be responsible for the selection of structures in Romania for WP 8.

**Partner 11 (RWT)** Rheinisch – Westfälische Technische Hochschule AACHEN/ Baustatik und Baudynamik (GER) is active in Structural Dynamics and Earthquake Engineering. RWT will act as TL for WP 1.

**Partner 12 (TUB)** Slovenská Technická Univerzita, Stavebná Fakulta (SK) is active in Structural Dynamics and Earthquake Engineering and will contribute to several WP’s. Further, TUB will be responsible for the selection of structures in Slovakia for WP 8.

**Partner 13 (TUV)** Technische Universität Wien/ Ingenieurgeodäsie (A) is active in geodetic methods and will adapt optical methods for assessment applications useful for Earthquake Engineering.

**Partner 14 (UPO)** Faculdade de Engenharia da Universidade do Porto (P) is active in many fields of Earthquake Engineering and will contribute to several WP's. UPO is the specialist for nonlinear modelling and lifeline engineering and will act as TL of WP 2. Further, UPO will be responsible for the selection of structures in Portugal for WP 8. UPO was also partner in the VAB project.

**Partner 15 (VCE)** Vienna Consulting Engineers (A) is a consulting firm, which is active also in many overseas countries. VCE is no typical designer, but very open to innovative concepts. VCE is specialized in assessment and monitoring techniques. VCE will contribute to WP 3.1. Further, VCE will act as TL for WP 9. The coordinator of the EC network Structural Assessment, Monitoring and Control (SAMCO, G1RT-CT-2001-05040) is manager of VCE.

**Partner 16 (WOE)** WÖLFL Beratende Ing. GmbH u. Co (GER) is specialised in Structural Dynamics and Earthquake Engineering (measurements and calculations).

**International Collaboration** will be established to coordinate activities with the United States, Japan and China. It is further important to disseminate the results outside of Europe to open the way to business. The introduction of virtual institutes with other major laboratories or partners involved will be discussed. First information about ISRECS was sent to Prof. Ko/ Hongkong and Dr. Loh from Taiwan. Further, Dr. Chang/ NSF-US was contacted. The level of this internationalisation activities will be decided later.

**Roadmap:** Meeting of the consortium (at least of the core group) in autumn 2002. First, the group has to establish the criteria for the selection of the civil engineering systems, which should be assessed, taking into account their environmental and social importance for each single participating country. Further, weak points of the concept have to be identified and further partners will be invited in order to improve the "scientific and geographical distribution". There should be a close contact with all ongoing European research projects in the field of Earthquake Engineering from the very beginning.

## **2. Integration and Networking of Natural Disasters Studies in Europe (EU-MEDIN)**

This Eol was coordinated by A. Dusi/ Italy and was initiated during the meeting of the steering committee of EUMEDIN in May 2002 in Madrid. It seems that the idea is highly appreciated by DG research/ environmental program and that a call will follow.

Natural hazards share numerous similarities in terms of problem-solving, prevention, risk assessment, risk perception, modelling, mitigation, disaster planning and management.

The proposed **EU-MEDIN** project seeks to make major advances in the development of integrated approaches to disaster research mitigation and management. Integration will be sought in a number of ways:

- integration across hazard types;
- integration across research disciplines (natural sciences, engineering, psychosocial sciences, socio-economical sciences);
- integration between researchers and stakeholders in disaster management;
- integration across the research and disaster management communities in the European member states.

The IP proposal focuses on natural hazards that have a significant impact on Europe: floods, landslides, volcanoes, avalanches, forest fires, earthquakes and hurricane.

The purpose of EU-MEDIN is to develop, maintain and sustain a European infrastructure and network for integrated disaster studies and for the dissemination of disaster-related information to research and user communities, in order to improve disaster preparedness and early warning, communication, rapid exchange of data and knowledge. A series of integrated risk assessment and risks management research projects, which draw on the **multi-disciplinary and multi-hazard character of the proposal**, are a central and integrating part of the proposed activities. The project will seek not only to **generate new research results**, but also to **make the body of existing European disaster research** available and accessible to a wide range of stakeholders. This will be achieved by developing the appropriate Web services that enable stakeholders to draw on research

results from across hazard types and thematically in relation to the three main activity areas of **risk prevention and mitigation, crisis management, rehabilitation and learning from past disasters**. The goal is thus to **establish the major access point for disaster related information and research results in Europe**, which will capture both existing and new resources in a format that is accessible and self-sustaining in the long term. This will be a key resource for all disaster related projects funded under the 6<sup>th</sup> framework programme, providing a unifying reference point and dissemination structure for the full body of existing and future European research

**Fig. 1:** General concept, workpackages and goals of project ISRECS

