8 NUMARALI AVRUPA YÖNETMENLİĞİ, SİSMİK BÖLGELERDE İNŞAAT ÜZERİNE BİR ÇALIŞMA

A RESEARCH PROGRAMME FOR EUROCODE 8 - CONSTRUCTION IN SEISMIC ZONES

R T Severn[1]

ABSTRACT

A review is presented of current initiatives by the European Community in earthquake engineering which aims to bring European activity in this area to a focus. Such initiatives include studies to standardise the performance of large shaking tables, and programmes of research in five major fields in support of Eurocode 8 - Construction in Seismic Zones. Mention is also made of the new reaction-wall facility at JRC Ispra. European earthquake engineering involvement in the International Decade for Natural Disaster Reduction (IDNDR) is also discussed.

LARGE FACILITIES PROGRAMME

In 1989 the Commission of the European Communities (EC) called for bids under a "Plan to Facilitate Access to Large-Scale Scientific Facilities of European Interest". These facilities were for research in neutron beam sources, large magnet fields, hydraulics, combustion technologies, earthquake engineering, oceanography and high power lasers. In earthquake engineering an award was made to the LNEC in Lisbon to augment their existing facilities by a new, and much larger (5 x 5 m) three translational axis table particularly for testing concrete and masonry structures of up to 40 tonnes. The details of this new table were widely publicised [1] and attracted considerable criticism for what was regarded by some as a low-technology approach to the removal of the rotational motions; the argument here being that state-of-the-art technology demanded full servo hydraulic active control of the six table degrees of freedom. It was said that the passive torque-tube restraint proposed by LNEC would uncouple restraint ability in the vital frequency range of 10-20 Hz, whereas the then available control technology provided satisfactory performance for 5 x 5 m tables in the 0.60 Hz range. Such technology was in use on the LEE table (4 x 4 m) in Athens and the 3 x 3 m table in the EERC at Bristol.

---

[1] Prof, Earthquake Engineering Research Centre, University of Bristol, UK

Following limited approval of support for new or enhanced Large Scale Facilities of the kind just discussed, the EC realised that a review of actual need for such facilities was an important next step, allied to a consideration of European research needs in these areas. Study Panels of experts were, therefore, formed in each area with, broadly speaking, one expert from each of the Member States with participation by the JRC, Ispra. The present author was the UK representative. The Study Panel for earthquake engineering reported in December 1990 [2], arguing that research and advanced training in earthquake engineering should be considered as an important priority for the EC, not only for its own intrinsic value as a life-saving science, but also because it involves the highest level of expertise in computer science, electronic instrumentation, control systems, non-linear mechanics, digital signal processing and so on, all of which are bases for stimulating growth in European technology.

In most areas of earthquake engineering the greatest need experienced at EC level was co-ordination of activities and standardisation of procedures. After completion of the LNEC table in 1993, and the massive reaction-wall at JRC Ispra in 1992, it was considered that the level of provision of large facilities was adequate, but that co-operation between the different research organisations was neither satisfactory, nor at the same level as in the USA or Japan. Bearing in mind the enormous potential of a unified EC approach to the construction of earthquake resistant structures world-wide, there lay here the possibility of a real European influence. As a first practical step towards the fulfilment of this idea, the Panel proposed a validation of present competence in the usage of large shaking tables and reaction walls through a common attack on a well-defined, but realistic, earthquake engineering problem. What follows is a list of the Panel's research proposals.

1 The simulation of earthquakes by shaking tables and the production of required spectra.
2 The relative roles of reaction-walls and shaking tables in studying response to earthquakes.
3 A rational approach to the specification of test spectra for seismic validation of civil engineering and offshore structures and special systems such as nuclear and chemical plants, life-lines and telecommunications.
4 Harmonisation of Eurocode 8 with existing national codes, and comparison with United States, Japanese and N Zealand codes.
5 A study of over-design currently employed in secondary structures, including vibration transmission between primary and secondary structures.
6 Specific matters with regard to the short duration/high acceleration/low displacement earthquakes common in Europe.
7 Ductility assessment of non-seismically designed structures.

8 Compatibility of Eurocode 8 with other Eurocodes.
9 Development of a design method which incorporates different "behaviour factors" (an EC8 innovation) in various parts of the structure.
10 In foundation engineering, a study of the relative value of shaking tables, centrifuges and cyclic load testing.
11 Further studies of zonation in Europe.
12 Civil emergency systems.

It will be seen below that these recommendations were well-received.

ATHENS-BRISTOL SHAKING TABLE ASSESSMENT (ABSTA)

In making the first recommendation above, the Study Panel were well aware that a successful EC programme would be predicated on standardisation of performance of the shaking tables used, or, at least, knowledge of their respective performance characteristics. As a start in this direction, a collaborative study of shaking table peformance was formulated by Athens and Bristol, being made up of three parts:-

1 Table performance review under four conditions, no payload, rigid payload, one degree of freedom payload, and two degree of freedom payload. The review included:

(i) Table frequency response
(ii) Response spectrum fidelity
(iii) Time-history fidelity

2 Software review.
3 Operations review, to include quality assurance aspects.

In the performance review, the tests were to be performed for each of the six axes of motion separately, and six combinations of these which were considered to be the most important. The performance limits in each case would be measured. Such tests would indicate any resonances in the platform, mechanical and servo-hydraulic systems which need to be compensated for either during a seismic test or subsequently in the data-processing phase. They would also show how the shaking table interacts with the test specimen, a crucial issue in the interpretation of experimental data. An essential ability of any shaking table is accurately to reproduce required response spectra in any single, or combination of, translational degrees of freedom and this is covered by (ii) above. In (iii) above the need is recognised for the table to reproduce accurately required acceleration, velocity or displacement time-histories. This is the most arduous test to perform since table-specimen interaction is difficult to predict and compensate for, particularly if the specimen is failing and becoming non-linear.

The programme outlined above had to be curtailed due to lack of available funds, but it did begin with a reduced budget of 100k ecu in the Summer of 1992. Unexpected difficulties have been experienced in fabricating identical test models in two laboratories, but the initial phases of the programme have been accomplished.

HUMAN CAPITAL AND MOBILITY PROGRAMME

The Third Framework Programme of the EC, adopted in April 1990 for the period 1990/94 with a total budget of 5.7 billion ecu, has fifteen sections, one of which is described as Human Capital and Mobility (HCMP) whose budget for 1992 was 109 million ecu. The HCMP itself is split into four parts:

1 Research Fellowships
2 Scientific and Technical Co-operation Networks
3 Access to Large-Scale Scientific and Technical Facilities
4 Euroconferences

The two which concern us here are the second and third, and I will deal with them in this order. Eurocode 8 - Construction in Seismic Zones, has been under development for some time, during which a large number of issues have been raised which can only be resolved by research. Professor Pinto, Chairman of EC8 Committee, and his colleagues, therefore, proposed a detailed list of research requirements, which, after much discussion, were grouped into the five sections Reinforced Concrete Frames, Infills, Reinforcing Steels, Bridges and Foundations, each of which were submitted as a co-operative network under 2 above. All five have been approved at a reduced funding level of 950k ecu with 19 laboratories participating under the General Co-ordinator Professor Michele Calvi of Pavia University with subject sub-co-ordinators Professor Carvalho (Portugal) for reinforced concrete frames, Professor Fardis (Greece) for infills, Professor Calvi himself for bridges and Professor Faccioli (Italy) for foundations. The reinforcing steels activity has been incorporated into the other four as appropriate. The general principle of the HCMP is the movement of researchers between Member States, and consistent with this, 60% of allocated resources must be spent on the researchers themselves, for travel, subsistence and publication of results. In addition, any participating laboratory can only offer its facilities to researchers from other Member States.

Referring to 3 above, it is clear that the EC8 research just described within the Networks Programme will require access to major European shaking tables, and it was also stated that an Athens/Bristol link had already been formed for standardising shaking table performance within the HCMP (Section 3 above) this link was strengthened by the addition of LNEC Lisbon and ISMES Bergamo, the four laboratories forming the European Consortium of Earthquake Shaking Tables

(ECOEST), with an initial plan for implementing the 12-point programme referred to earlier. In the out-turn the funding allocated in December 1992 was restricted to 1200k ecu between the four laboratories, for the time being at least, resulting in a concentration on two aspects; a comparison of the performance of the four tables in carrying out common tasks (ie standardisation) and shaking table tests required within the EC8 Networks research programmes already described above. The rules for the Large Facilities part of the HCMP are similar to those for Networks; one exception being that only 40% of total allocation is to be spent on the researchers themselves, the other 60% on maintenance and enhancement of the facility itself.

A further contribution to EC research in earthquake engineering will be made through its own Joint Research Centre at Ispra in N Italy. Here, the new 21 x 16 x 4 m reaction-wall, inaugurated in November 1992, will carry out full-scale tests on building structures using the pseudo-dynamic test (PDT) approach, which, although carried out quasi-statically, uses on-line computer calculation and control, together with experimental measurement, to provide a realistic simulation of dynamic response. These reaction-wall tests on full size buildings will be integrated with the ECOEST shaking table tests on models. Neither of these two methods of testing for earthquake loads provides a perfect answer of course, and it will be valuable to compare and contrast the results which they produce. Similar remarks may be made relating to seismic effects on foundation and on structure/foundation interaction. Here, computation, shaking tables, centrifuges and cyclic load tests have complementary parts to play. In the UK, such a study has been ongoing for two years between the Universities of Bristol, Cambridge and Glasgow supported by the SERC, and this study will be integrated with the EC8 foundations research through Dr Taylor of Bristol.

A ROLE FOR TURKEY - IDNDR?

Earthquakes do not respect national boundaries, and earthquake engineers only do so when forced. There is mutual benefit to both Turkey and the European Community through collaboration in the research programmes described above, and mechanisms do exist for this, but which require a financial contribution from Turkey, or any other non-EC country.

An alternative point of contact for Turkey with EC earthquake engineering issues might be through activities associated with the International Decade for Natural Disaster Reduction (IDNDR). The very last paragraph of the Bogazici University report to the Erzincan earthquake contains the following:-

"As far as the damage to building structures are concerned, the main underlying factor appears to be the ignorance and/or indifference of the designers, contractors and the controllers to the existing earthquake resistant design code.

Although there exists a mandatory earthquake resistant design code for at least half a century, there are still questions regarding its application and enforcement. The problem that needs to be addressed should not be the mode and means of enforcement of the code but rather the establishment of compulsory earthquake insurance, professional consultancy and a system to control practice".

This is the sort of sentiment which has been repeated world-wide after major earthquakes, and it is one of the themes which the Science and Technology Committee (STC) of IDNDR, based in Geneva, are promoting for study. The STC operates through international bodies, such as the International Council for Scientific Unions (ICSU) in Science, and the World Federation of Engineering Organisations (WFEO) in engineering, and it has asked these two bodies to promote studies in a number of topics. Of course, neither ICSU nor WFEO have any prescriptive right over what any member of the UN wishes to do, but clearly such international bodies have a role to play. In Engineering, WFEO have established a work-centre in Paris, and another at the Institution of Civil Engineers in London, and at the latter two IDNDR studies have recently been started, one on the instability of megacities and the other, which concerns us here, on the design, construction and management of buildings and other structures to withstand extreme natural events. The Overseas Development Administration of the UK government have agreed to fund both studies. From the WFEO viewpoint, it is hoped that a number of the more affluent UN-members will do likewise, and that studies can be made of all major areas where wind storms and earthquakes are prevalent. In particular, the UK-based group would naturally turn to collaboration with the Turkish IDNDR Committee, if this was welcomed, for a study of precisely those issues which are quoted above from the Erzincan report, and which may be summarised as "Quality Assurance in Seismic Design and Construction". A UN/IDNDR Conference is to be held in Tokyo in September 1994 to review progress on all the Scientific and engineering issues being promoted by the STC.

REFERENCES

1 Commission of the European Communities, Large Installations Plan. (1989-1992). Report of the Study Panels, Dec 1990, DGXII-H-1.

2 The New LNEC Shaking Table for Earthquake Resistance Testing by Messrs Emilio, Duarte, Carvalho, Olivereira-costa, Vaz and Ritto Carrea, Memories No 757, LNEC, Lisbon, 1989.

8 NUMARALI AVRUPA YÖNETMELİĞİ -SİSMİK BÖLGELERDE İNŞAAT ÜZERİNE BİR ARAŞTIRMA-

R.T. SEVERN

Bu çalışmada Avrupa Topluluğu'nca gerçekleştirilen ve deprem mühendisliği alanında Avrupa'daki girişimleri toplamaya yönelik güncel çabalar gözden geçirilerek sunulmaktadır. Bu çabalar içinde, büyük sarsma tablalarının işlerliğinin standartlaştırılması ve Eurocode 8' - Deprem Bölgelerinde İnşaat - destekleyecek beş ana konudaki araştırma programlarının düzenlenmesi konuları bulunmaktadır. Yine bu çalışmada FRC Ispra'daki yeni yatay reaksiyon duvarı olanaklarından ve Avrupa Deprem Mühendisliğinin, Uluslararası Doğal Afetlerdeki Zararı Azaltma Onyılı (IDNDR) ile ilgili ilişkileri üzerinde durulmaktadır.