

Special theme session: Use of historical data for the evaluation of earthquake risk

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ABSTRACT: The main outcome of the session - introduction and short summaries of the presentations - is presented.

Introduction

The idea of a Special Theme Session on the use of historical data for the evaluation of earthquake risk was suggested to the organizers of the X WCEE by the increasing interest in the retrieval of historical data on earthquakes, which is developing since about fifteen years. Engineers can be interested in historical data as users of catalogues, isoseismal maps and so on, but they also contribute to the interpretation of historical records in terms of classification of damage.

In order to organize the session a questionnaire, covering suggested topics to be discussed, was circulated among two groups of experts: those who were known to use historical data, and those who had sent papers to the X WCEE, the abstracts of which showed subjects useful for the session itself. The answers, about 30, oriented the goals as follows:

- to explore the potential of historical data with respect to engineering purposes;
- to discuss the new arrangement of building typologies in the 1992 version of MSK intensity scale, with special reference to masonry buildings;
- to investigate new developments in the use of macroseismic data.

The session was divided into two parts, was attended by about 30 people and consisted in about 10 short presentations, followed by discussion. It was decided that the Proceedings of the session would consist in a general summary, to which short papers condensing the presentations would be attached.

Part I: The potential of historical records

M. Stucchi (Milano) introduced the session pointing out the topics to be discussed. The first one was to explore the potential of historical records: what they are, how they are processed, which are the weak points in the interpretation currently performed by seismologists, how they can be used by engineers other than in terms of intensity, isoseismal maps, and so on. The problems connected with the interpretation of historical records, mainly with respect to building types and damage assessment, were introduced.

M. Bruneau (Ottawa) discussed the way historical

records can be used for the evaluation of earthquake risk in a structural engineering perspective, whose prime objective is the acquisition of knowledge capable of explaining why some unreinforced masonry buildings have surprisingly survived major earthquakes. According to the author, isoseismal maps available in Northern America are of little use to the structural engineer concerned with the performance of unreinforced masonry buildings. Photographic documentation is the most useful, as written accounts by non-technical reporters are generally inaccurate.

E. Karaesmen (Ankara) presented some examples of Middle East monuments damaged by past earthquakes; he suggested the possibility to reconstruct the effects of historical events analyzing historical buildings from an engineering point of view and studying the respective histories. The available written sources on the history of monuments and the identification of some characteristic failures, reconstructions, etc., likely caused by earthquakes, may help in the identification of ancient earthquakes which hit the building, as well as to estimate the behaviour of the monument for a specific severity of the vibratory ground motion.

M. Espinosa Moreno and J. Quesada Gómez (Granada) stressed the importance of historical methods for the historical investigation of earthquakes. They also underlined that data on buildings dimensions, materials, constructive methods, foundations can be retrieved in most countries with such a detail to allow the construction of models to test their physical properties.

S.K. Thakkar (Roorkee) presented selected cases of Indian historical monuments damaged by earthquakes. He stressed the importance of techniques of engineering constructions and shape of the structures, as relevant elements for the occurrence of specific typologies of damage. As a consequence, a valuable source of information can be identified in the existing written materials on reconstruction in repairing damage caused by the quakes in important buildings, as well as in the description of felt effects in the chronicles of monastery, etc. To prolongate backwards the seismic history of a region, the Indian experience on archaeological data (excavation reports, etc.) suggests also a more systematic use of these data.

Part 2: Macroseismic intensity scales (improvement and calibration), alternative use

Opening the second part of the session, *M. Stucchi* discussed how historical data are processed in terms of macroseismic intensity and presented some issues of the Working Group on "Macroseismic Scales" (chairman: G. Grünthal, Potsdam) of the European Seismological Commission (ESC), which is currently preparing the up-dated version (MSK-92) of the MSK intensity scale. One of the main achievements of the Working Group, the new arrangement of building types in a general typologies/vulnerability table, needs further calibration and seems to be a good occasion for collaboration among engineers, seismologists and also historians.

J. Schwarz (Weimar) reported about some engineering aspects of the up-dated version of MSK-scale and the serious problems arising from the classification of engineered structures following the well-known principles of the previous scales. He stressed that the introduction of vulnerability classes was a necessary decision to overcome the formal contradictions in handling the so-called non-engineered and engineered structures. The vulnerability table presented in the session has to be regarded as an attempt to indicate the scatter of vulnerability of one (global described) building type. The user of the up-dated scale has to estimate and select the vulnerability class in dependence on quality (strength of material and workmanship) and level of regularity of the sample of a building type. The vulnerability table itself is intended to further improvements (inclusion of other building types, specification of types given in the table with respect to load-bearing elements) and should be revised according to available observations. With the selection of the vulnerability class of the building type a better correspondence between results of statistical investigations and definitions of previous version of the macroseismic scale should be achieved. With respect to the antiseismic design (ASD), *J. Schwarz* emphasised that it would be impossible to introduce antiseismic (engineered) structures into the up-dated macroseismic scale without providing supplementary information. Therefore, an annex on engineered structures will be added to the scale. It should be noticed that the discussion about the engineered structures lead to the conclusion that any separation from the so-called non-engineered structures should be avoided.

D. Liberatore (Potenza) summarized some results of the investigation performed by an Italian team on the **results of damage surveys to buildings after some Italian earthquakes**, showing important discrepancies with respect to MSK-81 intensity scale. He then stressed the need for improving the definitions of the building types, evidencing that the type of horizontal structure plays a key role in seismic behaviour. Finally he underlined the importance of considering r.c. buildings with anti-seismic design in the frame of the MSK scale in order to establish more reliable relations between ground shaking parameters and damage.

A. Pomoni (Cambridge) pointed out the importance

of investigation on ground motion's damage potential for improving risk assessment. He presented some recent studies in which previous earthquake damage surveys have been used to calibrate a damage severity scale called PSI. This scale, continuous in terms of damage effects, is based on a damage database of about 70.000 buildings. In the mean time the scale has been also calibrated to ground motion by assembling a database of 15 damage surveys (2.300 buildings) in the vicinity (max 400 m.) of the recording accelerometer stations. According to the speaker, further advantages arising from the study are the possibility to investigate the usefulness of various strong motion parameters and to propose vulnerability function for different types of buildings, strictly correlated to each other.

A. Baratta (Napoli) discussed the application of probabilistic methods to the evaluation of seismic risk at urban level. These methods consider several parameters, like exposed structures and human lives, expected injured and homeless people, expected damage to life-lines, etc. Such models require calibration against existing data to avoid misinterpretation and incorrect results.

Further contributions were handled by *E. Esposito et al. (Napoli)* and *A. Moroni (Milano)*, and are also annexed. It was also evidenced that some papers presented at other sessions of the X WCEE, included in the Proceedings, had a strong link with the theme of this Session, such as for instance the one by *C. Margottini (Roma)* on the uncertainties of historical data and their effects in seismic hazard assessment.

Conclusions

Presentations and comments developed during the session may lead mainly to the following considerations:

- the historical study of earthquakes cannot be separated by the collection of comprehensive information on the historical context;
- the increasing use of computer equipments is leading to a mathematical use of intensity in very complex procedures in which this parameter is losing its original concept;
- new attempts are in progress for alternative uses of historical records; these include instrumental calibration of macroseismic scale and direct use of damage for the reconstruction of the ground motion.

In practice, it seems that the direct use of damage descriptions, provided that they are calibrated by careful historical investigations, may lower the uncertainties due to the interpretation of historical data in term of intensity. The dark side is that investigators have to go back to historical sources and re-consider the records in a new way, what certainly will require years of studies and research.