INSTRUMENT ARRAYS FOR A NEAR FIELD STRONG MOTION EARTHQUAKE SURVEY IN ITALY

S. POLINARI

SYNOPSIS

The antiseismic design of special buildings and facilities, such as dams, nuclear plants, chemical manufactures, large bridges etc, requires information on the high intensity ground motions near the earthquake epicenters. But most of data and records, collected so far, are inadequate for a reliable definition of the design ground motion characteristics, so that the maximum consequences induced by earthquakes can not be properly predicted. Purpose of this note is presenting a research program directed to obtain more adequate information within few decades.

In Italy a project is under consideration to install closely meshed instrumental networks on five areas where destructive earthquakes were experienced. In order to obtain a sufficient number of near field records in a short time, other countries ought to follow similar programs: in the case of such a choice the overall probability of recording would be significantly incremented.

INTRODUCTION

The protection of life and property against the effects of high intensity natural events requires the maximum effort to minimize risks that their occurrence implies.

The recent fast progress of the technological society does involve considerable interaction with environment, but the understanding of natural phenomena and their mechanism of being has not been characterized by an equally fast development. In the beginning, the scientific community produce data and results of studies and investigations which could not be used for social needs and new technological exigencies. Up to now, the main critical remark is that data and results have been directed mainly toward general descriptions of natural phenomena and evaluations of the order of magnitudes of the component

---

Italian National Commette for Nuclear Energy
P.O.Box 2400
00100 Rome, Italy

quantities.

On the contrary the design of technological structures requires the most complete scenario according to which natural events manifest themselves.

Furthermore, special buildings and facilities such as dams, large bridges, chemical manufactures, nuclear power plants - potentially more dangerous than other industrial installations - require significant levels of safety and protection.

Consequently, it is necessary that industrial corporations engaged in design, construction and management of such systems as well as governmental agencies responsible for protection of populations and environment, sponsor and carry out research and studies on exceptional natural events.

In particular the antiseismic design of mentioned social systems requires a better understanding of the nature of ground motion they may be expected to experience during a lifetime.

This understanding demands full description of the earthquake source mechanism, wave propagation characteristics and local soil conditions. This can ultimately come only by analyzing the records from strong ground motion.

DESIGN OF THE ARRAYS

At present, most high seismicity regions in the world are monitored by instrumental networks formed by a number of sensors uniformly spread in the concerned areas. But most of data and records collected so far are inadequate for a reliable definition of the design ground motion features, so that the maximum consequences induced by earthquakes can not properly predicted.

More realistic information may be gained only from dense arrays of instruments installed in the near field region of strong earthquakes.

This goal cannot be reached by simply increasing the number of instruments in the existing networks. Unsustainable costs and difficult managing problems prevent practical implementation of any program.

In Italy the National Commette for Nuclear Energy (CNEN) and the National Electricity Board (ENEL) set up a Joint Commission for analysis and studies of problems of seismic nature associated with the installation of nuclear facilities (CEJC). In the frame of this Commission, a network of more than 200 accelerograph instruments, extending over the whole Italian territory, has been positioned in 1974 by ENEL who manages also operation snd maintenance.

A project to install closely meshed instrumental arrays is now under consideration of CEJC in five areas where destructive earthquakes were experienced.

One of the purposes of this project is to overcome the lack of knowledge about the behaviour of soil and structures during a near strong hearthquake. Presently the theme of safety, for the protection of nuclear power plants against accidents caused by

strong earthquakes, is treated via a cautious methodology: this points out that the determination of reference ground motion be achieved through extremely conservative hypothesis.

The whole Italian area affected by historical seismicity of intensity X M.C.S. is approximately 22500 sq Km. Arrays will be installed in five sites located near Benevento; Cascia-Norcia, Scilla-Soriano, S. Sepolcro-Citta' di Castello and Pizzo Calabro. These networks will cover 4500 sq Km that constitute only the 20% of Italian seismic area, but they are responsible of 50 % of the high historical seismicity. It has been estimated that 200 strong motion accelerographs would be sufficient to give meaningful near field records within a decade. It comes out that from the statistical analysis of the time distribution of the Italian historical earthquakes, the probability of recording near field a destructive event in the next five years is about 25%.

SEISMOTECTONIC STUDIES

The selected sites are located (see fig.1) in the Central and Southern part of the Italian peninsula. The geotectonics is various and complex. Generally speaking, the area consists of a number of distinct compressional structures with reverse faulting with a dip slip faults motion accompanied by shortening and recent uplifting of the ground. For example an Eutyrrhenian deposit, with strombus, 120 thousand years old, located near Scilla, is uplifted about 120 meters above the actual sea level.

While the general tectonic style is evident, the deep seismogenetic tectonic structures, generating the strongest earthquakes, can not be easily recognized and delimited. This is due to the presence of some thousand meters thick overthrusted allectonous materials and the general complexity of geology. Other studies must therefore supply information needed for optimum instrument deployment. A careful analysis of the actual seismicity is being carried out. Data are available from the pre-existing seismic instrument networks - as for the areas of Scilla-Soriano and Pizzo Calabro - and from a network of 10 radiolinked seismometric instruments installed on purpose in the area of Benevento.

Isoseismic maps, along with neotectonic data, supply also very useful information. For this purpose, in several zones, geomorphologic paleogeographic and neotectonic research is carried out together with a more accurate - with respect to traditional standards used up to now - drawing up of the seismic catalogues and of the isoseismic maps.

COMPLEMENTARY NETWORKS

The five dense arrays of strong motion instruments deployed within the near field region of strong earthquakes are

supplemented with mobile stations to acquire data after the occurrence of high intensity earthquakes. The mobile stations will be installed with the scope of providing data useful for the study of local factors - as topography and soil features - as well as problems of engineering interest - as soil-structure interaction and soil liquefaction -. A detailed plan of installation of the mobile stations has been developed. The plan has been tested with success during the 1976 Friuli and the 1979 Norcia earthquakes.

Data from the near-field arrays will be completed by those recorded by the national network. The whole set of data will permit also significant path effect studies.

SUMMARY AND CONCLUSIONS

The realization of the Italian project will be an important implement for a better understanding of the nature of the ground motion but the probability of recording the destructive earthquake in the five areas within the 1985, is only 25%. It results that, if a larger number of instrumented areas is considered, the installing and operating costs would increase tremendously with respect to the increase of the recording probability. In this respect, the cost of the CNEN-ENEL project may be considered adequate to the necessity of obtaining near field records of destructive earthquakes within the near future. In order to obtain an adequate number of near field records in a short time, other countries ought to follow the same program of installing similar networks inside restricted and properly selected areas, so that the overall probability becomes significantly incremented. Partecipation and cooperation on the matter is desirable in order to make practical results available as soon as possible.

ACKNOWLEDGEMENT

The author refers about a project that has been established in the frame of the CNEN-ENEL Joint Commission. With the author partecipated to the project: P. Berardi, A. Berenzi, R. Cervellati, E. Jaccarino, G. Magri and C. Zaffiro.

REFERENCES

HUDSON, D.E., ed., Proc. Indo-U.S. Workshop on Natural Disaster (Earthquake and Wind) Mitigation Research (New Delhi, India, Dec. 1978), California Institute of Technology, Pasadena 1979.

IACCARINO, E. and C. ZAFFIRO, Studies on a network of strong motion accelerographs to be installed in Italy, Proc Fifth World Conference on Earthquake Engineering, Rome, 1974.

IACCARINO, E., G. MAGRI, M. MITTEMPERGHER, F. MUZZI, S. POLINARI and C. ZAFFIRO, Experience in the Field of Nuclear Safety Applicable in the Defence of Society and of the Environment from Natural Events, International Conference of Experts on the Defence of Society from Natural Calamities in the Mediterrenian Basin, Republic of San Marino, October 9-12 1979.

IWAN, W.D., ed., Proc. International Workshop on Strong-Motion Earthquake Instrument arrays (Honolulu, Hawaii, May 1978), California Institute of Technology, Pasadena, 1978.

MATTHIESEN, R.B., Planning and Design of Strong-Motion Instrument Networks, Wind and Seismic Effects; Proc. Eighth UJNR Conf., NBS, Dept. of Comm. Spec. Pub. 477, 1978.

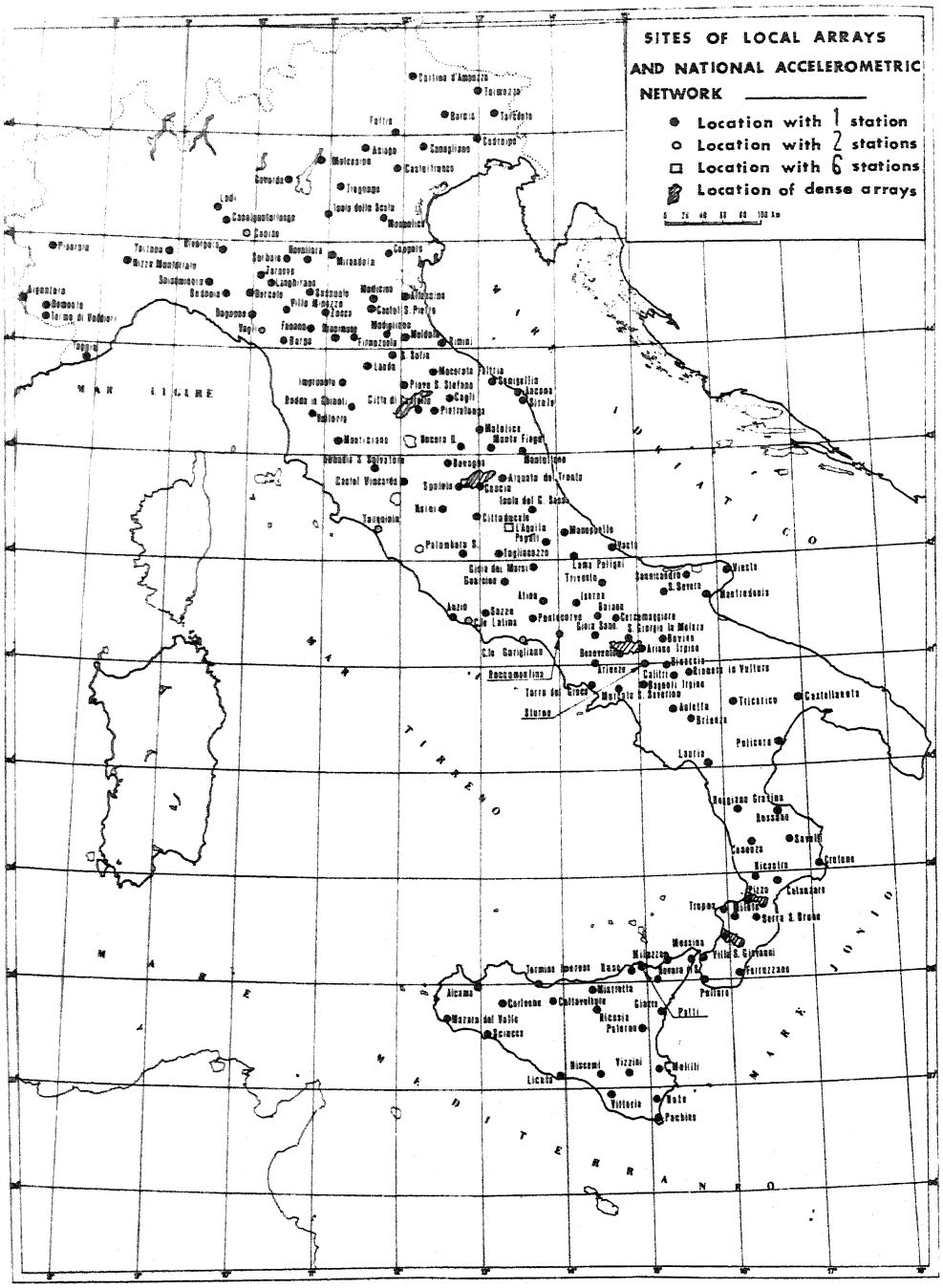

FIG. 1 Sites of local arrays and national accelerometric network