Irpinia 1980, Southern Latium and Abruzzi National Park 1984, Zafferana Etnea (Sicily) 1984, Mexico City 1985 earthquakes: Catalogues of damage

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PRESENTATION

Catalogues, which include more than 600 pictures, cannot be summed up: the few images shown in the rest of the publication do not pretend to be representative of the most important situations that may occur. The intention of the author is not to draw definitive and organic conclusions about the effects of earthquakes on structures.

Within the research activities that ENEA (Italian Commission for Nuclear and Alternative Energy Sources) conducts on nuclear plants and (more in general) energetic installations safety with reference to environment and, in particular, seismic events, great relevance possess the interventions performed in the occasion of earthquakes of large intensity according to the directives of the ENEA-ENEL (Italian Electricity Generating Board) joint commission for the study of seismic problems connected with nuclear power plants.

Among the other implications of these interventions there is the observation of the effects of earthquakes on structures. The iconographic and descriptive documentation is collected in catalogues which are compiled in the most objective form in order to permit:

(1) the determination of the behaviour of typologies and structural details;

(2) the assessment of their relations with the aspects of buildings as a whole;

(3) the comparison with analogue or sharply different typologies.

The aim of catalogues is to establish an irreplaceble experimental basis for studies devoted to:

- verify deficiencies or properties of design and building techniques;
- verify possible insufficiency of antiseismic regulations;
- establish univoque correlations between structural effects and macroseismic intensity.

Catalogues give also reliable information for building seismic instrumentation programs, e. g. the one that ENEA is developing in cooperation with the Ministry of Works.

Catalogues have been framed into a necessary compromise between

representative completeness, on one hand, and the exigencies of survey over a sufficiently large number of buildings, on the other one. They are available for Universities and Organizations and can be requested to: ENEA CRE CASACCIA PAS-ISP-ING.SITI, Strada provinciale Anguillarese km 1,300 - 00060 ROMA.

In the rest of the publication some of the typical seismic damage are shown. In order to avoid repetition Roman numerals are used according to the following criterium:
I): Irpinia 1980;
II): Southern Latium and Abruzzi National Park 1984;
III): Zafferana Etnea (Sicily) 1984;
IV): Mexico City 1985.

REFERENCE

G. Sofo. 1985 Mexico City earthquake. (Italian text in press)

Fig. 1. IV) An ideal sequence shows an usual collapse mechanism in columns without sufficient ties.

Fig. 2. IV) Brittle type failure in a heavily reinforced column partially induced by non-negligible stiffness of bars.

Fig. 3. I) Effects of lack of ties in a column-beam connection.

Fig. 4. I) Loss of bonding between steel and concrete in a column-beam connection. The earthquakes show that confidence in the use of high bond deformed bars is not completely justified.

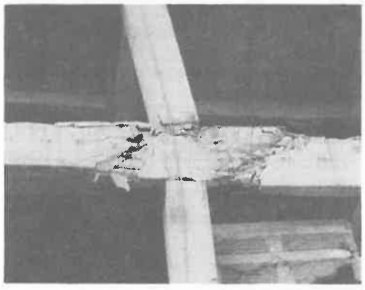


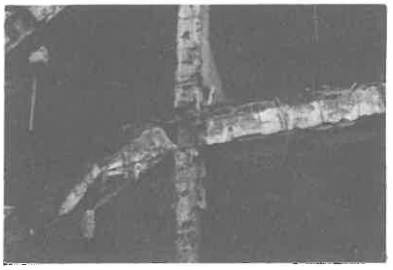
Fig. 5. IV) Apart from the specific case, the image gives an idea of possible consequences, in zones without or with feeble seismic regulations, of an earthquake on horizontal structures when shear forces due to the weight are prevalently assigned to bent bars.

Fig. 6. IV) Failure of longitudinal steel in a beam. This type of damage is much less common that brittle type failure of heavily reinforced concrete.

Fig. 7. IV) Direct and indirect effects of lack of transversal reinforcement in bidimensional structural elements.

Fig. 8. IV) Greater ductility (e. g. achievable by making use of spirally reinforced columns) can have a harmful effect if attained at stiffness expense because it involves a greater demanded ductility.

Fig. 9. II) A common type of damage resulting from brick infill panels not properly tied to structural frame.



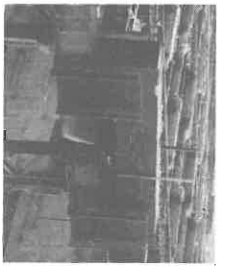


Fig. 10. IV) In old steel construction bolted connections are a weak point. In new steel construction weld failure in steel box columns resulting in buckling of steel plates.

Fig. 11. II) Cracking provoked by horizontal loading is greatest at upper floors of masonry buildings because they lack the beneficial effect due to the weight of floors above.

Fig. 12. IV) A spectacular example of foundation settlement caused by flow of clayey soil.

Fig. 13. IV) Damage to an aqueduct and to an unused rail line that had been covered by pavement.