Earthquakes also generally cause high indirect losses, like business interruption, unemployment, etc., particularly damaging to the economic development of Third World countries.

It is therefore worthwhile to consider economic steps to reduce the risk. Had the building shown in Figure 2 — and there are many comparable "human traps" in earthquake zones — been constructed with sturdy walls, of reinforced concrete down to the foundation, the average loss from a catastrophic earthquake would not have been more than a few percent, and negligible from smaller events. Properly designed buildings (cf. Fig. 3) did not suffer any notable damage during the otherwise destructive earthquake at El Asnam, Algeria in 1980.

A potentially dangerous design can be altered economically, thereby reducing the specific risk dramatically, e.g. by a factor of one hundred.

Needless to say that earthquake resistant design and careful construction are essential for buildings occupied by several people but also for some industrial facilities and chemical plants. Many of the latter pose a grave risk due to the threat of release of harmful or poisonous substances. Disasters like the one which occurred at Bhopal, India, in December 1984, are far more likely in earthquake zones because of multiple failures of pipes, fittings, tanks, etc. The probability of such accidents can be greatly reduced if proper steps are taken.

Earthquake insurance protection is also provided in other insurance branches like Marine, Aviation, Motor Vehicle Insurance, Personal Injury, or Life Assurance. This shows that a community may at least buy protection against the financial consequences of earthquakes. To ensure the availability of such protection it is, however, necessary that some conditions be met. The most salient ones are:

- The rating, that is, the pricing of insurance coverage must be compatible with the risk. Any noteworthy digression herefrom because of lack of professionalism, levelling of rates by trying to make low risks persistently support the high ones, inadequate differentiation between seismic zones, etc. will in due course cause the insurance capacity to shrink, or even to disappear.

- The professionalism must not only be applied to risk assessment and rating but also to accumulation control. Otherwise the likelihood of a very precarious situation arises, in particular if a country should be hit by more than one catastrophic earthquake within a comparatively short span of time. Without proper accumulation control, liabilities may surpass funds by a wide margin.

- The last remark brings us to the problem of adequate earthquake reserves, an issue which is beset in many ways. First of all there is a human psychological hitch: the generally comparatively long return periods, the average intervals between earthquakes, are not compatible with the notoriously short memory of humans. During such long intervals, demographic changes and the development of new regions or industries can change the total exposure in a dramatic way. Further, officials in charge of finance and revenue often

Fig. 3. *This building not far from those shown in the previous illustration withstood the earthquake very well as did many others which were of a symmetrical and sturdy design without large openings. Such comparatively stiff buildings are particularly well suited if they are founded on fairly deep alluvium. Buildings and structures founded on soft ground are far more exposed than those standing on hard foundation material. Therefore such sites should be avoided. There are, however, many towns and industrial facilities on comparatively soft and deep alluvium and it would not be realistic to demand that building activity be stopped at such places. Vice versa, as most good building sites are exhausted, mankind may have to build increasingly on unfavourable sites. The only economic method to reduce the chance of earthquake disasters is to heed the lessons taught by earthquake losses, for instance to avoid top heavy structures, soft ground floors, soft (flexible) buildings founded on soft soil, irregular and asymmetrical designs.*

appear to have insurmountable difficulties in understanding that the premiums received for earthquake insurance and funds built up are not profits but money needed one day to alleviate a catastrophe.

• Laws and rules governing earthquake insurance issues should be drawn up in a very cautious way. A large earthquake and even a smaller one affecting a critical concentration of elements at risk can assume the proportions of a national calamity. International insurance capacity whether in terms of funds or knowhow can only assist in mitigating the effect if co-operation is freely possible on an international scale. Obstacles raised by unwarranted national interference will not only reduce the assistance from outside but also the free exchange of expertise.

• Earthquake insurance in particular is no place for cut-throat competition, if only because of the uncertainties in establishing the exposure, the proper insurance premium, and the size of a catastrophe. The graver the consequences of an error the higher the standard which must be applied, and today expertise is still very unevenly distributed.

• Earthquake insurance is unthinkable without international risk spreading, that is distributing the burden on the shoulders of many. These shoulders must be strong and dependable, even if burdened with the liabilities from several catastrophic earthquakes within one year or during a sequence of years. Those off-loading their excessive earthquake burden elsewhere should scrutinize their ultimate reinsurers quite carefully. Otherwise the German saying: "Namen sind Schall und Rauch", loosely translated "names may not be more than sound and haze" could assume importance, in particular if a rather intensive seismic phase like the one at the turn of the century should recur, exposing mankind to an increased number of large earthquakes and a proportionate number of smaller ones. ■

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