Paper No. 2058. (quote when citing this article)
Eleventh World Conference on Earthquake Engineering
ISBN: 0 08 042822 3

THE USE OF EARTHQUAKE SCENARIOS IN THE INSURANCE INDUSTRY - OPPORTUNITIES FOR THE APPLICATION OF GIS

A. SMOLKA

Geoscience Research Group, Munich Reinsurance Company, D-80791 Munich, Germany

ABSTRACT

The use of earthquake scenarios in the insurance industry goes back quite a number of years. They have been used by leading insurance and reinsurance companies for estimating probable maximum losses (PMLs) since the mid-seventies. At that time, to be precise after the Guatemala earthquake in 1976, Munich Re introduced its zoning scheme for earthquake insurance. Within this scheme scenarios have their place in determining the "loss accumulation zone" which circumscribes the area afflicted by damage from a large hypothetical or historical earthquake event. The scenario PML serves as a basis for vital business decisions on the capacity to be allocated to specific areas and on the necessary protection against extreme losses as, e.g., in the form of reinsurance coverage.

In recent years various developments have claimed the attention of loss modellers and of users in the insurance industry:

- There were numerous earthquakes in the 1980s and early 1990s that provided evidence - and none more dramatically than the 1985 earthquake in Mexico - of how great an influence is exerted on the spatial loss pattern by the subsoil and other conditions. Over widespread loss areas by far the largest percentage of losses was concentrated in little damage pockets.
- Particularly the earthquakes of Northridge and Kobe have given new insight into the characteristics of near-field ground motion, whose relation to damage patterns is, however, not yet entirely clear.
- A steep rise in insured earthquake losses has occurred over the last 10 years. The trend towards even larger loss burdens will continue and may even become stronger. Evidence of this is provided by a recent study, which gives figures for the total (insured plus uninsured) losses to be expected in future earthquakes in the conurbations of San Francisco, Los Angeles, and Tokyo, which range from a few hundred billion US$ in California up to US$ 3,000 billion in Tokyo.

All these aspects point in the same direction: If the limited resources for insuring the loss potential of future earthquakes are to be exploited as effectively as possible, it is essential to assess this loss potential in the greatest possible detail, with the greatest possible degree of reliability and in the light of all relevant factors. The starting point for the considerations proferred in the following lies in the argument that although the individual causes of loss in earthquakes are widely documented, there is still only a limited understanding of the overall spatial pattern of losses and the interplay of the various loss factors behind it. The most dramatic example of the inadequacy of existing models was provided by the Northridge earthquake in January 1994, where the actual insured loss was underestimated by a factor of about 6 to 8. An understanding of this loss pattern is an essential precondition for the success of event scenarios designed to estimate losses from future earthquake disasters. There are three reasons for the gaps in knowledge referred to above:

- Reliable and sufficiently detailed data on the spatial loss profile have either not been collected or they have not been accessible.
- Loss-relevant measurements and data such as acceleration records and geotechnical parameters have not been available in the required density.

- There has not been a tool available that is capable of analysing spatially the whole range of factors that influence loss.

As to the first point, loss surveys after events usually lack a uniform and systematic approach, or do not render a sufficiently detailed picture of the regional loss distribution. Data on insured earthquake losses are in principle ideal material to work with. But their potential has yet to be tapped to an adequate degree. Studies produced within the insurance industry itself and documented in publications are few and far between and the data have seldom been available to researchers outside the insurance industry.

As to the second point, this is a key problem in many parts of the world. The amount of acceleration readings from the Northridge quake of January 1994 far exceeded anything a single event had ever provided before, thus making it a unique situation. As far as data on subsoil conditions are concerned, the problem is that, as in the case of loss data, although very valuable information exists, such as the bore hole data collected for oil exploration or construction site investigations, they are often difficult for external users to access.

As to the third point, recent years have seen the development of powerful computerized geographical information systems (GIS). These systems are an excellent tool to work with for the spatial analysis of losses and have created new opportunities for the application of the results obtained to the definition of earthquake scenarios. The strong point of GIS is to be found in the analysis of site-related loss factors, i.e. in making an inventory of the stock of buildings and the geological and topographical features. The aim of a GIS analysis is to isolate these factors and their quantitative effect in terms of damage. Prerequisite to a successful investigation is the availability of data that go beyond the pure surface geology, such as drilling profiles and construction site data (see above), which provide information on the composition of sediments near the surface and deeper.

The direction such a GIS analysis should take is demonstrated by a study that examined the earthquake of Liege/Belgium in 1983. On the basis of a detailed analysis of two profile lines extending across the loss area supplemented by a theoretical modelling of the ground motion, it was possible to establish a convincing correlation between loss features and the interaction of large-scale geological structure, basement topography, and sediments close to the surface. What the Liege study succeeded in doing with two profiles can be done on an areal basis - even at a purely empirical level - by a GIS. The beauty of an event analysis using a GIS as proposed here is that in the correlation between loss and loss factors there does not seem to be any need for a diversion via ground motion and that on the contrary a direct correlation can be established to the purely site-specific characteristics. This means that it is possible to avoid the problems inherent in using inadequate loss reference parameters such as macroseismic intensity (subjectivity, cannot be defined instrumentally, not suitable for high-rise buildings, by definition connected to extent of loss) or peak acceleration (neglecting the spectral components and the duration of the quake). Nowadays, in the age of GIS availability, it would really be worth making an attempt to draw on the loss data of past earthquakes such as those that occurred in Chile and Mexico in 1985, Armenia in 1988, Newcastle, Australia, in 1989, and, of course, Northridge and Kobe. Therefore, this paper concludes with a plea for the opening of the paths of communication between the insurance industry on the one hand and earthquake engineers, geotechnical engineers and seismologists on the other in order to make the most effective use of the enormous potential of GIS in the analysis of the spatial pattern of past earthquake losses and, going on from there, in the simulation of future earthquake losses.

The practical value of analyses such as those proposed here is by no means restricted to applications in the insurance sector. Another very important field of application, also in line with the long-term interests of insurers, is the development of projects aimed at reducing and preventing future earthquake losses. These goals harmonize well with the goals of the International Decade for Natural Disaster Reduction (IDNDR) proclaimed by the UN for the last decade of this century.