

Earthquakes

Protection through engineering, planning and insurance

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Of all the natural phenomena capable of inflicting disasters upon human communities, earthquakes are perhaps the most frightening, the most unpredictable, and the most expensive. The 1994 Northridge earthquake in California caused insured losses of over \$10 thousand million; the total losses were significantly higher. Total losses from the Kobe earthquake in Japan the following year were around \$150 thousand million. Yet neither of these were great earthquakes. Both had magnitudes of just under 7. From this one should learn that even moderate earthquakes can cause very high losses if they score a direct hit on a major city, especially cities that are unprepared because they are mistakenly believed not to be at risk.

At one time it was thought that earthquake prediction would solve this problem. This now looks increasingly unlikely. After decades of research there still is no prospect of reliably predicting

earthquakes. Many scientists are now discussing the idea that such predictions may be impossible because of the chaotic nature of earthquakes. Also, the societal impact of earthquake prediction is now being questioned. For example: if earthquakes were to become predictable, could they be insured against?

Increasingly, it is being seen that the key to protecting against earthquakes is threefold: engineering to strengthen buildings, planning to minimise casualties, and insurance to cover the cost. All these approaches require advice from the seismological community in order to strike the right balance. The engineer needs to know what sort of shaking to design against; the planner needs to know what sort of effects to prepare for, and the insurer needs to know how to cost the expected risk correctly.

There are three basic types of information that are relevant:



Concrete frame office building completely destroyed in Kobe earthquake of 1995.

- Seismicity — the raw information about how frequently earthquakes affect a place;
- Seismic hazard — the probability that a certain strength of shaking will occur;
- Seismic risk — the probability that a certain amount of loss will occur.

Seismicity information is useful in making preliminary assessments about whether earthquakes are a serious threat in any particular place. Then seismic hazard information is used by engineers to derive design parameters for structures, while insurers and planners need seismic risk data to assess the likelihood of existing buildings being damaged.

The BGS has been involved in research into seismicity and seismic hazard since the mid 1970s. It is becoming increasingly involved in seismic risk work as well, especially in developing new approaches to tackling this important subject. By looking at past data, one can estimate the way damage to particular types of buildings is distributed as a function of earthquake magnitude and distance from the focus of the earthquake. One can then apply simulation techniques to estimate the probability of damage from future earthquakes. Software to perform this analysis is now being licensed by the BGS to reinsurance firms; a way of applying the scientific knowledge of seismologists to the practical goals of the insurance industry.

Seismic risk: these curves show the probability of different amounts of loss to buildings of different degrees of vulnerability for a town in Western Turkey. The background map shows the seismicity of the area.

