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EARTHQUAKE LOSS ANALYSES FROM THE INSURER'S STANDPOINT

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SUMMARY

Earthquake loss analyses are an important part in the assessment of the loss potential of an event in an earthquake insurance portfolio. Insurance data of four quakes of the last decade was examined to calculate mean damage ratios as a function of earthquake intensities. The results show the influence of parameters like building size, age, height, type and subsoil conditions on building vulnerability. The largest proportion of the total loss amount is always due to damage to nonstructural elements.

OBJECT

An insurance company offering earthquake coverage is confronted with two problems:

- What is the adequate premium rate?
- What is the maximum possible loss from one event?

The second point can be crucial for the survival of the company when a whole portfolio with thousands of policies which can be affected by the same event is covered against earthquake. Methods applied to answer these questions consist of quantifying seismicity (e.g. in terms of return periods for intensities) on the one hand and vulnerability of the insured items (e.g. mean damage ratios for different building categories) on the other hand. Based on this data and additional information about the portfolio composition and spread, event scenarios can be calculated.

The main sources for vulnerability assessment are loss analyses based on insurance data from the affected portfolio. Apart from sum insured and loss paid per affected policy, the per-risk-information available is usually sparse and limited to rough indications about building type, material, height, age, subsoil, main cause of damage, etc. This kind of analysis is therefore not appropriate for detailed damage studies on single buildings. However, for a large number of affected buildings, the results provide a representative picture of the real financial consequences of building damage.

METHOD

Insurance data on the following events was compiled and analysed:

Location	Date	Magn	Max. Int.	No. of fatalities	Loss (10^6 US$) total	insured	No. of claims analysed
Albstadt/FRG	03.09.78	5.3	VIII	0	50	35	1620
Popayán/CO	31.03.83	5.5	VIII	280	400	50	210
Chile	03.03.85	7.8	VIII	300	2000	90	2800
Mexico City	19.09.85	8.1	IX	10000	4000	220	1800

The main objective of the examination was to calculate mean building damage ratios (total loss amount divided by total value) as a function of earthquake intensities and to quantify the influence of various factors. Another interesting value for the insurance side is the size distribution of the individual loss amounts, which can be used to estimate the effect of cover limitations (deductibles or indemnity limits).

MEAN DAMAGE RATIOS FOR BUILDINGS

The following results were found:

EVENT	ZONE/LOCATION	INTENSITY (MM)	MEAN DAMAGE RATIO (%) affected buildings	all buildings
Albstadt	Onstmettingen	VII-VIII	6.0%	4.9%
Popayán	City of Popayán	VII-VIII	15.6%	11.5%
Chile	Valparaíso	VIII	11.4%	4.8%
	Santiago	VII	3.3%	2.3%
Mexico	Mexico City, Zone C	IX	54.7%	n.a.
	Mexico City, Zone 2	VI-VII	23.5%	n.a.
	Coastal districts	VI-VIII	19.8%	n.a.

INFLUENCE OF VARIOUS FACTORS

The limited size of the data samples means that it is hardly possible to evaluate precisely how the different risk features influence vulnerability. Individual characteristics such as for instance height, age, regularity, etc. cannot be extracted with the degree of refinement necessary to consider them completely independently of other parameters. Thus the following findings can only disclose general tendencies.

Risk Size or Sum Insured   Larger risks normally show lower average damage ratios. Considering only the affected buildings, the damage ratio of small risks (e.g. single family houses) was found to be many times higher than that of large risks (e.g. big dwelling risks, commercial or industrial buildings). Looking at the whole portfolio, this effect is partly offset by the increasing proportion of affected policies with growing risk size.

Building Age For obvious reasons, new buildings generally behave better than old ones. Albstadt and Chile data revealed about four times higher damage degrees for buildings older than 25 years, compared to constructions of the last decade. This tendency is more pronounced for low quality houses (e.g. adobe, unreinforced masonry). Damage degrees of concrete or steel constructions are less age-dependent. This may be due to the fact that these building types have always been designed with a certain amount of engineering input.

Height The important role of the building height for increased damage due to resonance phenomena is well known for buildings over 5 storeys in the Mexican quake. The Chile quake, with dominating frequencies of 2 - 3 Hz, reveals that the damage degree of buildings with three or four storeys is more than twice as high as the average.

Occupancy Industrial risks are generally less affected than dwelling houses, independent of construction type. However, it is difficult to separate this effect from connected parameters like age, regularity, etc.

Building Material Low quality constructions like adobe or unreinforced masonry buildings were found to be up to ten times more vulnerable than top quality steel or concrete frame constructions. The difference tends to get smaller with higher intensity.

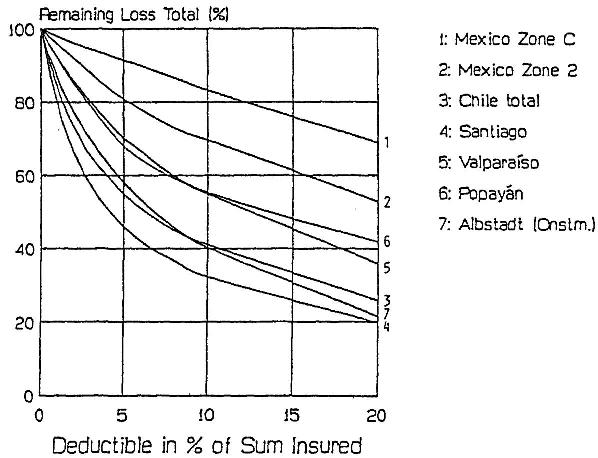
Type of Damage Damage to nonstructural items of the buildings always produces the major proportion of the total loss amount. In Albstadt, about half of the losses were due to bearing or non-bearing building parts (foundations, walls, columns, slabs, roofs, chimneys), whereas the other half was paid for damage to equipment or accessories (heating, plumbing, machinery, etc.). In Chile, about 70% of the affected buildings showed only nonstructural damage (non-bearing walls, ceilings, equipment, etc.). In all events, the damage of the structural elements came to less than 20% of the total loss amount.

Subsoil The spectacular effect of the Mexico Zone C subsoil on the damage generation has already been clearly revealed by many other studies. Also less salient soil features may significantly influence the damage degrees. Albstadt, as an example, shows a mean damage ratio more than two times higher for buildings situated in valley basins on alluvial deposits, compared to constructions on hill-sides or plateaus with limestone or marly rock.

SIZE DISTRIBUTION OF THE INDIVIDUAL LOSS AMOUNTS

The individual losses are distributed more or less log-normally, with variation coefficients between 1.5 and 3. The log-normal distribution fits especially well in the case of small affected areas with a relatively uniform building portfolio (Albstadt, Popayan). This finding is relevant from the insurance viewpoint, as it permits the calculation of the effect of different cover conditions. A deductible, i.e. a percentage of the sum insured that is deducted from each claim and has to be borne by the insured, can substantially reduce the total loss burden and the number of loss payments, particularly in the case of small quakes with a large number of trifling losses. Fig. 1 shows the potential event loss reduction as a function of the deductible.

Fig. 1: Effect of Deductibles on Total Event Loss



CONCLUSIONS

The calculated damage ratios complement other studies on this topic (Ref. 1, 2, 3). The large variation in the results for different building parameters underlines that mean damage ratios have to be considered as average values, highly influenced by individual risk characteristics. To estimate the vulnerability of an insured building portfolio adequately well, detailed knowledge of the portfolio composition is essential. Without sound underwriting and risk assessment by the insurance company, the quality of the insured buildings may be worse than the overall building standard due to severe adverse selection.

From the engineer's standpoint, the findings confirm the well-known fact that the majority of earthquake damage has to be attributed to nonstructural parts (cf. Ref. 4). It can be questioned whether this is adequately reflected in building codes. Further developments in anti-seismic regulations should therefore not only concentrate on design and calculation, but also on qualitative aspects like configuration, construction details, secondary elements and equipment.

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