EARTHQUAKE BASICS

INSURANCE

WHAT ARE THE PRINCIPLES OF INSURING NATURAL DISASTERS?

■ Introduction

This volume of *Earthquake Basics* is intended to be an introduction to the business of insurance and the problems of insuring against earthquakes, and includes basic insurance terms and concepts. *Earthquake Basics* is a series of reports and other topics connected with insurance, such as mitigation, economic recovery, and the efficacy of building codes, which may be covered in more detail in future editions. While this commentary will focus on insuring against earthquakes, the principles apply to hurricane insurance and other natural catastrophes. The brief draws heavily from California's extensive, well-documented experience with earthquake insurance. While the principles of earthquake insurance are the same in any state, the specifics about coverage, availability, and affordability vary from company to company and state to state. This *Earthquake Basics Brief* will be useful in considering how insurance can be a better tool to promote both mitigation and community recovery.

Richard J. Roth, Jr.
California Insurance Department

In the last decade, the insurance industry has paid out record amounts of money for insured losses caused by earthquakes and hurricanes, including $12 billion in 1994 for the Northridge earthquake and $16 billion in 1992 for Hurricane Andrew. Not since the 1906 San Francisco, the 1925 Santa Barbara, and the 1933 Long Beach earthquakes has the insurance industry faced the possibility of a natural disaster causing hundreds of thousands of insurance claims and billions of dollars of insured damage.

The insurance industry has responded to the specter of large losses in three ways. First, it has been working with members of the United States Congress to establish a federal natural disaster insurance program to augment the capacity of private industry to provide disaster insurance. The industry's argument is that the federal government has the cash flow needed for paying claims after a major natural disaster. Second, the insurance industry has sought advice from scientists and engineers regarding where and with what probability earthquakes are likely to occur; which structures are likely to be damaged; and how underlying soil conditions and construction characteristics contribute to damage. Third, some insurers are choosing not to accept new policies or renewals in areas of high seismic risk.

The business of insurance, including life and health insurance, plays a major financial role in our society, making up approximately 15 percent of the national gross domestic product. This does not include Social Security, Medicare, and most health provider programs. Virtually everyone is covered under some form of insurance. Insurance plays a major role in providing security for major assets, especially the home, which is where earthquake insurance is particularly important. Insurance is a mechanism to spread losses and rapidly pay defined amounts for the repair of earthquake damage. It is essential for the economic recovery of individuals, families, and communities.

The California Insurance Department

Like insurance departments in other states, the California Insurance Department is concerned with the availability and affordability of insurance, and the solvency of insurance companies. California monitors the financial health of its insurance companies to maintain a viable and efficient insurance market for businesses, workers, and individuals in California. In fulfilling that responsibility, the California Insurance Department has taken an active interest since the 1971 San Fernando earthquake in studying the science of earthquakes.

Every modern industrial country must have a stable insurance industry. In the U.S., insurance is sold by both private industry and government. There is a federal flood insurance program administered by the Federal Insurance Administration, part of the Federal Emergency Management Agency (FEMA). There is also a federal crop insurance program. There are windstorm insurance pools in some states administered by the state governments. Earthquake insurance is sold generally by private insurers, but a new state-managed program is just starting in California. There could be some type of federal involvement in the provision of earthquake insurance if Congress passes legislation creating a federally-backed insurance program.

The challenge is to find the capital and financial resources needed to speed the economic recovery of the region after a damaging earthquake. Ideally there would be a structured sharing of the cost of recovery among property owners, the insurance, banking, and capital markets, as well as federal and state disaster programs. The banking industry currently does not participate significantly in economic recovery after disasters other than loans, because it wants to invest money with little or no risk. Banks, which only loan money, expect the money to be paid back and only loan if the applicant's credit rating is good. The capital markets (the stock and bond markets) do not participate in recovery, although they are now exploring the possibility of selling "Acts of God" bonds which allow the waiver of interest and principal if an earthquake occurs.

The Business of Insurance

Insurance is a highly competitive and highly regulated business. Insurance companies are either mutual or stock companies. Mutual companies are owned by the policyholders, while stock companies are owned by stockholders. The mutual company policyholders elect the management. Historically, mutual companies were formed to provide insurance to a local group, such as a farming cooperative or a group of physicians for medical malpractice. A disadvantage of mutuals is that they cannot raise capital by selling stock in the event of earthquake. Stock insurers are usually able to sell more stock to the public, even after an earthquake. Usually, mutuals will pay dividends to policyholders if business has been more profitable than expected. Thus, there is a wide diversity in the forms and origins of insurance companies, which leads to a competitive industry. Every insurer must file more detailed financial statements with the regulators than do publicly traded companies on the New York Stock Exchange. In addition, all mergers and acquisitions must be approved by state regulators. The main concern is solvency, since insurers act in a fiduciary capacity with policyholders' money until all claims are paid.

Insurance is a product: it focuses on a market; it has a value to the customer and a price (or premium). Insurance has a feature which distinguishes it from most other consumer products: the cost to the seller is determined after the product is sold, not before. Therefore, the insurance company's expected losses and expenses must be estimated and controlled beforehand. The company assumes the risk.

In the United States, there are over 3,000 insurance companies, but most of them focus on a specific market, such as farm risks or title insurance. In general, only large multi-line, multi-state companies insure catastrophes. Only a few companies sell earthquake insurance. Even in California only about 175 insurers actively sell earthquake insurance, out of a total of about 800 property/casualty insurers and about 700 life and health insurers. The small insurance companies operating only within the state lack the financial

resources to pay for a large catastrophic event. Many small insurers barely survived the Northridge earthquake. About ten small insurers became insolvent in Florida after Hurricane Andrew in 1992. In the event of a large earthquake which depletes their capital, mutual companies cannot raise new capital. They can only raise insurance rates. Stock insurers can sell more stock to raise additional capital after an earthquake.

The property/casualty insurers in 1994 had premium income in California of $32.8 billion for everything from automobile to ocean marine insurance. It is estimated that there were $1 billion in earthquake insurance premiums (the true number is not known, since earthquake insurance premiums are often combined with the premiums of other coverages). As an example of how much is collected in premiums for all types of insurance, Table I shows the amount of premiums for each major line of insurance in California for 1994. All of these lines of insurance can have claims arising from an earthquake.

Table I:

1994 Premiums for California Lines of Insurance

Line of Insurance	1994 Premiums
Homeowners Multi-Peril	$2,691,182,226
Commercial Multi-Peril	$2,567,660,531
Workers Compensation	$7,626,390,232
General Liability	$2,247,010,769
Private Auto Liability	$7,222,529,843
Commercial Auto Liability	$1,281,995,299
Private Auto Physical Damage	$4,244,382,370
Commercial Auto Physical Damage	$446,624,927
Earthquake	$1,000,000,000
All Others	$2,604,602,355
Total—Property & Liability Lines	$32,817,526,521

Some Basic Insurance Terms

As in every profession, insurance terms have precise meanings. The following section briefly reviews some of these basic terms and their definitions:

Loss

The term loss can mean the amount paid for an individual claim or the aggregate of all payments in one earthquake event. A loss under the policy means that the policyholder received a payment from the insurer. The statement that the industry *lost* $12.5 billion in the Northridge earthquake means that the industry paid policyholders $12.5 billion.

Claim

A claim means that the policyholder has notified the insurer that he/she is seeking to recover the costs of injury, damage or losses under the policy. However, a claim will not result in a loss (i.e., payment to the policyholder) if the amount of the damage or loss is below the deductible or subject to a policy exclusion. From the insurer's perspective, even if there is no loss, there are still expenses in documenting and investigating the claim.

Peril

Peril is a specific term meaning "the damage-causing event." Wind, fire, hail, earthquake, flood, and hurricane are perils.

Hazard

The words "hazard" and "peril" are often used interchangeably. However, there is a difference. Hazard is a term which refers directly to that which makes the damage worse. When a house is not bolted to the foundation, that is a hazard. The earthquake (a peril) causes the house to shake, but the lack of bolting to the foundation (a hazard) causes the damage to be even greater than it would be otherwise. Mitigation reduces or eliminates hazards, but there is nothing that can be done about perils.

The Contract of Insurance

Insurance is a contract. As an example, Section 22 of the California Insurance Code defines insurance as a contract whereby one undertakes to indemnify (compensate) another against a loss, damage, or liability arising from a contingent or unknown event. An insurance policy is a contingent contract in which the insurer agrees to indemnify the insured only if all of the following are true:

a) The insured must have sustained a loss or damage to property that the insured (not anyone else) owns, or the insured has done something to create a liability to another person that is enforceable in court.

b) The loss, damage, or liability can be reduced to a definite dollar amount so that the insured can be indemnified for the loss, damage, or liability.

c) The event which caused the loss, damage, or liability was a contingent or unknown event, meaning that the occurrence of the event is unexpected and out of the control of the insured. Sometimes words like *fortuitous* and *aleatory* are used to emphasize that the event must be random and unexpected. A house knowingly built on a fault is insurable, because the occurrence of an earthquake is considered contingent and unpredictable.

Adverse Selection

Adverse selection means that those with a greater risk of losses seek insurance. Homeowners and businesses with less vulnerable buildings, or in areas of low seismicity, do not purchase earthquake insurance. By insuring the most vulnerable buildings, the available capacity may be squandered on a few buildings, leaving lack of capacity for others. The term is also used to describe earthquake insurance that is clearly underpriced with respect to a property.

Adverse selection is not as great a problem to an earthquake insurer as is sometimes suggested. Actuarially, there is no problem if the earthquake premium properly reflects the vulnerability of the house to damage considering the soil conditions, the proximity to faults, and the condition of the house.

Rating

Rating is the process of determining the proper rate that will be applied to a specific policyholder. Rating considers the risk characteristics of what is being insured. For instance, the rate for automobile insurance is based on the driver's age, sex, driving record, and type of car. For earthquake insurance, the rate is based on the susceptibility to shake damage of the structure and contents, the proximity to known faults, the characteristics of the faults, and the soil conditions under the structure.

Underwriting

Underwriting is the process of determining whether to insure the risk, what should be covered, and at what price. Underwriters work for insurance companies. The underwriting process advises against insuring buildings made vulnerable by very poor construction, very poor soil conditions, and close proximity to major faults. Underwriting uses deductibles to share responsibility for losses with the insured party and to eliminate the numerous small losses that occur with an earthquake. Underwriting uses exclusions to eliminate coverage for certain structures such as swimming pools, decking, or brick veneer. Exclusions are also used to exclude non-seismic earth movement, such as landslides. Underwriting could be a powerful mitigation incen-

tive if it required retrofitting of vulnerable properties for them to become insurable.

Deductibles

Deductibles are losses that the policyholder is responsible for before an insurance company will pay a claim. Because deductibles on house damage are often quite high (10 to 15 percent of the insured value), they eliminate claims for the smaller damages that result from an earthquake. Ten to 15 percent of the insured value of the house amounts to $20,000 to $30,000 for an average $200,000 house. A large deductible also reduces claim processing costs at a time when the insurer is inundated with claims, but mainly the purpose is to limit the total possible insured damage for one single earthquake event.

Probable Maximum Loss (PML)

Probable maximum loss is an estimate of the largest loss a company might incur from the coverage of a specific commercial property, or for a portfolio of properties in the largest probable event. Because every insurance company has a specific amount of financial resources, insurance managers need measures to quantify the potential loss that the company might sustain from a catastrophic event. For instance, if an insurance company has sold earthquake insurance on 100,000 homes in the San Francisco Bay Area, with an average replacement cost of $200,000, the aggregate replacement cost of those homes might be $20 billion ($200,000 x 100,000). However, it is highly unlikely that any disaster event could destroy all 100,000 homes. Most of the homes would be partially damaged, and many not damaged at all. Insurance managers use the concept of a probable maximum loss to estimate how much of a particular building would likely be damaged in a disaster event.

The California Insurance Department extended this concept to earthquake insurance and multiplied the replacement cost of insured homes by a PML percentage factor to give the expected average damage to all of the insured homes in a defined earthquake zone. Assuming a factor of 1.7 percent of the insured value in the San Francisco Bay Area, a single family residence with a 10 percent deductible earthquake policy (10 percent of the value of the building) would have a PML percentage factor of 1.7 percent. This means that the expected average PML loss from a major earthquake would be $340 million (1.7 percent x $20 billion). The 1.7 percent factor was determined by measuring the damage factors after past earthquakes in the state and adjusting the factors to get a factor to fit a large earthquake in San Francisco.

Let's compare this calculation to what happened in Northridge. In earthquake zone B2, where Northridge is located, the PML factor is 1.4 percent. As a rough calculation, assume that there are 1.5 million homes in this zone and that the average replacement value of the structure and contents is $200,000. Then the estimated PML would be $4.2 billion (multiplying the three numbers together). This is an estimate of the insured loss to single family structures and contents, excluding damage to garden walls, swimming pools, and walkways. It is still lower than the actual loss, but not a bad estimate all things considered. (The $12.5 billion total insured loss included commercial and multi-family structures, automobile and other losses not contemplated in this residential PML calculation.) Estimated PMLs can also be calculated for commercial structures. The PML percent varies from fault zone to fault zone (see Roth's biannual report, *California Earthquake Zoning and Probable Maximum Loss Evaluation Program*, for a full discussion and analysis of PMLs).

Capacity

An insurer's capacity is the maximum amount of exposure, or possible losses, that an insurer is willing to accept. From a business manager's point of view, the $340 million in the example above is a much more useful number to reflect capacity than the $20 billion figure. If the manager only wants to commit $250 million of the insurance company's financial resources to a possible earthquake event in the San Francisco Bay Area earthquake zone, the $340 million figure indicates that there are too many earthquake policies in that zone.

A limit placed on a certain earthquake zone, such as $250 million, is called a capacity limit. An insurer's capacity—or the resources they are willing to risk in any one area—is the maximum amount of PML exposure that an insurer is willing to insure in any one earthquake zone. This capacity is a business decision that a company makes to insure a certain return for its policyholders (in a mutual company) or a stock value and dividend rate (in a stockholding company).

Sometimes capacity is calculated in terms of the state of California as a whole. After the 1994 Northridge earthquake, insurance managers re-evaluated their PML exposures in relationship to their chosen capacity for California earthquake exposure. Many insurers announced that they would not sell new earthquake insurance policies (but would renew existing policies). Many property owners realized the damage an earthquake can do after the Northridge earthquake, and decided to purchase earthquake insurance only to find that it was not available.

Related to this issue of capacity is the fact that earthquake insurance policies usually are "replacement coverage" policies—that is, they pay the cost of replacing the destroyed building with a new building. Because the cost of a new building is often greater than the insured value of the old building before the earthquake, replacement policies use up a higher proportion of a company's capacity. Even when buildings are only partially destroyed, replacement coverage for things like pipes, stucco, drywall, etc. can exceed the insured value for those items.

Reserves

Loss and loss adjustment expense reserves are amounts that insurers set aside for the payment of claims which have already been filed but have not been settled yet. Claims are not settled until the repair work is completed or litigation is settled. Reserves are not available to pay claims for structural damage caused by future earthquakes. Reserves are reported as a liability on the insurer's balance sheet.

Policyholder Surplus

Policyholder surplus is defined as the insurance company's assets minus the liabilities. The terms net worth, capital, surplus, and retained earnings are all loosely used to refer to policyholder surplus. It does not include the reserves defined above. It is the value of the company left over after all of the liabilities and debts have been settled. It represents the maximum amount available to pay for catastrophic events, such as earthquakes. It would be comparable to the amount of a homeowner's equity, the value of personal property and investments, and all bank accounts minus the liabilities.

Reinsurance

Reinsurance is the process by which one insurance company insures another insurance company. It is an essential part of controlling capacity. For instance, one insurance company would insure a $40 million commercial building for earthquake damage, then find another insurer to share half the risk for half the premium. If there is a damaging earthquake, the two insurers would share the loss equally. Any insurer can act as a reinsurer, and some insurers act only as reinsurers. About half of today's earthquake reinsurance is sold by reinsurers in the United States, and half by reinsurers around the world, mostly in London and Europe. Practically every commercial earthquake policy is reinsured with other insurers, but very few residential earthquake policies are reinsured since the expected damage per house is relatively small. An individual building can be reinsured alone, or as part of a designated group of buildings. A reinsurance policy can also insure one earthquake event, but usually only up to a stated amount, such as $200 million.

Multiple Peril/Multiple Line

A multi-peril or multiple peril policy is the most common type of insurance policy sold and covers multiple perils in one policy. Prior to 1955, separate policies would have had to be purchased for each peril. A multi-line or multiple line insurer is an insurance company licensed to sell all of the types of property/casualty insurance, such as workers compensation, automobile, fire, earth-

quake, commercial coverages, etc. The term usually just means that the insurance company is very large and operates in most states.

Are Earthquakes Insurable?

The question "Are earthquakes insurable?" can be answered from two perspectives—according to either the principles of finance or the principles of probability.

In finance, the possibility that a house could be destroyed by an earthquake is known as a risk of losing the value of the house in the event of an earthquake. If the house is all that one owns, then this risk is a threat that one would want to avoid. If an investor is willing to accept this risk in return for a modest amount of money, then the homeowner would enter into a contract that transfers the risk for a fee. In other words, the house is insurable because someone is willing to insure it. In the insurance world, many insurance companies are willing to accept a limited amount of earthquake risk simply because the management is willing to earn premiums and take the chance that no earthquake will occur, or because the insurer is large enough to absorb the loss if an earthquake does occur. Thus from the perspective of finance, earthquakes are insurable.

In probability, there is the "Law of Large Numbers." The insurance industry exists because of this law. In fact, the term insurable means that the Law of Large Numbers applies. The problem is that this law is based on certain assumptions that are not valid in the case of catastrophes. Technically, the law states that for a series of independent and identically distributed random variables (such as automobile insurance claims), the standard deviation of the average amount of claim decreases as the number of claims increases. For example, if one goes to Las Vegas and places a bet on roulette, the casinos expect that individual to lose an average of a little more than 5 cents for every bet of $1. But each time the individual bets, he/she will either win or lose whole dollars. If he/she bets ten times, his/her average return is his/her net winnings and losses divided by ten. The Law of Large Numbers says that the average return will converge to a loss of 5 cents per bet. It also says that it will converge to a loss of 5 cents per bet very quickly (as the number of bets increases). In insurance terms, an insurance company can insure 10,000 automobiles on which its actuaries say that it will make an average of $50 per year for each automobile insured, and that will almost always be true. Therefore, an insurance company can operate with only a few million dollars in premiums and still have stable financial results.

The Law of Large Numbers also assumes that each claim is independent of the other claims (like automobile accidents which are single events). However, in an earthquake, all of the earthquake insurance claims happen in the same event, not independently. In addition, the Law of Large Numbers applies more readily to events that are frequent and more predictable in terms of numbers and losses. Earthquakes are rare and difficult to predict in terms of when they might occur and what the losses will be. If insurance were based on a long period of time, say 100 years, the number of independent events and expected losses would be more predictable. But tax laws require the losses to be calculated on an annual basis, preventing build-up of capacity to cover rare events. Risk cannot be spread over a number of years without risking corporate assets.

So, are earthquakes insurable? The answer is yes, but the uncertainty is great. The art of insuring natural catastrophes generally follows a strategy of limiting the potential insured loss in each location where an earthquake is likely to occur. For instance, the California Insurance Department has divided the state into eight earthquake zones (Zones A-H). Assuming that the damage effects of any earthquake in one zone cannot extend into another zone, an insurer could limit the number of earthquake policies to an equal number in each zone. In that way, an earthquake could affect at most only one-eighth of the policies at one time. Then the Law of Large Numbers would start to take hold, even though the likelihood and consequences of an earthquake in Zone A (San Francisco County) is much greater than an earthquake in Zone H (Modoc County), which is less seismically

active. In addition to limiting the number of policies in any one earthquake zone, an insurer can limit the coverage by applying a large deductible.

In addition to spreading the earthquake policies geographically and limiting the possible insured loss from any one earthquake, an insurer can look for a risk taker, a reinsurer. For instance, one insurance company might insure a $100 million commercial building for earthquake damage and then make a contract with nine reinsurers to insure $10 million of that building each. In the event of a damaging earthquake, the insurance company and each of the reinsurers would pay only one-tenth of the loss each. Using reinsurance is a common way of making a risk more insurable.

Some people believe that earthquake insurance has to be mandatory to spread the risk. However, there is no actuarial reason for making earthquake insurance mandatory. In California, over two million of the state's six million residences are covered by earthquake policies. This does not include earthquake insurance policies on commercial buildings. The advantages of diversifying geographically were gained long ago. If the objective is to make building owners at low risk of damage subsidize building owners at high risk of damage (such as owners of old or unreinforced masonry buildings in fault areas), the coverage is no longer actuarially accurate, and a mandatory tax scheme may be a more equitable public policy.

Earthquake Insurance

A typical earthquake policy insures for loss against structural damage, damage to contents, and loss of use (residential) or business income (commercial). Loss of use covers the costs of a hotel or other rental and meals until the structure is repaired. Business income covers the income and rental losses arising from the shutdown of the business (sometimes called business interruption). In the Loma Prieta earthquake, out of every $100 of insured residential damage there was an average of $20 for insured contents damage and $10 for insured loss of use.

California Insurance Losses

In the aftermath of the San Fernando earthquake in 1971, concern about the exposure of the insurance industry to earthquakes greatly increased, leading the California Insurance Department to issue Ruling 226, which requires all licensed insurers to report each year on their insured exposures for earthquake shake damage on residential and commercial structures in California. At that time, the percentage of homes and commercial structures insured for earthquake damage was only about 7 or 8 percent, and the insurance losses from the San Fernando earthquake were about $46 million. Since then, the demand for earthquake insurance has grown dramatically, along with a dramatic increase in housing and commercial building values.

The detailed questionnaires provided by the department include calculations for estimating the Probable Maximum Loss (PML), or expected insured loss after deductible for structural and contents damage from a major earthquake in each designated earthquake zone. From these annual earthquake questionnaires, the department compiles estimates of the aggregate insured PML losses by earthquake zone and publishes these results. The state is divided into eight zones, but Zones A (San Francisco) and B (Los Angeles/Orange County) are the most important. In 1992, the aggregate PML for Zone B was about $16 billion and will be about $20 billion in 1995 for structural damage only. The questionnaires for individual insurers are not made public.

The California Insurance Department also uses these questionnaires to monitor the amount of earthquake exposure that each insurance company writes in relation to its financial strength. The questionnaire shows the amount of earthquake insurance by earthquake zone and by residential and commercial

building classes. In addition, there is detailed information on reinsurance. This questionnaire helped lead to the development of the many earthquake simulation models that are now available, and has encouraged insurers to gain knowledge about seismicity, geology, and structural engineering.

As part of its regulatory authority, all earthquake insurance rates must be filed and approved by the California Insurance Department. Almost all rate filings are filed by actuaries and include earthquake loss estimates by territory based on seismology and building characteristics.

The insurance industry paid about $1 billion dollars in claims for shake damage in the Loma Prieta earthquake, making 1989 the first year since 1906 in which earthquake losses paid exceeded premiums collected for shake damage. An analysis of the losses revealed that poor soil conditions (landslides in Santa Cruz mountains and liquefaction in San Francisco) were major causes of insured losses, especially to the seriously damaged structures. The majority of insured losses occurred within 20 miles of the projection of the fault rupture on the earth's surface, most of it within 10 miles. Insured losses beyond 20 miles almost always were associated with soil effects. This was clearly demonstrated in the Marina district of San Francisco where poor soil, the age of the buildings, and poor quality construction contributed to high losses.

The insurance industry paid out about $12.5 billion in claims on all lines of insurance after the 1994 Northridge earthquake, one of the largest insured disasters ever. The insured losses were about one-third commercial and two-thirds residential. High ground acceleration was the primary cause of damage to houses, contents, chimneys, and garden walls. Building damage from landslides and liquefaction was not as common as in the Loma Prieta earthquake.

Earthquake-related damage is covered by various forms of insurance besides the standard earthquake insurance policy on structures. Losses on these lines represent a significant portion of the insured loss. For example, of the $12.5 billion paid out after Northridge, approximately 20 percent ($2.5 billion) was paid from these types of insurance policies, not from earthquake insurance which only covers shaking damage. The standard fire policy covers fire regardless of cause, including fire arising from an earthquake. Damage to automobiles is covered by the comprehensive coverage in the auto policy even if the earthquake causes damage to the car. In the Northridge earthquake, there were 32,249 claims for $56 million paid on automobile insurance policies. The fire losses were $154 million on 635 claims. While the $10 billion shaking damage is more than all of the earthquake insurance premiums collected in this century, the loss should be compared to the current premium volume for that line, because so few structures were insured in past years. In 1994, California earthquake insurance premiums were about $1 billion out of a total of nearly $33 billion for all property and casualty insurance.

Table 2
Lines of insurance that cover earthquake damage

1)	Fire
2)	Property damage and bodily injury liability
3)	Architects and engineers professional liability
4)	Workers compensation
5)	Commercial and private passenger vehicles
6)	Loss of life, disability, and medical expenses
7)	Building code upgrade requirements
8)	Exposure for high value contents
9)	Glass breakage
10)	Boiler and machinery damage
11)	Burglary and theft
12)	Indirect economic losses (e.g., interruption of suppliers)
13)	Losses to lifelines (fuel, electricity) business interruption
14)	Insurance on the revenue from toll roads and bridges

California Residential Earthquake Insurance Coverage

The percentage of homes with earthquake insurance in California has grown dramatically. In 1980, fewer than 10 percent of the homes had earthquake insurance. In the last fifteen years, there has been a steady increase each year, along with larger increases after significant seismic activity. Earthquakes, media publicity and sharply rising property values during the 1980s are the main reasons for the rise in this residential demand. There has been a parallel rise in commercial earthquake insurance.

During 1996 the California Insurance Department issued a special questionnaire to all insurers writing earthquake insurance in California requiring them to report detailed information on homeowners policies and earthquake insurance policies to the Department. Some of the results are given in the table below.

The number of homeowners policies in force in California at the end of 1994 approximates the number of single unit dwellings in California. The table does not include mobile home policies. It shows the number of homes which have earthquake insurance. At the time of the January 17, 1994, Northridge earthquake about 40 percent of the homes in Los Angeles County had earthquake insurance. This did not change over the remainder of 1994, because insurers refused to increase the number of earthquake policies.

The questionnaire also showed that those who buy earthquake insurance tend to have a higher-valued house than those who do not. This has been a trend for many years. After these data were gathered, the Department of Insurance approved substantial earthquake insurance rate increases and allowed companies to raise the deductible to 15 percent of the structure coverage from the 10 percent that was common at the time of the Northridge earthquake. This has affected the number of people who buy earthquake insurance.

Table 3

Percent of Dwellings, Condos, & Apartments (renters) with Earthquake Insurance

California Market for Earthquake Insurance as of the end of 1994.
Results of a Survey of Insurers writing Homeowners (HO) and Earthquake (EQ) Insurance.

	Dwellings			Condos			Renters		
County	Number of HO Policies	Number With EQ	% with EQ Coverage	Number of HO Policies	Number With EQ	% with EQ Coverage	Number of HO Policies	Number With EQ	% with EQ Coverage
Alameda	285,949	123,418	43.2%	17,637	9,234	52.4%	29,983	15,636	52.1%
Contra Costa	215,930	75,114	34.8%	21,626	9,286	42.9%	19,374	8,306	42.9%
Fresno	138,478	18,715	13.5%	3,045	617	20.3%	10,728	1,655	15.4%
Kern	125,744	28,571	22.7%	2,329	613	26.3%	6,706	2,374	35.4%
Los Angeles	1,575,670	573,408	36.4%	104,352	62,119	59.5%	109,209	62,119	56.9%
Orange	459,346	173,634	37.8%	80,559	38,392	47.7%	50,033	26,839	53.6%
Sacramento	278,466	23,881	8.6%	8,357	1,420	17.0%	24,808	5,277	21.3%
San Diego	490,400	122,133	24.9%	56,867	23,576	41.5%	60,299	28,101	46.6%
San Francisco	117,161	41,634	35.5%	10,278	5,310	51.7%	32,691	20,536	62.8%
San Mateo	150,109	68,565	45.7%	11,731	6,267	53.4%	20,124	10,548	52.4%
Santa Clara	323,866	150,551	46.5%	25,524	13,722	53.8%	38,945	20,231	51.9%
Santa Cruz	57,161	24,118	42.2%	3,167	1,537	48.5%	5,201	2,464	47.4%
Rest of State	2,724,170	724,954	26.6%	130,864	59,991	45.8%	201,190	76,361	38.0%
Totals	6,302,093	1,931,449	30.6%	434,028	212,947	49.1%	549,206	254,850	46.4%
Total: insured/uninsured	6,481,927			833,118			3,865,777		
% Insured	97.2%	29.8%		52.1%	25.6%		14.2%	6.6%	

Source: California Insurance Department; California Statistical Abstract, 1995.

The California Earthquake Authority

From the financial point of view, one of the most important consequences of the Northridge earthquake has been the withdrawal of private agencies from the business of residential earthquake insurance (Russell and Jaffee, 1996). According to a May 1, 1995 California Department of Insurance survey, insurers representing 93 percent of the California homeowners' insurance market stopped writing new or renewal policies. Pressure put on state officials by insurance carriers has resulted in the creation of the California Earthquake Authority (CEA). This new agency provides "mini" earthquake insurance policies, not covering pools, patios, fences, driveways, or detached garages. The deductible will be 15 percent; the policies cover no more than $5000 worth of a home's contents, and provide a maximum of $1500 in living expenses. The administration of the contract, claims adjustment, claims settlement, etc. will be left to private insurers in the state who will be able to offer the CEA policy if they make a commitment of capital to the CEA fund.

The cost of these new policies varies throughout the state, depending on the earthquake risk and the age and construction of the home. The cost is highest in San Francisco, where the policy for a $300,000 wood frame house built before 1960 would cost $1,710 per year. In Sacramento, the same policy would cost $600.

The funding for this new authority is an interesting combination of funds. None of the budget for the authority will be provided by the state. The funding will be a combination of cash contributions by insurers, post-earthquake event assessments on insurers, reinsurance, possible sale of "Act of God" bonds, bonds sold by the State Treasurer, and post-earthquake event surcharges on future earthquake insurance premiums. If the CEA's capital is exhausted, policyholders will receive pro-rata payments. Those insurers who do not make a commitment of capital to the CEA will not be allowed to place policies into the CEA. An insurer which is not a participant in the CEA can sell residential earthquake policies, but then must retain the risk of an earthquake. Insurers will continue to offer commercial earthquake insurance.

The success of the CEA will depend on the number of policyholders who choose to participate in the program and the occurrence of major, damaging earthquakes. A large number of policyholders and few earthquakes would allow the capital available to pay off losses to build up so that a substantial amount would be available for the next catastrophic earthquake. Undoubtedly other states will be watching the future of the CEA with great interest.

What Insurers Need to Know From Engineers and Earth Scientists

Insurers need information so they can decide whether to offer earthquake insurance, and if so, for what types of losses and what deductible rates and amounts. More specifically, they need the following information from engineers and earth scientists:

- Engineering information that is used in a *damage ratio.* A damage ratio is the ratio of the expected insured loss to the replacement value of the structure and contents for a given shaking intensity. Engineers can provide information on the expected performance in an earthquake for classes of buildings, based on structural type, code applicable during construction, and effect of building components.

- Maps of shaking intensity to apply to structures with known damage ratios to estimate the expected average annual loss to that structure at that location.

- Surface geology maps showing areas of likely ground failure.

- The distribution of damage ratios in defined geographic areas, based on engineering judgments. The distribution allows the industry to estimate the number of small losses as well as identify areas of large losses. This information is needed to determine the effect of changing deductibles.

- Exceedance probabilities—the probability of exceeding certain levels of ground shaking that will result in higher than average losses. For instance, the probability of exceeding $12 billion in insured losses from a given earthquake event is critical information for reinsurers, who may then

be expected to cover the losses that exceed a certain amount. Insurers can then combine these probabilities with the information they have on insured properties—building inventories and geographical distribution.

- Probable maximum loss (PML) estimates for individual buildings. It is critical that a standard definition of PML for individual buildings, as well as a methodology to calculate it, be developed. Individual PMLs, currently developed using a wide range of different techniques, have a tremendous effect on property values.

Insurance companies manage their portfolios by reducing the high concentrations of risks in certain areas. While it may be very difficult to predict when and where the next earthquake will occur, the relative amount of damage among different types of building construction and among different types of soil conditions is useful. It is important to know how the amount of damage varies with the distance to the area of energy release and the potential magnitude of an earthquake. The relative importance among the structural, soil and fault proximity factors is important because this is reflected in the proper premium rate to charge for each building at a particular location. For instance, if the cost to repair damage to a masonry building is expected to be ten times greater than the cost to repair damage to a wood frame building, then the premium rate should be ten times greater. There are some efforts now underway among various insurers to collect this information and use it in decision making; however, these efforts need to be standardized and improved in terms of accuracy and consistency.

The last major study undertaken by structural engineers to estimate damage ratios was ATC-13, *Earthquake Damage Evaluation Data for California*, published by the Applied Technology Council in 1985. In view of the extensive building damage in the 1994 Northridge earthquake, the insurance industry would welcome a confirmation or update of that study by the structural engineering profession. The ATC-13 study (funded by FEMA) is the basic analysis used by the insurance industry. The FEMA/National Institute of Building Sciences (NIBS) methodology, currently under development, will contain updated damage ratios. The California Insurance Department has partly funded, along with the U.S. Geological Survey (USGS), two studies on damage ratios based on insurance industry claims statistics (see Steinbrugge and Algermissen, 1990; Steinbrugge and Roth, 1994).

Insurers need to work closely with earth scientists and engineers in interpreting available data. For example, damage patterns may be fairly predictable with a strike/slip fault (as distance from the fault rupture plane increases, damage usually decreases, except in poorly constructed buildings on poor soil). However, it may be more complicated with a thrust fault. Since the fault plane dips at an angle with a thrust fault, serious damage may occur in places that might not be indicated by traditional models that work with surface fault traces. In the special case of buried thrust faults, damage patterns may be even more difficult to predict. By working closely with scientists and engineers, insurers can make decisions that reflect a more sophisticated understanding of the earthquake risk.

The Potential for Mitigation

As an organization composed of earthquake professionals, the Earthquake Engineering Research Institute's interest in earthquake insurance lies in its potential to mitigate or reduce the losses and disruption from earthquakes and its role in recovery. At present, as explained below, there is greater potential for mitigation with commercial earthquake lines than residential lines. Insurance companies do not promote mitigation for residential structures because the premium amount is not enough to pay the cost of a reasonable inspection of the property and to give a credit on the premium rate for mitigation.

Insurance does have some mitigation incentives. Insurance ratings use date of construction. Owners of older homes pay a higher premium (surcharge). If the homeowner can document that the house has been retrofitted, the surcharge is removed and the house is rated the same as a new house. Another incentive used by residential

insurers is to refuse insurance until a vulnerable house has been retrofitted. An insurer's refusal to insure is one way that the insurance industry can promote mitigation.

Further complicating the ability of the insurance industry to promote mitigation through residential earthquake insurance is the fact that insurance policies are only written for one year at a time. Many policyholders shop around each year for the best "deal," and show no loyalty in staying with the same company. Inspection and retrofit requirements vary from company to company, and many policyholders may prefer a company that does not require proof of retrofit or does not otherwise take vulnerability into account in setting rates. In addition, there are questions in the technical community about the performance of residential structures in earthquakes. A house is usually constructed by a builder who just meets the minimum code requirements and makes money selling the houses as quickly as possible. Until those questions are resolved, some insurance carriers may be reluctant to require certain retrofit measures.

There are some important differences with commercial earthquake insurance. The premium is much larger, sometimes reaching over $1 million per year for larger buildings. With premiums this high, insurers can afford to inspect the building very thoroughly. There is an incentive for the building owners to spend money on mitigation (e.g., bracing walls, ceilings, storage tanks, etc., to qualify for insurance and to get a lower premium). In addition, commercial buildings are often built by the businesses that will occupy them and have a long-term view. Therefore, building owners may be willing to spend extra money at the time of construction for earthquake mitigation to protect the business and reduce future insurance costs. A business can deduct the cost of mitigation to the commercial building from taxes. There are generally more mitigation measures applicable to commercial structures and inventory than to homes.

Mitigation measures for the other lines of insurance that cover claims after an earthquake are possible, but the industry has yet to develop them.

Conclusion

The demand for earthquake insurance by the public has grown dramatically in recent years and, hence, so has the insurance industry's exposure to large earthquake losses. Ordinarily, insurance companies cover many small independent losses, the total of which is predictable because it is based on past loss experience. In contrast, earthquake insurance deals with rare but high consequence events and the past events are not necessarily useful for predicting the future losses. The insurance industry must rely on engineering, geological, and seismological information and expertise to estimate the potential loss exposure to a group of insured buildings in a particular area.

With the riskier exposure to large earthquake losses, the insurance industry is looking for ways to reduce both this exposure as well as the potential losses. The recent creation of the California Earthquake Authority is one approach to reducing the insurance industry's exposure with residential earthquake insurance for one particular state. Its ultimate success will be determined by the number of policyholders who choose to carry this type of insurance and the frequency of major damaging earthquakes. Obviously, two Northridge-size earthquakes in the first ten years of the CEA's existence will make it difficult to pay all the claims. Insurers and policyholders need to look for additional ways to reduce potential losses. One way to do this would be for insurers to require certain mitigation measures in exchange for lower premiums.

Recent earthquakes have also illustrated the important role that insurance plays in fostering the economic recovery of individuals, families, businesses and communities after an earthquake. Community leaders, engineers and building owners need to recognize this role and involve the insurance industry more directly in planning, mitigation and rebuilding decisions. This *Earthquake Basics Brief* can be used as a first step in improving dialogue among insurers and community leaders and residents, in the hope that a better understanding of these issues will ultimately strengthen the role of insurance in both mitigation and recovery.

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Earthquake Engineering Research Institute
499 14th Street, Suite 320
Oakland, California 94612-1934
Phone (510) 451-0905
Fax (510) 451-5411
e-mail: eeri@eeri.org
website: http://www.eeri.org

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