CRS' COMMERCIAL EARTHQUAKE INSURANCE CLASSIFICATION SYSTEM

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SUMMARY

As part of the ISO Commercial Risk Services, Inc. (CRS) general program of modernizing and updating rating manuals, rules and forms, a completely revised earthquake insurance classification system was developed for implementation in 1983. The new earthquake classifications were the result of a review of the latest available seismic data and earthquake damage reports.

BACKGROUND & GENERAL INFORMATION

Insurance Services Office (ISO) has formed a new subsidiary called "ISO Commercial Risk Services, Inc. (CRS)". Like ISO, CRS is a not-for-profit, incorporated organization whose primary mission is to provide a variety of commonly needed survey, rating and policy services to the property-liability insurance industry through a pool of highly-trained and professional staff, making such services cost-efficient through the economies of scale. CRS' primary services are information gathering through individual property and community survey programs, development of advisory specific rates and classifications, distribution of a variety of insurance rating and underwriting information, and quality control and statistical coding services for commercial policies.

One of CRS's functions, that has undergone extensive review over the last several years, is the responsibility to develop uniformity in the application of commercial property rating. This review was the driving force behind the change CRS recently made in developing a major revised earthquake classification system. Earthquake classifications and rating information are contained in Insurance Services Office, Inc. "Commercial Lines Manual" (CLM), Division Five-Fire and Allied Lines.

Because of the special nature of the earthquake peril, CRS does not use premium and loss data to establish rates. In most states outside of California the loss ratio for a ten or twenty year period is negligible, being less than a few percent. Major earthquakes occur so infrequently that it is not possible to accumulate adequate statistical data in an actuarial period of 10 or 20 years or even longer time periods. Therefore; the use of experience data to determine earthquake rates is not feasible because of the extreme loss potential from major or "great" earthquakes.

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Since it is not possible to apply the usual loss to premium methods to develop earthquake rates, engineering analysis had to be used based on studies of earthquake damage to various types of buildings and the history of earthquakes in the United States. The earthquake rates are based on seismic data from the U.S. Coast and Geodetic Survey which makes it possible to divide the country into different earthquake zones.

The earthquake zones previously in use were based primarily on intensity and did not relate to frequency of earthquake occurrence. For insurance purposes, however, the recurrence interval of severe earthquakes is of critical importance.

Much work has been done in recent years on the important earthquake factors of intensity, recurrence intervals and area of damage as well as other variables. There is consequently sufficient published and unpublished data to zone the United States on a simplified, updated basis which is considered adequate for insurance purposes.

The zones follow county boundaries for practical insurance coding purposes. While this introduces some discrepancies, since county boundaries do not generally coincide with theoretical seismic boundaries, adequate weight is given to population concentrations and to property value in establishing the boundaries. Borderline cases of zoning are avoided in order to keep the number of zones within reasonable limits. The total number of zones is limited to five which is consistent with the quality of the available data.

Primary sources used for establishing CRS' earthquake zones in the United States were the U. S. Department of Commerce publication titled, "Studies in Seismicity and Earthquake Damage Statistics", 1969; Applied Technology Council report titled, "Tentative Provisions for the Development of Seismic Regulations for Buildings", 1978; and, the U. S. Department of the Interior Geological Survey titled, "A Probabilistic Estimate of Acceleration in Rock in the Contiguous United States", 1981. Based on these reports and using the latest available material, the country was divided into five zones with Zone 1 being the highest and Zone 5 the lowest earthquake potential. These zones indicate degrees of earthquake damage considering the recurrence interval, area of damage and earthquake intensity.

The existing building rates for Zone 1, the highest earthquake zone, were established as one guide point representing the maximum rates. The existing building rates for the lowest earthquake zone were established as the second guide point representing the minimum rates of Zone 5.

The rates in the intermediate zones (zones 2, 3 and 4) were then determined by relating them to the maximum and minimum rates for Zones 1 and 5 based on an analysis of the frequency of strong earthquakes, (using intensity VIII as a base) and the area of damage. Table 1 indicates the average frequency for certain areas.

TABLE 1

AVERAGE FREQUENCY OF EARTHQUAKES WITH MAXIMUM INTENSITIES V THROUGH VIII FOR CERTAIN AREAS*

Geographic Area	Earthquakes Per 100 Years per 100,000 KM^2			
	V	VI	VII	VIII
California, Nevada	300	84.6	23.8	6.72
Montana, Idaho, Utah, Arizona	64.4	17.7	4.89	1.35
Puget Sound, Washington	68.0	16.3	3.92	0.94
Mississippi Valley, St. Lawrence Valley	24.2	7.65	2.42	0.76
Nebraska, Kansas, Oklahoma	13.0	4.20	1.35	0.45
Wyoming, Colorado, New Mexico	32.8	6.85	1.42	0.31
Oklahoma, North Texas	13.3	3.73	1.07	0.30
East Coast	12.8	3.39	0.88	0.23

*From "Studies in Seismicity and Earthquake Damage Statistics, 1969", page 20, a report to HUD by Environmental Science Services Administration.

The adjusted seismicity for each zone was then calculated using these known locations. In states Other-than-Western States, earthquakes are damaging over much wider areas than are those for the Western States for earthquakes having equal maximum vibrational intensities. The ratios of these areas, with Zone 1 being 1.0, is called the "area - intensity" factor. One recent study established a ten to one ratio for the southeastern United States, while another study suggested a similar ratio for the midwest. Puget Sound appears to have a four to one area - intensity ratio based on preliminary estimates.

A comparison of relative aggregate loss probability per unit of time can then be made by multiplying the adjusted seismicity by the area - intensity factor, giving the results as shown in the last column of Table 2.

TABLE 2

Zone	Seismicity*	Area-Intensity Factor	Ratio R
1	9.14	1	9.14
2	1.82	4	7.28
3	0.79	6**	4.74
4	0.24	10	2.40
5	0.15**	10	1.50

*Adjusted seismicity for MM=VIII per 100 years per 100,000 sq. km.
**Estimated

The relativities for Zones 2, 3 and 4 for each specific construction class were then determined by using the previously established Zone 1 and Zone 5 ratios by using the following proportional formula:

$$P_n = \frac{R_1 - R_n}{R_1 - R_5} \times 100$$

P_n = % reduction in the difference between Zone 1 and Zone 5 ratios using Zone 1 as the base

R_1 = Ratio for Zone 1 (Table 2)

R_n = Ratio for Zone n (being 2, 3 or 4)

R_5 = Ratio for Zone 5 (Table 2)

The results were P_1 = 0%, P_2 = 24%, P_3 = 58%, P_4 = 88%, and P_5 =100%

Rates for our rating table were then computed by using the same equation format as above but using rates instead of R-ratios and solving for R_n.

In the states Other-than-Western States, one additional change was made in the rate calculation. A rating modification based on the relatively limited seismic data available and the previous rate level history was made for these states. The rates for Zone 2 (the highest zone in these states) were reduced by 50% and proportional reductions less than 50% were made in Zones 3 and 4. The rates in Zone 5 (the lowest zone) remained unchanged (except for change due to construction changes) since these were minimum existing rates.

Earthquakes in the states between the Rocky Mountains and the Pacific Ocean have similar characteristics, this being in contrast to another group of somewhat similar characteristics for those states east of the Rocky Mountains. Therefore, resulting aggregate loss patterns are quite different east of the Rocky Mountains than west of them. Additionally, earthquake frequency is generally much greater west of the Rocky Mountains than east of them.

Based on the foregoing, plus consideration for historical insurance differences, the United States was divided into "Western States" (including Alaska and Hawaii) and "Other-than-Western States".

Before starting any insurance discussion relating to earthquake losses to buildings, there must be a clear understanding of what constitutes a building. Further, since the earthquake hazard varies substantially among construction types and designs, it is also vital to have a suitable and practical building classification system.

The earthquake definition of a building is distinctly different from its fire counterpart. For example, two structurally independent buildings existing side by side but with communicating floors may be one building from a fire standpoint, but they may be two from an earthquake standpoint. Not only can they pound each other during a shock, but it often happens that one or the other has less earthquake damage susceptibility.

As a second and converse example, a brick firewall which is also a party wall may be the basis for defining the construction on each side as a separate building for fire. However, the party wall is an integral structural part of both sides and the failure of the wall during an earthquake will cause damage on both sides. This second example may therefore be considered as one building from an earthquake standpoint but two from a fire standpoint.

Building classes for earthquake insurance purposes are determined by construction characteristics rather than by occupancy characteristics. Examples of construction characteristics include steel frame, reinforced concrete frame, wood frame, etc., while occupancy characteristics include hotels, schools, hospitals, etc.

In general as one investigates occupancy vs. construction in more detail, it becomes evident that the structural characteristics of a building substantially predominate over occupancy characteristics with respect to the degree of damage. Therefore, earthquake classification by construction characteristics is the practical solution for insurance purposes.

Construction information gathered for fire insurance rating purposes is a source of data for earthquake classifications of buildings. Clearly, costs are reduced if data commonality exist. Further, since earthquake insurance is normally an endorsement to the fire policy, commonality in building definitions is highly desirable. But, unfortunately, an earthquake is a distinctly different peril from fire and commonality can be only partly achieved.

A few moderate size communities in California adopted building codes which required earthquake bracing in the years following the 1925 Santa Barbara, California earthquake. After the 1933 Long Beach earthquake, a number of southern California communities adopted these codes, with their usage spreading generally to northern California by 1950, and then in varying degrees throughout the United States, particularly in the Western States. Concurrently, over time, improvements in research and design practices have led to substantially improved earthquake resistive construction. The impacts of the foregoing have been significant on earthquake insurance classification systems.

CLASSIFICATION SYSTEM

CRS introduced its' latest earthquake building classification system in January of 1983. It was developed from existing classification systems with a view towards modernization and adaptability to today's property insurance practices.

Previous to CRS revised classification system there were 23 earthquake building classes in Western States, and 16 classes in Other-than-Western States. Of these, 12 required specific rating verification in the Western States and 5 in Other-than-Western States. The earthquake building classifications for all states were then consolidated into 11 Building Rate Grades. The earthquake building classification descriptions were not uniform for the Western States and Other-than-Western States.

The following major objectives are incorporated in the revision:

- Consolidate the number of earthquake building classifications, and those special classifications requiring specific rating verification.
- Modify both Western States and Other-than-Western States earthquake building classifications so that they reflect the same classification descriptions and the same number of rating distinctions.
- Make all building classifications eligible for class rating.

CRS' building classes may be placed into one of two general categories; either by materials of construction (Classes 1 through 5), or by special damage control design (Class 6). The Manual wording for Class 6 buildings does not convey a mental image of the type of construction involved. It is therefore desirable whenever a Class 6 building has an equivalent, or a near equivalent, to use the appropriate 1 to 5 classification number. This creates no rating problems due to equivalences developed in the methodologies, and is easier for users who rarely consider the earthquake classifications in their day-to-day work.

The manual classifications and definitions for class rating any commercial building is contained in Insurance Services Office, Inc. "Commercial Lines Manual", Division Five-Fire and Allied Lines. Table 3 provides a quick summary of the type of identification system. The numerals are used to designate the type of construction. The letters are used to indicate the differences in details of construction within a type of construction and will connotate the relative degree of damage to which such building may be susceptible. No CRS building class is given for 1 to 4 family dwellings because these are not included in the Commercial Lines Manual.

TABLE 3

1C & 1D:	Wood Frame Buildings
2A & 2B:	All Metal Building
3A, 3B & 3C:	Steel Frame Buildings
4A, 4B, 4C & 4D:	Reinforced Concrete Buildings
5A, 5AA, 5B & 5C:	Mixed Construction Buildings
6:	Earthquake Resistive Buildings

For those building classifications for which specific rating verification is requested, CRS has developed a publication titled, "Guide for Determination of Earthquake Classifications". Table 4 outlines the items reviewed and ranges of credits and charges developed due to the damageability of that specific feature being analyzed.

TABLE 4

GUIDE FOR DETERMINATION OF EARTHQUAKE CLASSIFICATIONS PROFILE

Item	Damageability Low	Damageability High	Credits/Charges
	Building Classification Rating Points		
FRAMING SYSTEMS:			
Bearing Wall Systems	2	20	______
Building Frame Systems	3	18	______
Moment Frame Systems	4	24	______
WALLS:			
Exterior or Interior	2	30	______
PARTITIONS:	0	10	______
DIAPHRAGMS:			
Floors and Roofs	3	25	______
SIZE:			
Area and Height	0	10	______
ORNAMENTATION:	0	16	______
SHAPE:			
Horizontal and Vertical Irregularities	0	15	______
EQUIPMENT:	0	5	______
DESIGN:	-4	16	______
QUALITY CONTROL:	-4	8	______
	Rating Penalties		
SITE DEPENDENT HAZARDS:			
Geologic Faulting	0%	25%	______
Foundation Materials	10%	25%	______
Site Topography	0%	50%	______
EXPOSURE:			
Pounding	0%	30%	______
Overhanging Structures	5%	20%	______
ROOF TANKS OR HEAVY ROOF MOUNTED EQUIPMENT HAZARDS:	0%	25%	______

To determine the applicable rates for the various Rating Points established by the "Guide", the following correlation of Rating Points and the rate applicable to the associated classification are found in Insurance Services Office, Inc. "Commercial Lines Manual":

Rating Points	Building Classification
Up to 9 pts.	1C, 2A
10 - 18 pts.	1D, 2B
19 - 29 pts.	3A, 4A
30 - 42 pts.	3B, 4B, 5A
43 - 54 pts.	3C, 4C, 4D, 5AA
55 - 79 pts.	5B
80 or more pts.	5C