SEISMIC HAZARD MAPPING OF CALIFORNIA
AND PROBABILISTIC DAMAGE ESTIMATION

by

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SYNOPSIS

Probabilistic Poisson model is used to develop a seismic hazard map of California. Peak ground acceleration contour lines are drawn for 10, 20, 30, 40 and 50 years of future time periods and 10% change of exceeding that level of acceleration. Geologic faults are modeled as seismic line sources. Area sources are used in regions with high seismicity, where geologic faults are not well defined. Past earthquake data on earthquake occurrences, Richter magnitudes, epicentral locations, and focal depths, are used to develop log-linear recurrence relationships for each seismic source. Esteva's 1973 attenuation relationship is used to translate the effect from all sources to the site of interest. A maximum Richter magnitude is assigned to each source depending on the length or area and the general seismicity of the area.

In addition to the hazard maps, cumulative probability distributions are obtained for San Francisco, Sacramento, Los Angeles, San Diego, Santa Barbara and Eureka. Acceleration zone graphs and charts are developed for these cities relating return period of events and peak ground acceleration values.

Sensitivity analysis is performed for all parameters of the model. The slope of the recurrence relationship β is found to be most sensitive to variations in the data. Similarly, highest uncertainty in the final peak ground accelerations is observed to be due to fluctuations in the α and β values. Considerable variations are found also with changes in maximum Richter magnitude. On the other hand, uncertainties in focal depth and fault location cause little error in the final results.

To obtain the expected damage at a site a model is devised which combines the information obtained from the hazard map translated in terms of response spectra parameters with past earthquake damage data. For each structure class, damage levels from 0 to 10 are defined. Then a correlation is obtained between damage and a reliability parameter $r^j(\eta,T)$. The reliability parameter is defined as the difference between design response spectrum value and a demand response spectrum value.

In general, damage for structure class j will increase as $r^j(\eta,T)$ becomes more and more negative until it reaches a lower limit and decrease to zero shortly after $r^j(\eta,T)$ becomes positive. This correlation is used to obtain a probability distribution on damage from which the expected damage can be obtained for the different classes of structures in a given area. For further details, see Kiremidjian, A. S. and Shah, H. C., "Seismic Hazard mapping of California," TR No. 21, JABEEC, Dept. of Civil Engineering, Stanford University, Stanford, California, USA, November 1975.

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