CHAPTER 4

PREDICTION OF STRONG GROUND MOTION FOR FUTURE LARGE EARTHQUAKE

4.1. BAYESIAN ATTENUATION REGRESSIONS: AN APPLICATION TO MEXICO CITY

Mario Ordaz, Shri Krishna Singh and A. Arciniega

We describe the application of a bayesian linear regression technique to the problem of deriving strong-motion attenuation relations. This approach provides a conceptual framework for the formal incorporation of knowledge about the involved phenomena that comes from sources other than the observed data (*prior information*, according to the bayesian terminology). The procedure produces numerical solutions that are more stable and rational than those obtained from conventional regression schemes. We illustrate the use of the proposed technique with the derivation of attenuation laws for the Fourier acceleration spectrum, as a function of magnitude and distance, at a hill-zone station in Mexico City.

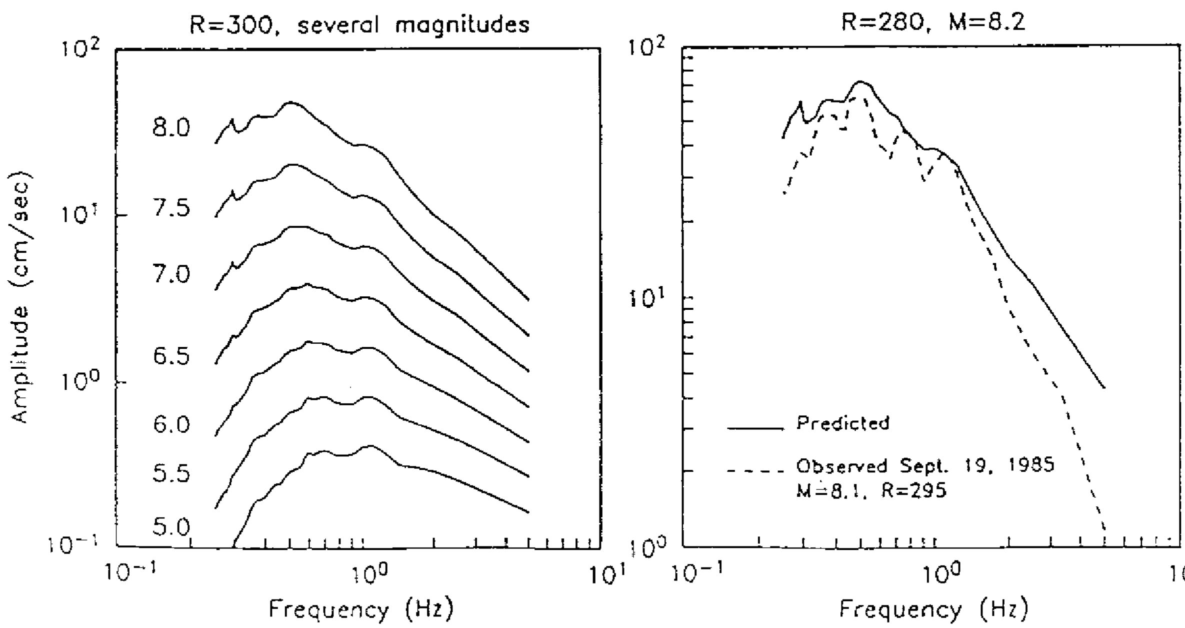

Fig. 4.1.1. Left: Median spectra predicted using the bayesian regression with $E(\alpha_2)$ = -0.5, for R = 300 km and several magnitudes. Right: Median spectrum predicted for a M=8.2, R = 280 km, hypothetical earthquake in the Guerrero gap. For comparison, we also put the spectrum of the 1985, M=8.1, Michoacan earthquake.

4.2. ESTIMATION OF STRONG GROUND MOTION FOR FUTURE EARTHQUAKES IN MEXICO

Kojiro Irikura and Jorge Aguirre

We attempt to estimate strong ground motions for future earthquakes in Mexico. The method is based on the empirical Green's function technique considering the spectral scaling law between large and small events and the scaling relations of source parameters. It is well known from the experiences of the past earthquakes that the propagation path and site effects from the coast to Mexico are too complex to estimate theoretically assuming surface geology along the paths. The empirical Green's function technique has a great advantage to include accurately such complex path and site effects. Necessary data for this method are ground motion records from small events occurring near target source areas. Further informations for this method are the locations of source areas, source rupture processes and source scaling relations. The source areas should be determined from historical seismic activities. It is reported that many of seismic gaps along the Mexican subduction zone have been filled by large earthquakes during the last two decades. However, the Guerrero gap, 250 km to southeast of the 1985 Michoacan earthquake, has not broken since 1911. Therefore, in this paper, we estimate ground motions from the hypothetic Guerrero earthquake Seismic records from the April 25, 1989 San Marcos earthquake occurring near the Guerrero gap are recorded at many points not only in the coast region but also in Mexico. Those data are very useful as the empirical Green's functions

Synthetic motions for the Ms=6.9 event are calculated for three cases where the starting point is located at the top (A), center (B), bottom(C) relatively within the source area. Rupture propagates at a velocity of 2.4 km/s radially from starting point The synthetic velocity and acceleration for the above three cases (A), (B) and (C) are compared with the observed We find that the synthetic motions for case B agree well with the observed records, where rupture starts from the center of the source area.

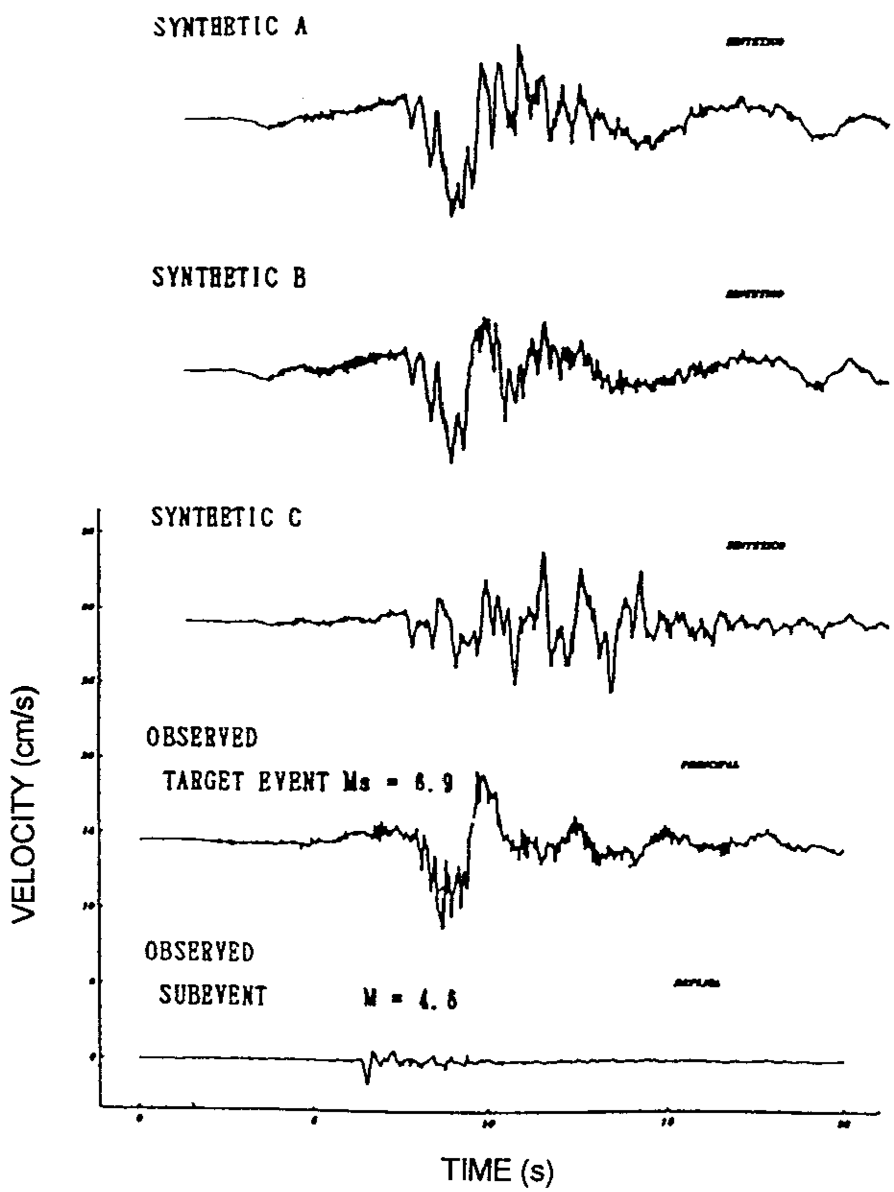

Fig. 4.2.1. Comparison of observed velocity recorded with synthetic motions for the 1985 Acapulco earthquake in three cases where the starting point is located at the top (A), center (B) and bottom (C) within the fault plane. The lowest trace shows the observed record of the small event (Ms=4.9) used as the empirical Green's function.

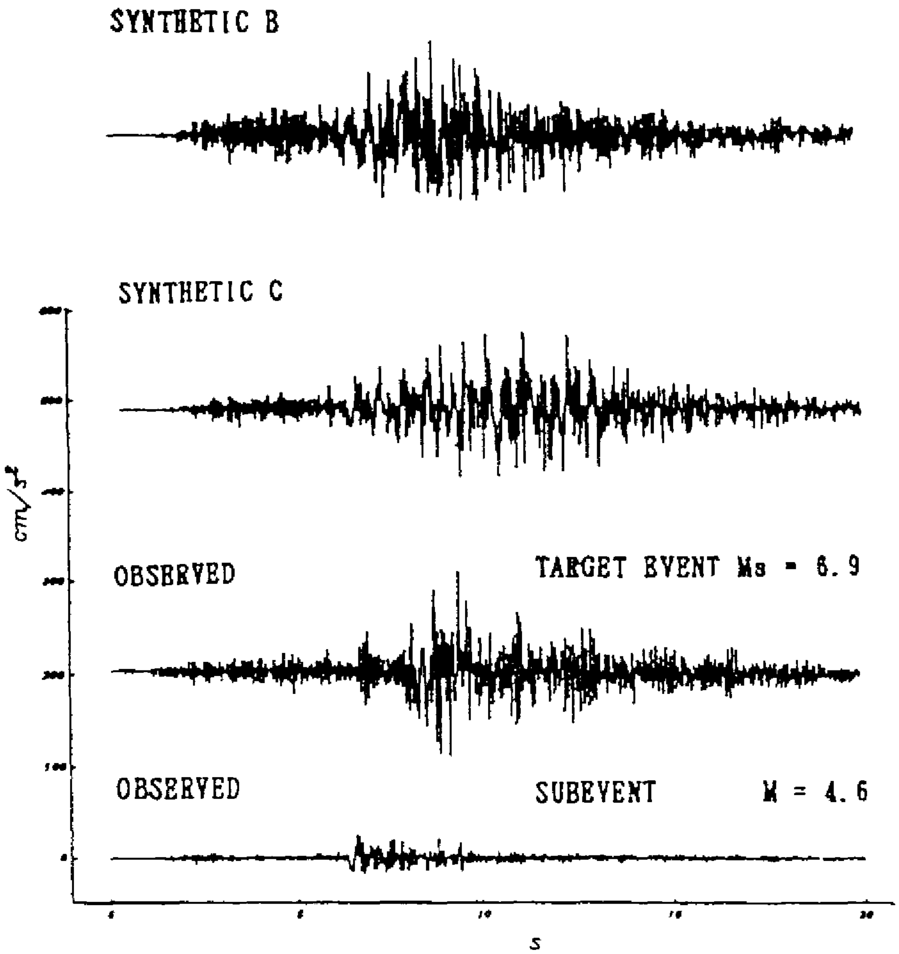

Fig. 4.2.2. Comparison of observed acceleration record for the 1985 Acapulco earthquake in two cases where the starting point is located at the center (B) and bottom (C) within the fault plane.

4.3. A SCHEME OF RANDOM SUMMATION OF AN EMPIRICAL GREEN'S FUNCTION TO ESTIMATE GROUND MOTION FROM FUTURE LARGE EARTHQUAKES

Mario Ordaz, Jorge Arboleda and Shri Krishna Singh

We present a scheme for random summation of an empirical Green's function to synthesize ground motions from future large events. This scheme obeys the ω^2 scaling law at all frequencies, and produces time histories whose envelopes are realistic. Assuming that the source parameters of the empirical Green's function are known, one needs only to specify the stress parameter of the target event. In the method, the extended target area is approximated by a point source, whose rupture duration, however, is in accordance with its dimension. Although the method does not account for directivity of the source, tests with Mexican data show a good agreement between observed and synthesized motions. We use this approach to compute expected ground motions in the Valley of Mexico from a hypothetical M=8.2 event in the Guerrero gap

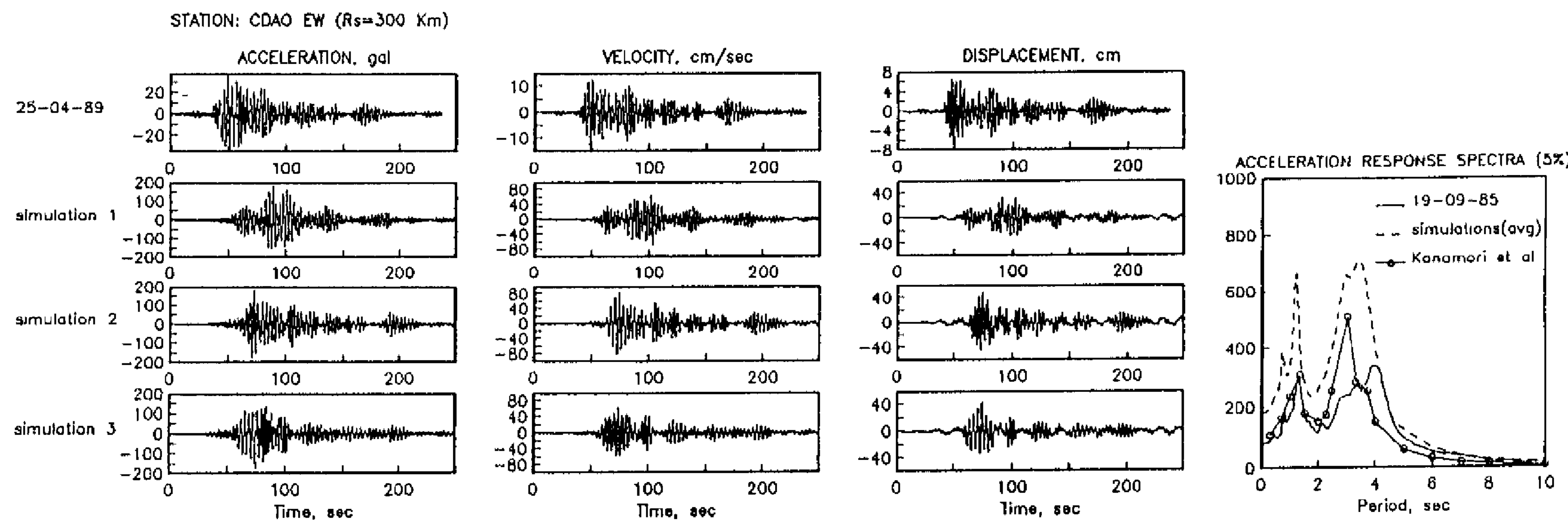

Fig. 4.3.1. Prediction of expected ground motions at the lake-bed station, CDAO, in the Valley of Mexico from a postulated M=8.2 event in the Guerrero gap. Empirical Green's function: earthquake of 25 April 1989. Average pseudoacceleration response spectrum (5% damping) from these simulations is compared with that given by Kanamori et al. (1993) on the right hand side of the figure.

CHAPTER 5

SEISMIC MICROZONING AND RISK ASSESSMENT

5.1. DATABASE FOR THE ESTIMATION OF SEISMIC RISK IN MEXICO CITY

Mario Ordaz, Roberto Meli, Carlos Montoya-Dulché, Lorenzo Sánchez and L.E. Pérez-Rocha

After the September 19, 1985 earthquake, which produced severe damage to buildings in Mexico City's lake-bed zone, many efforts have been made to better understand the nature of ground motions and the seismic behavior of structures. Results from these efforts give now the possibility of combining several sources of information to estimate the intensities and damages that would be expected due to the occurrence of postulated earthquakes In this paper we describe a model to estimate expected ground motions and building damage, based on intensity-damage relations derived for 14 classes of buildings representative of Mexico City's construction. This information, along with the geographic distribution of construction density, allows computation of expected losses during a given event and their spatial distribution throughout the city. Relevant information is stored in a database, and results are presented by means of a geographic information system.

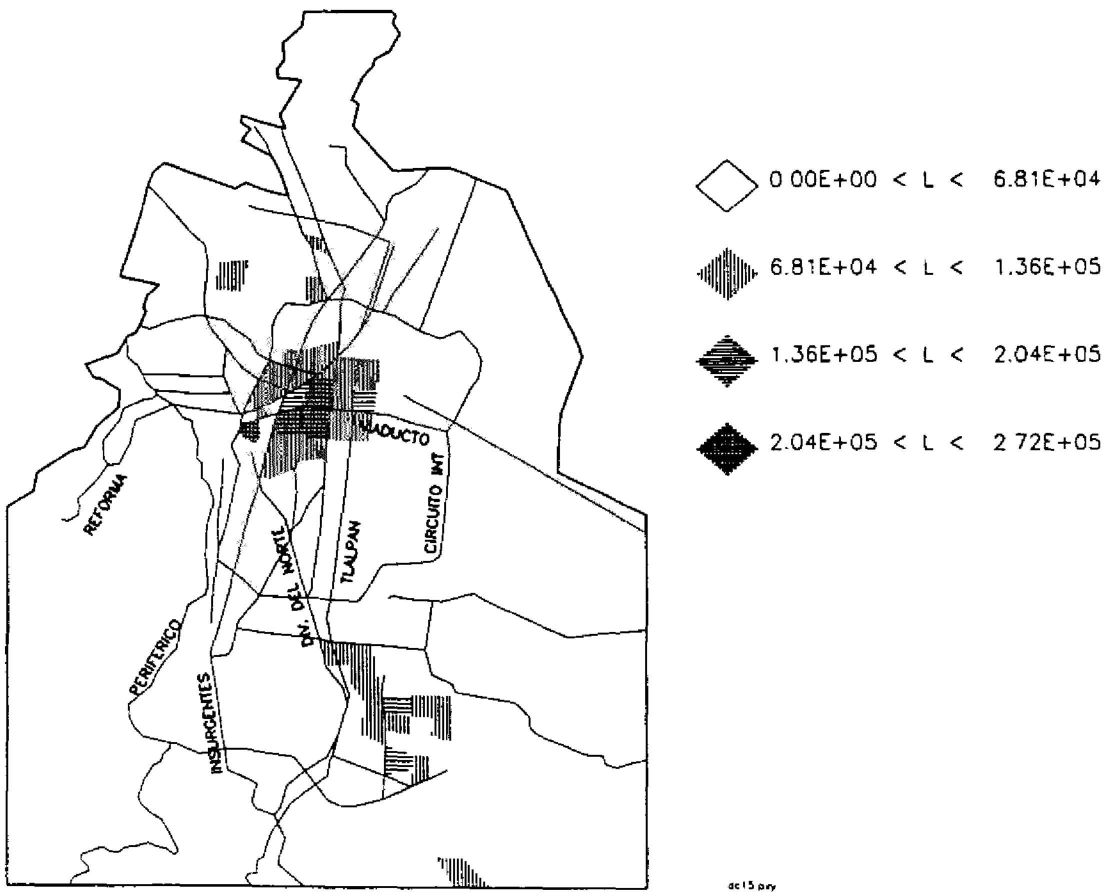

Fig. 5.1.1 Distribution of expected losses, L, in km^2, for all kinds of structures during an earthquake with the same characteristics of September 19, 1985 earthquake.

5.2. SRO-SEISMIC RISK OBJECTS, GENERAL CONCEPTS FOR A RISK EVALUATION AND ANALYSIS SYSTEM

Carlos Montoya-Dulché and Flavio Vitello Sborgia

General concepts are presented for a new seismic risk evaluation philosophy and an analysis procedure based on Object Oriented Programming (OOP) With this point of view any item related to a seismic risk can be defined by a Seismic Risk Object (SRO) The theoretical model can apply addition operator among several SRO to generate a new object composed by objects The resulting seismic risk value will be the same if integration of different objects is performed or if a new object is used since the same algorithm could be applied in both cases. The recursive composition of SRO increases dramatically the risk evaluation speed and expected damage maps generation. Those aspects are very important for the development of early damage estimation systems and emergency handling. Even if the background is seismic risk analysis, extension of this technique to other risk types is feasible.

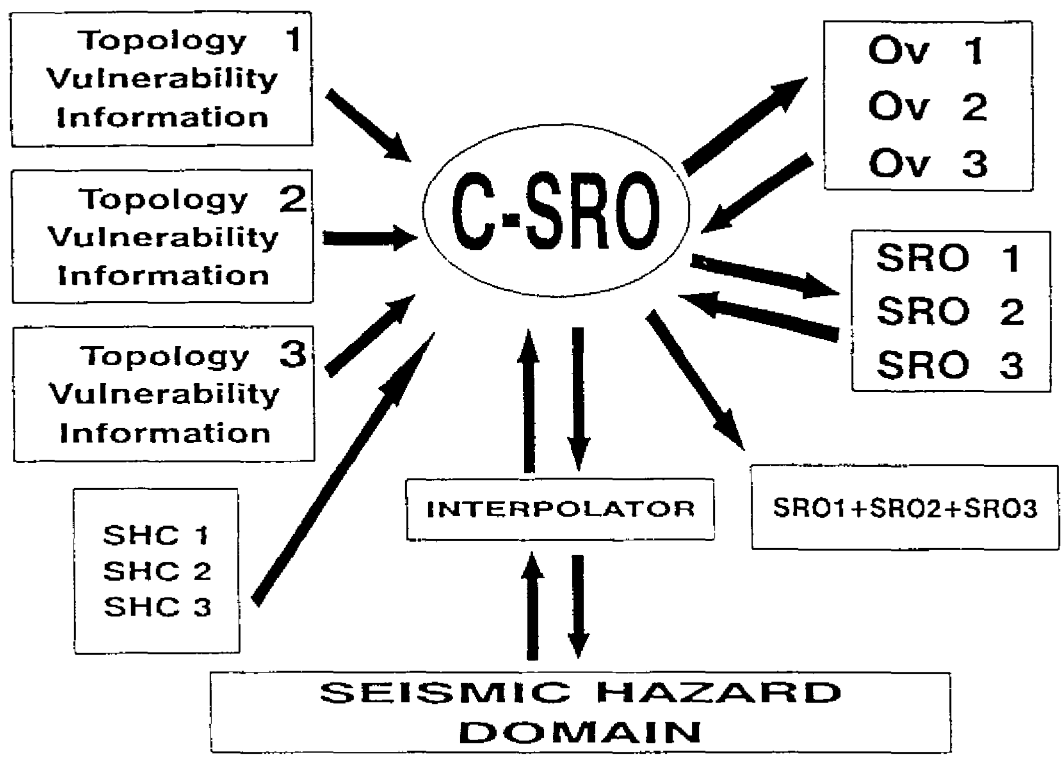

Fig. 5.2.1. SRO compiler structure

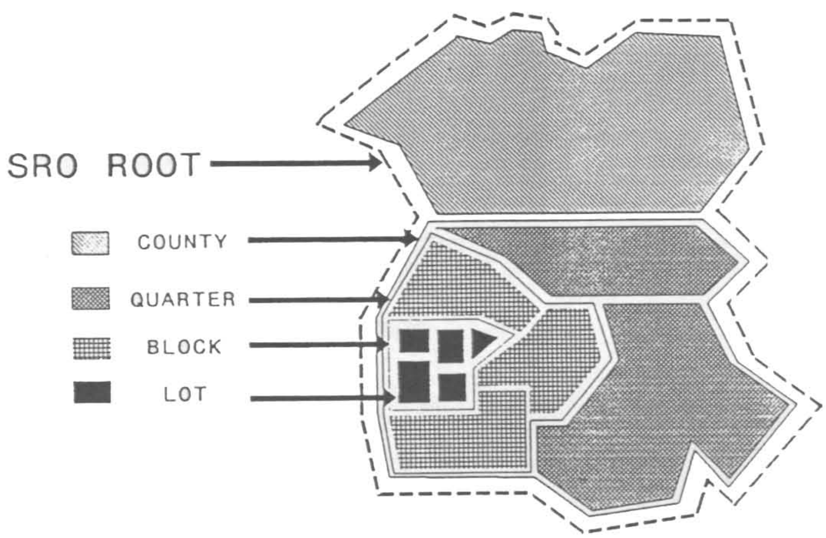

Fig. 5.2.2. Recursive composition of SRO model

5.3. SEISMIC HAZARD MAP IN COLIMA CITY

Carlos Montoya-Dulché and Flavio Vitiello Sborgia

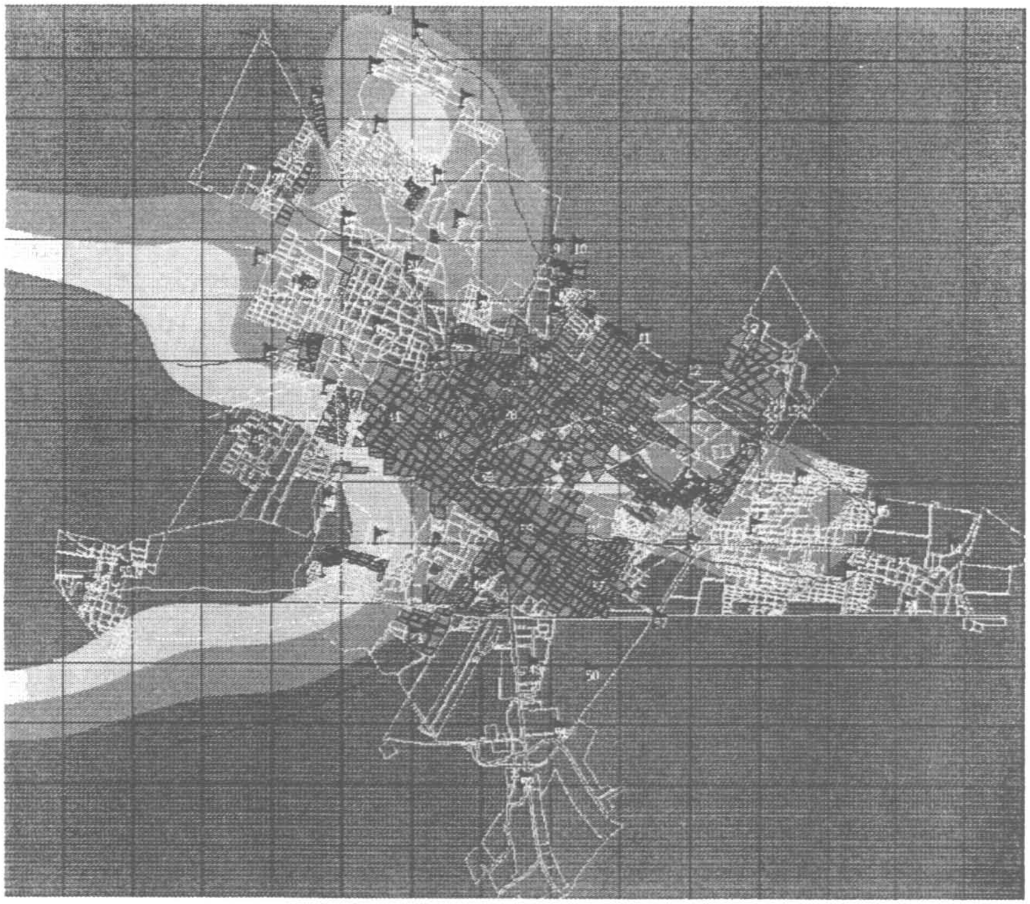

Fig. 5.3.1. Seismic hazard map for Colima City. Shaded areas show zones with different maximum acceleration values estimated for strong ground motion. Highest acceleration values were determined for western part of the city mainly used for industrial facilities. Flags represent microtremor measurement points.

5.4. APPLICATION OF THE GENETIC ALGORITHM TO THE OPTIMUM SEISMIC MICROZONATION PROBLEM

Carlos Montoya-Dulché and Flavio Vitiello Sborgia

The problem of optimal seismic microzonation is solved using an analogy with biological systems. Seismic microzonation is defined as the aggregation of several administrative areas with a specific number of different structural types in a finite number of zones. For each existing construction type in an administrative area a cost function that represents the amount, in a selected unit, due to a seismic coefficient assigned is known. The aggregation that minimizes the total of all cost functions is called optimal seismic microzonation. With this perspective, every possible seismic microzonation is an organism which evolves, reproducing itself and competing against its similar to preserve its genetic patrimony. In this process the winning organisms are those that can adapt to the environment under natural selection, generation after generation, converging to the solution. Genetic algorithms offer excellent tools to incorporate all the different issues of the natural selection to establish a complete analogy between biological and artificial organisms, in this case, the presumed optimal microzonation. To improve the algorithm's performance, a simple method to compute an initial population of solutions is proposed using those patterns which offer all the basic components that minimize the different cost functions, due to expected damages, separately and joined.

In the first part of this article the problem of seismic microzonation is described, in the second we introduce the genetic algorithms philosophy and some techniques for the evolutionary simulation. In the third part genetic algorithms are applied to revolve an example case, and a general procedure to improve the optimization process is proposed. Finally the results are discussed.

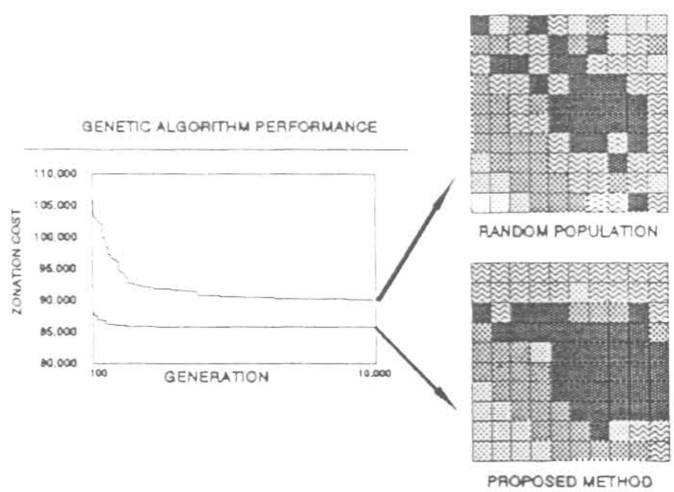

Fig. 5.4.1. Comparative performance between random and predefined populations to use genetic algorithms theory