ATTENUATION OF INTENSITIES AND DESIGN EARTHQUAKES IN CENTRAL U.S.A.

INDRA N. GUPTA[I]

Many more destructive earthquakes occur in the western than in the eastern United States of America. There is also a high density of coverage of the western states (especially California) by strong-motion instruments as well as by seismographs. For these reasons, earthquake engineers concerned with the design of earthquake-resistant structures generally use empirical relationships developed from data obtained in California. However, several recent studies (e.g., Nuttli, 1973) have demonstrated that the attenuation of seismic waves is considerably smaller in the region east of the Rocky Mountains than west. As a consequence, an earthquake in the east will have a much larger area of perceptibility and of damage than an earthquake of the same magnitude or epicentral intensity that occurs in the west. Several large historic earthquakes show that a factor of 10 or more may be involved (see Figure 2, Nuttli, 1974). Empirical relationships describing spatial attenuation of ground motion and only based on earthquake data from the west coast (e.g., Schnabel and Seed, 1973) are therefore not applicable to regions in the eastern United States.

Very little strong ground motion data are at present available in the central United States, considered to be the region east of the Rocky Mountains and west of the Appalachians. The spatial attenuation of ground motion has to be therefore determined principally using the Modified Mercalli (MM) or other intensity observations. Several recent studies of attenuation of intensities (e.g., Howell and Schultz, 1975) suggest a relationship of the form

$$I(R) = I_o + a + b\,R + c\,\log R$$

where I(R) is the site intensity at a distance, R from the epicenter of an earthquake of epicentral intensity, I_o and a, b, and c are empirical constants. Using data from isoseismals of the December 16, 1811, New Madrid, Missouri and the November 9, 1968, southern Illinois earthquakes and an average value for the coefficient of anelastic attenuation, Gupta and Nuttli (1976) obtained for $I(R) \geq IV$ (MM),

$$I(R) = I_o + 3.7 - 0.0011\,R - 2.7\,\log R; \quad (R > 20 \text{ km})$$

where R is in km. Similarly, by measuring the areas occupied by isoseismals of various intensities of ten earthquakes with epicentral intensities, $I_o \geq VI$ (MM) and applying the least squares method, the following attenuation relationship has been obtained (Gupta, 1976)

$$I(R) = I_o + 2.35 - 0.00316\,R - 1.79\,\log R; \quad (R > 20 \text{ km})$$

I. Senior Seismologist, Ebasco Services, Incorporated, 2211 W. Meadowview, Greensboro, N.C. 27407 U.S.A.