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STOCHASTIC PREDICTION OF GROUND MOTION AND SPECTRAL RESPONSE PARAMETERS AT HARD-ROCK SITES IN EASTERN NORTH AMERICA

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ABSTRACT

Empirical predictions of ground motions from large eastern North American earthquakes are hampered by a lack of data for such events. For this reason, most prediction techniques have been based, at least in part, on data from the seismically active and well-instrumented western North America. Concentrating on the prediction of response spectra on hard-rock sites, we have used a relatively new, theoretical technique that does not require western data to make ground motion predictions for eastern North America. This method, often referred to as the stochastic model, has its origins in the work of Hanks and McGuire, who treat high-frequency motions as filtered random Gaussian noise, for which the filter parameters are determined by a seismological model of both the source and the wave propagation. The model has been successfully applied to the predictions of ground motions in the Western United States and to short-period magnitudes from large to great earthquakes worldwide. For our application, the essential parameters of the model are estimated by using existing data from small to moderate eastern North American earthquakes. A crucial part of the model is the relation between seismic moment and corner frequency. The relation proposed in 1983 by Nuttli for mid-plate earthquakes leads to predictions of ground motions that are lower than available data by a factor of about 4. On the other hand, a constant stress parameter of 100 bars gives model predictions in good accord with the data. To aid in applications, the ground motion predictions are given in the form of regression equations for earthquakes of magnitude 4.5 to 7.5, at distances within 100 km of the source. The explanatory variables are hypocentral distance and moment magnitude (*M*). Because predictions are often required in terms of m_{Lg} rather than *M*, we have used the theoretical model to establish a relation between the two magnitudes. The predicted relation agrees with the sparse data available, although the large uncertainties in the observed magnitudes for the larger events, as well as the sensitivity of the theoretical magnitude to the attenuation model, make it difficult to discriminate between various source-scaling models.

INTRODUCTION

The prediction of ground motion or response amplitude as a function of earthquake magnitude and distance is of fundamental importance to the assessment of seismic hazard. Historically, attenuation relations were first developed empirically for California by regression analysis of observed ground motion parameters, most typically peak horizontal acceleration (a_{max}). Recent relations of this genre (Joyner and Boore, 1981; Campbell, 1981) are quite reliable for California, where there is now a good strong-motion data base, albeit with significant shortcomings for large magnitudes at near distances. For eastern North America (ENA), the lack of a strong-motion data base necessitated the development of prediction relations by indirect methods. Typically, correlations of Modified Mercalli Intensity (MMI) with a_{max}, and possibly distance, were combined with observations on the attenuation of

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