SOIL-TYPE DEPENDENT SEISMIC HAZARD MAP FOR THE BAYAMO REGION (EASTERN CUBA)

Seismic hazard for the Bayamo region (eastern Cuba) is computed taking into account the local soil characteristics. A detailed geological map was used for this and two approaches were followed: the use of soil related PGA attenuation relations and the application of soil amplification factors to bedrock estimates. A detailed hazard map like the one here presented can be used for further risk estimates. In addition, a comparison is done between the PGA hazard estimates and those in terms of macroseismic intensity. Also this last assessment derives from the use of differentiated attenuation relations and the application of amplification factors to average intensity estimates.

It is possible to establish the differences within the complex geological and tectonic framework of the Bayamo territory, due to several evolution stages, taking into account the age, tectonic setting and geological characteristics. Two main geological structures can be seen in the Bayamo area: the Sierra Maestra Anticlinorium and the Cauto Basin. Fundamentally, Paleogenic rocks of the island arc constitute the first one, which is transitioning gradually to terrigenous and carbonate sequences, or both. The second one is constituted by typical sediments of the terrigenous-carbonatic neoplatform stage of Neogene-Quaternary age.

The detailed seismic hazard assessment for the Bayamo region has been performed according to the well consolidated seismotectonic probabilistic approach (Cornell, 1968). This approach requests the space definition and the seismic characterisation of the seismogenic zones (SZs). The present study benefits of the results of Garcia (2001) as the same seismic model is here used. Hazard maps of regional validity have been computed for a 475-year return period and for different soil types (rock, stiff, and soft soils) by the SEISRISK III computer code (Bender and Perkins, 1987) considering the Ambraseys et al. (1996) PGA attenuation relations and taking into account the standard deviation of the relations. In order to obtain a soil-dependent PGA map, the local soil characteristics have been associated to the main soil classifications available in literature. More precisely, the classification of Ambraseys et al. (1996) has been used to differentiate PGA attenuation relations and the one proposed by Field et al. (2000) has been introduced to quantify the soil amplification factors with respect to rock. In fact, Field et al. (2000) proposed amplification coefficients for different soil types with respect to PGA at the bedrock: they are based to the velocity of the shear waves in the upper 30 m ($V_{30}$). $V_{30}$ has been estimated for the geological formations in the Bayamo region according to their different geotechnical properties. The PGA map according to the different Ambraseys et al. (1996) attenuation relations was obtained simply by taking the proper PGA value according to the soil type (rock, stiff or soft soil). Similarly, also the PGA map according to the Field et al. (2000) amplification coefficients was obtained. In this case the PGA values on rock were amplified with the proper coefficients. As there is no way to judge, which of the previous maps is better, it was decided to average at 50% the previous
results. The final PGA map so obtained shows two different sectors around Bayamo: the first is wider than the second and is characterised by values lower than 0.19 g while in the second, along the Bayamo river valley, the PGA exceeds 0.21 g.

The most recent intensity hazard map for Cuba (Garcia, 2001) shows a regular pattern in the Bayamo region with values increasing from VII MSK to VIII MSK going from NW to SE (as usually done, no standard deviation on attenuation has been introduced). Although the attenuation relations used in that study are source-specific, they are not obviously capable to take into account the local response. Evernden and Thomson (1985) related the observed local intensity amplification to the site geological characteristics in California. The Evernden and Thomson (1985) classification has been applied also in the present study considering the geological map and the related amplification terms. It can be seen that a more detailed differentiation of rock types is introduced with respect to Field et al. (2000). The intensity hazard map resulting from the application of these last amplification terms differs strongly with the regional map: the values, in fact, generally decrease from north to south, reaching the maxima along the river valleys at the contact of the anticlinorium and basin formations. Bayamo is located in an area where intensity is expected not to exceed X MSK but along the valley of the Bayamo river higher values can be reached. This last map displays very high values that have never been observed in the region. The PGA estimates have been, therefore, transformed into intensity values by the inverse of the Trifunac and Brady (1975) relation: the results range now between VII and VIII MM, showing a general agreement with the average intensity map computed. It must be pinpointed that these intensity estimates come from PGA estimates with standard deviation of the attenuation relation while no uncertainty was considered in the regional intensity map. The shape of the equal intensity areas is now controlled by geological features, the maxima following the deposits of fluvial valleys.

REFERENCES