ESTIMATION OF ECONOMIC LOSS IN STRUCTURES ASSOCIATED WITH SEISMIC HAZARD IN TUXTLA GUTIERREZ

González Herrera, Raúl; UNICACH. Email. raul.gonzalez@unicach.mx
Mora Chaparro, Juan Carlos; UNAM-IG
Aguirre Gonzalez, Jorge; UNAM-II
Aguilar Carboney, Jorge Alfredo; UNACH
Narcía López, Carlos; UNICACH

Computational seismology

This research was realized in the city of Tuxtla Gutierrez, Chiapas considering the geotechnical, geological, morphological, hydrological, social and economic characteristics of the city, as well as a study of seismic microzonation. We developed a detailed earthquake hazard analysis of the downtown of the city. With this purpose we considerate urban planning projects and lithographs dating from the early 19th century up to present to understand site effects from historical sources. Additionally, we observed the evolution of housing type as well as the city´s growth trends. We documented the river paths and flows, bodies of water, sprawl areas. In these zones the ground presented special dynamic features. We used various geophysical techniques like Nakamura, SPAC, Calicatas-SPAC, to determine from microtremors (environmental vibration), the dominant periods, the relative amplifications, and velocity profiles. We delimited two zones: 1) Slope areas that have a maximum frequency of 15 Hz, this region corresponds to the original soil without modification; 2) Downtown area (Valley), which presents maximum spectral values of 2 at 1 Hz, which corresponds to soft soils. The relative amplification values ranges from 2 up to 25 times depending on the local soil characteristics identifying a site effect located in downtown area lose to the Sabinal River. We elaborated an earthquake catalog using the database from the National Seismologic Service 1974-2012 and the Inter University Earthquake Engineering Network 1995-2012. The earthquake hazard was estimated with different PHSA techniques such as CRISIS (2007), PRODISIS (2008), and empirical Green's functions. As a result of our analysis, we estimated an expected maximum PGA of 589 for a 475-year return period. We identified thirteen local building systems as a result of the fieldwork and we established their distribution in the city. That building systems were modeled with SAP2000 and NONLIN to assess dynamic parameters such as lateral distortion and maximum rotations. As an outcome of this research we developed an algorithm in Matlab named SORIS that evaluates the vulnerability of each system integrating the effects of structural irregularities to obtain the fragility curve of each construction systems. In addition, we built a database that includes the specifics of about 6,000 buildings distributed in the urban area. Each building was selected according to statistical inference. The database is a statistically representative sample of the households in the city. SORIS provides the following scenarios for the different construction systems:

Scenario 1 (50-year return period; 0.15g): 106,140 buildings (73.21%) without damage; 30,595 (21.10%) immediately occupancy with minor damage; 7,081 (4.88%) living conditions with moderate damage; 1,039 (0.72%) partial collapse prevention; and 121 (0.08%) total collapse.

Scenario 2 (100-year return period; 0.27g): 85,792 buildings (59.18%) without damage; 45,095 (31.10%) immediately occupancy with minor damage; 11,890 (8.20%) living conditions with moderate damage; 1,740 (1.20%) partial collapse prevention; and 459 (0.32%) total collapse.

Scenario 3 (150-year return period; 0.43g): 51,934 buildings (35.82%) without damage; 66,966 (46.19%) immediately occupancy with minor damage; 20,083 (13.85%) living conditions with moderate damage; 4,495 (3.10%) partial collapse prevention; and 1,498 (1.03%) total collapse.

Scenario 4 (475-year return period; 0.60g): 10,754 buildings (7.42%) without damage; 89,194 (61.52%) immediately occupancy with minor damage; 21,605 (14.90%) living conditions with moderate damage; 14,089 (9.72%) partial collapse prevention; and 9,329 (6.43%) total collapse.

The results of this study were calibrated considering the local impact from the earthquakes of October 20, 1995, and April 7, 2011 confirming the estimated scenarios. Finally, our results are presented in maps that display the spataila distribution of damage for the different scenarios which can be used for earthquake risk management in Tuxtla Gutierrez City.