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Site effects zonation of Roquetas de Mar town (SE Spain) from seismic methods and geotechnical surveys

Antonio García-Jerez (1), Marcos Martínez-Segura (2), Ignacio Valverde-Palacios (3), Marina Arrien (1), Juan F. Navarro-López (2), Manuel Navarro (1), Luis Molina (4), Francisco Luzón (1), Francisco J. Sánchez-Sesma (5), Rubén Candela-Medel (1), Helena Seivane (1), and Francisco Navarro (4)

(1) Dpto. de Química y Física, Universidad de Almeria, CITE II-A, 04120 La Cañada, Spain, (2) Dpto. de Ingeniería Minera, Geológica y Cartográfica, Universidad Politécnica de Cartagena, Paseo Alfonso XIII, 52. 30203 Cartagena, Murcia, Spain, (3) Dpto. de Construcciones Arquitectónicas, Universidad de Granada, 18071 Granada, Spain, (4) Dpto. de Biología y Geología, Universidad de Almeria, 04120 Almeria, Spain, (5) Instituto de Ingeniería, Universidad Nacional Autónoma de México, Coyoacán 04510 CDMX, Mexico

Roquetas de Mar town is within the Campo de Dalías basin (Almeria province in southern Spain), a large coastal plain in one of the most seismically active regions of the Iberian Peninsula, between Alboran Sea and the south-eastern front of the Betic mountain range. Roquetas is the second most populated municipality of the province, after Almeria city, with more than 93000 permanent inhabitants and important seasonal increments due to touristic activity.

Several studies have been conducted to assess potential seismic site effects in the main urban area of Roquetas de Mar, including active- and passive-source seismic surveys and the analysis of compiled geotechnical and borehole data as well.

In particular, the shallow ground mechanical properties have been investigated by means of multichannel analysis of surface waves (MASW) and geotechnical information gathered from reports of construction projects. Almost 2 km of S-wave velocity cross-sections with penetration of 20-30 m have been performed along six MASW profiles. These results show significant variations in the Vs structure across the town. The highest velocities have been found in the SW of Roquetas Pueblo district, with values from 600 to 1000 m/s down to the prospected depth ($\sim$ 25 m). The softer soils were around a seasonal stream at NW Roquetas Pueblo district and in a salt marshes area at NW Algaida district. In these two cases, sediment velocities range from 100 to 350-400 m/s within the upper $\sim$ 10 m, whereas velocities exceeding 700 m/s are found at about 16 m depth.
The liquefaction hazards and expected earthquake-induced settlements have been computed from the geotechnical information. Soils are classified as liquefiable in terms of the liquefaction potential index (LPI > 5) in several seaside zones of the town.

A much deeper velocity contrast is revealed by high period peaks of the H/V spectral ratios of ambient noise (AN). These measurements were carried out approximately at the vertexes of a 500 x 500 m square grid. Two array measurements of AN (560 m and 810 m aperture) and the geological record at a deep borehole show that this contrast corresponds to the boundary between Neogene materials and the Triassic limestones and dolomites of Sierra de Gádor mountains, at about 500 m depth in the centre of Algaida district.
The bulk of the fundamental periods range from 0.8 s to 2.5 s, increasing towards the south and southeast. The deepest zone is bounded to the south by the trace of the Guardias Viejas antiform, which crosses the basin with ENE-WSW trend.
The shallow low-velocity layers are evidenced by secondary high-frequency peaks, often with large amplitudes. Their periods range from 0.1 to 0.3 s in the northern districts, pointing to possible resonance effects for existing building structures.