

## Learning from Earthquakes

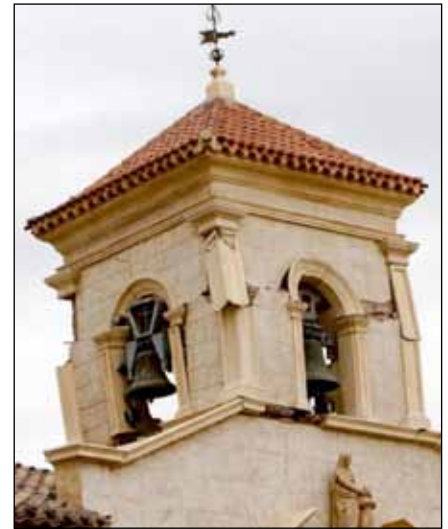
### Lorca, Spain, Earthquakes of May 11, 2011

*This report was prepared by Janira Irizarry, Tanit Frontera, and Xavier Goula of the Institut Geologic de Catalunya, Barcelona, and EERI member Alex H. Barbat of the Technical University of Catalonia. They will be conducting a more in-depth reconnaissance in late May.*

On May 11, 2011, at 16:47 GMT (18:47 local time), a shallow  $M_w$  5.1 earthquake occurred less than 5 km northeast of the city of Lorca, in southeast Spain. A maximum intensity of VII (European Macroseismic Scale, EMS) was assigned to this event by the Spanish Geographical Institute (Instituto Geográfico Nacional, IGN). It was preceded by an  $M_w$  4.5 earthquake, which occurred at 15:05 GMT the same day, with an assigned maximum intensity of VI. The intensity estimation for the second event is much more complex

because of the short time interval between the two earthquakes.

Lorca is located over a system of faults that generated the earthquakes. The damage in the center of the city is worse than would be expected from the earthquake's magnitude, as nine lives were lost and many buildings have been declared uninhabitable. Due to the proximity of the epicenter to the city and the shallowness of the source, the building stock suffered significant accelerations — 0.37g was recorded in IGN's Lorca accelerometric station. In addition, the presence of soft soils in Lorca could have caused an amplification of the seismic waves. Its building stock includes a large number of buildings constructed before seismic construction codes were officially implemented in the 70s, increasing its seismic



*Damaged church bell tower in Lorca (photo: Reuters/Francisco Bonilla).*

vulnerability.

From a preliminary look, it seems that the majority of the damage occurred to unreinforced masonry (URM) buildings, with cracked walls and loss of connection between walls. Many nonstructural masonry elements such as eaves and cornices were damaged; their fall to the street was the main cause of the majority of deaths. Many URM monuments, such as a castle and a monastery, have been heavily damaged, including fallen belfries. Some damage has been observed in reinforced concrete buildings, mainly to nonstructural elements, but no results from specific damage surveys are available at this moment. One three-story reinforced concrete frame collapsed during the second earthquake; the cause is still being investigated.

The local and regional authorities of Murcia deployed 26 teams of experts that completed an initial inspection of the damaged buildings in the center of Lorca in 48 hours. This inspection resulted in more than 1,000 buildings declared uninhabitable. The Spanish Association of Seismic Engineering (AEIS) is coordinating a field survey in which inspections will validate the vulnerability functions that are currently applied in simulations of seismic risk scenarios.

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