PHYSICS OF THE DAMAGING GROUND MOTION IN THE VALLEY OF MEXICO ON SEPTEMBER 19TH, 2017 (MW7.1)

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Built-up on top of ancient lake deposits, Mexico City experiences some of the largest seismic site effects in the world. The M7.1 intermediate-depth earthquake of September 19, 2017 (S19) collapsed 43 one-to-ten story buildings in the city close to the western edge of the lake-bed sediments, on top of the geotechnically-known transition zone. In this work we explore the physical reasons explaining such a damaging pattern and the long-lasting strong motion records well-documented from past events by means of new observations and high performance computational modeling. Besides the extreme amplification of seismic waves, duration of intense ground motion in the lake-bed lasts more than three times those recorded in hard-rock a few kilometers away. Different mechanisms contribute to the long lasting motions, such as the regional dispersion and multiple-scattering of the incoming wavefield all the way from the source. Recent beamforming observations at hard-rock suggest that duration of the incoming field is significantly shorter than the strong shaking in the lake-bed. We show that despite the highly dissipative shallow deposits, seismic energy overtones dominating the ground motion from distant earthquakes can propagate long distances in the deep structure of the valley, promoting also a large elongation of motion. However, our results for the S19 earthquake indicate that the damage pattern in this case is most likely due to the propagation of the surface waves fundamental mode across the transition zone of the basin. Transduced and induced waves along the basin edge are thus responsible of the localized damage pattern.