LESSONS LEARNED FROM THE 21ST AUGUST 2018 M_t 6.9 EARTHQUAKE IN TRINIDAD

PAPADOPOULOS I.

The University of the West Indies, seismic Research Centre, St. Augustine Campus, Trinidad.

Corresponding author: ilias@uwiseismic.com

ABSTRACT

On 21st August 2019 evening, Trinidad was rocked by an M_t 6.9 magnitude earthquake occurring north of the Paria Peninsula. It is the largest magnitude event of the past 250 years and resulted in minor damages on buildings at the north of the island and significant deformation on the ground at the southern part. Analysis of data from the Port of Spain Strong Motion Network reveals that the level of structural damage in the capital is between the expected ranges, while structures built without engineering inspection suffered more severe damage. At the south area of Los Iros, significant ground deformation led to the destruction of agricultural farms and ponds, while an area prone to landslide slumped to the coast. Ongoing research shows the area subjected to lateral spreading due to the prolonged duration of the earthquake. The UWI SRC collected more than 1000 citizen reports through the online “Did You Feel It?” module and the Citizen Seismologist Project, revealing the spatial distribution of perception of shaking. Macroseismic intensity map shows a normal distribution of the ground shaking decreasing with distance. A social media poll a year later shows that citizens responded to the violent shaking with prayers and fear, while a lot were concerned about their family and caught by surprise. The low level of damage created the false impression to a lot of citizens throughout the country that the building stock is of high quality, when compared to other areas with similar magnitude events (e.g. Haiti, 2010), not taking into account the geometrical parameters of the different events.

The Port of Spain Strong Motion network

Starting in mid-2017, The UWI SRC began the installation of strong-motion sensors in the urban areas of Port of Spain. The installation sites are depicted and guided by the results of the Microzonation Project, conducted by The UWI SRC and which concluded in the Port of Spain area in 2016. By August 2018, seven strong-motion sensors had been installed in Port of Spain (see Table 1). On 21st August 2018, six of them were operational and able to record waveforms of the earthquake. Due to the high intensity, in Woodbrook area the power was cut off, and two of the sensors weren’t able to record the full waveform.

In Figure 1 we present the recorded spectral acceleration from the Port of Spain Strong Motion Network. Given that two stations did not record the whole waveform, we focus on the rest four that were fully operational during the event. We also added the design spectrum for Soil Class C, as well as the attenuation equations prediction for the 21st August 2018 event. This can help understand what this specific event triggered in Port of Spain, and guide for further discussion.

In the same figure we have also included the design spectrum for 2% probability of exceedance in 50 years. This design is followed by engineers when the building is of public interest or is considered a critical facility (eg. hospitals, schools, religious and government buildings). The building codes require this type of buildings to be designed to withstand the seismic load of any potential event, hence the design curve is much higher than the 10% equivalent one.

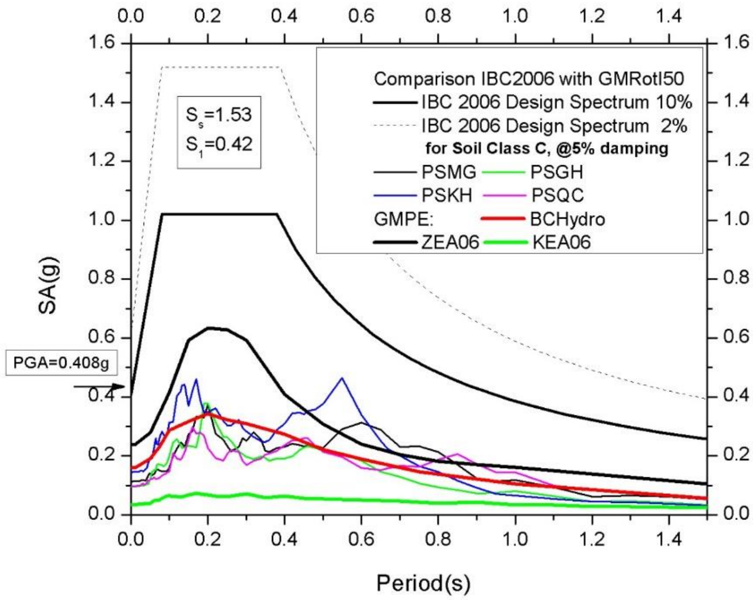

Figure 1: Recorded spectral acceleration in four station of Port of Spain (thinner coloured curves). For comparison purposes the previous figures are also included; Attenuation equations predicted spectral acceleration (thicker smoothed curves) and design spectrum (top black curves).

When we compare the recorded spectral acceleration with the design spectrum, we can conclude that the shaking produced by this event is nowhere near the design (is at ~30% of the design in amplitude at all periods), except when we consider some very special cases. In both the design spectrum and attenuation equations spectra, after about 0.4s the curves decay exponentially according to the physical laws. However, in the case of Maraval, there is an increase leading to a sharp peak at 0.55s, which stands out and does not follow the decay law. The same observation occurs for Mucurapo, at 0.62s. Both cases are not captured by the theoretical curves, because this is the result of the local soil conditions, where the surface geology plays dominant role in concentrating the seismic energy in certain periods, thus amplifying the energy there. This can be due to the basin geometry, trapping of the seismic waves into a low velocity zone, multiple wave reflections on the boundaries of geological zones, or as a result of resonance due to the existence of the sediments package.

Lessons learned from the 21st August 2018 earthquake

The Port of Spain Strong Motion Network proves to be useful in order to study in a domestic environment the effects of big events on the ground and hopefully, through collaboration with engineers, the effects of earthquakes on the building stock. This specific event did not cause major structural damage to the engineered constructed buildings, rather than minor damage to non-structural parts, which is backed up by the theoretical modelling of the earthquake using attenuation equations as well as the reports collected so far. The strong motion data and processing support the results from the microzonation study conducted in Port of Spain, showing the variation at high resolution of the local site effects. Our plan and hope is that we will expand the network to other areas in the country, given the resources. It is an ambitious task, but necessary to be able to study the seismic hazard in the country in high resolution.