



## Strong ground motion records of the Zagreb earthquake of 22 March 2020

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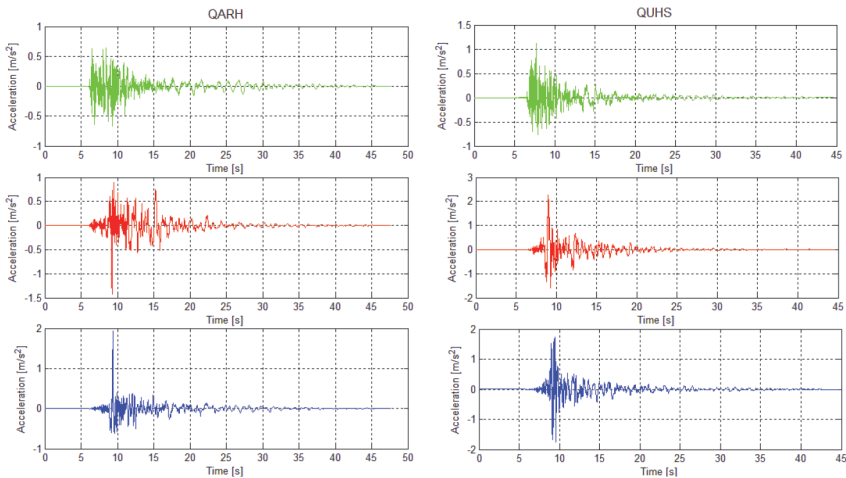
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### Abstract

In the morning of 22 March 2020 at 5:24 (UTC) a damaging earthquake struck Zagreb, the capital of Croatia. This shallow local magnitude 5,5 earthquake was the strongest instrumentally recorded earthquake in the NW part of Croatia since 1908 when the first seismological station was installed in Zagreb. The strongest aftershock of local magnitude 4,9 happened at 6:01 (UTC) on the same day. Both events were recorded by two strong motion stations in the City of Zagreb, located close to the epicentres (10 km).

**Key words:** strong motion record, PGA, response spectra

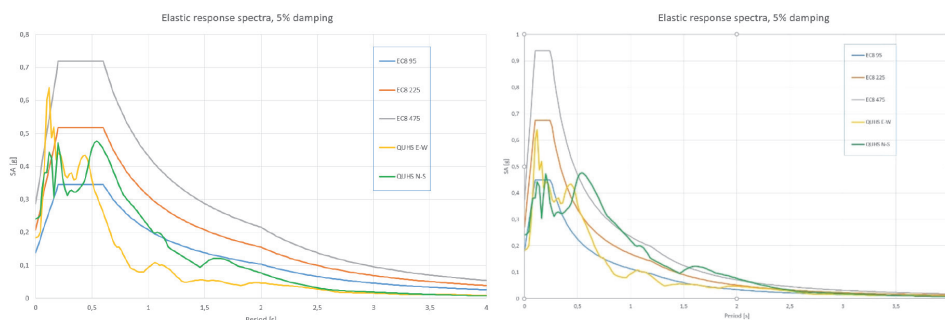
In the morning of 22 March 2020 at 5:24 (UTC) a damaging earthquake struck Zagreb, the capital of Croatia. This shallow local magnitude 5,5 earthquake was the strongest instrumentally recorded earthquake in the NW part of Croatia since 1908 when the first seismological station was installed in Zagreb. The strongest aftershock of local magnitude 4,9 happened at 6:01 (UTC) on the same day. Both events were recorded by two strong motion stations in the City of Zagreb, located close to the epicentres (10 km). Time histories of both events are presented in Fig.1.



**Figure 1. Strong motion records of the main event  $M_L=5,5$  recorded on the stations QARH (left side) and QUHS (right side). Three components are displayed: vertical (top row), N-S (middle row) and E-W (bottom row)**

Corrected values of  $PGA$  recorded during the main event were  $PGA_{corr}(QARH) = 0,20g$  and  $PGA_{corr}(QUHS) = 0,22g$ . For the strongest aftershock, corrected values of  $PGA$  recorded on these stations were  $PGA_{corr}(QARH) = 0,04g$  and  $PGA_{corr}(QUHS) = 0,07g$ . One of the main tasks was to evaluate this recorded  $PGA$  values in the light of the current seismic hazard map of Republic of Croatia compiled in 2011 for return periods of 95 and 475 years [1]. In order to enable the best practice to be included in the new Law for reconstruction of the damaged building stock, seismologists from Department of Geophysics therefore additionally defined soon after the mainshock seismic hazard map for return period of 225 years. Seismic hazard map presents  $PGA$  values on the bedrock (ground type A according to [2]), hence influence of local ground conditions on the site of the stations QARH and QUHS had to be taken into account in order to enable comparison with recorded  $PGA$  values. Microzonation study was not performed for this part of Zagreb where these two stations are located. However, station QUHS is located very close to the area already covered by microzonation study ([3]) where in its southern part prevalent ground is of type C. Station QARH is located to the south of the river Sava, where deep alluvial deposits are expected. Therefore, it is reasonable to classify ground type

on these sites as type C. Values of  $a_{gR}$  defined by seismic hazard map are almost identical for both locations QARH and QUHS for all three different return periods:  $a_{gR}(95) = 0,12g$ ;  $a_{gR}(225) = 0,18g$  and  $a_{gR}(475) = 0,25g$ . Fig. 2 shows elastic response spectra of strong ground motion of the main event recorded on station QUHS, compared to elastic response spectra of type 1 currently used in Croatia ([4]) for assumed ground type C (corresponding soil factor is  $S = 1,15$ ) and for different return periods (95, 225 and 475 years). In addition, comparison was also made to elastic response spectra of type 2 for assumed ground type C (corresponding soil factor is  $S = 1,5$ ).



**Figure 2. Elastic response spectra (5 % damping) of the strong motion record on station QUHS compared to elastic response spectra according to [2] of type 1 – left side and type 2 – right side derived in respect to different levels of seismic action defined using seismic hazard map of Croatia for return periods of 95, 225 and 475 years**

These records provide valuable data for earthquake engineering and engineering seismology and again open the question of whether elastic response spectra of type 2 is more adequate to use.

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