

December 29, 2020, M6.4 Petrinja, Croatia earthquake: preliminary report

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Around noon of December 29, 2020 (local time: 12:19pm) a magnitude 6.4 earthquake occurred near Petrinja, Croatia with the epicentre located 47km southeast of Croatia's capital Zagreb. The same area was hit by three foreshocks on the preceding day, the largest foreshock being magnitude 5.0. At the time of writing, the earthquake already claimed six lives [1] and caused widespread destruction in Petrinja and neighbouring towns. The ongoing COVID-19 pandemic presents challenges for emergency response as well as for evacuation of affected population.

The epicentre of the main shock was located about 3km WSW of Petrinja (45.422°N 16.255°E) with hypocenter at a depth of 10km. The event presumably resulted from shallow strike-slip faulting within the Eurasia Plate where focal mechanism solutions for the event indicate that rupture occurred on a nearly vertical fault striking either to the southeast or southwest [1]. More information about the event including a tectonic summary and description of past seismicity is available from USGS [2] as well as from University of Zagreb, Department of Geophysics [3] and European-Mediterranean Seismological Centre (EMSC) [4]. In an interview for HRT (Croatian Radio Television) [5], one of the leading people from Croatian Seismological Survey stated that this earthquake does not have a direct link to the earthquake that struck Zagreb in March 2020 other than both being a result of tectonics in the convergent boundary region between Africa and Eurasia. Additionally, so far there seems to be no increased activity in the Medvednica fault zone, the one responsible for the Zagreb earthquake, as a result of Petrinja earthquake [6].

While central part of Croatia is far less densely populated than the capital, with Petrinja having a population of about twenty-four thousand, the building stock is particularly vulnerable as it primarily consists of (unreinforced) masonry buildings. Moreover, this region was severely affected by the war in the early 1990's and unfortunately has not fully recovered since, neither economically nor infrastructurally. There is widespread destruction in Petrinja — a subset of photos and videos of damage from local media outlets is available via links listed in [7]. Additionally, there is significant damage in the neighbouring town of Sisak where the main hospital was rendered unusable and evacuated with patients redirected to Zagreb. There are also reports of damage reaching as far as the northernmost part of Croatia. In Zagreb, some 40km north of Petrinja, in addition to damage to government buildings, a children's hospital was evacuated and the main maternity clinic, the one evacuated after the March 2020 earthquake, suffered further damage. Large parts of Zagreb had no electricity in the aftermath with frequent shortages still ongoing. There are reports of damage to chimneys in the northernmost part of Croatia while a nuclear power plant Krško, located in neighbouring Republic of Slovenia, temporarily ceased operation (in this case a routine procedure as performed in the case of significant natural disasters). A map of 'I felt it!'-type reports is available from EMSC [4].

Building on the experience from the March 2020 Zagreb earthquake, a volunteering post-earthquake building evaluation effort was initiated in collaboration between the Faculty of Civil Engineering Zagreb, Croatian Chamber of Civil Engineers, City office for Emergency Management and Civil Protection Directorate. Shown in Figure 1 are some of the photos from the evaluation. In fact, as a couple of major foreshocks preceded this event, the evaluations were ongoing when the main event occurred trapping some of the volunteers in damaged buildings. The situation luckily got resolved without casualties.



Figure 1. Photos of damage taken during post-earthquake building evaluation efforts. Bottom most photo shows volunteers getting trapped in a damaged building due to the main shock. Source: Croatian Center for Earthquake Engineering (HCPI, [8]), personal communication.

In summary, we will paraphrase and reiterate our words from our preliminary report of the March 2020 Zagreb earthquake — the type of construction severely damaged in this earthquake is prevalent not only in Croatia but in the entire region. While the estimation of losses and damage is still ongoing, it is clear that this earthquake was truly a disaster with far reaching consequences. Given that similar earthquakes might occur in other European cities with low to moderate seismicity, the experiences from this event have a bearing on seismic resiliency of Europe as a whole.

References:

- [1] <https://dnevnik.hr/vijesti/hrvatska/snazan-potres-jacine-6-3-po-richteru-pogodio-hrvatsku---634027.html>
- [2] USGS: <https://earthquake.usgs.gov/earthquakes/eventpage/us6000d3zh/executive>
- [3] Croatian Seismological Survey (CSS): https://www.pmf.unizg.hr/geof/seizmoloska_sluzba/izvjesca_o_potresima?@=1m68n#news_45225
- [4] <https://www.emsc-csem.org/Earthquake/earthquake.php?id=933701#summary>
- [5] HRT Dnevnik, aired on 12/29/2020

[6] Krešimir Kuk in a interview for Croatian Radio, 12/29/2020

[7] List of hyperlinks [in Croatian]:

- <https://www.jutarnji.hr/vijesti/hrvatska/ovo-su-prve-fotografije-nakon-razornog-potresa-u-petrinji-prizori-su-uistinu-uznemirujuci-15039622>
- <https://www.index.hr/vijesti/clanak/foto-ovako-petrinja-izgleda-veceras/2242659.aspx>
- <https://www.vecernji.hr/vijesti/gradonacelnik-dumbovic-u-petrinji-je-poginulo-dijete-1457301>

[8] HCPI (Croatian Center for Earthquake Engineering): www.hcpi.hr