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AFTERSHOCK OF TURKISH EARTHQUAKE: WHAT LESSONS SHOULD UKRAINE LEARN FROM IT?

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On February 6, 2023 a 7,8 magnitude earthquake lasting 80 seconds struck the region of northwestern Syria and southern Turkey. A 7,7 magnitude earthquake followed nine hours later centered 95 km to the northeast from the first. Earthquakes were followed by more than 1 100 aftershocks [1; 2].

It was the second-strongest earthquake in Turkey since 1668 and the deadliest seismic event since 526. By early March 2023, there are more than 55 000 deaths and roughly 120 000 people injured in Turkey and Syria [2]. The total cost of this earthquake is estimated to be at least 84,1 billion US dollars or approximately 10 percent of Turkish GDP in 2022 [1].

Such devastating consequences including collapse of the buildings and mass deaths can be prevented or at least minimized due to modern earthquake warning systems and revising of building regulations.

The main goal of this paper is to analyze Ukrainian seismic safety system and find possible weak spots which can be fixed to prevent such catastrophic consequences.

Seismically active zones with estimated seismic intensity from 6 to 9 are covering approximately 20 % of the Ukrainian territory (120 km^2) with a population over 10 million people. Zones with estimated seismic intensity from 7 to 9 are covering approximately 12 % of the Ukrainian territory with a population of 7 million people. Overall up to 40 % of Ukrainian territory may be affected by direct and dangerous seismic activity and nearly 70 % can be affected by combined influence of earthquakes, floods, shifts and other geological processes which can severely damage the buildings [4].

The most devastating earthquake on the Ukrainian territory with 6,7 magnitude occurred in 1927 near the south coast of the Crimean Peninsula. The first wave came on the 26 of June and the second, more powerfull, wave came on the 9 of September and caused aftershocks and tsunami. Second wave also led to release of natural gas from the sea floor which caused explosions along the coastline [5].

According to the Ukrainian state building regulations, seismic safety of buildings and respectful measures to assure it must be done by owners of the building. However, the information about seismic activity on the territory of the country can be received only from systematic observations of seismic stations which belong to the National Academy of Sciences of Ukraine. There are 38 seismic stations, 2 regional (Lviv and Simferopol') and 1 national (Kyiv) seismological centres across Ukraine [4]. This net can be seen in Figure.

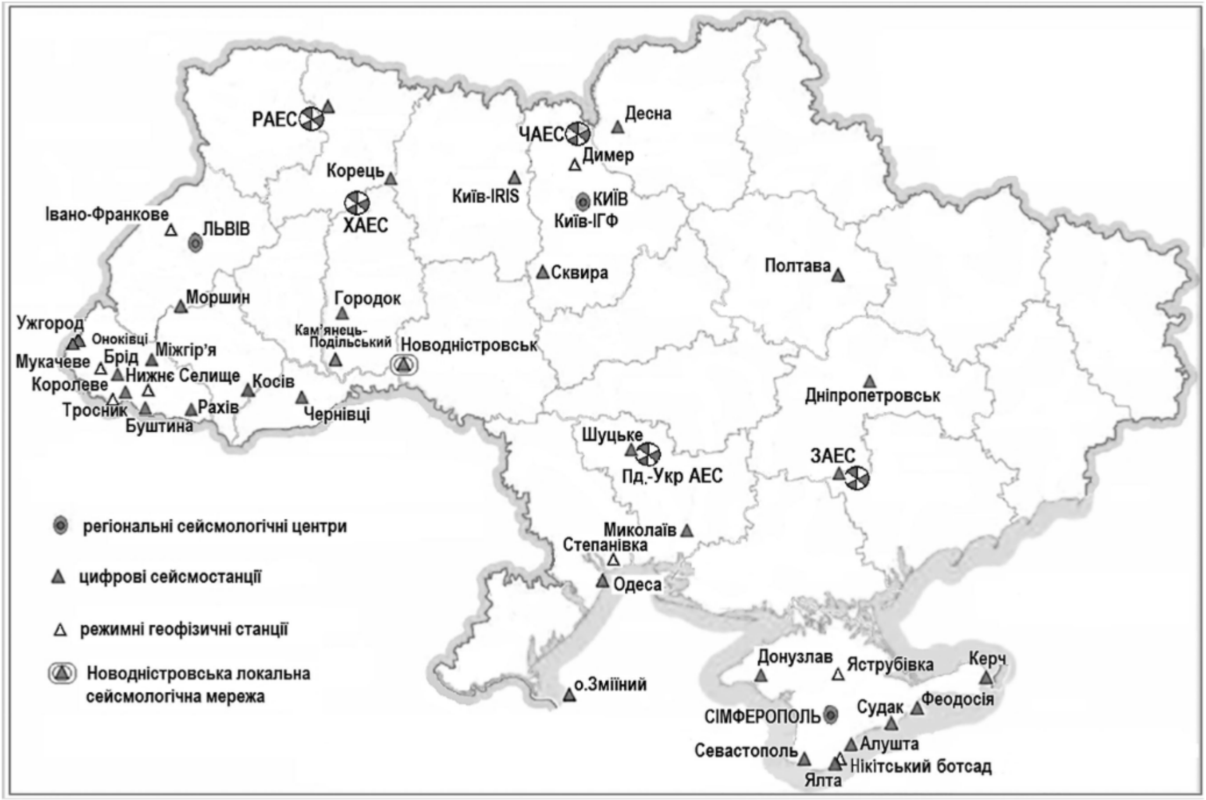

Fig. Network of seismic observations of the National Academy of Sciences of Ukraine

Such system creates a bottleneck in communication between owners and building companies and data they need to assure safety. For example, data collected by the most modern station, created in partnership with Albuquerque Seismological Laboratory, Kyiv-IRIS is closed to the public without special equipment [6]. There is also a clear gap in seismological system in south-eastern region. Dnipro station is the only one operating in this region which is obviously not enough. System of stations and regional center must be created here to provide all the necessary information, especially considering perspective of rebuilding war-torn regions.

Possible impact on energy infrastructure should be considered especially carefully. In case of Turkish earthquake transformers were destroyed in a significant part of the provinces affected by the earthquake. However, in some areas, the electricity distribution grid was damaged to extinction. Although the problems in the main energy transmission facilities and lines have been resolved, problems continue in the inner-city distribution sections in some districts and provincial centers [1].

Ukrainian critical infrastructure (including some nuclear power stations) is located on the potentially seismically active territory. Damage to energetic infrastructure may cause energy cut-offs and even blackouts on a huge territory and make process of liquidation of consequences even more complex. Official building regulations did not include part about seismic safety of critical infrastructure until the end of 2016 when special regulations were made [7]. Official regulations mostly mention safety measures for buildings in case of earthquakes with a magnitude over 7,0 while ignoring possible damage from earthquakes with less magnitude [8].

These regulations must be reconsidered and set new rules for critical infrastructure and civil buidings respectfully to the new seismological date. Protection from earthquakes with magnitude less than 7.0 should also be explored.

Special attention should be paid to the regions which border the so-called Vrancea zone. This seismically active zone is located on Moldovan-Romanian border. Epicenters of earthquakes capable of causing microseismic impact on the territory of Ukraine are located in the mantle at depths from 80 to 190 km. Maximum magnitudes of earthquakes from this zone have reached 7,6. Earthquakes in this zone provoke shakes with magnitude from 7.0 – 8.0 in the south-west of Odessa oblast' to 3,0–4,0 in the north-east of Ukraine [4].

Conclusions

1. Communication between building owners and construction companies and the National Academy of Sciences should be direct and quick. Data about possible earthquakes and other dangerous events should be open and easily accesable.
2. Seismological net should be expanded to the south-eastern region and new regional center should be created.
3. Official building regulations for seismic zones must be revised. Creation of new regulations for seismic safety of nuclear power plants and civil buildings from earthquakes with magnitude less than 7,0 should be considered.
4. Surveillance of geological activity in the Vrancea zone should be strengthened.

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