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ABOUT THE SEISMIC RISK OF SABAYIL DISTRICT OF BAKU

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ABSTRACT. The seismic risk of Sabayil district of Baku is considered. The seismicity of East Azerbaijan has been investigated, potential zones and their seismic potential that can create a seismic hazard in Baku have been identified, the main factors causing seismic risk in the research area (engineering-geological conditions of separate areas, types of building-objects, sustainability situations etc.) have been widely analyzed. It was found that the territory of Sabayil district is characterized by the high seismic hazard. In addition, areas where many people live and many administrative buildings are concentrated are characterized by unfavorable ground conditions and this factor raises the level of seismic hazard to 9 points on the 12-point MSK-64 scale. The presence of frequently recurring Bayil landslides zone in the area is an additional source of hazard.

The assessment of possible seismic hazard in Baku where numerous administrative and high residential buildings, large industrial enterprises and other state-owned facilities are located, about 40% of the republic population is concentrated, is one of the actual problems of the period.

The territory of Azerbaijan is a part of Alpine-Himalayan folded system, characterized by the high seismic activity. The maps of epicenters (Fig.1and Fig.2) of strong and medium (M≥3,0) earthquakes [In the territory of Azerbaijan.... 1980-2016 years] recorded during the last 36 years (1980-2016 years) and strong (M≥5,0) earthquakes [Novıy..1977] occurred since 427 years until now create full impression about the high seismic activity of the Azerbaijan territory.

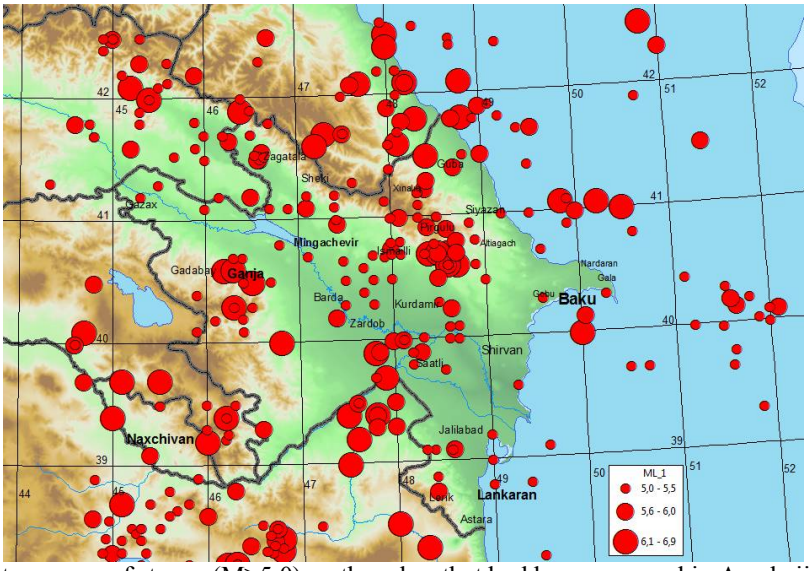

Figure 1.Epicenters maps of strong (M≥5.0) earthquakes that had been occurred in Azerbaijan and adjacent territories during 427-2016 years.

As can be seen from the maps, the eastern part of the republic is seismically active. In this region, the earthquakes occur mainly in the Caspian Sea.

In general, the Caspian Sea takes a particular place in the seismic life of Azerbaijan. Strong (M_{LH}≥6,0) earthquakes [Novıy catalog, 1977] that had occurred in 1910, 1935, 1963, 1986, 1989 have

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repeatedly trembled Baku and other coastal areas with high intensity (5-7 points on the 12 point MSK-64 scale).

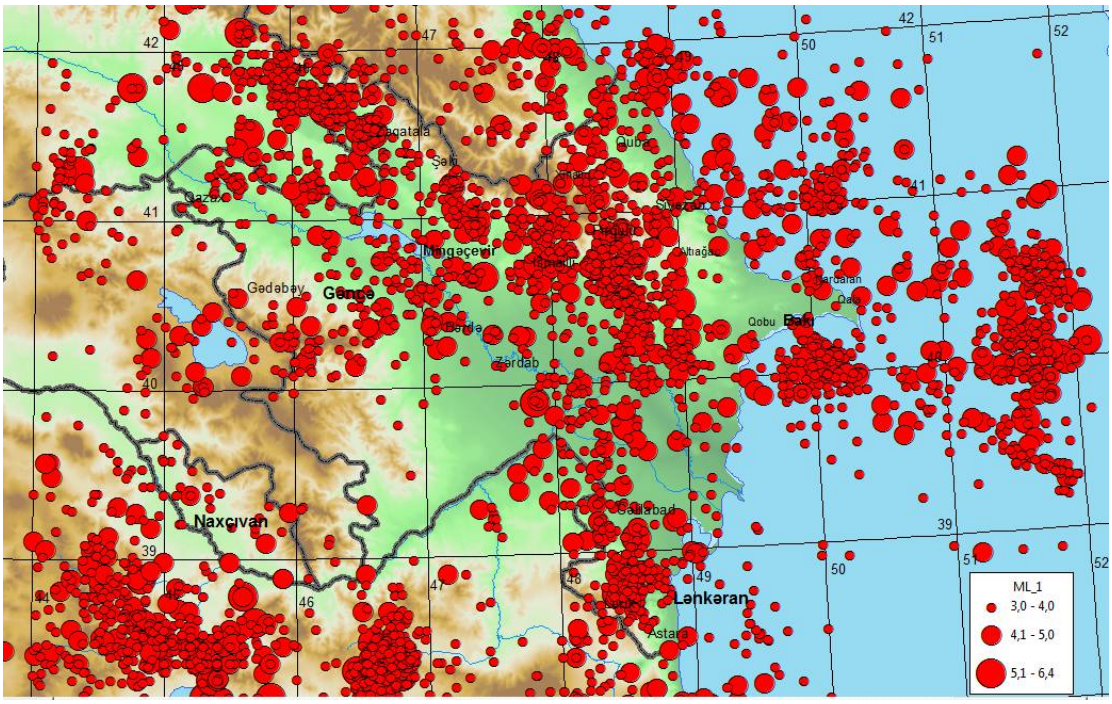
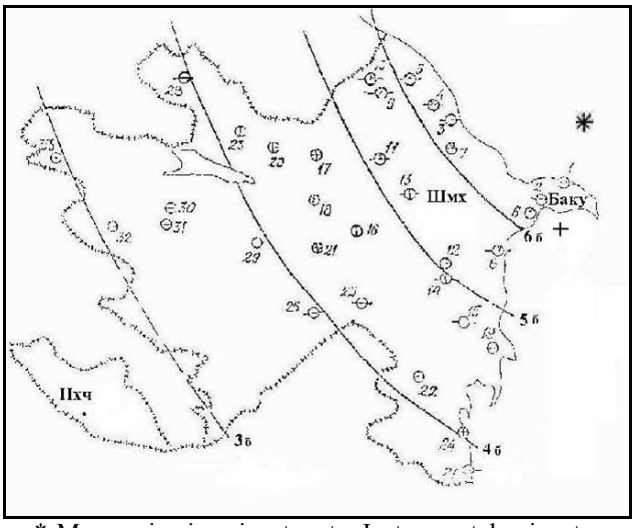


Figure 2. Epicenters maps of M≥3,0 earthquakes that had been occurred in Azerbaijan and adjacent territories during 1980-2016 years.

An earthquake with magnitude M_{LH}=6,1 that had occurred in the Caspian Sea (φ=40,3^0 N; λ=51,6^{0}E) on March 6, 1986, was felt in Neft dashları up to 7-8 points and in Baku up to 5 points.

A strong earthquake recorded on September 16, 1989 (φ=40,2^0 N; λ=51,8^{0}E; M_{LH}=6,3) was felt up to 5 points intensity in Absheron peninsula and some coastal areas.

The last strong earthquake in the Azerbaijani part of the Caspian Sea (M=6.2) occurred on November 25, 2000, 50-60 km south of Absheron and was felt in Baku and some coastal areas up to 6-7 points [Hasanov et al., 2005] (Fig.3).



*-Macroseismic epicenter; + - Instrumental epicenter

Figure 3. November 25, 2000. Isoseyst map of the Caspian Sea

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The seismic intersection constructed on different profiles indicated that with the exception of a few H = 60-70 km depth hypocenters that the earthquake sources were spread at the depth of up to 50 km in the Caspian Sea [Hasanov et al., 2000].

The strong earthquakes that took place on November 25, 2000, in the south of Absheron and their aftershock distribution characteristics on the place again confirm the results mentioned above [Hasanov et al., 2004]. It should be noted that the seismicity was at the background level in the earthquake area. A strong foreshock with M_{LH}=5.8 was also recorded 1.5 minutes before the main shock of the M_{LH}=6.2. The occurrence of two consecutive strong earthquakes within a short time (1.5 minutes) had resulted in the recording of numerous aftershocks (Fig.4 and Fig.5).

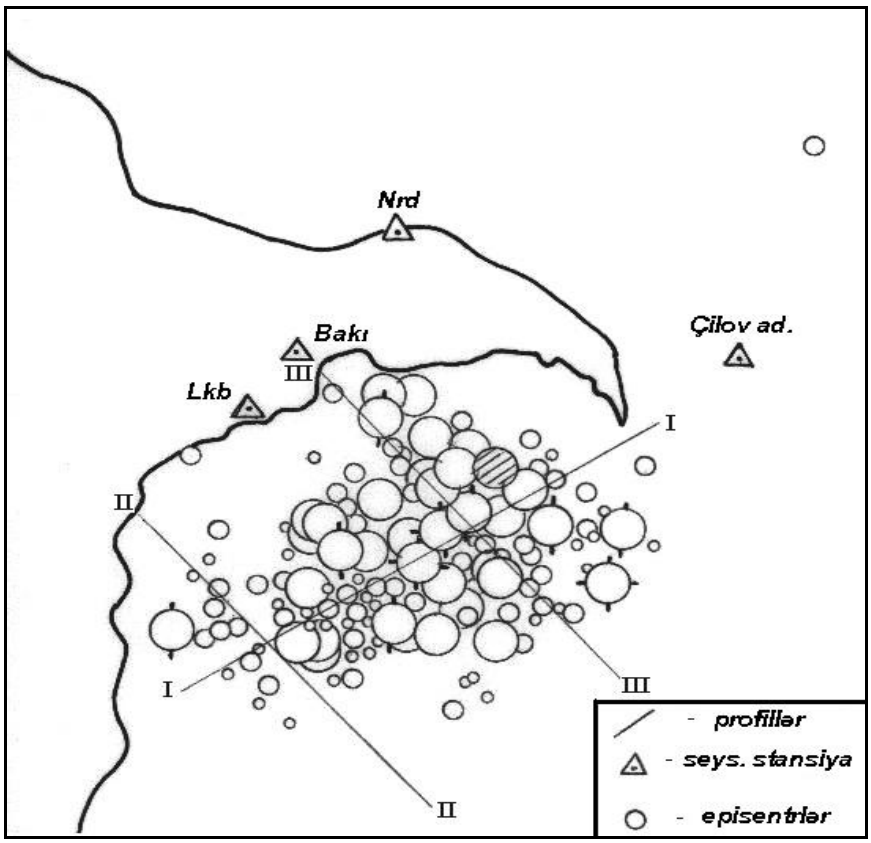

Figure 4. Epicenters map-scheme of general aftershocks of Caspian earthquake occurred on November 25, 2000

In general, the analysis of historical and present - day, macroseismic and instrumental data on earthquakes in the territory of Azerbaijan shows that there was no earthquake which was higher than 7 point on the 12 point MSK-64 scale in the Absheron peninsula including Baku city. However, this conclusion obtained from the observations does not give a reason to say that there will be no more intensive earthquakes in Baku in the future.

In order to determine the spatial position of the potential source zones of Azerbaijan territory, the connection of spatial (both lateral and vertical) distribution regularities of strong and weak earthquakes and intense concentration zones of seismic aftershocks with large depth faults have been investigated [Mammadli, 2011].

It is known that the largest seismic hazard is expected from potential source zones that are located in the Ajichay-Alat, Palmir-Absheron, Goychay, Vandam, Siyezen and Makhachkala-Turkmenbashı depth faults with high-intensity activity for the area where Absheron peninsula, including Baku city is located.

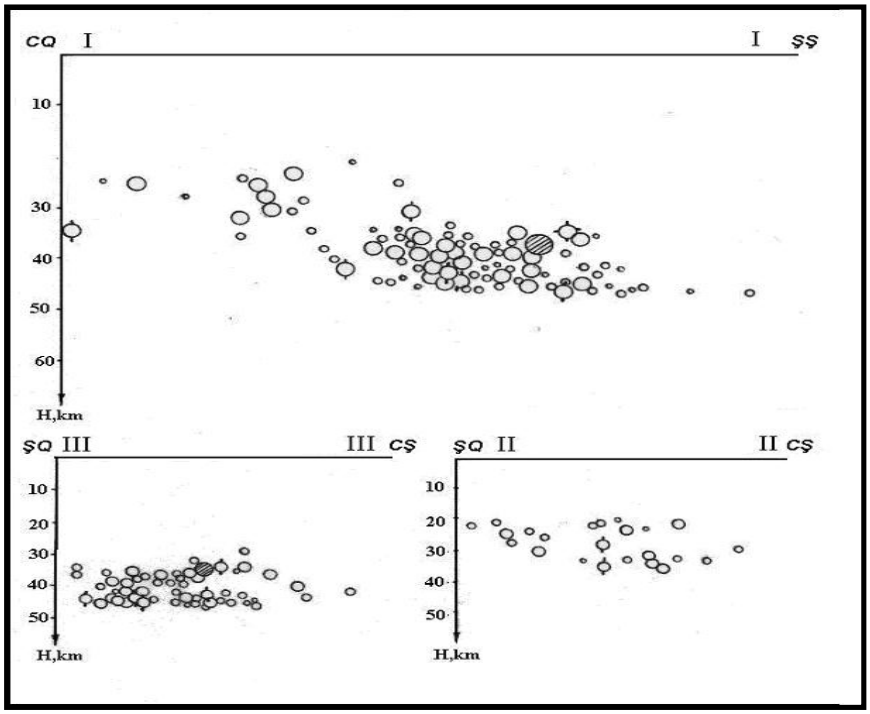

Figure 5. Distribution of aftershocks of November 25, 2000 earthquake according to the depth

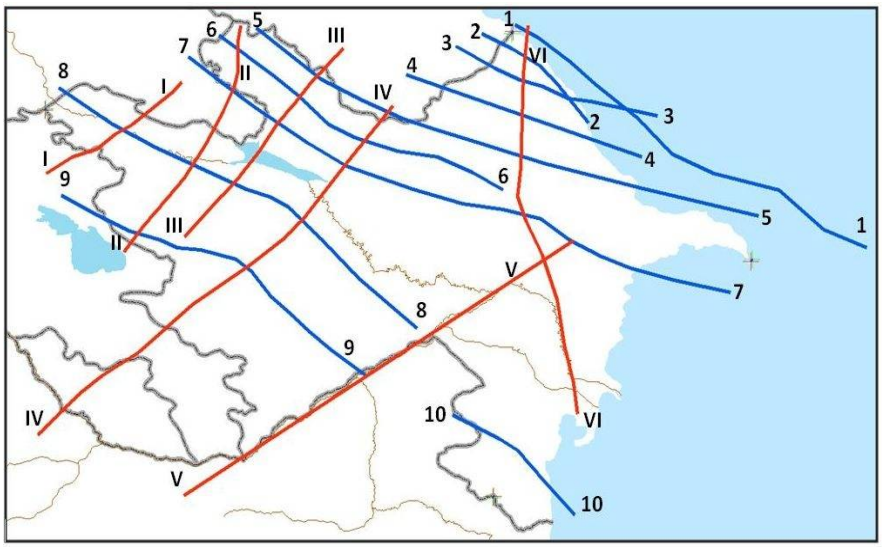

Figure 6. Map-scheme of generalized depth faults of Azerbaijan territory

1-1 Makhachkala – Turkmenbashi
2-2 Khudat – Gilazi
3-3 Akhtı-Nugadi-Gilazi
4-4 Siyezen
5-5 Qaynar-Zengi
6-6 Vandam
7-7 Ajıchay-Elet
8-8 Kura
9-9 Lesser Caucasus
10-10 Talysh

I-I Gazakh-Siqnakh
II-II Sharur-Zagatala
III-III Ganjechay
IV-IV Arpa-Samur
V-V Palmir-Absheron
VI-VI West-Caspian

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Currently, background level of seismic hazard of various regions of Azerbaijan is estimated on the basis of "Temporary seismic zoning map of Azerbaijan territory" [Ahmedbeyli et al., 1991] (Fig.7).

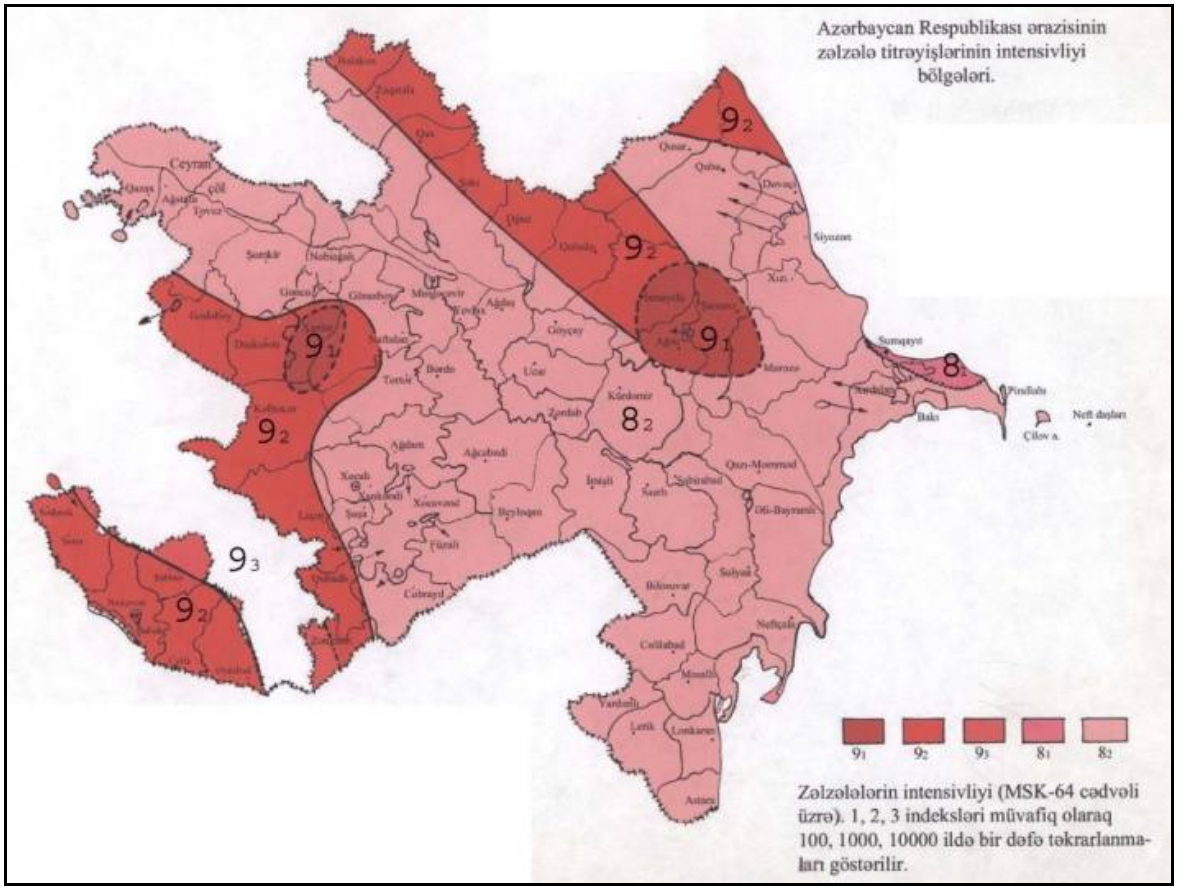

Figure 7. Seismic zoning map of Azerbaijan (1991)

According to this map, the background level of seismic hazard of the Absheron Peninsula, including Baku is 8 point according to 12 point MSK-64 scale. In addition to the background level, also the engineer-geological and hydrogeological condition of this area has great influence on the level of seismic hazard.

These conditions are not identical in Baku. Therefore, the strong Caspian Sea (Baku) earthquake on 25.11.2000 (M=6.2) was felt differently in the various areas of Baku [Hasanov, Mammadli, 2008]. The earthquake mostly was felt in the area where coastal zones of the city - soft, wet grounds are widespread and the groundwater levels are close to the ground surface.

The Sabayil district of Baku is an area with the complex relief where a number of important administrative departments and organizations and buildings of various types is concentrated. The variety of the types of buildings (a new high, old one or two-floor buildings and etc.), level of groundwater and ground necessitates research on seismic risk assessment.

In order to investigate the impact of engineer- geological and hydrogeological condition to the seismic level, the engineering-geological data on well drilling in the area where high-rise buildings were constructed within the last 10-15 years had been analyzed (Fig.8).

It was found that soft, wet grounds are widespread in the coastal zone of this district and the level of groundwaters is close to the ground.

As a result of the impact of these factors, the level of seismic hazard in this area had risen and this area should be evaluated as 9 points on 12 point MSK-64 scale.

Figure 8. Location scheme of engineering geological wells drilling in the Sabayil district

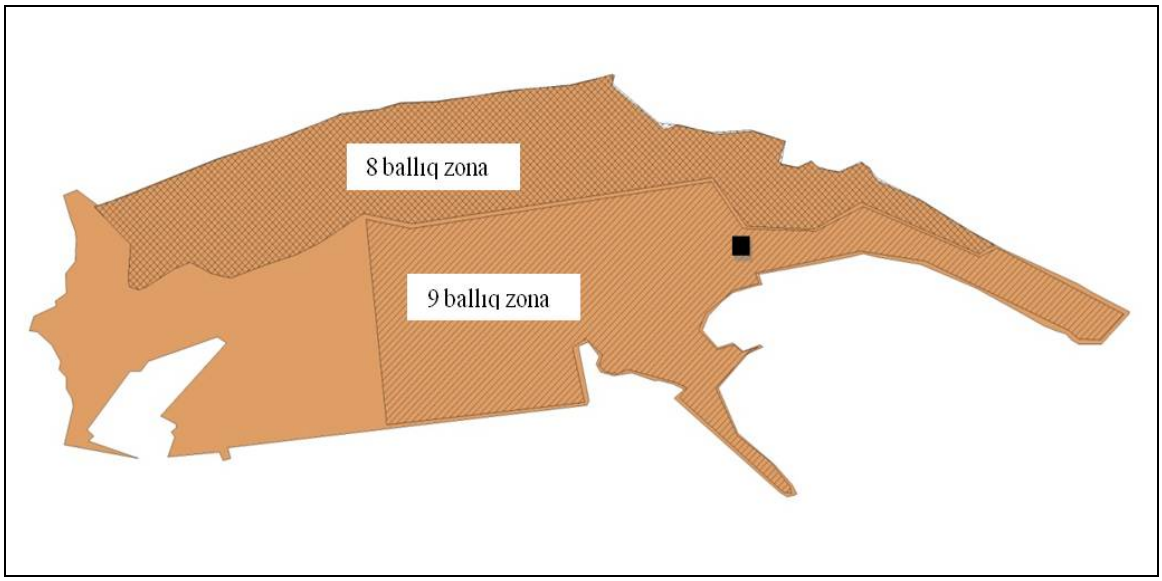

Figure 9. The estimated seismic hazard level scheme by taking into account engineer-geological data on well drilling in the area of Sabayil district.

The estimated risk assessment was conducted in the high seismic hazard zones mentioned at the next stage. The seismic risk means the socio-economic and other losses likely to occur as a result of seismic hazard. These losses are largely dependent on the seismic stability (technogenic risk) of buildings and facilities, and the level (social risk) of people's preparedness to a strong earthquake. Additionally, the losses caused by the indirect hazards (fires occurring after the earthquake, landslides, etc.) also belong to seismic risk.

The resistance level of living and administrative buildings located in Sabayil district has been investigated separately. For this purpose, the whole area has been researched and the district territory is divided into separate areas (Fig.10; 11) due to the structure and other characteristics of the buildings.

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High-rise buildings built in recent years

The villa-style buildings built in recent years

High-rise 9 storey buildings built in the past (during Soviet times)

4- 5 - storey buildings built in the past (during Soviet times)

1-2 storey houses built in the past (during Soviet times)

Bayil landslide area

Figure 10. Types of buildings in Sabayil district

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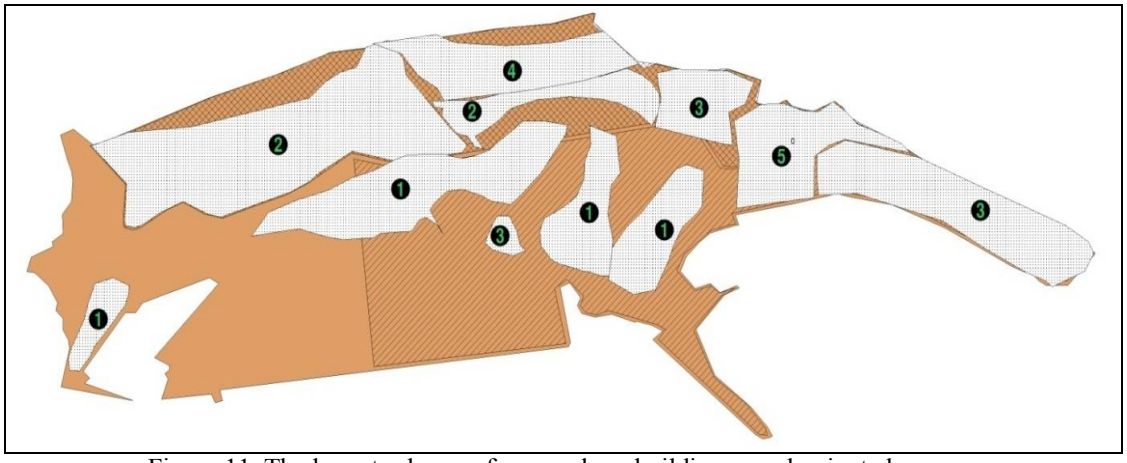

Figure 11. The layout scheme of areas where buildings are dominated.

Symbols:

1. Old private houses
2. Villa-style new houses
3. New high-rise buildings
4. 5-9-storey old buildings
5. 3-5 storey historical buildings

Symbols of 8-9 points zones

The seismic risk map-scheme of the region has been compiled by the comparison of seismic hazard levels with areas where buildings with different duration level are located (Fig. 12).

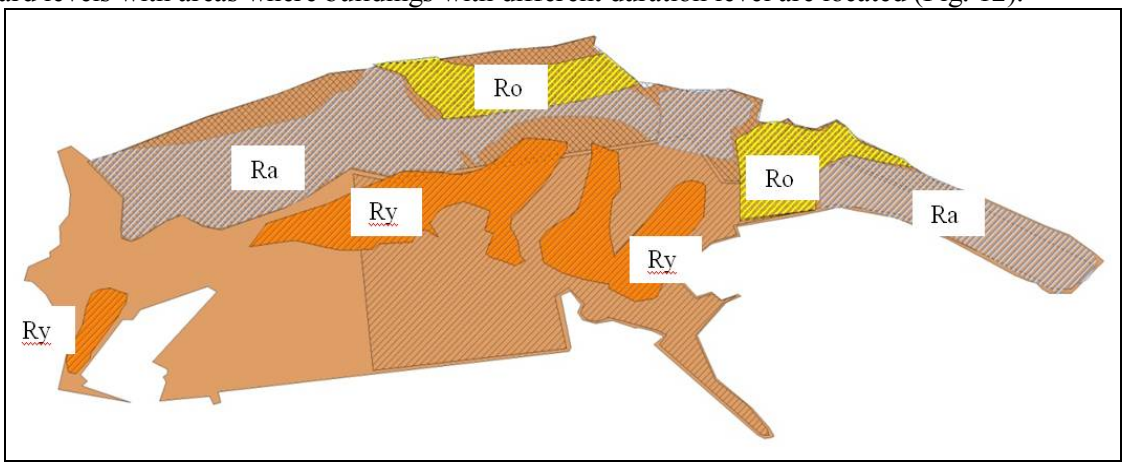

Figure 12. Seismic risk map-scheme of Sabayil district

Ra- low-risk area
Ro- medium risk area
Ry-high risk area

Thus, it was found that the level of seismic risk on separate areas of Sabayil district of Baku city is different: the low risk is observed in the areas where the buildings are constructed with strict observance of construction norms in the last 10-15 years regardless of the seismic hazard level (8 or 9 points). The medium risk is the characteristic for areas where middle and high-rise buildings are located which were constructed in the 1970's of the last century. Despite that the buildings were constructed with the construction norms in these areas, their seismic stability in the seismic zoning map compiled at that time was calculated to the level of seismic hazard defined for Absheron as well as Baku which evaluated one point below (7 points). The high-risk zones are the areas where the slums and houses are in an emergency condition built in the 1950-60's years without complying any construction norms.

Conclusion

The level of seismic hazard in separate areas of Sabayil district of Baku has a high degree of differentiation and this is conditioned by a number of factors.

- The seismic hazard level of the area is quite high (probably seismic hazard in the Absheron peninsula, as well as in Sabayil district of Baku is estimated at 8 points according to 12 point MSK-64 scale).
- Many areas of Sabayil district of Baku, where administrative buildings and the majority of population are concentrated, are characterized by unfavorable ground conditions and this factor raises the level of seismic hazard to 9 points on 12 point MSK-64 scale.
- There is a large, frequently repeated Bayil landslide zone in Sabayil district of Baku. During the strong earthquake, these sliding processes can be activated and increase the scale of the destructions.

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