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IMPACT OF ENGINEERING GEOLOGICAL CONDITIONS ON SEISMIC HAZARD IN BAKU CITY, YASAMAL DISTRICT

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Introduction: The territory of Azerbaijan is characterized by high seismic intensity. It is known that after the occurrence of strong earthquakes, collateral natural and technogenic dangers, avalanches, landslides, sediments, dilution of the soil and other events can occur. In this regard, the investigation of the physical-mechanical properties of soils and other engineering-geophysical seismic factors indicators during the seismic hazard assessment in the construction areas is important.

Baku is divided into several administrative districts. Geological and lithological conditions are different in those regions.

Yasamal district is one of the central districts of Baku. The region is bordered by Sabayil in the south, Garadagh in the west, Binagadi in the north and Nasimi in the east. The territory of the district is 16.22 km^2. The population density in the district is 15 160 people per square kilometer.

The increase in population density increase the demand for reasidental buildings in Baku city. In this regard, it is important to study the seismicity in the area and to assess the impact on the seismic hazard.

As a result of seismotectonic investigations, there are several fault zones in the Absheron peninsula that determining seismic hazard (Shikhalibeyli, 1970-1996 yy.):

1) Makhachkala-Turkmenbashi; 2) Gaynar Zengi; 3)Siyezen: 4)Vandam: 5)Adjichay-Alyat: 6)Western Khazar (Fig.1.)

The zone of the depths faults Makhachkala-Krasnovodsk (Turkmenbashi) separates the Middle Caspian from the south-Caspian sediments. It was determined that, the block on the north has risen along this fault in the Caspian Sea and the Caucasus, the geosynclinal block is down deeper in the west.

Amplitude dislocations are observed up to 15 km at the foundation and on the surface of "Moho" in some places. The depth of seismic tensions in the zone increases from the north-west to the south-east just as it moves towards the middle of the sea, from 10-25 km to 30-35 km and in some cases it increases more than 60-70 km. Earthquakes magnitude with M~6,0 occurred in this area.

Siyazan fault has a long enough length. Seismic shocks can spread up to 20-25 km deeper in this fault. The continuation of Siyazan fault is followed in the sea.

Gaynar-Zengi fault bordering from north the Vandam anticlinarium of Greater Caucasus extends in the west from Mazimchay to Aghsuchay river.

The results of the geophysical research show that the Gaynar-Zengi fault is completely cut off the surface. An earthquake with a high intensity (M = 7.0) occurred in the Shamakhi part of the fault. Shamakhi was completely destroyed in the earthquake that occurred in 1667 and repeated aftershocks and disturbances in relief, changes in springs were taken into account. Earthquakes are spread with depth intervals (H =10-25 km) observed across of the southern slope of the Greater Caucasus.

Vandam depth fault. Weak shocks spread to a depth of 25-30 km, here. One of the strongest earthquakes in Azerbaijan (M = 6.9), destroying the Shamakhi city, has taken place in this fault zone.

The continuation of the Adjıchay-Alyat fault in the sea is considering Sangachal- Ogurchu fault. The event occurred on November 25, 2000 in this zone and entered to the seismological chronology as the Baku earthquake consisted of two seismic shocks (M=5,8 və M=6,2) and was accompanied by numerous aftershocks.

V.E.Khain attaches great importance to the Palmir-Absheron depth fault and shows that it separates the Turkmen-Iranian and Caucasus-Eastern Anatolian segments. Seismic shocks are spread in some parts of zone at a distance of 15-25 km and some parts in the depth of 30-35 km.

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West- Caspian transverse depth fault has been determined by many experts (Belenovich T.Y., 1983 и Gadjiyev A.N., Popkov V.İ., 1988) based on geophysical data but V.E.Khain (Khain V.E., Lamize M.G., 1995) and others have described the fault in more detail. This fault zone separates the southern Caspian (Transcaucasia) depression from the southern Caucasus depression. In the areas of the Greater Caucasus, where the fault occurs, earthquakes are spreading to a relatively small (10-25 km) depth, which is characteristic of the mountainous zone, while seismic shocks in the Kura sediments of fault reach to greater depths (15-45 km).

Seismic shocks occurring in these faults caused an earthquake with magnitude of maximum 7 in the Absheron peninsula.

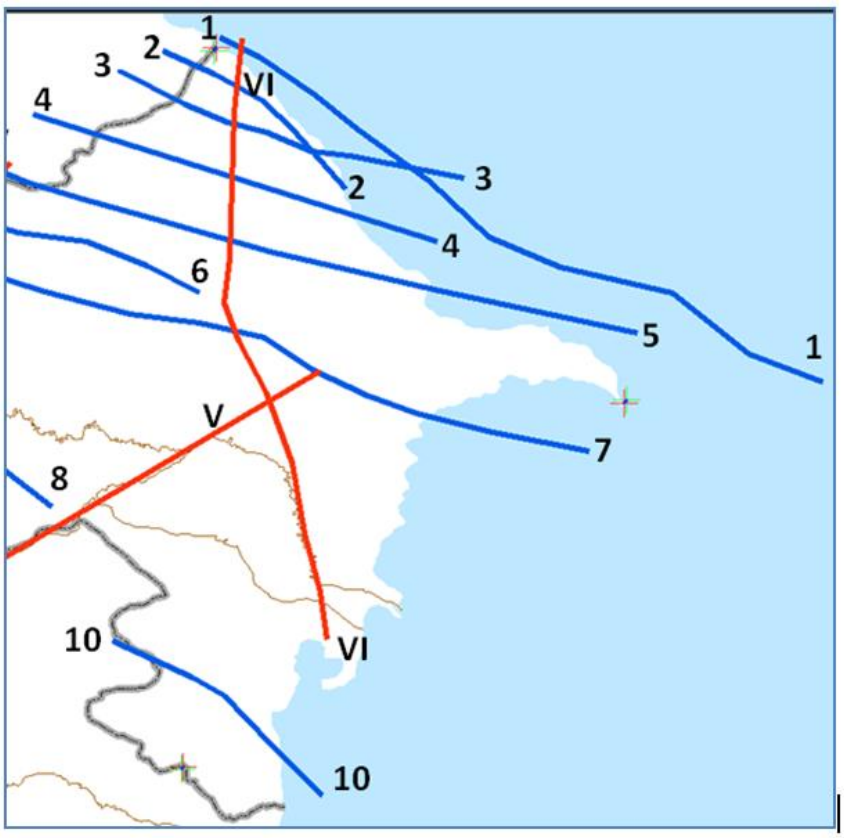

Figure 1. Tectonic fault zones in East Azerbaijan

1-1	Makhachgala - Turkmenbashı	7-7	Adjıchay-Alyat
2-2	Khudat - Gilezi	8-8	Kura
3-3	Akhtı-Nugedi-Gilezi	9-9	Front Lesser Caucasus
4-4	Siyezen	10-10	Front Talish
5-5	Gaynar - Zengi	6-6	Vandam
V-V	Palmir – Absheron	VI-VI	West – Caspian

In order to assess the impact of the geological conditions on the seismic hazard in the Yasamal region, along with active depth faults (Fig.1), the earthquake epicenter map (Fig.2) was created, geological-lithological structure of the earthquake, hydrogeological conditions, physical and mechanical properties of soils and other information was collected.

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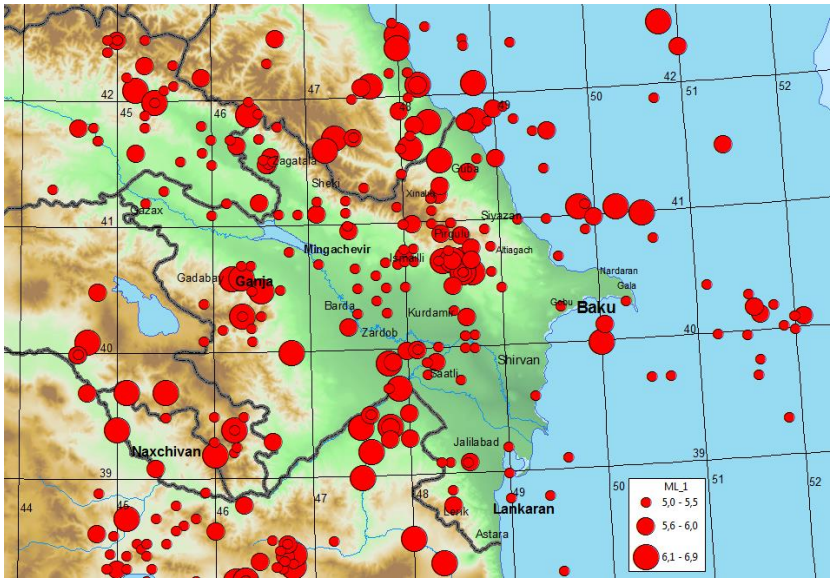

Figure 2. Epicenter map of strong earthquakes in Azerbaijan and adjacent territories(M≥5.0) during 427-2018 years.

The geological-lithological section of the area has been studied as a result of drilling in the construction areas of the Yasamal district. Their thickness varies from 10 to 30 m. These sediments are of continental origin and have different lithological contents. Most of the geological sections up to 30.0 m depth with the exception of technogenic rocks forming the upper part of the faults consist of clays, sandy clays, clay sands, low-clay sands with small-size seashells, moistened limestone and sorting of the loam layers. The exposure of rocks to moisture is due to hydrogeological conditions. During the study of engineer-geological conditions, it has been known that the rocks in the Yasamal district were separated into 3 (three) engineers-geological elements (geological- engineering elements).

These engineering-geological elements are weakly durable limestone with a thickness of 3 meters under the foundation with a horizontal and large depth and more semi-solid clay and semi-solid loam.

While conducting geological works, consistence from information on some properties of rocks (JL), density (ρo, ρd) and other parameters are used and the calculations are carried out. One of the significant parameters for the assessment of seismic hazard is to determine the velocity of seismic waves propagation in longitudinal (Vp) and transverse (Vs) in groundwaters. Using GEODE-24 engineer-seismic station at the RSSC of ANAS, these speeds are determined with the greatest possible accuracy. The physical and mechanical properties of the widespread geological-engineering elements that are separated are as follows.

1) The most common average values for the consistency, density and the consistency of the semi-solid loam soil are JL = 0.14; it density is ρ_d= 1,62 q/sm^3 in case of dry; the spreading velocity of transverse seismic waves in ground is V_s= 360-430 m/min.

2) The consistency of the semi-solid clay soil are J_L= 0,02-0,34; it density is ρ_d=1,47-1,66 q/sm^3 in case of dry; the spreading velocity of transverse seismic waves in ground varies between V_s= 380-550 m/ min.

3) The most commonly encountered prices for softness coefficient, density and speed of weakly durable limestone are $K_{yum.}$ = 0,60-0,66; ; it density is ρ_d= 1,85-1,97 q/sm^{3}in case of dry; the spreading velocity of transverse seismic waves in ground varies between V_s= 580-660 m/min.

Three of the separated soils suitable for II class as a result of the research according to the normative document the construction in seismic zones AzDTN 2.3.-1. There were underground waters in most wells drilled in the field.

The various groundwater are mainly formed in the loam and limestone ground. That is, the porosity coefficients of the grounds are not more than e = 0.7 and the velocity of seismic waves propagation speeds are rarely below 400m/min.

The density is also within the normal range ρ_d=1,50-1,65 q/$sm^{3.}$

Based on the above and on the results of the research, Yasamal district has been attributed to the 8-point zone.

Conclusion

1. The Absheron Peninsula, as well as the seismicity of Baku, is related to the strong earthquakes in the depth faults near the area.
2. The seismic hazard of the Yasamal region of Baku city is influenced by the physical-mechanical and seismic properties of the soils in the area. Three engineer-geological elements have detected here. All three engineer-geological elements belong to the II class.
3. In the Yasamal district of Baku, underground waters are encountered at different depths. Basically, ground water is encountered at a level, rarely found in two horizons, and it is negligible affected by the composition of soils.
4. The seismicity of the Yasamal district of Baku is estimated at 8_2 (eight) magnitude on the MSK-64 scale based on the analysis of hydrogeological observation materials and seismological researches, engineer-geological and tectonics of the area, "Temporary schematic seismic zoning map of the territory of the Republic of Azerbaijan" (1991 years) and Az DTN-2.3.-1 normative document.

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