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ENGINEERING-LITHOLOGICAL AND SEISMIC ASSESSMENT OF PARENT ROCKS (THE EXAMPLE OF CONSTRUCTION SITES IN NIZAMI DISTRICT)

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Abstract

Parent rock is a fundamental concept in engineering geology and is essential for ensuring the reliability and safety of construction sites. Parent rock refers to dense, strong rocks found deep within the Earth, including limestone, sandstone, granite, and basalt. They have high density, low porosity, and low deformability, making them capable of effectively absorbing and transmitting both static and dynamic loads. The high propagation velocity of seismic waves in such rocks confirms their strength and stability.

The low permeability of parent rock reduces the influence of groundwater and reduces the risk of foundation erosion, weakening, and uneven precipitation. Therefore, studying the lithological composition, physical and mechanical properties, and depth of such rocks is of particular importance in engineering geological surveys. Incorrect assessment in geological conditions often leads to foundation deformations, water infiltration, and reduced stability at construction sites. Given the relevance of the topic, a comprehensive assessment of the engineering and geological conditions of construction sites in the Nizami District was conducted, and the properties of the parent rock were studied.

Keywords: construction site, parent rock, engineering and geological conditions, seismic exploration, Vs30 parameter, foundations, permeability, seismic resistance.

ANA SÜXURLARIN MÜHƏNDİSİ-GEOLOJİ QİYMƏTLƏNDİRİLMƏSİ VƏ NİZAMİ RAYONUNDA TİKİNTİ ŞƏRAİTİNƏ TƏSİRİ

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Xülasə

Ana süxur mühəndisi geologiyanın fundamental anlayışlarından biri olmaqla, tikinti obyektlərinin etibarlılığı və təhlükəsizliyinin təmin edilməsində mühüm rol oynayır. Ana süxur dedikdə, adətən yer səthinin altında yerləşən, yüksək möhkəmliyə və yükgötürmə qabiliyyətinə malik bərk süxur layları nəzərdə tutulur. Əhəngdaşı, qumdaşı, qranit və bazalt kimi süxurlar bu qrupa aid edilir. Fiziki-mexaniki xüsusiyyətlərinə görə ana süxurlar yüksək sıxlığa, aşağı məsaməliliyə və zəif deformasiya qabiliyyətinə malik olduqlarından həm statik, həm də dinamik yükləri etibarlı şəkildə qəbul edir və ötürürlər. Bununla yanaşı, seysmik dalğaların bu mühitdə daha yüksək sürətlə yayılması onların sərt və dayanıqlı geoloji mühit olduğunu göstərir.

Ana süxurların zəif sukeçiriciliyi və az məsaməliliyi qrunt sularının təsirini məhdudlaşdırır, nəticədə bünövrələrin yuyulması, zəifləməsi və diferensial çökmə riskləri azalır. Bu baxımdan mühəndisi-geoloji tədqiqatlar zamanı ana süxurların litoloji tərkibinin, fiziki-mexaniki parametrlərinin və dərinlik şəraitinin öyrənilməsi xüsusi əhəmiyyət kəsb edir. Təcrübə göstərir ki, su sızmaları, bünövrə deformasiyaları və tikililərin dayanıqlığının pozulması halları əksər hallarda geoloji şəraitin düzgün qiymətləndirilməməsi ilə əlaqədardır.

Tədqiqatın aktuallığını nəzərə alaraq, Nizami rayonu ərazisində aparılan tikinti sahələrinin mühəndisi-geoloji şəraiti kompleks qiymətləndirilmiş və ana süxurların xüsusiyyətləri öyrənilmişdir.

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Açar sözlər: tikinti sahəsi, ana süxur, mühəndisi-geoloji şərait, seysmik kəşfiyyat, Vs30 parametri, bünövrələr, su keçiricilik, seysmik dayanıqlılıq.

ИНЖЕНЕРНО-ЛИТОЛОГИЧЕСКАЯ И СЕЙСМИЧЕСКАЯ ОЦЕНКА МАТЕРИНСКИХ ПОРОД (НА ПРИМЕРЕ СТРОИТЕЛЬНЫХ ПЛОЩАДОК В РАЙОНЕ НИЗАМИ)

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Аннотация

Материнская порода является одним из основных понятий инженерной геологии и имеет важное значение для обеспечения надёжности и безопасности строительных участках. Под материнскими породами понимаются плотные, прочные горные породы, залегающие в недрах Земли, к которым относятся известняк, песчаник, гранит и базальт. Они обладают высокой плотностью, низкой пористостью и слабой деформируемостью, благодаря чему способны эффективно воспринимать и передавать как статические, так и динамические нагрузки. Высокая скорость распространения сейсмических волн в таких породах подтверждает их прочность и устойчивость.

Низкая водопроницаемость материнских пород снижает влияние грунтовых вод и уменьшает риск размыва оснований, их ослабления и неравномерных осадок. Поэтому при инженерно-геологических исследованиях особое значение имеет изучение литологического состава, физико-механических свойств и глубины залегания таких пород. Ошибочная оценка геологических условий часто приводит к деформациям оснований, просачиванию воды и снижению устойчивости на строительных участках.

С учётом актуальности темы была проведена комплексная оценка инженерно-геологических условий строительных участках на территории Низаминского района и изучены свойства материнских пород.

Ключевые слова: **строительный участок**, коренная порода, инженерно-геологические условия, сейсморазведка, параметр Vs30, фундаменты, водопроницаемость, сейсмостойкость.

Parent rock is the main indicator for designing foundations in these areas when designing high-rise buildings. The strength and durability of buildings depend on the environment in which they are located, especially on the properties of the bedrock. These properties are the main factors ensuring the safety of construction. Hard rocks can reduce the impact of an earthquake, while soft and loose rocks can amplify vibrations. Therefore, the composition of the rock should be carefully studied during construction.

Engineering geology is one of the most important scientific directions in the field of construction, studying the geological conditions of the area where buildings, bridges, roads and other engineering structures are being built. The safety and durability of the construction work directly depend on the engineering and geological conditions.

In order to ensure the successful completion of constructions at construction sites and their long-term durability, it is necessary to check in advance the strength indicators of the rocks that make up the building material and its foundations, as well as the natural and artificial factors affecting them.

Our research area, Nizami district, is located in the southwestern part of Baku city. The purpose of the research is to study the engineering-lithological and geophysical properties of the parent rock, assess their impact on the construction process and identify existing risks.

The article uses an electronic database created by the RSSC based on Microsoft Excel for construction sites designed on the Absheron Peninsula (1998-2025), based on engineering-lithological and seismic data. The engineering-geological and geophysical conditions of the construction sites constructed in the Nizami district were investigated and out of 130 construction sites in this district, 16 (sixteen sites) have structures with parent rock (Vs≥600 m/sec, thickness h ≥ 5.0m) (Fig. 1, 2).

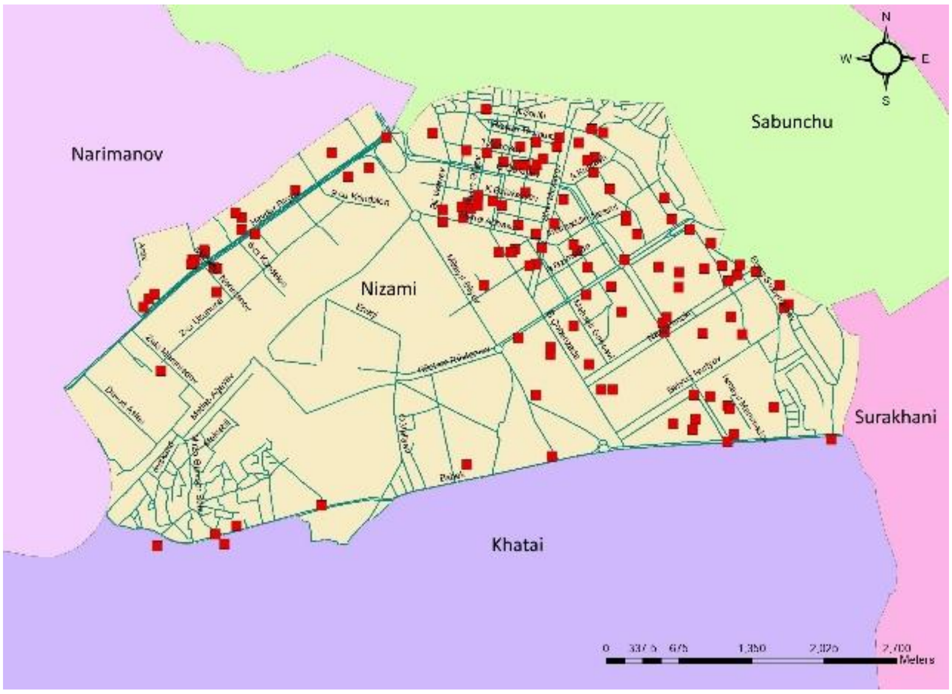

Fig. 1. Research areas in Nizami district

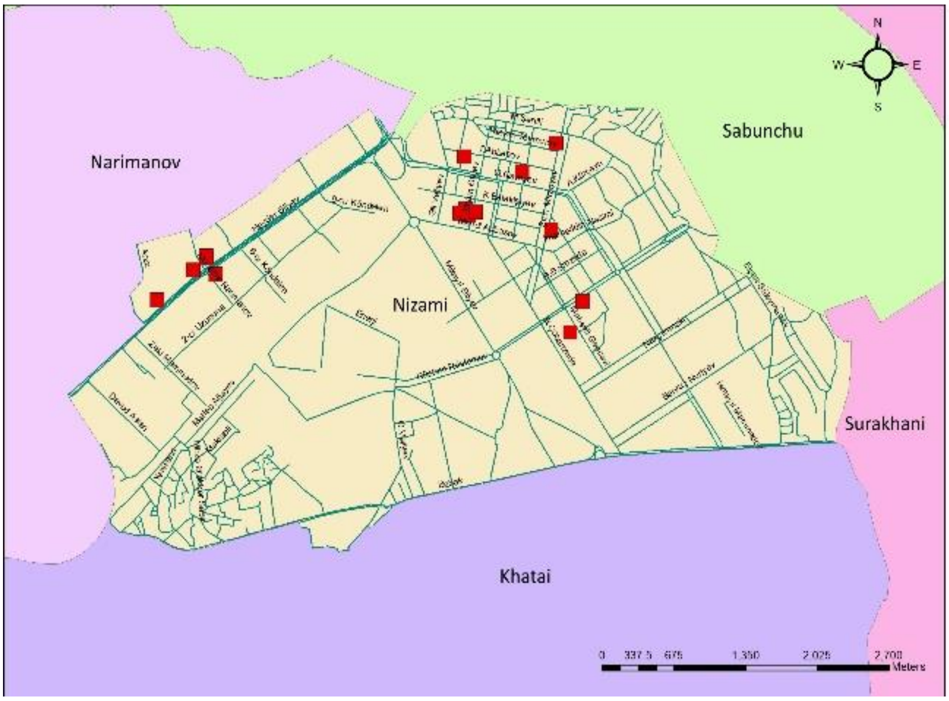

Fig. 2. Study areas with parent rock in Nizami district

The coordinates of the construction sites with parent rock in the Nizami district, determined based on the ArcGIS program, the depth of the wells, the lithological composition of the soils, the engineering geological elements (EGE), the thickness of the bedrock and the depth of the bedrock are shown in Table No. 1.

Table 1.

Engineering-geological and seismic indicators of the parent rocks encountered in the construction sites of the Nizami district.

№	Construction site coordinate		Well depth (m)	Engineer-geological element (EGE)	Transverse wave velocity, Vs (m/sec)	Parent rock thickness (h, m)	Parent rock depth (m)
	X	Y					
1.	49,898925	40,411841	40,0	Limestone, shale, gravel-pebble	710	7,40 - 8,50	31,0 - 40,0
2.	49,898036	40,413226	120,0	Clay soil, firm consistency, with sand layers in between	680	I layer-5,0-19,0; II layer 18,0-19,0	I layer 53,0-80,0; II layer 101,0-120,0
3.	49,89645	40,41229	60,0	Limestone, cemented, sandy, shale	670	5,50-6,0	1,0 – 7,0
4.	49,892294	40,410005	60,0	1. Limestone, less durable 2. Clay soil, hard consistency	1. Limestone - 750; 2. Clay -680	5,50-6,40; 5,20-6,20	1,60-8,0; 24,0-30,20
5.	49,897962	40,413343	65,0	Limestone, medium-durable, gravelly composition	650	5,90-6,40	3,30-9,80
6.	49,927267	40,415448	25,0	Limestone, less durable, semi-rocky, igneous	760	5,20-8,40	11,0-20,0
7.	49,937351	40,420918	25,0	Limestone, weakly resistant, shale, with interbedded sand and clay layers	770	7,10	1,50-8,60
8.	49,926959	40,415951	25,0	Limestone, less durable, semi-sandy, herringbone, gravel and sandstone in composition	770	5,90-8,0	2,0-11,0
9.	49,926311	40,415659	25,0	Limestone, less durable, semi-sandy, felsic, gravel and sandstone in composition	770	5,90- 8,0m	3,0-11,0
10.	49,937787	40,405419	28,0	Clay soil, of a firm consistency, containing cemented shells, pebbles, and limestone aggregates	690	7,70-9,20m	2,0-10,20m
11.	49,93344	40,41877	28,0	Limestone, less durable, semi-rocky, igneous	670	6,80-8,40	10,30-18,70
12.	49,936318	40,413866	28,0	Limestone, weakly durable, semi-rocky	730	7,50-7,80	13,50-21,30
13.	49,927141	40,420262	32,0	Limestone, weakly durable, slightly cracked, with interbedded clay and sand layers	670	5,10-13,30	11,40-32,0
14.	49,9363	40,413867	30,0	Limestone, weakly durable, gravelly, with interbedded sand layers	720	6,90-13,70	8,80-28,0
15.	49,939394	40,407866	30,0	Limestone, weakly resistant, shale, sandy	700	5,0-10,10	2,0-12,10
16.	49,928066	40,415704	30,0	Limestone, weakly durable, with sand layers in between	710	6,30-7,10	2,0-10,0

Parent rock is the main geological layer from which soil is formed. Parent rock determines both the mineral composition and physical properties of the soil. They are mainly located in the lower layer. In some cases, they can be located close to the upper layer and on the surface. Parent rock in Absheron consists of layers of limestone, clay, sandstone. Usually, parent rock begins after 30-50 cm.

An example taken from construction sites located in the Nizami region with parent rock is shown (Figure 3,[6]).

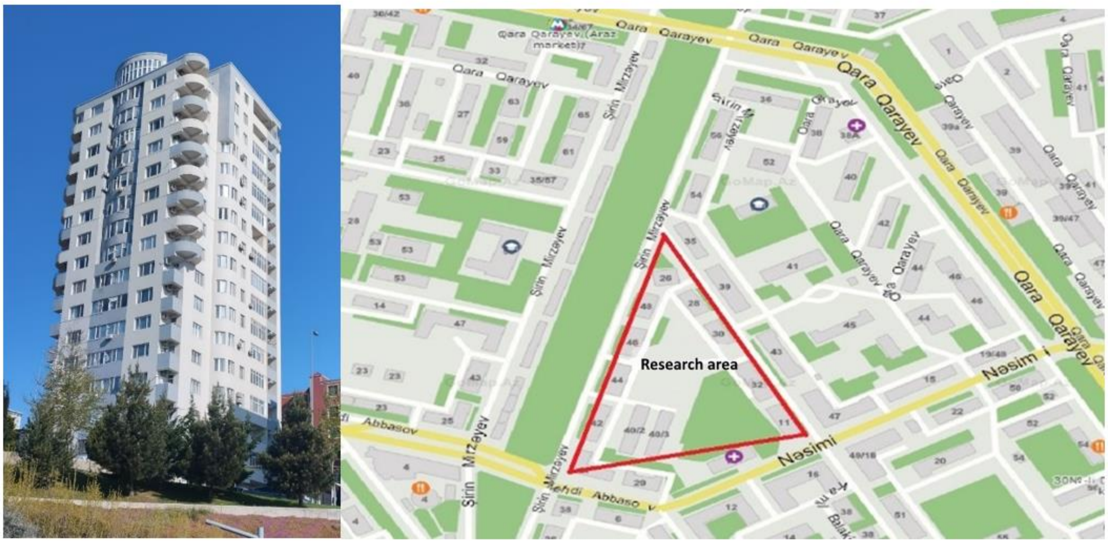

Fig. 3. Research area in Nizami district, Baku city.

Geomorphologically, the studied area is located in a small area in the northeast of the Baku syncline trough, slightly inland on terraces. Tectonic faults and exogenous geological processes are not recorded in the study area.

Various engineering-geological and geophysical methods are used to study the host rocks, and improper implementation of geological assessment leads to serious problems in construction sites [9].

Examples of geological-lithological and seismic sections of the studied construction site are shown in the figure (Figures 4 - 8).

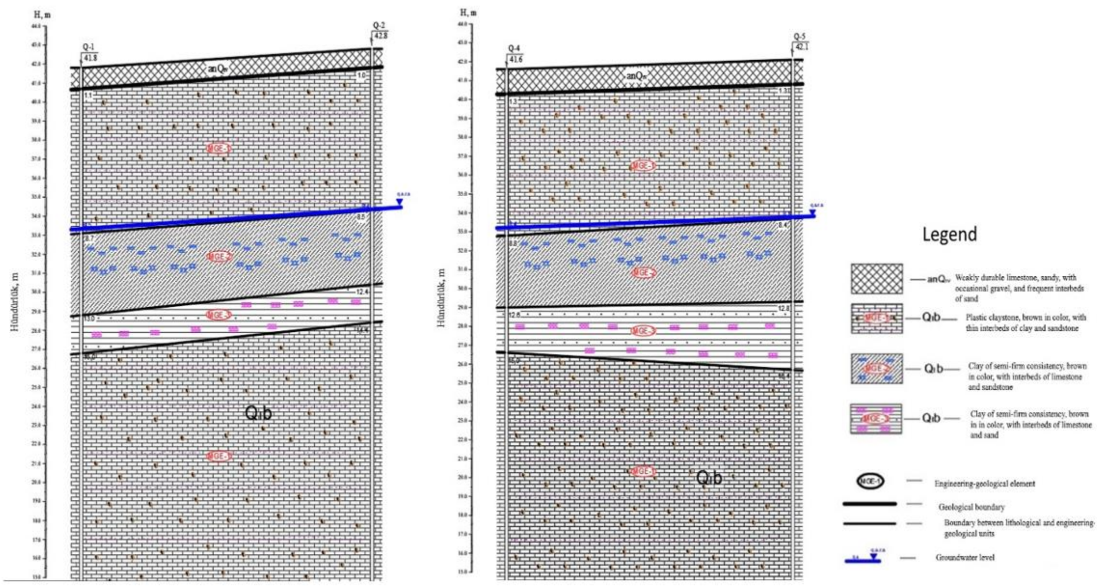

Fig. 4. Geological-lithological cross-section of the construction site with parent rock in Nizami district.

The seismic method is one of the most widely used methods in geophysics. In this case, artificial waves are created or noise from the environment is recorded (actively and passively) and their propagation in rocks is studied.

In order to study the seismic structure of the study area, the “Test Microtremor” (Test Microseism) method was used during the engineering-seismic exploration works. The “Test Microtremor” method uses the phase data of the wave field recorded for each profile [4, 5, 7, 10].

For the purpose of studying the tested microseisms, the GEODE-24 engineer seismic station, 24 seismic receivers for recording signals, a 55-meter seismic exploration grid and a 12-kg impact hammer were used. Noise from the environment and microvibrations created by the impact method are taken as seismic sources.

The method of data acquisition and collection consists of obtaining 12 micro vibration recordings of 30 seconds. The converted wave field of the received recordings shows the dispersion curve of transverse waves. The dispersion curve of transverse waves is selected from the converted wave field and then these selections are modelled to construct the velocity intercept of transverse waves.

The Seismic module Controller software package was used to obtain recordings in the study area, and software such as ReMiVspect4.0 and ReMiDisper4.0 were used to process the obtained recording results.

In modern approaches, one of the main parameters in the assessment of soil conditions is the transverse wave velocity (Vs). This indicator provides important information about the density, elasticity of rocks and the propagation characteristics of seismic waves.

As can be seen from the figure, the distribution of the transverse wave velocity (Vs) over the depth was monitored based on the engineering-seismic exploration work carried out to assess the engineering-seismic properties of soil layers in the study area.

Analysis of seismic sections shows that with increasing depth, the development of denser and stronger layers is observed in the geological environment. This pattern is characterized by the compaction of rocks, a decrease in porosity and an improvement in elastic properties. In particular, the increase in the transverse (S) wave velocity over the depth is one of the main geophysical indicators reflecting the increase in the hardness and shear resistance of the geological environment.

5 layers were recorded on seismic profiles (Figure 5-8): for the first layer, the transverse wave velocity (technogenic soils) is 174-300 m/sec; It is 300-425 m/sec for the second layer; 426-550 m/sec for the third layer; 551-674 m/sec for the fourth layer; 675-800 m/sec for the fifth layer.

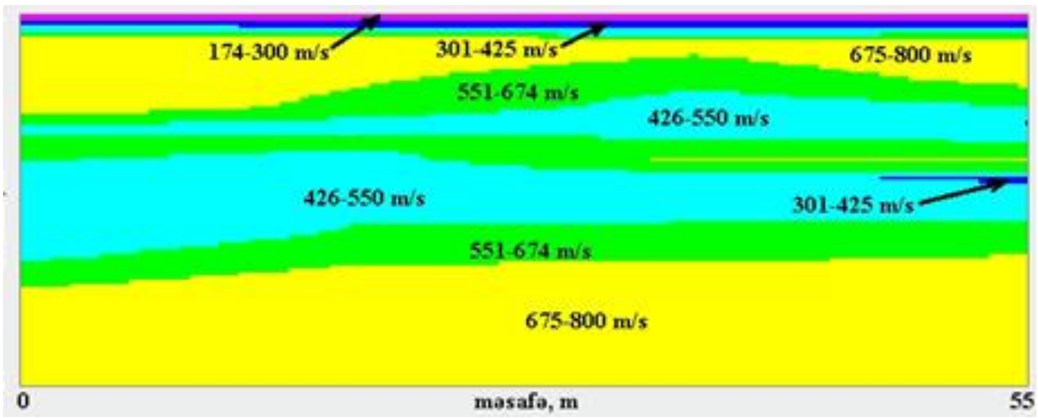

Fig. 5. 2D velocity cross-section of a transverse wave along a seismic profile at a construction site in Nizami district

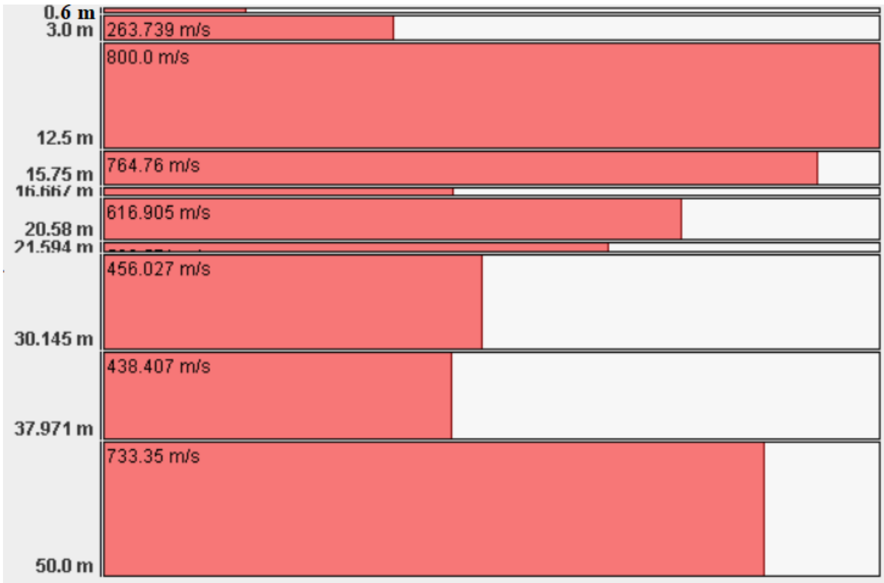

Fig. 6. 1-dimensional velocity cross-section of a transverse wave along a seismic profile at a construction site in Nizami district

The average transverse wave velocity parameter was calculated along the profile up to a depth of 30 m. The average transverse wave velocity parameter is calculated using the following formula:

$$V_{s30} = \frac{30}{\sum\limits_{i=1,N} \frac{h_i}{V_i}}$$

where, hi and V_i are the thicknesses of the "i" layer of soil layers up to a depth of -30 m and their corresponding transverse wave velocities. Based on the calculation, we obtain:

Vs30= 443 m/s

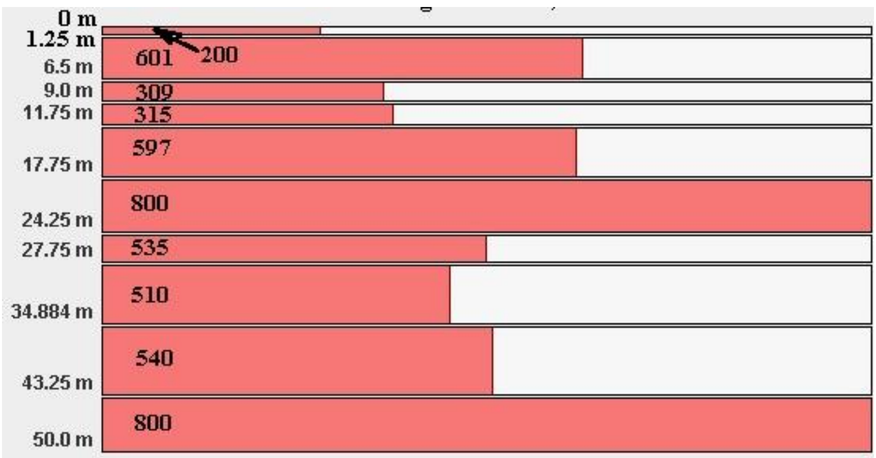

Fig. 7. 1-D velocity cross-section of a transverse wave along a seismic profile at a construction site in Nizami district

The average transverse wave velocity parameter was calculated at a depth of 30 m in the area and

Vs30= 492 m/s

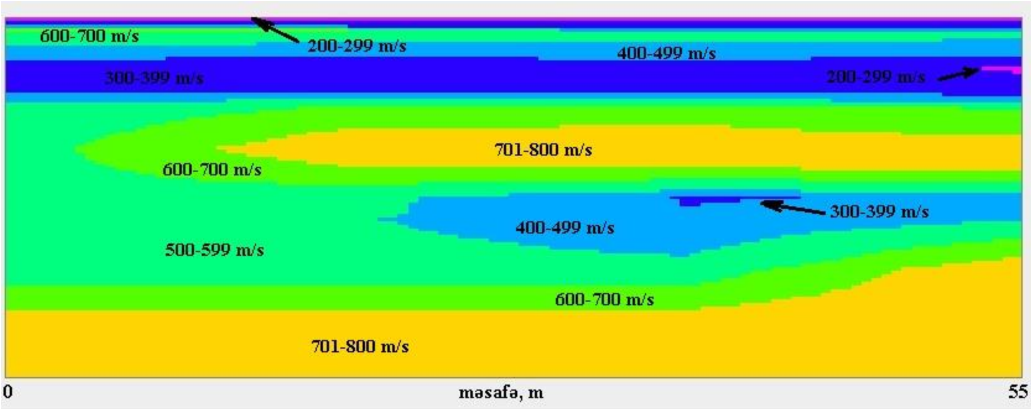

Fig. 8. 2D velocity profile of a transverse wave on a seismic profile at a construction site in Nizami district

In modern engineering, the parent rock is considered not only as a support for the foundation, but also as a key indicator for assessing geological risks. Weak and unstable rocks increase the risks of landslides, avalanches and collapses. On the contrary, solid bedrock minimizes these risks and ensures the longevity of the structure. At the same time, the propagation speed and strength of seismic waves during an earthquake also vary depending on the properties of the rock. While hard parent rock transmits seismic waves faster, soft soils can amplify these waves.

One of the most important sections of modern geology is hydrogeological conditions in construction. It is important to take into account groundwater during construction work. Groundwater affects the stability and load-bearing capacity of the foundation. Incorrect assessment of hydrogeological conditions can pose serious risks to the building, such as subsidence and subsidence.

Since the contact of water with soils is different, their property variability due to the influence of water also has different characteristics and mainly causes a decrease in strength. In engineering geology, water in the soil layer is studied as a factor affecting the strength of soils and how they behave under structures, in short, engineering-geological conditions. In this regard, any changes and states of water in soils are of interest [11].

If the water level is high, deep piles are selected. Because, in this case, a shallow foundation becomes risky. Piles are used to transfer loads from buildings and structures to a deeper, stronger soil layer. Piles transfer the load to the soil, spreading it both through the pile tip and along the lateral surface. The pile group distributes the load between individual piles. This leads to a decrease in the stress on the soil [2].

It should also be taken into account that, according to the Az.DTN 2.3-1 standard, the seismicity of the construction site cannot be changed regardless of the structural features of the foundations and the depth of their installation, as well as the improvement of the properties of the soil by strengthening [1].

The data of engineering-geological exploration-wells carried out in the Nizami district of Baku were studied (1998-2025, 130 construction sites, 1884 well sections of various depths) and the widespread distribution of mainly semi-solid clay (thickness 5.0-28.0 m) soil in this region was determined [8].

Physical and mechanical indicators: porosity coefficient e=0.650÷0.820, consistency IL ≤0÷0.24, dry density ρ_d =1.51 ÷ 1.64 g/cm3, transverse wave velocity VS = 400-585 m/sec. The groundwater occurrence level in these construction sites is 1.0-17.0 m, and the settlement level is 0.20-16.30 m.

The obtained parameters such as density, depth, transverse wave velocity, porosity, consistency, water permeability, and models based on these parameters should be prepared in a multidisciplinary manner with measurements taken in the area and have the character of initial information for other scientific studies. At the same time, these studies provide effective solutions to engineering problems [3].

Thus, the conducted studies allow determining the physical and mechanical properties of the parent rocks, the level of groundwater, etc. processes. The information obtained ensures the selection of the right structural solutions at the design stage. In addition, the application of modern engineering technologies and international standards during construction is recommended. During the implementation of projects, quality control should be strengthened and the suitability of the materials used should be checked.

As a result, parent rock is one of the main natural resources of the construction industry. Their correct selection is of great importance for the strength, safety and durability of structures. Its strength, load-bearing capacity and resistance to seismic effects allow for a more accurate study of geological conditions using modern research methods. These technologies increase the safety of construction projects, reduce risks and ensure more efficient work.

Results

1. Based on the engineering-geological and seismic exploration studies conducted in the Nizami district, the distribution of parent rock characterized by high strength and low compressibility in a significant part of the territory was determined (at depths of 3, 38 and 18, 43 m).

2. The presence of parent rock was determined in 16 construction sites studied and these sites were assessed as favourable from an engineering-geological point of view. Parentrock was noted as an important factor that reduces the risk of deformation and subsidence of the foundation base, as well as ensuring reliable absorption of static and dynamic loads, especially increasing the stability of multi-storey and large-scale buildings.

3. It was determined that the semi-solid clay soils widespread in the Nizami district are classified as category II soils based on their seismic properties, and that these soils have medium seismic stability.

REFERENCES

1. AzDTN 2.3.-1. Construction standards in seismic regions. Baku-2011 (original in Azerbaijan language)
2. Ipatov P.P., Strokova L.A. Mechanics of soils, foundations and foundations: Tomsk: Изд-во ТПУ, 2002.-228 p. 2011 (original in Russian language)
3. Investigating Geophysical Methods of Soil Engineering and Seismic Bedrock Parameters of IPEK Yaprak, Menemen Plain. September, 2017 Izmir, page 61. 2011 (original in Azerbaijan language)
4. Louie, J.N. Faster, Better: Shear-wave velocity to 100 meters depth from refraction microtremor arrays. Bulletin of the Seismological Society of America, 2001, v. 91, p. 347–364.
5. McMechan, G.A., Yedlin, M.J. Analysis of dispersive waves by wave field transformation. Geophysics, 1981, v. 46, p. 869–874.
6. Mammadov G.Sh., Hashimov A.J., Verdiyev A.E., Mammadova E.A. Fundamentals of engineering geology. Baku: Elm, 2012. – 798 p. 2011 (original in Azerbaijan language)
7. Nazarian S., Stokoe II K.H. In situ shear wave velocities from spectral analysis of surface waves. Proceedings of the World Conference on Earthquake Engineering, 1984.
8. Engineering-geological reports of the designed construction sites in the territory of Nizami district. “Mənzil” KM, “GEO-Servis” LLC, “GeoEngineering” LLC (1998–2025). 2011 (original in Azerbaijan language)
9. Panahi Sh.A., Karimov V.M., Tagiyev A.Sh. Engineering-geological properties of rocks. Baku, 2018. – 111 p. 2011 (original in Azerbaijan language)
10. Park C.B., Miller R.D., Xia J. Imaging dispersion curves of surface waves on multi-channel record. Society of Exploration Geophysicists, 1998.
11. “Garayev City” MTK (Nizami district, 2400th block). Engineering-geological report. Baku, 2018. “Apartment” K.M. 2011 (original in Azerbaijan language).