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Research Article

ENGINEERING-SEISMOLOGICAL AND GEOPHYSICAL RESEARCH IN THE CONSTRUCTION OF MULTI-STOREY BUILDINGS IN SEISMIC AREAS

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ABSTRACT
The article presents the results of engineering-geological and geophysical studies conducted at the pre-project stage of construction of multi-storey buildings in urban areas. At the same time, based on the complexity category of the engineering and geological conditions of the construction site, the number of mine workings and the depth of the study are selected. In parallel with this, geophysical studies are carried out and, based on the ground conditions of the terrain, an increase in seismic intensity is calculated using the physical and seismic properties of soils.

***Keywords**: Lithologic, Geophysical Methods, MASW Method, Seismic Methods, MSK-64, Seismicity, Geomorphologic, Golodnostep, Engineering-geological, Monitoring, Vs30, Geological*

INTRODUCTION
In recent years, the population's demand for housing has been sharply increasing in our country, since the construction of multi-storey residential buildings is required to meet this need. As we know, more than 75% of the territory of the Republic of Uzbekistan is located in seismically active zones. The construction of multi-storey residential buildings in seismically active areas requires significant investments (Abelev and Abelev, 1979). Naturally, the construction of multi-storey buildings and structures is preceded by engineering-geological, geophysical and seismological studies of construction sites. Where antiseismic measures are carried out during construction, it is possible to significantly reduce the damage and even avoid it, and the costs of antiseismic measures are always justified. At the same time, the increase in the cost of construction is assumed with an increase in seismicity from 6 to 7 points is equal to 4%, from 7 to 8 - 8%, from 8 to 9 - 10-15%. In this regard, at the stage of technical drawings, detailed engineering and geological studies were carried out to substantiate the construction site of multi-storey buildings and structures in the "Mall of Tashkent and business center Complex at the intersection of Babur and Mukimi streets in Tashkent." These studies were carried out in two stages - engineering-geological and geophysical studies. The research was conducted under the supervision of V.A. Ismailov, research associates R.S. Ibragimov, A.H. Ibragimov, E.M. Yadgarov, T.U. Mamarazikov, J.Sh. Bozorov, etc.

MATERIALS AND METHODS
Based on the above, the purpose of the research was engineering-geological and geophysical studies related to the construction of multi-storey buildings in the seismic areas of Tashkent. Execution of research works on the topic: "Quantitative assessment of seismic hazard and calculation of synthesized accelerograms for the construction site of the Mall of Tashkent and Tashkent Tower in Tashkent" was done at the Institute of Seismology of the Academy of Sciences of the Republic of Uzbekistan.

RESULTS AND DISCUSSION
The purpose of engineering-geological surveys is to obtain complete information about the engineering-geological conditions of the construction site. Below are the results of engineering-geological and geophysical studies conducted for the 41-storey building.

The investigated site is located in the southern part of Tashkent at the intersection of Babur and Mukimi streets, in the Yakkasaray district. The surface of the plot is relatively flat, with a slight slope from north to south. towards the ar. Salar. Absolute marks on the passed workings in the section vary within 426.20-425.90 m. The survey site is represented by the former territory of the bakery, with a cleared and planned construction site. Geomorphologically, the site is confined to the surface of the third above-floodplain terrace of the Chirchik River. Quaternary alluvial-proluvial deposits of the Golodnostep complex (apQIIIgl) take part in the geological structure of the site. Depending on the category of complexity of engineering and geological conditions of construction sites, the distances between rock wells are determined and, based on the number of storeys of buildings and structures, the depth of drilling and sinking of pits is selected, which will pass from the foundation base.[9]
Lithologically, to a proven depth of up to 7.6 m, the site is composed of clay soils, which from a depth of 6.7-7.4 m are underlain by pebble deposits. Clay soils are represented by loess-like loams, mostly powdery with rare layers of sandy loam, moist and water-saturated state, from solid to fluid consistency. Large-block soils on the site are represented by pebble deposits with sand-gravel aggregate, water-saturated state. At the base of clay soils, in places there are low-power layers of medium-grained sands, because of the low power, they are not distinguished as an independent element. From the surface, the soils are covered with bulk soils, with a capacity of 1.2-2.0

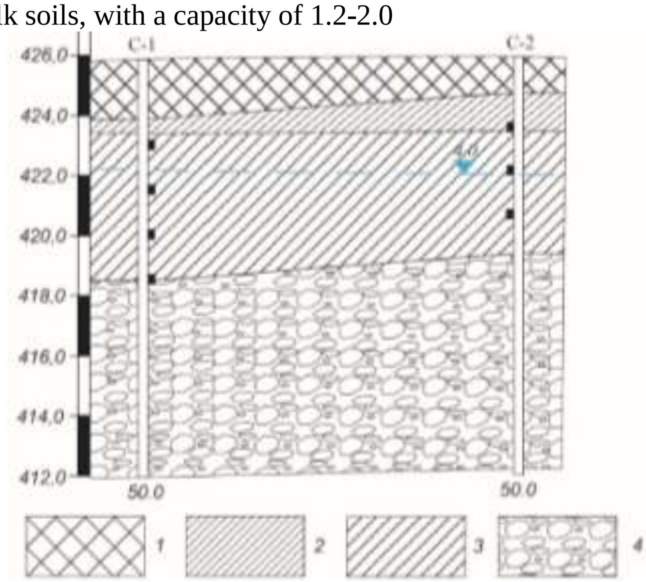

Figure 1: Engineering-geological section
1-bulk soil, 2- loam above the UGV, 3- loam below the UGV, 4-Pebbles

Based on the type of soil, condition (water saturation), lithological structure, physical, strength and deformation properties of soils in the explored thickness, three engineering-geological elements were identified: IGE-1 - Loess-like loam, moist, from solid to refractory; IGE-2 - Loess-like loam, water-saturated, from refractory to fluid; IGE-3 - A pebble with a sand-gravel filler.
Geophysical methods are the main means of studying the physical properties of soils on the construction site. These methods differ in the type of waves, frequency composition and observation systems both inside the array of pounds and on the daytime surface. Of the seismic methods, the most common and well-known is the method of fractured waves. Geophysical methods are used for mapping loose sediments and determining the depth of bedrock, detailed dismemberment of the upper part of the section, assessment of the physico-mechanical and water-physical properties of rocks in their natural occurrence, study of fracturing and disturbance of the massif, determination of the groundwater level and their dynamics. The tasks of geophysical methods also include the study of the stressed state of bedrock, the identification of geodynamic phenomena and seismicity (karst, suffusion, landslides, landslides,

subsidence, etc.) that pose a danger to future construction, monitoring the operation of critical structures and studying their impact on the geological environment [6]. Seismic exploration by MASW method was

Table 1: Normative and calculated values of IGE-1 characteristics

Name of the characteristic	Unit of measurement	Normative values	Calculated values for a =	
			0,85	0,95
Soil density	t/m3	1,87	1,85	1,82
The density of the soil in a dry state	t/m3	1,55		
Density of soil particles	t/m3	2,70		
Porosity	%	42,7		
Porosity coefficient	Without dimensional	0,751		
Natural humidity	share per unit	0,209		
Degree of humidity	Without dimensional	0,75		
Humidity at the yield point	share per unit	0,309		
Humidity at the rolling limit	share per unit	0,206		
Plasticity number	share per unit	0,103		
Turnover rate	Without dimensional	>0		
Specific coupling	kPa	18	12	7
Internal friction angle	gradus	26	24	23
Modulus of deformation: at natural humidity	MPa	6,3		
with water saturation	MPa	1,2		
Relative drawdown At P=0,1 MPa 0,2 MPa 0,3 MPa	Without dimensional	0,006 0,010 0,014		
Initial drawdown pressure	MPa	0,21		

Figure 2: The layout of the reception arrangement. The red line indicates the location of the receiving arrangement, the numbers indicate the corresponding numbers of geophones.

carried out at the construction site **"Mall of Tashkent and Tashkent Tower".** The purpose of the seismic survey was to determine the propagation velocity of elastic waves in the ground layer at the construction site, to determine the Vs30 parameter at the construction site. To carry out the work, a right-flank observation system was used, with a fixed reception arrangement. The reception arrangement consisted of 24 geophones with a step of the reception point of 3 m, the total length of the reception arrangement was 69 m. The pitch of the excitation point was also 3 m, the total number of physical observations was 9 units (Fig. 2).

A seismic survey station "MAE X820-S" (manufactured in Italy) with the use of vertical seismic receivers with a frequency of 4.5 Hz was used for field work. The processing of field data consisted in entering and assigning the geometry of the survey, suppressing the first performances in order to isolate Rayleigh waves on seismograms. Next, the Radon transformation was performed, where the dispersion curves of the dependence Vf(f) were obtained (Fig. 3)

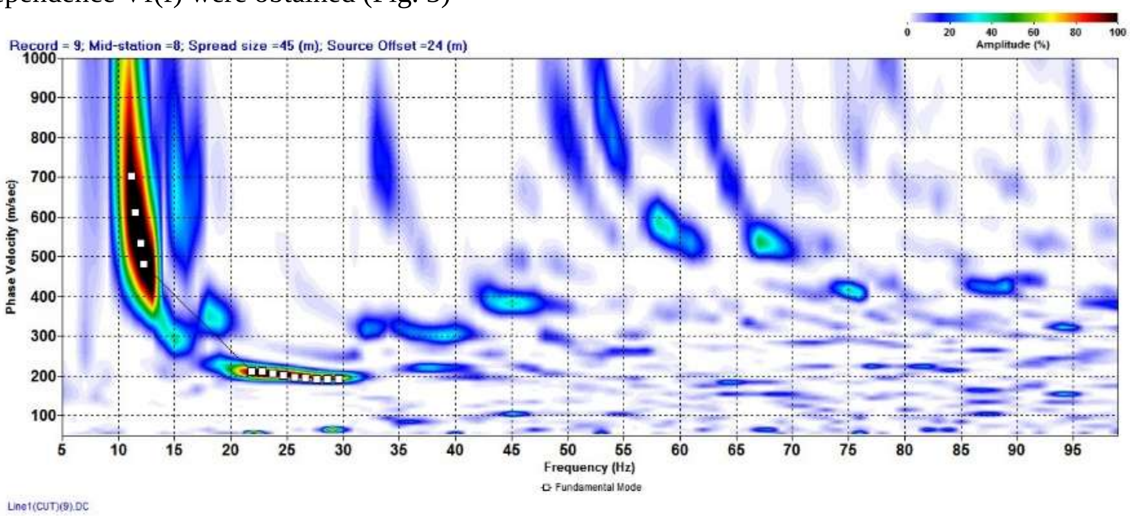

Figure 3: Dispersion curves of the dependence Vf(f). The numbers of the physical surveillance system

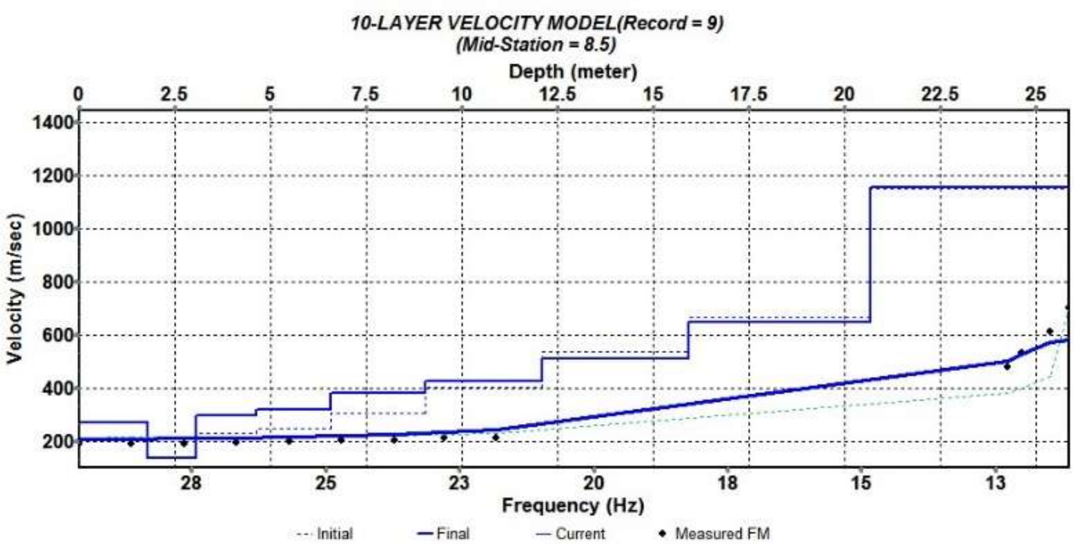

Figure 4: Inversion of dispersion curves

Analysis of the dispersion curves allows us to conclude that the section is a three-layer model. The inversion of the dispersion curves makes it possible to switch from the parameters of the phase velocity of

Rayleigh waves to the velocity of transverse waves. The inversion is performed on the basis of the model calculated during the allocation of dispersion curves (Fig. 4).
Based on the results of the inversion (Fig. 4), a model of the velocity of transverse waves was constructed (Fig. 5). Two boundaries are distinguished on the section, determined by the thickening of the isolines. The first border is at a depth of 8 meters, the second border is at a depth of 21 meters. The speeds along the section vary from 160 to 800 m/s. Based on the data obtained, the Vs30 profile was calculated (Fig. 6).

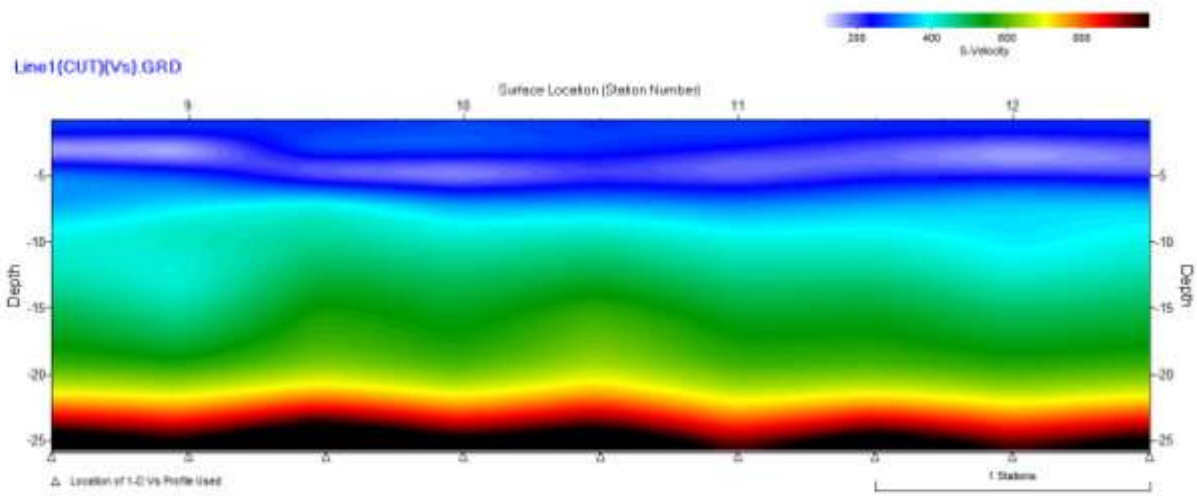

Figure 5: Model of the velocity of transverse waves

Based on the results of seismic exploration by the MASW method, the structure of the section, the velocity of propagation of the transverse wave in the soil massif, Vs30, was determined. The average value of this parameter in the profile is 404 m/s, which, according to Table 1. CMC 2.01.03-96, according to seismic properties, can be attributed to soils of the triple category [KMK, 1998]

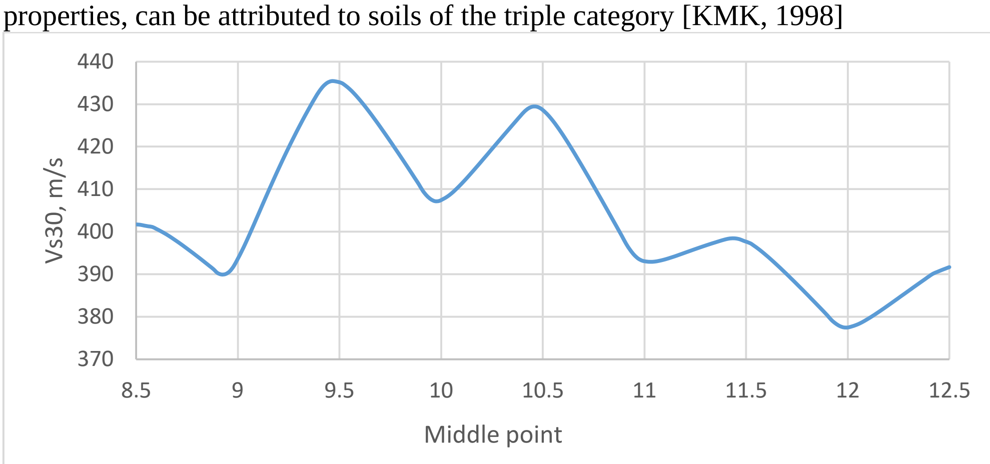

Figure 6: Vs30 profile

Calculations of the increment of seismic intensity were made according to the formula of S.V.Medvedev (1962), i.e., according to the seismic rigidity of soils:

$$\Delta I_{общ} = 1{,}67 \lg \frac{V_0 \cdot \rho_0}{V_i \cdot \rho_i}$$

where Vo and Vi are the velocities of seismic waves in the reference and studied points,

roiri is the density of the soil in the reference and the studied points.
To calculate the increment of seismic intensity, graphs of changes in the density of soils with depth, established by the results of laboratory studies on seismic profiles, were used: Calculations were carried out using the results of the values of the velocity of transverse waves of soils. Loess-like loam having a predominant distribution in the territory with a thickness of up to 30 m and characterized by the following physical indicators were accepted as a reference soil: the velocity of the transverse waves is 404 m/sec, the density is 1.87 g/cm3. The seismic rigidity of the reference soil was 755.48 Calculations of the increment of the seismic intensity of the site are given in Table 2.
The analysis of the obtained results shows that the most seismically dense soils are common on the studied site, they are represented by sandy loams and loams with inclusions of sand, underlying pebbles with a close occurrence of the groundwater level, which is of no small importance in assessing the seismic intensity of the site.

Table 2: Summary data on the seismic characteristics of soils and the increment of seismic intensity at the site under study

Name of the object	Observation point	Velocity of transverse waves (average value for 10 m thickness) m/s	Soil density (average value for 10 m thickness), g/cm3	Average value of seismic stiffness	Increment of seismic intensity in points
Construction of a multi-storey residential building	10 м	403,5	1,87	754,545	+0,65
	30 м	830,7	2,05	1702,935	+0,40

CONCLUSION

Based on the conducted geophysical and engineering-seismological studies, the following conclusions can be drawn: in the past, the site under study experienced maximum concussions with an intensity of I = 8 points, according to the MSK-64 scale; according to seismic surveys, soils in the foundations of buildings of a multi-storey residential building located on the street "Mall of Tashkent and business center Complex on the intersections of Babur and Mukimi streets in Tashkent" belong to the III category of soils according to seismic properties and the increment of seismic intensity is +0.5 points to the initial seismicity; due to the deterioration of the engineering and geological conditions of the site, there is an increase in seismic intensity by +1 point; in order to maintain stability and in the further operation of the projected buildings and structures on the site under study, this conclusion must be taken into account.

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