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Some Results of Engineering Geological Investigation for the Construction Site, Ulaanbaatar, Mongolia

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Abstract: **Mongolia is landlocked country located between Russia and China. The climate of Mongolia is characterized by arid and semi-arid conditions. The aim of this study is to determine the engineering geological condition based on the soil properties at the construction site of tourism conmplex where located in Khan-Uul disctirct, the southwestern part of Ulaanbaatar city. In the study area, a total of 34 boreholes were drilled in May 2024. The borehole depths range 10-20 m. A total of 139 unbroken soil samples were collected to define the physical and mechanical properties of soils. The soil in the study area were classified into four engineering geological elements based on the results of laboratory analysis. The depth of seasonal freezing varies depending on soil type, ranging from 2.78 to 3.97 m. The study area was determined to have moderate engineering geological conditions based on the physical and mechanical parameters of soil.**

Keywords: ***Engineering geological element, Soil density, Soil mechanics, Soil physics.***

Introduction

Mongolia is landlocked country located between Russia and China. The climate of Mongolia is characterized by arid and semi-arid conditions. The capital city, Ulaanbaatar, is the largest urban center in the country. The average annual air temperature is -2.6°C, the highest temperature reaches 31.4°C in July and the coldest temperature is -39.9°C in January. The average annual precipitation is 248.8 mm and mean wind speed is 2.3 m/s.

The first engineering geological survery in Ulaanbaatar city was conducted in 1947 (Beejinkhuu, 2015). The engineering geological survey of construction sites are comprehensive studies aimed at determining the geological and hydrogeological conditions of area designated for building structures (Lipatova et al., 2020). In recent years, construction activities in Ulaanbaatar city have been intensively developed.

The aim of this study is to determine the engineering geological condition based on the soil properties at the construction site of tourism conmplex where located in Khan-Uul disctirct, the southwestern part of Ulaanbaatar city (Figure1).

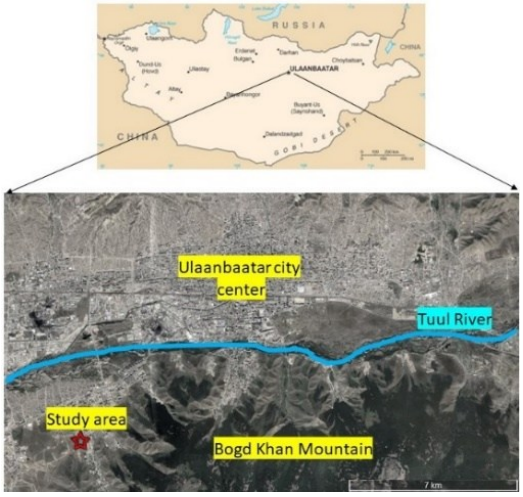

Figure 1, Study location.

Methodology

In the study area, a total of 34 boreholes were drilled using UGB-50M and UGB-1BC drilling machines (Figure 2) in accordande with the BNbD-11-03-21 standard in May 2024. The borehole depths range 10-20 m. A total of 139 unbroken soil samples were collected from boreholes to define the physical and mechanical properties of soils in the soil laboratory.

Figure 2, Drilling work at study area.

Result

Top soil was found to be 0.2 m thick and technogenic soil layer was 0.8 m thick in boreholes N33 and N34. The groundwater depth from surface were measured ranging from 1.5 to 6 m. The laboratory results are shown in Table 1. The soils in the study area were classified into 4 engineering geological elements according to the soil classification standard MNS 3263:2014 based on the results of field survey and laboratory analysis.

Enigneering geological element 1: The soil is brown and grey colored clay loam soil of Quaternary proluvial deposits. A strong swelling may develop within the seasonal freezing zone. The depth of seasonal freezing is 2.78 m.

Enigneering geological element 2: The soil is brown and grey colored gravel with sandy loam soil of Quaternary proluvial deposits. A moderate swelling may develop within the seasonal freezing zone. The depth of seasonal freezing is 3.97 m.

Enigneering geological element 3: The soil is brown colored gravel with clay loam soil of Quaternary proluvial deposits. A strong swelling may develop within the seasonal freezing zone. The depth of seasonal freezing is 3.97 m.

Enigneering geological element 4: The soil is reddish colored gravel and clay loam soil of Quaternary proluvial deposits. A moderate swelling may develop within the seasonal freezing zone. The depth of seasonal freezing is 3.52 m.

Conclusion

The study area is located in the Khan-uul district of Ulaanbaatar city, in the southern part of the Tuul River. Geomorphologically, it belongs to the transitional zone between Bogd Khan Mountain and the Tuul River valley. Regarding the hydrogeological conditions, the groundwater depth was found ranging 1.5-6 m below surface. The surface runoff in the study area will be occur in a south to north direction.

The soil in the study area were classified into four engineering geological elements based on the results of laboratory analysis. The depth of seasonal freezing varies depending on soil type, ranging from 2.78 to 3.97 m. The study area was determined to have moderate engineering geological conditions based on the physical and mechanical parameters of soil.

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Table 3, The lab result of physical and mechanical properties of soils.

Parameters		Max	Min	Average
		Engineering geological element 1: Clay loam soil		
Number of definition		7	7	7
Moisture content (W)		0.18	0.11	0.14
Parameters for plasticity	Liquid limit (W_L)	0.28	0.25	0.26
	Plastic limit (W_P)	0.17	0.14	0.15
	Plasticity index (J_P)	0.12	0.09	0.11
Density, (g/cm^3)	of particles (ρ_s)	2.72	2.71	2.72
	of soil (ρ)	2.13	2.05	2.09
	of dry soil (ρ_d)	1.90	1.76	1.84
Porosity (n)		35.30	30.24	32.45
Porosity factor (e)		0.55	0.43	0.48
Degree of saturation (G)		0.91	0.65	0.78
Specific cohesion (kPa)		46		
Angle of internal friction (degree)		46		
Deformation (MPa)		33		
Resistance (kPa)		350		
		Engineering geological element 2: Gravel with sandy loam soil		
Number of definition		42	42	42
Moisture content (W)		0.14	0.02	0.07
Parameters for plasticity	Liquid limit (W_L)	0.21	0.15	0.18
	Plastic limit (W_P)	0.16	0.11	0.13
	Plasticity index (J_P)	0.07	0.03	0.06
Density, (g/cm^3)	of particles (ρ_s)	2.70	2.67	2.69
	of soil (ρ)	2.24	2.08	2.15
	of dry soil (ρ_d)	2.15	1.85	2.02
Porosity (n)		31.34	19.38	24.86
Porosity factor (e)		0.46	0.24	0.33
Degree of saturation (G)		0.91	0.21	0.50
Specific cohesion (kPa)		6		
Angle of internal friction (degree)		6		
Deformation (MPa)		43		
Resistance (kPa)		400		
		Engineering geological element 3: Gravel with clay loam soil		
Number of definition		69	69	69
Moisture content (W)		0.24	0.03	0.10
Parameters for plasticity	Liquid limit (W_L)	0.27	0.19	0.22
	Plastic limit (W_P)	0.17	0.11	0.13
	Plasticity index (J_P)	0.13	0.07	0.09
Density, (g/cm^3)	of particles (ρ_s)	2.72	2.69	2.71
	of soil (ρ)	2.23	2.07	2.14
	of dry soil (ρ_d)	2.09	1.72	1.96
Porosity (n)		36.46	22.67	27.72
Porosity factor (e)		0.57	0.29	0.39
Degree of saturation (G)		1.12	0.30	0.66
Specific cohesion (kPa)		12		
Angle of internal friction (degree)		12		
Deformation (MPa)		30		
Resistance (kPa)		400		
		Engineering geological element 4: Gravel and clay loam soil		
Number of definition		21	21	21
Moisture content (W)		0.25	0.05	0.12
Parameters for plasticity	Liquid limit (W_L)	0.31	0.19	0.24
	Plastic limit (W_P)	0.18	0.11	0.14
	Plasticity index (J_P)	0.15	0.07	0.10
Density, (g/cm^3)	of particles (ρ_s)	2.73	2.70	2.71
	of soil (ρ)	2.16	2.05	2.11
	of dry soil (ρ_d)	2.05	1.65	1.89
Porosity (n)		39.04	24.51	30.15
Porosity factor (e)		0.64	0.32	0.44
Degree of saturation (G)		1.07	0.37	0.70
Specific cohesion (kPa)		17.5		
Angle of internal friction (degree)		17.5		
Deformation (MPa)		25		
Resistance (kPa)		350		