Technical Report of the Engineering and Geological Study Conducted for Drawing up the Project of Full Reconstruction of the Mtatsminda Ropeway in Tbilisi

Tbilisi

2016

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Annexes

Technical Assignment
On Engineering and Geological Studies

1. The name of the project - the arrangment of the ropeway connecting Mtatsminda park in Tbilisi
2. Pits shall be made in the places indicated by the customer on the schematic plan (at the foundations of the supports of the existing towers)
3. A borehole shall be made at # 2 support in order to determine the benchmarks(elevations) of basic unexhausted rocks.
4. Soil samples shall be taken from pits, an, in case of the detection of ground water – samples, and shall be conducted appropriate laboratory studies;
5. The technical report shall be presented on the basis of the conducted works.

An Expert-Constructor: A.Kaipanjiani

I. General Part

I.1. Introduction

On the basis of #1004820116 order of 6 June, 2016 of Tbilisi Transport Company, the Kiriak Zavriev Structural Mechanics, Earthquake Engineering and Engineering Expertise Department of Legal Entity of Public Law Levan Samkharauli National Forensics Bureau conducted from August, 2016 up to October(included) in the central part of Tbilisi City the engineering and geological survey works in order to draw up the project of the full reconstruction of the Mtatsminda ropeway. The project foresees the reconstruction of the lower station, designing the upper station and placement of four(4) support pillars for ropes in the preliminary planned places.

Currently, according to the technical assignment there shall be carried out the engineering and geological studies in the defined points of the supports:

1. For soils – the determination of the composition and physical and mechanical properties, ground waters and aggressiveness towards construction materials (concrete, metal).
2. For rocky soils – the determination of the depths of exhaustion, a normative value of limit load.

In order to assess the engineering and geological and hydrogeological conditions around four supports of ropes has been examined in detail by the geological routes the places of their disposal and the surrounding areas; in order to identify the geological sections there has been made a pit and borehole; in addition there has been carried out cleaning. The drilling works were carried out by the installation УРБ 2А2 for engineering and geological research, in dry condition, without using the washer fluid, with full extraction of kern; the total volume of drilling - 46, and the pit is 7 meters in length.

The works were performed by the order of the Austrian company "Doppelmayr", according to the profile and topobase along the ropeway route drawn in 1: 1000 scale in 2016 and using the plan of Tbilisi City drawn by the 4th enterprise in 1: 2000 scale in 1978 and updated in1987.

Eight samples of cohesive soil were taken from the borehole. The determination of the location of observations points and the attachment of excavations was implemented by the client in the indicated places. After the end of fieldworks the excavations were filled.

Beside the geological and hydrogeological study of areas, special attention was paid to the detection of the modern geodynamic processes, slope stability assessment and determination of soil quality. The present engineering and geological study report-the conclusion has been drawn on the basis of the above data, where is used the results of geological, engineering and geological and hydrogeological studies previously conducted by a variety of geological and design organizations in this vicinity.

Field engineering and geological studies were carried out and technical report has been drawn according to the applied normative documents of Georgia – Construction Norms and Rules 1.02.07-87(Engineering studies for construction), Construction Norms and Rules 1. PN 02.01.08; 2. 2.02.01-83 (Bases of Buildings and Structurs); 3. PN 01.01-09 "Seismic Resistant Construction"; 4. PN 01.05-08 "Construction Climatology "; 5. Sakh. Standarti (State standard) 25100-82 soils.

I.2 Meteorological characteristics

The explored area belongs to the Kvemo Kartli lowland dry subtropical steppe climate zone with mild winters and hot summers(III c subzone of the construction-climatic zoning). The climatic elements are given in accordance with the data of climatographique manuals and existing in the same climate and landscape zone, the nearest to Tbilisi - "Mtatsminda" and "Observatoria" weather stations.

Description of Climatic Elements

Table #1

Weather Stations	Elevation metrs)	Air temperature in degrees			Relative Humidity%		Average wind speed m/sec	Precipitation, mm			Daily Maximum of precipitation
		Most Cold	Most warm month	Average Annual	Average Annual	Most dry		Annual Sum	In Cold Period	In Warm Period	
Tbilisi-Mtatsminda	930	-6	22,1	10,8	68	57	3,5	635	179	456	154
Tbilisi - Observatoria	404	1,0	24,4	12,7	66	57	2,4	559	164	452	147

The average annual temperature 10,8/12,7°C. The coldest month is January, the average Temperature -0,6 / 1,0°C. Frosts may begin in November and continue untill March. The absolute minimum is -24 / -23°C. The warmest month is July, The average temperature is 22,1 / 24,4°C, the absolute maximum is 38 / 41°C.

The annual total of precipitation in average is 635/559 mm. Their maximum quantity is in May-June, the minimum - in January, the second minimum is in August. The daily maximum of precipitation is 154/147 mm. Snow may come from November to April. Snow does not come every year, respectively, the solid snow cover is relatively rare or can last 21/14 days. The average height of snow is - / - cm, while Maximum height is 55/44 cm. In both cases, the weight of the snow cover equals 0.50 kPa.

Relative humidity annual average rate is 68/66%. Average relative humidity at 13 o'clock in January is 61/39%, and in July is 43/39%. The amplitude of average daily relative humidity for the same months is 11/25 and 26/35.

Despite of the height difference between the stations the most of the characteristics of winds are close to each other. During the year in these areas are dominated the North-West (39/28%), the North (10/26%) and South-East (32/25%) winds. Much less are the South (7/8%), the South-West (5/2%), the East and West (both 3/4%) winds, while the least is the North-East direction - 1/3%. 22/23% of the total number of the wind observations is still. The average biggest and average smallest speeds of wind are following: in January at Mtatsminda is 5.6 / 1.7 m / s and near Observatoria is 4.8 / 0.5 m / s, and in July at Mtatsminda is 6.7 / 2.8 and near the Observatoria of 4,6 / 1,0 m / s in. The normative value of wind pressure are 5 and 15 once a year respectively eqwuals to 0,30 / 0,38 and 0,48 / 0,48 kPa.

Biggest possible wind speed at least once m / s

Table #2

Every year	In 5 years	In 10 years	In 15 years	In 20 years
21/19	23/24	27/27	28/28	29/30

In the area the thunderstorms can be throughout the year with a maximum intensity from May to August. Hail is relatively rare, but can come from April to November, with maximum in May. The prsence of fog is possible during the year with maximum in November-March. The snow storm is rare, more often it may take place in January and February.

Special events of atmosphere during the year, Day

Table # 3

Station	Thunderstorms		Hail		Fog		Snow Storm	
	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
Mtatsminda	34	48	1,6	5	41	82	0,3	4
Observatoria	35	52	1,6	7	33	62	-	-

Normative soil freezing depth for loam/loamy soils is 18 cm of soil, and for fine sand and sandy soils 22 cm, for gravel of large and medium thickness is 23 cm and coarse-grained soils 27 cm.

I.3. Morphometry

Ropeway route is strictly linear. Near the lower station, at the Rustaveli Prospect areas, on the artificially graded terrace level, absolute markers are 432-434 meters. To South-South-West, in the direction of the upper station, near the second pillar, on the truncated cone-shaped graded peak of irregular shape, with slope inclination up to 40-45°, the height reaches up to 464-465 meters. In the same direction, the third support is located almost in the middle of the slope of Mtatsminda – steep (inclination from 25-28 up to 33°) section, on the 540-541 m marker (elevation) of rocky edge of the slope located between two dry ravine. At the last section of the ropeway rout, the inclination of Mtatsminda slope before plateau, after the noticeable morphological regrinding (near the 4th support), is relatively decreased up to 20, then 10 and 8° degrees. Here are located two last supports the 4th - 690-691 m and the 5th - 708-709 m on absolute heights. Cableway The upper station of the ropeway is at the Northern edge of the flat surface of the Mtatsminda plateau with the absolute height of 716 m. Thus, the maximum height difference totally along the ropeway line equals to 285 meters.

I.4. Surface Waters

Permanent waterpipe for surface waters is not exactly in this studed area. In the vicinity of the stations and supports the surface waters are formed only from frontal rains or more rearly when snow melts in form of temporary streams. Here immediately takes place the direct Infiltration in soils a small part of precipitation, while the remaining flows quickly drain, via widely developed clefts, and finally drain through ravine and slope systems to the lower part of slope into the collector wells allocated along streets.

All waterpipes are directed towards the bottom of the North slope. Accordingly, All object of ropeway are free fro the risk of flooding.

I.5. Geomorphology

All objects of the ropeway line are located on the end of one of the last branches of Trialety ridge - Mtatsminda ridge and includes the North orientation slope of the ridge along the total length. In terms of geomorphology its separate facilities are in dramatically different conditions.
The lower station is located on the high, accumulative, terrace level of the river Mtkvari.. It is the second according to sequence, it is of the upper Pleistocene Age, and is known as "Vake- Saburtalo" Terrace. The step (level) is constucted by alluvial clay, loam and cobbles with sand and gravel filler. Its leveled surface is occupied by transverse Rustaveli Avenue and Kostava street, with short, small branches and well developed infrastructure.
The second pillar(support) includes the cone-shaped hill peak, at the end of low meridian hill, partly hardened erosion Slopes. Here, at the foot of the slope of Mtatsminda intense slope the accumulation of the breakdown products of rocks brought from slopes. The hill is completely built from powerful dealluvial-proalluvial proalluvial loam soils of the Upper Pleistocene Age with rich inclusions of thin pieces of broken material. On the next stage of relief development the accumulation was replaced by the erosion processes, resulting in the formation of two dry ravine with branches and watershed hill placed between them. At present, the foots of the ravines include the Sarajishvili and Dzmebi Kakabadzeebi streets, while the densely populated streets of Zaldastanishvili and 8 March are situated on the top of the hill.
The third pillar is located in the middle part of the slope of Mtatsminda. There in conditions of high inclination of slopes the intense rock disintegration, also, erosion washout and gravity move is going on. As a result, there has developed sharply clear, erosiive and gravitative, rocky, sculptural forms of relief. The base of the pillar(support) is allocated at the rocky edge of the slope . Everywhere around the protrusions of rocks are covered with small power cobble and sandy soils.
The fourth and fifth pillars(supports) include the part near the top of the upper slope of Mtatsminda. There the slope inclination, after 768 meters decrease greatly and the morphological barrier is formed, over which the erosion-gravitatative forms are much less, and the surface is more united and indivisible. Also, the riginal relief has changed drastically by the anthropogenic relief. Through the desintegration of the old ropeway Infrastructure there is created pits, holes, ditches, ribs of old foundations, leveled surfaces, and so on, in rocks. Around, the outcomes of rocks are covered with coarse pieces of material.
The upper station includs the Northern edge of the peneplenised top of Mtatsminda ridge. Here, also, the formation of the currant surface has been done through the significant economic activity of humans. The area is dug up and most of the cavernous with the remains of fundaments of old station is dug with old walls and concrete columns, often, the construction remains are scattered around.

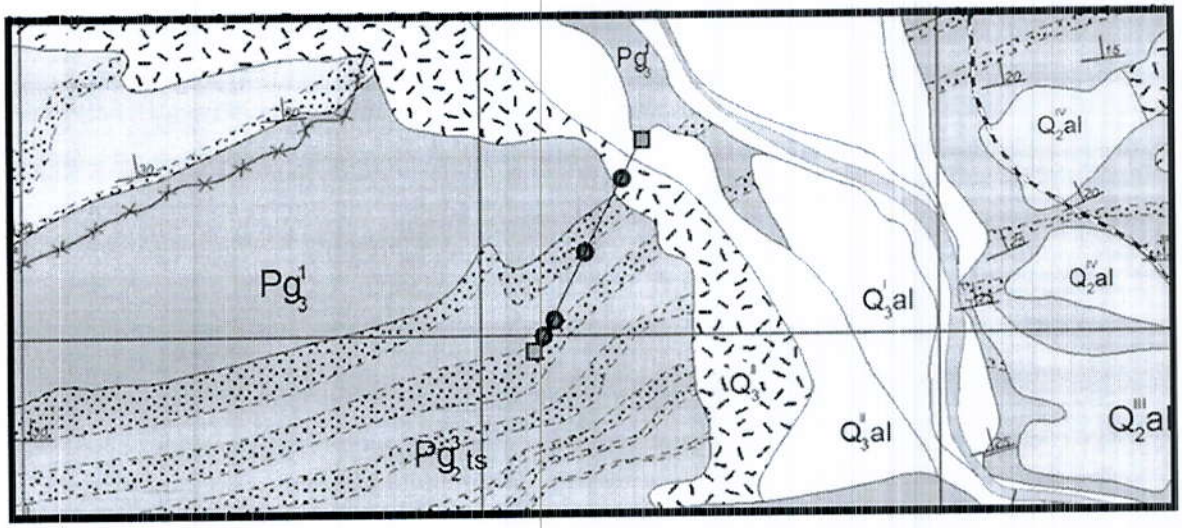
I.6 Geological structure

The tectonically researched site is located in the folded system of the Lesser Caucasus, Adjara-Trialeti zone, the east border of South subzone and includes the north wing Mtatsminda anticlinal fold.
According to the following fragments of Geological map drawn by the geological service of Georgia in 1971, 1: 25000 scale, the geological foundation of the area is built by the alteration of the Upper Eocene Epoch of Tbilisi numulitic Structure (P23ts) thin -layer sandstones and addition of argilite clays, or interlayers.

Common, unexhausted sandstones are gray, and light gray, steel-blue color, on clay and cement, with fine and medium grain, with fine, medium and thick layers. Argilite clays are dark, blackish, brownish, brown, with thin layers and foils. Both kinds of geological lithology are weathered to the different extent in the upper part of geologic section, they are fractured and discolored. The direct expositions of these rocks at the surface are observed along the total length of Mtatsminda slope, from Polikarpe Kakabadze Street up to and included the upper ropeway station.

Geological Map

The extract from the geological map of the east part of Adjara-Trialeti folded system drawn by D. Papava, V.Devdariani, and V, Ageev in 1971, with 1: 25000 scale



Symbols

$P2^3ts$ Upper Eocene. Tbilisi numulitic set. Sandstones with thin interlayers of Argillites

dpQ_3 Upper Pleistocene. Loam soils with inclusions of cobbles and gravels.

upper station lower sattion. Pillars(supports)

In the lower part of ropeway, between the Polikarpe Kakabadze street and the Rustaveli Avenue, The basic rocks are overlain by Pleistocene dealluvial-proalluvial (dpQ3) formations, with opened capacity of 46 m and alluvial sediments of the same age (aQ3).

I.7 Hydrogeological conditions

The formation of ground waters, movement and distribution on the studed area mainly is determined by the geomorphological Conditions of the north slope of Mtatsminda ridge and geological structure.

The entire length of the slope is well drained from the surface waters and their Infiltration in rocky soils is minimal. The ground water distribution is sporadic on the slope with the law degree of water content. In addition, the natural outlets of ground waters in form of sources or leakages are not observed in any of the surveyed areas.

The surface, cover layers of rocks in the bottom of the slope also contain water. Here rocks are dry and unhydrated – near the second pillar up to 46m, and near the lower station up to 5,0-6,0 m. Thus, according to the field and the fund data waters are deeper and do not create any hindering conditions for the construction in these areas.

Special Section

II.1 Engineering and geological conditions of the plot allocated for the placement of 2nd pillar

The second pillar of the ropeway is placed in the garden plot of #34 yard of 8 March street, to reach it is possible only through the Sarajishvili steet or Dzmebi Kakabadzeebi street. On the basis of the recognition touts carried out there it was established that in this area and adjacent areas is not indicated any sign of the development of dengerouse geological processes. The West and North slopes of the eart plot mainly are supported by bearing walls. Only the adjacent part of the upper edge of Notht slope is not reinforced and the East slope is without any reinforcement at all. There in the upper part is recorded the landslide movement trace of local area and small power. The above mentioned circumstance is a negative factor in the assessment of the study land stability. In order to ensure the stability of the land plot, in the future perspective, it will be necessary to plan the engineering measures in the project. In particular, the reinforcement by the bearing walls of the East slope that is not reinforced and the upper part of the North slope that is not reinforced too. According to Annex 10 of Construction Norms and Rules 1.02-07-87 the study area belongs to the category of II (medium) difficulty.

One 7,0 m pit was made and one 46 m deep examination borehole was drilled for taking soil samples in order to determine the lithological profile of the area and carry out the laboratory research. Drilling was conducted through the mechanical-shaft method, with the drilling installation with УРБ 2А2 112-131 mm diameter, by continuous extraction of kern and through the dry drilling procedure. In the process of drilling was taken eight(8) sample of indestructible structure. Laboratory research of the samples was conducted in the geotechnical laboratory of the Engineering Examination Department by the chief specialist T. Jajanidze. Ltd. "Geotekservisi" has performed the field drilling works and accompanying field visual engineering petrological description of kern based on the agreement concluded with the Examination Department.

On the basis of the conducted field and laboratory researches it was established that in the Geological area of the study territory, there are five kinds of soils or layers different from each other: # 1 layer - a layer of soil (Q); # 2 Layer – fill-up ground (tQ_{IV}); Layer # 3 - loamy solid (dpQIV).Layer # 4 - loamy solid wih content of cobbles (dpQIV).Layer # 5 - loamy solid with cobbles (dpQIV).

Below is given the engineering and geological desctiption of these layers.

The spread of the layers is given on the lithological columns of the borehole and pit (see. Annex # -). Soil classification is made according to Sakh.Standarti (State Standard) 25100-82.

II.2 Physical and Mechanical Properties of Soil

Table #4

# #	Physical properties			unit	Range of received data	Averige arithmetical (normative)
1	Plasticity number		Ip	-	8,7-9,7	9,2
2	Natural humidity		W	%	14,5-17,6	16,1
3	Density	Soil	p	g/cm³	1,98-1,99	1,99
		Dry soil	p_d		1,68-1,74	1,71
		Soil particles	p_s		2,69	2,69
4	Porosity		n	%	35,4-37,4	36,4
5	Porosity ratio		e	-	0,548-0,598	0,573
6	Flowability index		I_L	-	-0,31-0,57	-0,44
7	Degree of moisture		S_r	-	0,712-0,792	0,752

1 layer - a layer of soil (Q) is spread throughout the whole study area, it is the first layer from the surface. The layer was not sampled. The power of the layer is 0,15-0,2 meters.

2 layer - fill-up ground (tQIV) is distributed in the form of a second layer under the soil cover. It is opened by both mining excavations, is presented by the dark brown solid calcareous clay with the remains of gravel ground, cobble and construction waste, the self-hardening process is completed. The layer is not sampled. The layer is assessed and described visually. The ground-density (ρ) according to the fund materials is 1.75 G / m3. A layer is without water. The power of the layer is within 2,4-3,1 m.

Layer # 3 - dark brown loam, solid carbonate (dpQIV), thin sand Interlayers and lenses is opened by pit in the depth of 3.8 m and by a borehole in the depth of 3,8-33,5 m. The layer is sampled by 2 samples of indestructible structure.

In the table # 4 is given the variability tange of parameters values of main features of the physical properties and their average normative value received through the laboratory study.

According to the data given in the table the layer is classified as loamy solid, because Ip=9,2, flowability index I_L=-0,44.

The data given in the table can be used for calculation if required.

The solidity of layer (Φ^0,C), and deformation modul (E) values are taken according to the physical properties of the layer_(IL;e), the Construction Norms and Rules on Foundations of Buildings and Constructions (PN 02.01-08), according to tables of Annex 2 and 3 and are equal to: Internal friction angle ϕ = 24°; specific adhesion C = 0,35 kgf / cm²; deformation modulus E = 270 kgf/ cm ²; Optional design resistance value is calculated by the method of double interpolation with the use of relevant formula R_o=3,1kgf/sm², the layer does not contain water.

Layer #4 - Loamy brown, solid, cobble content (dpQIV), with thin sand interlayers and lenses. The layer is opened with a borehole in 5.2 m depth. The Layer is sampled with 3 samples of indestructible structure. Below in the table # 5 is given the variability tange of parameters values of main features of the physical properties and their average normative value received through the laboratory study.

Table #5

# #	physical properties			Unit	Range of received data	Averige arithmetical (normative)
1	Plasticity number		Ip	-	7,1-8,3	7,7
2	Natural humidity		W	%	7,6-10,8	8,9
3	Density	Soil	□	g/cm³	1,93-1,97	1,94
		Dry soil	□d		1,78-1,79	1,78
		Soil particles	□s		2,68-2,70	2,69
4	Porosity		n	%	33,1-34,1	33,7
5	Porosity ratio		e	-	0,494-0,516	0,508
6	Flowability index		I_L	-	-0,89-1,50	-1,25
7	Degree of moisture		S_r	-	0,412-0,566	0,473

According to the data given in the table the layer is classified as loamy solid, because Ip=7,7, flowability index I_L=-1,25. Values of the internal friction angle (ϕ°); specific adhesion (C); deformation modulus (E) are calculated according to the relevant method "Methods of assessing the strength and compressibility of coarse soils with silt and clay filler and silt and clay soils with coarse inclusions" DalNIIS Gostroya, USSR 1989

Based on the physical properties of soil, see the Annex # -- and for consolidated soil it equals to: Internal friction angle ϕ = 22°; specific adhesion C = 0,35 kgf / cm²; deformation modulus E = 214 kgf/ cm ²; Optional design resistance value is calculated by the method of double interpolation with the use of relevant formula Ro=3,5kgf/sm²

Layer #5 - brown loam, solid rubbly, carbonate sand thin Interlayers and lenses, it is opened by borehole in the depth of 23.5 m. The layer is sampled by 3 samples of indestructible structure.

Below, in the table # 6 is given the variability tange of parameters values of main features of the physical properties and calculated average (normative) value, received through the laboratory study.

Table #6

# #	physical properties			Unit	Range of received data	Averige arithmetical (normative)
1	Plasticity number		Ip	-	8,0-11,3	9,1
2	Natural humidity		W	%	10,4-14,4	11,6
3	Density	Soil	p	g/cm³	1,90-1,97	1,93
		Dry soil	pd		1,66-1,79	1,73
		Soil particles	ps		2,68-2,70	2,69
4	Porosity		n	%	33,7-38,0	35,7
5	Porosity ratio		e	-	0,544-0,614	0,556
6	Flowability index		I_L	-	-0,67-1,16	-0,96
7	Degree of moisture		S_r	-	0,516-0,629	0,560

According to the data given in the table, the layer is classified as loamy solid, because Ip=9,1, flowability index I_L=-0,96.

Values of the internal friction angle (ϕ°); specific adhesion (C); deformation modulus (E) are calculated according to the relevant method "Methods of assessing the strength and compressibility of coarse soils with silt and clay filler and silt and clay soils with coarse inclusions" DalNIIS Gostroya, USSR 1989 Based on the physical properties of soil, see the Annex # -- and are equal to: Internal friction angle ϕ = 23°; specific adhesion C = 0,32 kgf / cm²; deformation modulus E = 233

Conclusions and Recommendations

1. The plot of land for the construction of II pillar of II ropeway is located at the following address: #34,. 8 March str., Tbilisi, On the right bank of the River Mtkvari, in the top part of conoid hill. Absolute elevation is within 464 meters.
2. The area is built by the Upper Eocene(P_2^3) Age sedimental rocks by the alteration of so called sandstones and argilite clays of Tbilisi numulitic set, which are covered by loams of Dealluvial-proalluvial genesis (dpQ_{IV}) and bulk Ground (tQ_{IV}). The power of cover rocks is more that 46 meters.
3. Ground water is not found up to 46 m depth.
4. There was no trace of hazardous geological processes in the surveyed area and surrounding.

5. On the basis of data received through the field and laboratory studies in the lithological profile of the studied area,- except for the soil layer and bulk ground that because of low power and heterogeneous composition will not be used for making foundation,- are detected three(3) Engineering and Geological Elements(E.G.E):

I E.G.E - loam slid (dpQIV) layer #3;
II E.G.E - loam solid with cobble content (dpQIV) layer #4;
III E.G.E- loam solid rubbly (dpQIV) layer #5;
Below in the Table #7 is given the normative values of all necessary characteristics of physical and mechanical properties of all three engineering and geological elements received on the basis of the Laboratory-defined data, #2 and #3 tables of the Annex of the Construction Norms and Rules on the Foundations of Buildings and Constructions (PN 02.01-08), and the existing methodology "Methods of assessing the strength and compressibility of coarse soils with silt and clay filler and silt and clay soils with coarse inclusions" DalNIIS Gostroya, USSR 1989, and using the reference literature that has to be applied in the design caculation.

Table #7

##	Soil Characteristics	Design values		
		I. E.G.E Layer#2	II E.G.E Layer#4	III E.G.E Layer#5
1	Density p g/cm²	1,99	1,94	1,93
2	Internal friction angle ϕ°	24	22	23
3	specific adhesion C kgf/cm²	0,35	0,35	0,32
4	deformation modulus E kgf/cm²	270	214	233

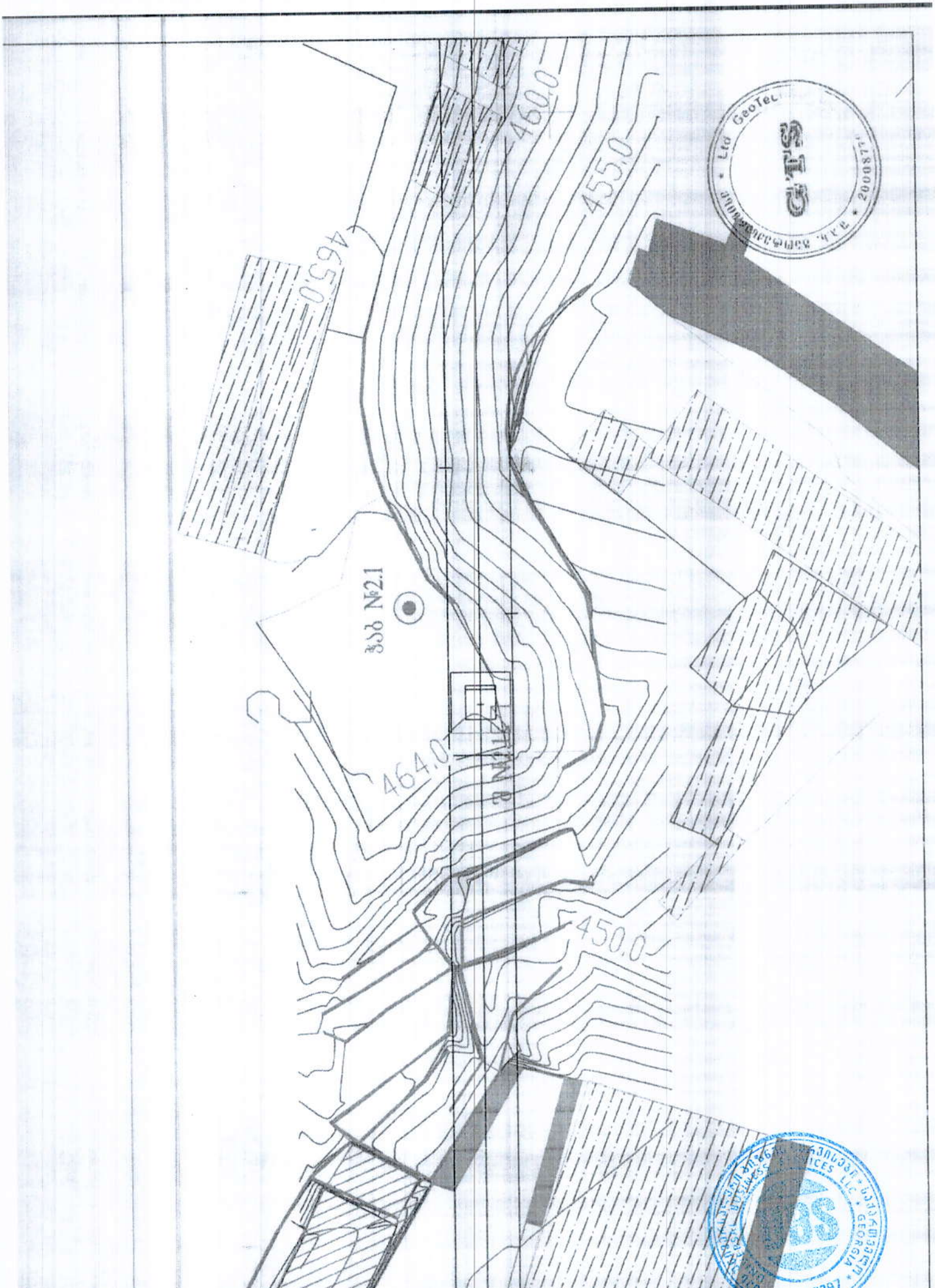
Engineering –Geological Elements-E.G.E.

5	Optional design resistance	3,1	3,5	3,4
6	Bed coefficient kgdz / cm^3	4	4	4
7	Poisson coefficien μ	0,35	0,35	0,35

6. In order to ensure the stability of the studied area, it is necessary to reinforce the upper part of the North slope and East slope with bearing walls.
7. It is required to implement the measures of the collection and removal from the area of support pillar the atmospheric precipitations. At the same time it is desirable to conduct surface Leveling, and changing the existing orchard irrigation from the method of area watering by the drip watering method.
8. Digging up of cavity for the support pillar and arrangement of the pillar fondation should be conducted in the shortest possible period.
9. The maximum allowable inclination of artificial slopes of a cavity made for the establishment of the support pillar is taken according to the requirements of the construction Norms and Rules 3.02.01-87 3,11; 3,12 and the construction Norms and Ruls III-4-80 .
10. According to the construction Norms and Rules on the "Earthquake-Resistant Construction" (PN 01.01-09), and the Seismic Hazard Map, Tbilisi belongs to the 8-point seismicity zone.
    According to Table # 1 of the same normative document, on the basis of the seismic properties, the soils of the study area belong to : ## layers 1 and 2 - III
    Category; layers ##; 3, 4 and 5 - II category.
    Design seismicity is taken 8-point.
11. Groups of soils spread on the territory of the studied area according to the difficulty of their treatment based on 1.1 table of IV-2-82 of the Construction Norms and Rules belong to :
    Layer # 1 -9 F
    Layer # 2 - 24 A;
    layers ## 3, 4 and 5 - 33 C.

Engineer and Geologist Gabriel Chincharauli

Field and Laboratory Study Results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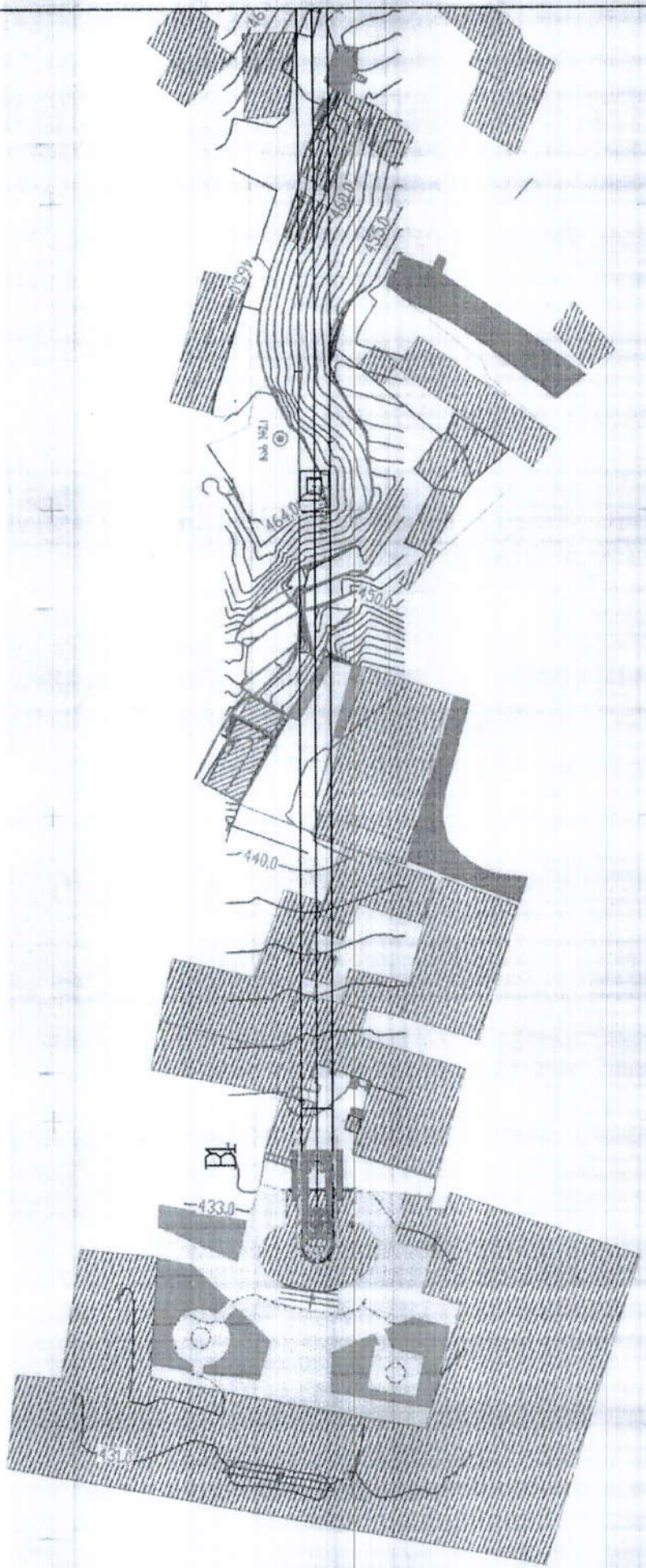
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Time of Comencment:
Date of Accomplishment: 09.09.16
Time of Accomplishment:

Hole 1

Type of Drilling: in columns
Executor: GEotech Service
Drilling Vehicle: URB – 2A2
Driller: Z. Kashiashvili

Diameter of the Hole

15.0 მ-დან 41.0 მ-დე 127 (მმ)
41.0 მ-დან 46.0 მ-დე 108 (მმ)
89 (მმ)

ABC mak

Depth of the Hole	Sample: Depth	Sample: Type	Sample: Sample N	Sample: SGE	Description of the layer	Depth fo the Layer (m)	Value Symbol
20						0.0	
21				II	Clay layer, brown, solid, carbonate, containing Pebbles, with thin layers of the sand and Lenses.		
22							
23						23.5	
24	23.5-23.8	U	7				
25							
26							
27							
28	28.3-28.5	U	8	III	Clay layer, brown, solid, carbonate, containing Pebbles, with thin layers of the sand and Lenses.		
29							
30							
31							
32							
33						33.5	
34	33.5-33.8	U	9	I	Clay layer, brown, solid, carbonate	34.5	
35							
36							
37				III	Clay layer, brown, solid, carbonate, containing Pebbles, with thin layers of the sand and Lenses.		
38							
39							
40	39.8-40.0	U	10				

Notes

Revealing of the underwater Solid level

Executor: Z. Ghaghanidze

Geo Tech Service

Technical research of the Engineering

Drawing N

Time of Comencment:
Date of Accomplishment: 09.09.16
Time of Accomplishment:

Diameter of the Safety

Hole 1

Diameter of the Hole

0.0 მ-დან	15.0 მ-დე	127 (მმ)
15.0 მ-დან	41.0 მ-დე	108 (მმ)
41.0 მ-დან	46.0 მ-დე	89 (მმ)

Type of Drilling: in columns
Executor: GEotech Service
Drilling Vehicle: URB – 2A2
Driller: Z. Kashiashvili

ABC mak

Depth of the Hole	Sample				Description of the layer	Depth fo the Layer (m)	Value Symbol
	Depth	Type	Sample N	SGE			
20						0.0	
21				II	Clay layer, brown, solid, carbonate, containing Pebbles, with thin layers of the sand and Lenses.		
22							
23						23.5	
24	23.5-23.8	U	7				
25							
26							
27							
28	28.3-28.5	U	8	III	Clay layer, brown, solid, carbonate, containing Pebbles, with thin layers of the sand and Lenses.		
29							
30							
31							
32							
33						33.5	
34	33.5-33.8	U	9	I	Clay layer, brown, solid, carbonate	34.5	
35							
36							
37				III	ayer, brown, solid, carbonate, containing Pebbles, with thin layers of the sand and Lenses		
38							
39							
40	39.8-40.0	U	10				

Notes

Revealing of the underwater Solid level

Executor: Z. Ghaghanidze

Geo Tech Service

Technical research of the Engineering

Drawing N

2.2

Date of Commencement:	07.09.16
Time of Comencment:	
Date of Accomplishment:	09.09.16
Time of Accomplishment:	

Diameter of the Safety

Hole 1

Diameter of the Hole

15.0 მ-დან 41.0 მ-დე 127 (მმ)
41.0 მ-დან 46.0 მ-დე 108 (მმ)
89 (მმ)

ABC mak

Type of Drilling:	in columns
Executor:	GEotech Service
Drilling Vehicle:	URB – 2A2
Driller:	Z. Kashiashvili

Depth of the Hole	Sample				Description of the layer	Depth fo the Layer (m)	Value Symbol
	Depth	Type	Sample N	SGE			
40						0.0	
41							
42				III	Clay layer, brown, solid, carbonate, containing Pebbles, with thin layers of the sand and Lenses.		
43							
44							
45	44.5-44.7	U	11				
46						46.0	
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							

Notes

Revealing of the underwater Solid level

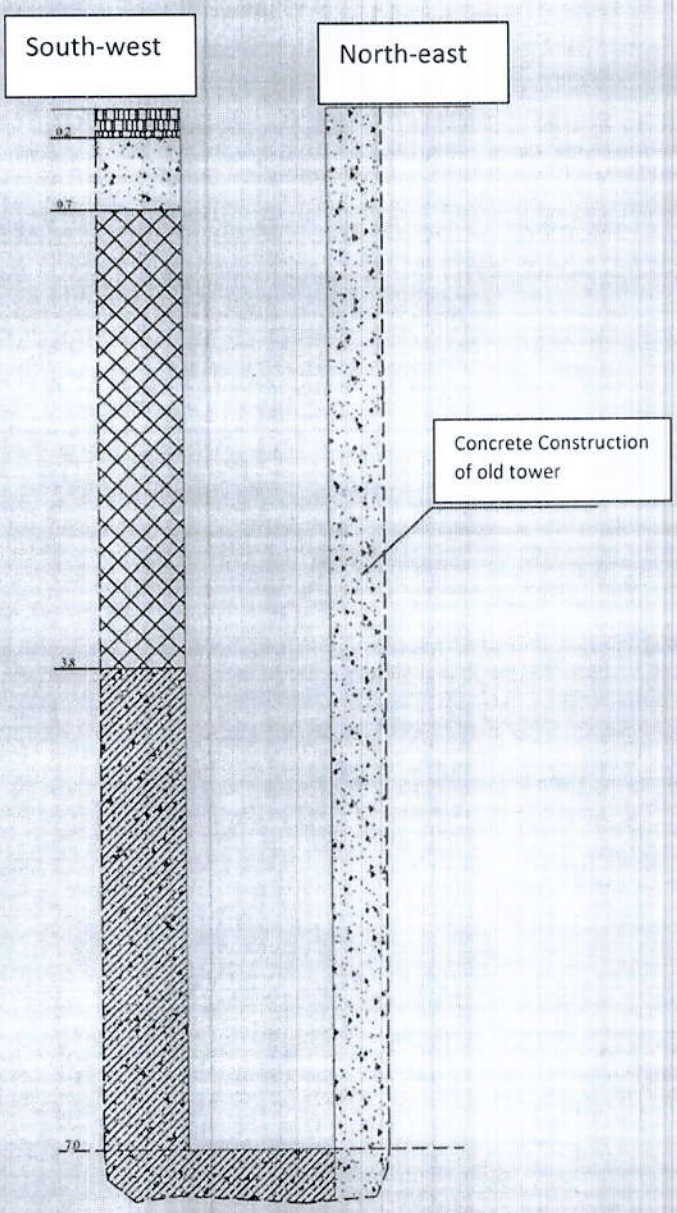
Executor: Z. Ghagharidze

Technical research of the Engineering and Geological Study Conducted for

Drawing N 2.3

Tower N2

Hole N2.1



Optional remarks

	Concrete constructure
	Soil layer
	Soil, with Clay layer, dark brown, solid, with crushed stone and gravels. (also with construction trash) of about 15-20%
	Clay layer, dark brown, solid, with 10-15% of crushed stone and gravels. With thin middle layers of sand

LLC GEOTECSERVICE

Engineering and Geological works for planning the ful reconstruction of the ropeway of Mtatsminda, Tbilisi

Lithological Pits

position	signature	Surname	Figure N3.1
Director	[signed]	B. Bendukidze	Paper N1
Draw	[signed]	Z. Ghaghanidze	Stage
Check	[signed]	S. Ghaghanidze	M.P

Cumulative table of laboratory tests of soils

Borehole #	Interval of Taking Samples, M	Fraction Size												Natural humidity w	Plasticity			Flowability Index IL	Dencity gr/sm³			Porosity, n %	Porosity ratio e	Humidity Rate, Sz	Internal friction angle ϕ° (ϕ°)	Specific adhesion, C	Deformation modulus ,E	Description of Soils
		> 20.0	20.0 - 10.0	10.0 - 5.0	5.0 - 2.0	2.0 - 1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.01	0.01-0.005	< 0.005		Upper Limit WL %	Lower Limit Wp %	Number of Plasticity Ip		Mineral Particles p_s	Natural, p	Structure, p							
1	3.5-3.8		2.5	4.3	7.6	6.0	12.8	13.4	16.7	6.1	10.2	14.8	5.6	14.5	25.9	17.2	8.7	-0.31	2.69	1.99	1.74	35.4	0.548	0.712				Loam solid
1	6.0-6.3		1.4	3.9	17.0	5.6	9.0	10.0	13.0	8.3	12.1	12.6	7.1	7.6	26.6	19.0	7.6	-1.50	2.68	1.93	1.79	33.1	0.494	0.412	22	0.35	211	Loam solid with content of cobbles
1	16.0-16.2			7.5	14.4	7.3	15.2	12.7	11.5	9.2	4.7	8.5	9.0	10.8	24.2	17.1	7.1	-0.89	2.69	1.97	1.78	33.9	0.513	0.566	22	0.35	215	Loam solid with content of cobbles
1	19.7-20.0			9.0	15.6	8.7	14.4	9.6	11.4	4.5	8.0	10.2	8.6	8.4	27.9	19.6	8.3	-1.35	2.70	1.93	1.78	34.1	0.516	0.439	22	0.35	217	Loam solid with content of cobbles
1	23.5-23.8		7.4	9.7	12.9	5.8	10.9	8.4	10.5	7.9	10.4	9.3	6.8	10.4	26.8	18.8	8.0	-1.05	2.70	1.93	1.75	35.3	0.544	0.516	24	0.30	245	Loam solid, rubbly
1	28.3-28.5	4.6	3.0	8.4	13.7	5.2	8.0	7.0	10.6	9.6	11.0	10.4	8.5	10.1	27.6	19.5	8.1	-1.16	2.70	1.97	1.79	33.7	0.509	0.536	24	0.30	243	Loam solid, rubbly
1	33.5-33.8				0.9	1.7	12.7	14.1	14.1	14.7	12.7	15.1	14.0	17.6	32.8	23.1	9.7	-0.57	2.69	1.98	1.68	37.4	0.598	0.792				Loam solid
1	39.8-40.0		8.1	9.3	11.0	6.0	9.6	6.2	9.2	9.5	6.3	15.2	9.6	14.4	33.3	22.0	11.3	-0.67	2.68	1.90	1.66	38.0	0.614	0.629	22	0.37	211	Loam solid rubbly

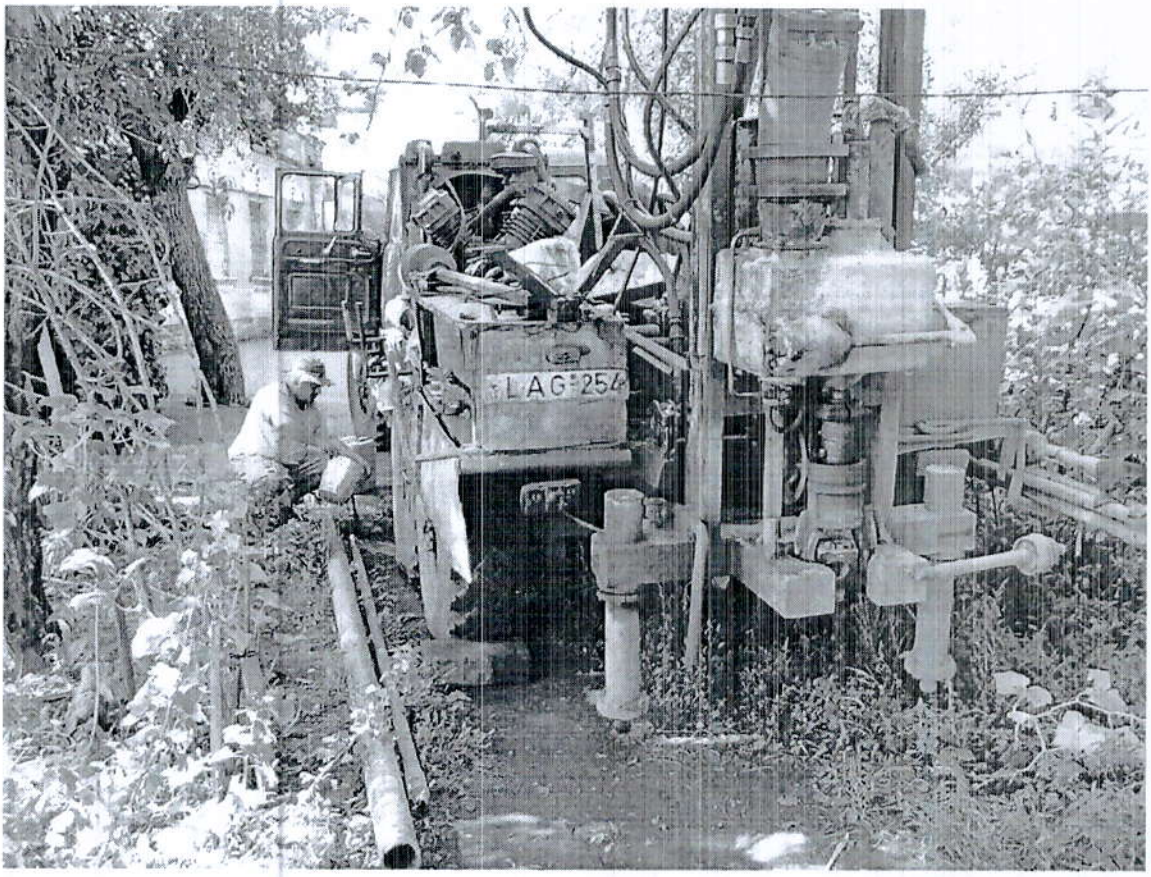
Specialist: TaTia Jajanidze

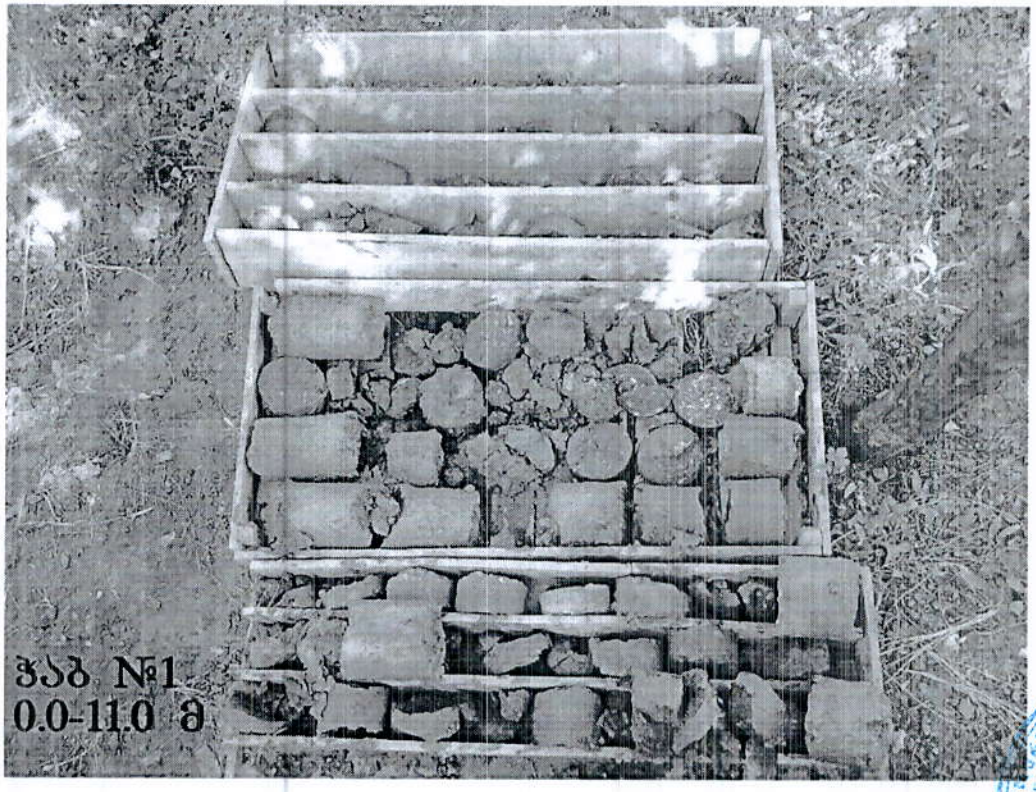
Results of the determination of normative values of the strength and deformation characteristics of soils

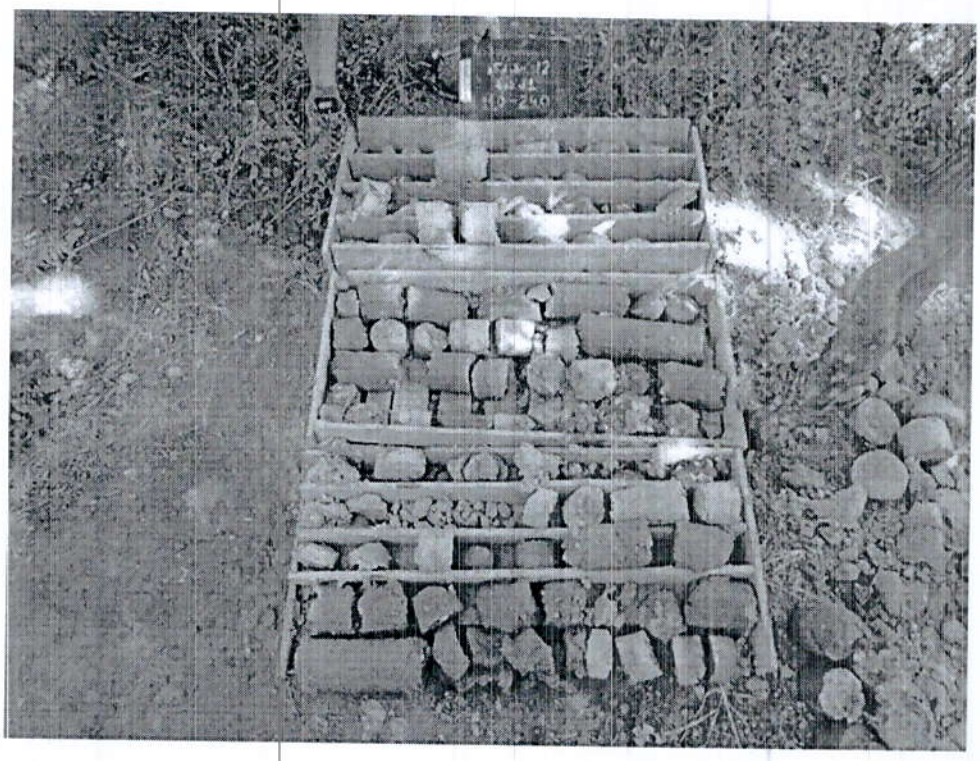
#	Borehole #	Interval for Taking Samples, m	Plasticity Number	Flowability Index	Soil Density, g/sm^3	a percentage content of fraction less than 2 mm-	a percentage content of fraction more than 2 mm-	Strength of inclusions, kgf/sm^2	Normative Density of soil	Large fragments rounding coefficient for internal friction angle	Large fragments rounding coefficient for Specific Adhesion	Soil physical equivalent	Coefficient in case of M_i indicator	n Coefficient depending of the density of soil	Coefficients for M_t equivalent indicators		$\phi_n=k_1k_\phi37(0.234)Mt$,grad	$C_n=k_2kp87M_t0^{.51}/(1+I_L)^{3.85}$, kgf/sm^2	$E=k_Ek_1kp*1/(0.088Mt-0.15MtI_P+0.017)$, kgf/sm2	Name of Soils
			I_P	I_L	ρ	P_1	P_2	ρ	ρ_n	K_1	K_2	M_ϕ	K_ϕ	K_ρ	K_E	K_L				
1	1	6.0-6.3	0.076	0.00	1.93	77.7	22.3	200	2.17	1	1	0.2648	0.879	0.8	0.983	1	22	0.35	211	Loam solid with content of cobble
2	1	16.0-16.2	0.071	0.00	1.97	78.1	21.9	205	2.16	1	1	0.2532	0.868	0.8	0.983	1	22	0.35	215	Loam solid with content of cobble
3	1	19.7-20.0	0.083	0.00	1.93	75.4	24.6	190	2.22	1	1	0.2544	0.877	0.8	0.982	1	22	0.35	217	Loam solid with content of cobble
4	1	23.5-23.8	0.080	0.00	1.93	70.0	30.0	220	2.26	1	1	0.1867	0.855	0.8	0.956	1	24	0.30	245	Loam solid, rubbly
5	1	28.3-28.5	0.081	0.00	1.97	70.3	29.7	200	2.26	1	1	0.1917	0.864	0.8	0.960	1	24	0.30	243	Loam solid, rubbly
6	1	39.8-40.0	0.113	0.00	1.90	71.6	28.4	200	2.26	1	1	0.2849	0.884	0.8	0.981	1	22	0.37	211	Loam solid, rubbly

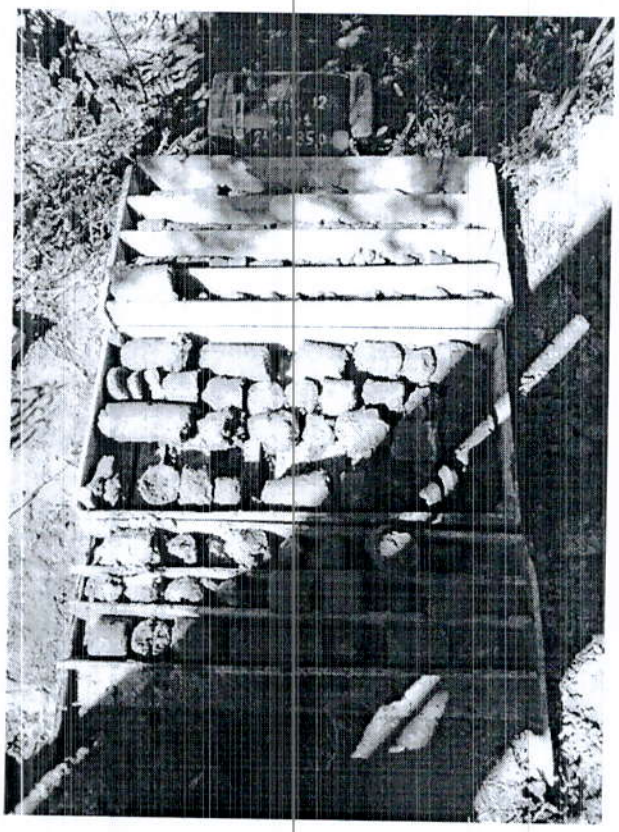
Chief specialisti: *T. Jajanidze*

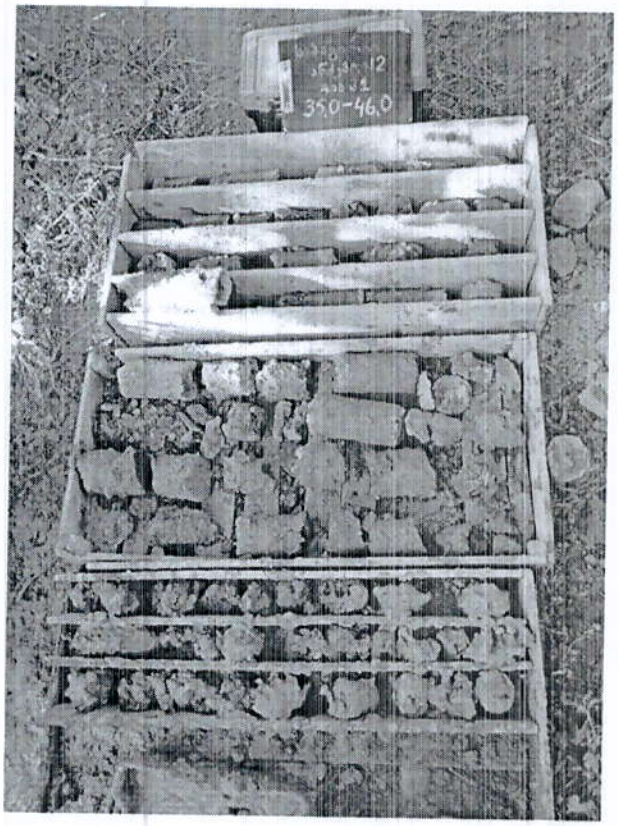
Photo Documentation







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