GEOLOGICAL – GEOTECHNICAL INVESTIGATION

AT THE SITE OF THE PROPOSED

MALL OF LIMASSOL BUILDING

PLOT No. 547
SHEET/PLAN 54/510101

MESA GEITONIA

LIMASSOL

JANUARY - FEBRUARY , 2023

GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
Applied Geology – Geotechnics – Materials Testing
Environmental Engineering

Viotechniki Periochi Aglantzias No 10, P.O.Box 20476, 2152 Aglantzia,
Tel: 22 33 00 93, Fax : 22 33 01 18, e-mail : info@geoinvest.com.cy
Web: http://www.geoinvest.com.cy

Celebrating 37 Years of Excellence in Testing
&
17 Years of CYS EN ISO/IEC 17025 Accreditation

GEOINVEST
ISO/IEC 17025

09/02/2023
X\Geotech23/*J+APhilipou-Mall-Limassol*

J+A Philippou architects-engineers L.L.C.
Att: Pavlos Philippou/ Director,
Nicosia.

Dear sir,

SUBJECT: GEOLOGICAL – GEOTECHNICAL AT THE SITE OF THE PROPOSED MALL OF LIMASSOL BUILDING PLOT No. 547 SHEET/PLAN 54/510101, MESA GEITONIA, LIMASSOL

We are glad to advise you that the above ground investigation is completed.

The investigations comprised drilling, in situ and laboratory testing, as well as the evaluation of the data obtained. A detailed account on the results of the ground investigation, are presented in the report that follows. It is believed that this work will facilitate the effort of your engineers in finding the most suitable solution to this case.

Finally, we would like to express our sincere thanks for entrusting our firm the execution of this site investigation and remain at your disposal for any clarifications or further information on this subject.

Sincerely yours,

GEOINVEST
ISO/IEC 17025:2017

Andreas Shathas
(Geologist - Managing Director)
Registration Number ETEK A035735

Contents

Tables

Figures

1 INTRODUCTION

The results of the ground investigations carried out at plot No. 547, Sheet/Plan 54/510101 Mesa Yeitonia, Limassol, the location of which is shown below, are presented in this technical report.

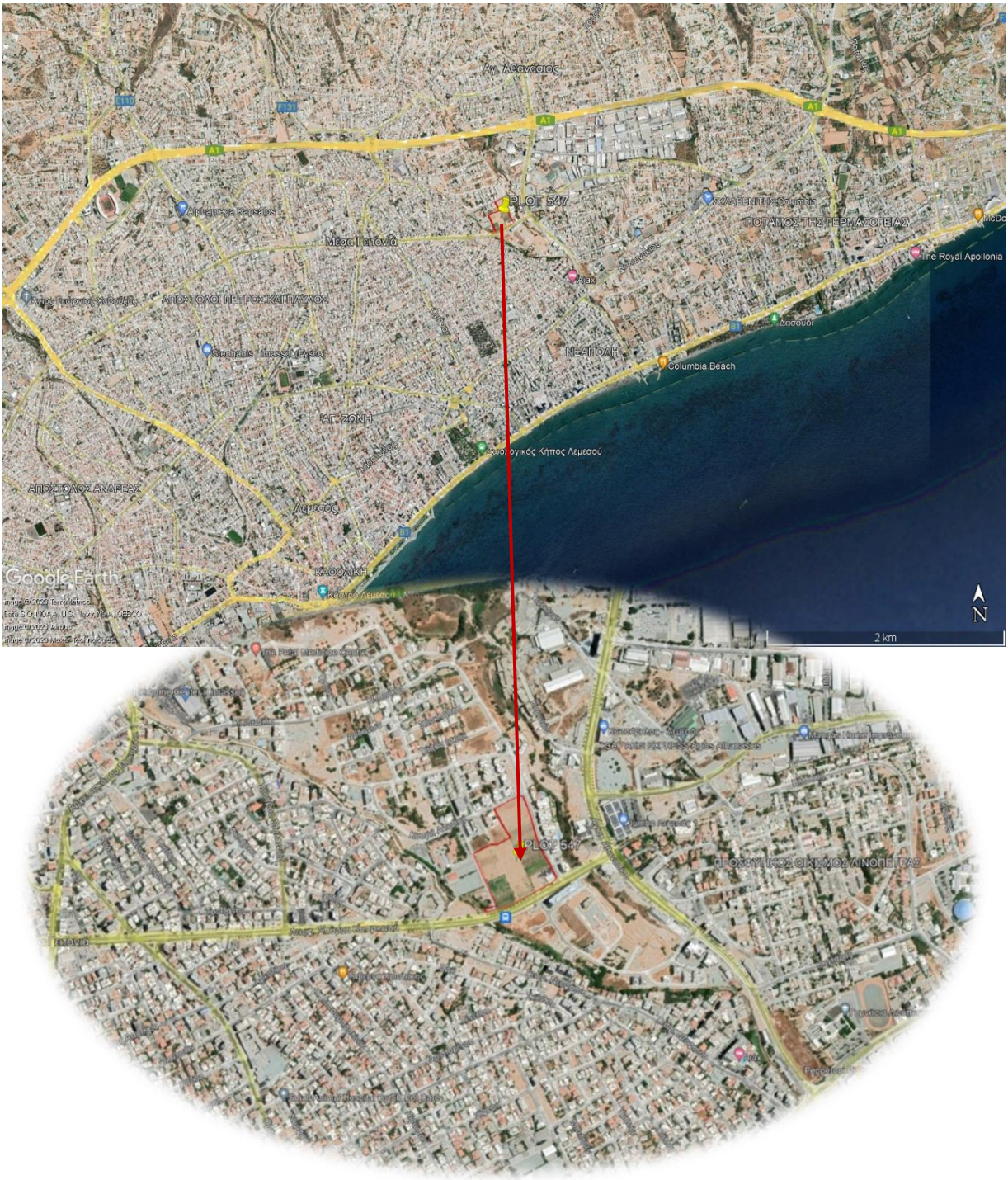


Figure 1: Site Location

Geoinvest Ltd has been retained by the project's consultants, J+A Philippou architects-engineers L.L.C., to conduct geotechnical field investigations and the related reporting to support the foundation design and to assess the excavation conditions and the stability of the excavations.

1.1 Brief description of the proposed construction

The project consists of a commercial building with and a basement, ground floor, mezzanine and two floors.

1.2 Purpose and scope of works

The ground investigation specified by the consultants, intends to provide details of ground conditions in the Project area, with special reference to the final design of buildings' foundations and earthworks.

These investigation works provide the following information:

- Ground profile. With reference to the specific requirements of the works, investigations and tests were carried out to better define the variability of the natural ground profile at the site.

- Geotechnical and mechanical parameters for design. The ground investigation included destructive drilling in combination with coring in selected sections, in situ testing and laboratory tests to provide detailed information on the geotechnical parameters, including physical characteristics, and mechanical properties of soils and rocks.

- Hydrogeological regime.

- Chemical aggressiveness of soils.

In summary, **the purpose** of the investigation according to the Client's requirements, is:

- To establish the stratigraphy and investigate the geotechnical properties of the strata underlying the site in relation to foundation design for the structures and roads.
- To provide information about the excavation conditions and in correlation with the hydrogeological regime to assess the necessity of supporting retaining walls and facilitate their design.

T**he Scope** of the investigation is:

a. Provision of boreholes and trial pits
b. In-situ testing
c. Sampling
d. Laboratory testing for geotechnical properties

e. Factual and, on engineering geological criteria, Interpretative reporting, where the general and specific geological picture, the geotechnical parameters, the foundation, and excavation conditions are evaluated.

The results are presented in this report, which consists of 1 volume, comprising the presentation of the works executed and the engineering geological evaluation of the results.

1.3 Relevant Codes and Standards

- EN Standards,
- UNI Standards,
- ASTM Standards,
- BS Standards,
- ISRM Suggested Methods,

1.4 Organization of this report

This report is organized in the following sections:

FACTUAL PART OF THE REPORT

1. Introduction
2. A brief description of the site
3. Regional Geology of the area
4. Ground Investigations, works carried out

INTERPRETATIVE PART

5. Subsurface conditions and characteristic geotechnical parameters along the investigated site.
6. Foundation conditions at the structures sites - Geotechnical considerations for foundations.
7. Excavation conditions
8. Hydrogeological conditions
9. Geologic Hazards
10. Conclusions

1.5 Units of measure

In this report the International System of Units (SI) is used where length is described in meters (m), force in Newton (N), stresses and pressures in Pascal (Pa). For larger or smaller quantities, the appropriate prefix is used (e.g. mm, kN, kPa or MPa).

2 SITE DESCRIPTION

2.1 Site Location

The site of development is located along Spyrou Kyprianou Avenue about 0.6 kilometer to the southwest of Linopetra Junction and 160 m to the west of Jumbo Limassol. It covers an area of about 31181 m^2. The location is shown on figure 1.

2.2 Site Morphology

The site area is characterized by a mild topographical relief, gently dipping to the south.

The broader area, to the north of the site, could be characterized as semi-mountainous to mountainous, with rising elevations up to almost 55 meters immediately to the north of the site reaching elevations of the order of 500 towards Phasoula, some 6-7 Km to the north. There is a general dip to the south. Several hill ridges are dissected by several small streams running from north to the south. Most of them are short with small catchment areas, except Potamos tis Germasogeias, which is the biggest in the area with the biggest catchment area starting from Farmakas area.

The morphology is the result of geology in combination with the climatic conditions. The whole of the area is occupied by the carbonaceous sediments of various ages and geological formations, whereas the lowlands along the coastal zone are covered by superficial deposits consisting of both fine (sand, silt and clay) and coarse (gravel, cobbles occasionally boulders) accumulations of both igneous and sedimentary origin. The proportions of the various soils types vary and in places predominate the fine and in others the coarse soil types. The vegetation is medium dense and represented mostly by Maquis shrubland, which is characterized by small bushes. The trees are rare.

3 REGIONAL GEOLOGY

The site under study is characterized by the Maestrichtian (Late Cretaceous) to Middle Miocene carbonatic marine sediments, upper Miocene reef limestones, Messinian evaporates, Pliocene marginal to shallow-marine deposits and Quaternary non-marine to coastal deposits. The sedimentation basin belongs to The circum-Troodos sedimentary cover, which as a whole is represented by a thick sequence (~200-1000m) of sedimentary rocks deposited on the Troodos ophiolitic massif since the Late Cretaceous (92 - 85 Ma; Gass et al., 1994; Mukasa and Ludden, 1987). At the study site these sediments are covered with alluvial and nearshore, marine sediments of considerable thickness.

3.1 Stratigraphy

The main lithostratigraphic units present in the area under study are presented below and their relationship with the rest of units is presented on table 1 and on geological map on figure 3.

Pakhna Formation (Late Oligocene/Early Miocene to Tortonian)

The period of Pakhna sedimentation started during the lower miocene time and lasted up to the upper Miocene in a pelagic, hemipelagic and turbiditic environment. Several types of sediments were deposited during this time; Limestones, chalks, marly chalks, chalky marls, marls, calcarenites, sandstones, laminated marls rich in planktonic foraminifera. This sedimentation took place on a tectonically unstable shelf environment adjacent to the emerging Troodos island (BouDagher-Fadel and Lord, 2006).

Kalavasos Formation

This formation represents the uppermost Part of Pakhna formation, although most of the geologist consider Kalavasos as a different formation of upper Miocene age when Mediterranean sea turned into a lagoonal sea with the sedimentation of the evaporites.

At the site under study the Kalavasos Formation consists of off white chalky marls, gypsiferous marls, and irregularly shaped and sized gypsum bodies.

The Quaternary deposits

The deposition of these deposits took place due to the progressive uplift of the Troodos Massif and global eustatic sea-level change during the Pleistocene. They are both marine and terrestrial, alluvial, colluvial and residual soils on top of which, in several places, secondary limestone was developed, known as havara and kafkalla. Both are local names given to tan to off-white, carbonaceous colluvial deposits (calcrete) developed all over Cyprus and represent soils cemented with secondary calcium carbonate. Havara is for the softer soil and Kafkalla for the harder.

The relationship of the above sediments, outcropping to the east and west of the site (the rest is covered with Fill), is shown on the geological map below. The Pakhna, shown with orange color, is in contact with the carbonatic rocks of Lefkara formation (green color) of Oligocene age, which in turn is in faulted contact with the bentonitic clays of Kannaviou Formation of Campanian age. Further to the north the area is occupied by the igneous rocks of the Limassol Forest, which forms a part of the Troodos Ophiolite Complex. The younger formations are shown with yellow colors along the southern part of the map.

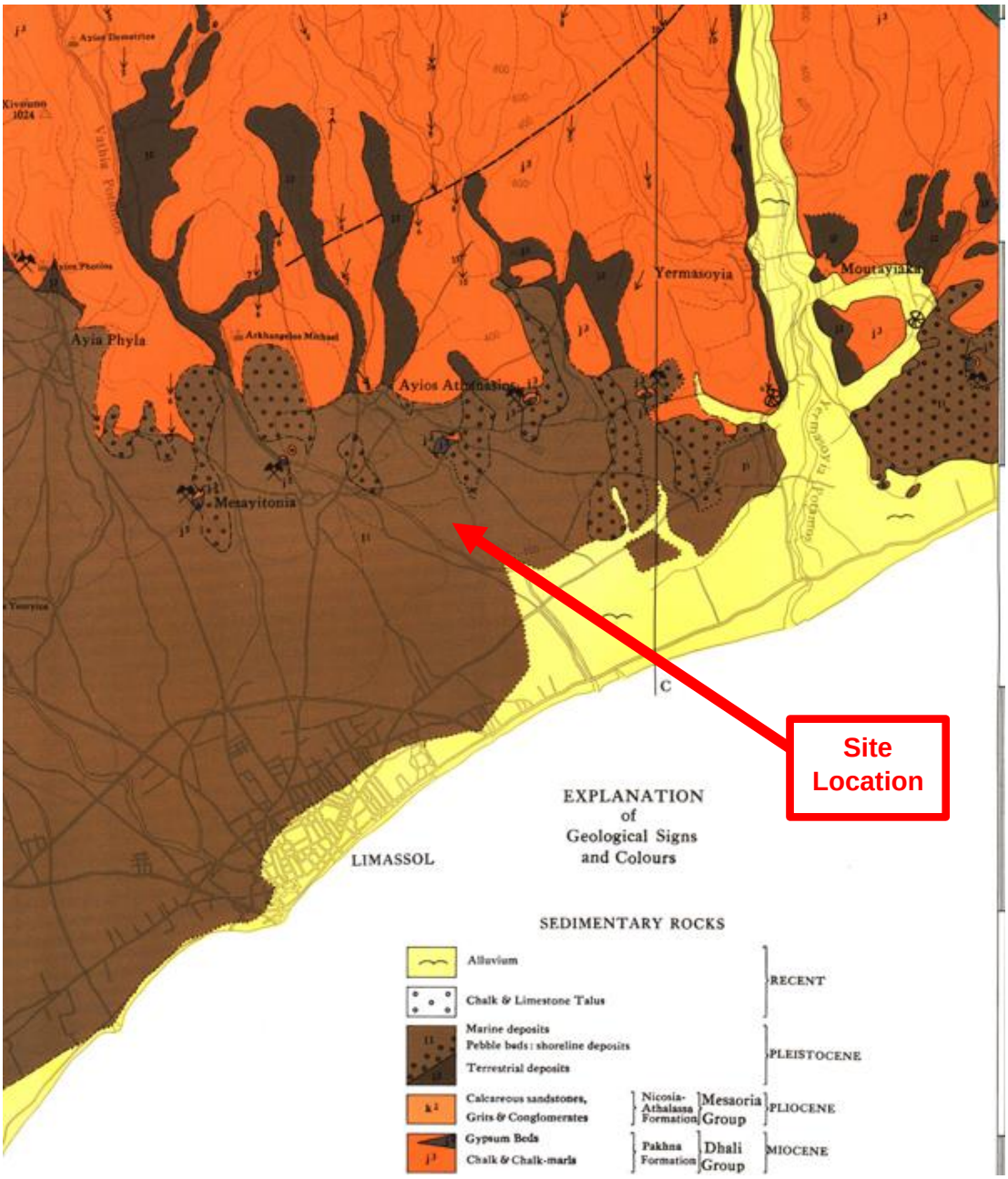


Figure 2. General Geological Map of the area from Geological Map of Apsiou – Akrotiri Area (Cyprus, GSD)

3.2 Regional structural setting

As described at the beginning of this chapter, Cyprus Island is in an active and complex geodynamic setting, a result of different tectonic phases, which, in accordance with recent studies, led to the following fault systems:

- E-W extension in west and southwest Cyprus, during late Miocene extension, led to the formation of faults of N-S orientation, whereas in south central Cyprus, NW-SE extension led to the formation of NE-SW faults
- The localized NNE-SSW extension during the late Pliocene led to the formation of WNW-ESE faults.
- A pervasive compressional/transpressional event, which occurred throughout the south of Cyprus during Pleistocene-Recent compression and transpression led to the reactivation of pre-existing structures and the formation of E-W and NNE-SSW-trending left lateral faults and NNW-SSE-trending right lateral faults.

3.2.1 Local structural setting

With regards to local structural setting, the area under study is characterized by NW/SE, N/S and NE/SW striking faults. The most important is the acting, Yerasa fault, striking NW/SE between Trimiklini and Ayios Tychon, Amathus and the Yermasogia fault striking N/S, as shown on figure 5. Most of the earthquake events in the area are related with these fault zones as presented on figures 6 and 7. The above structural regime can be observed in detail in the area under study. Small, local faults exhibit the above directions, as well as the various joint systems developed. In several exposures in the area, the directions and dip of the various discontinuity systems were recorded and found to follow the same directions as the regional structure.

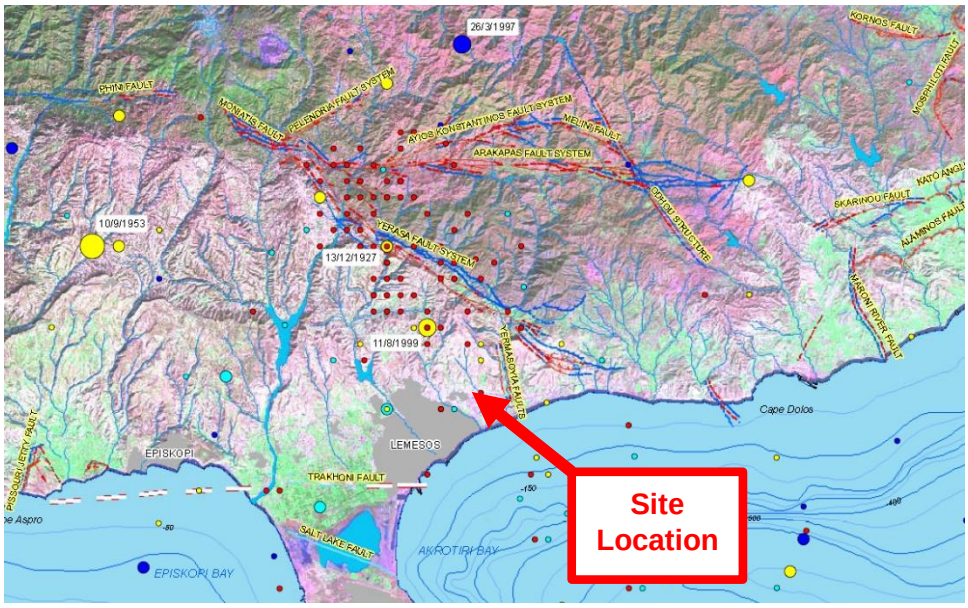


Figure 3: Regional faults in the broader Limassol area

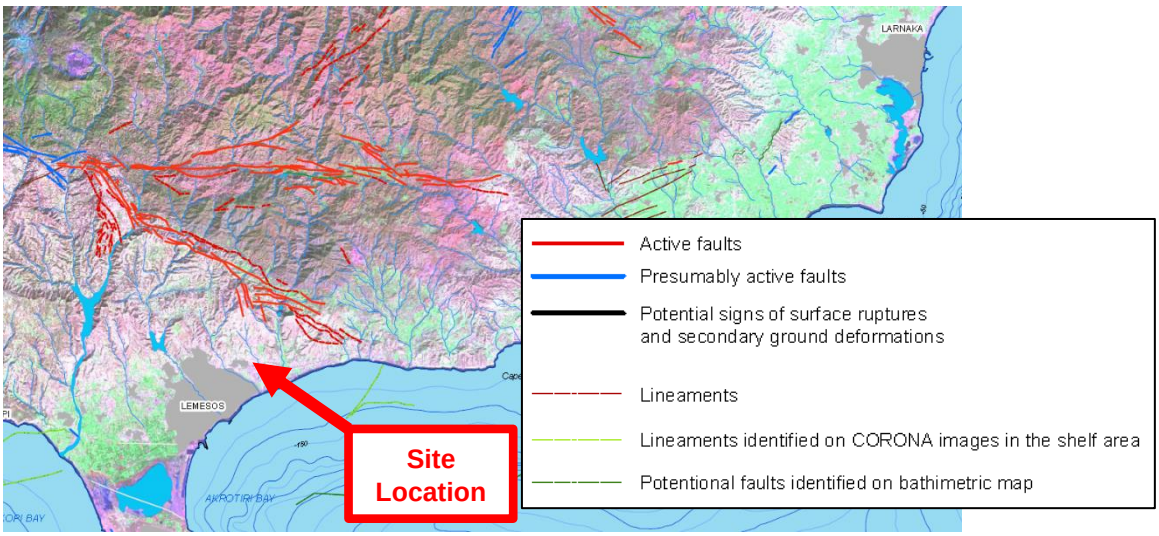


Figure 4. Part of the map with active faults in Cyprus, Geoter, Neocyp Consortium και B. Grellet, «Study of active tectonics in Cyprus for seismic risk mitigation, WP8-Final Report» Nicosia, Cyprus, 2005

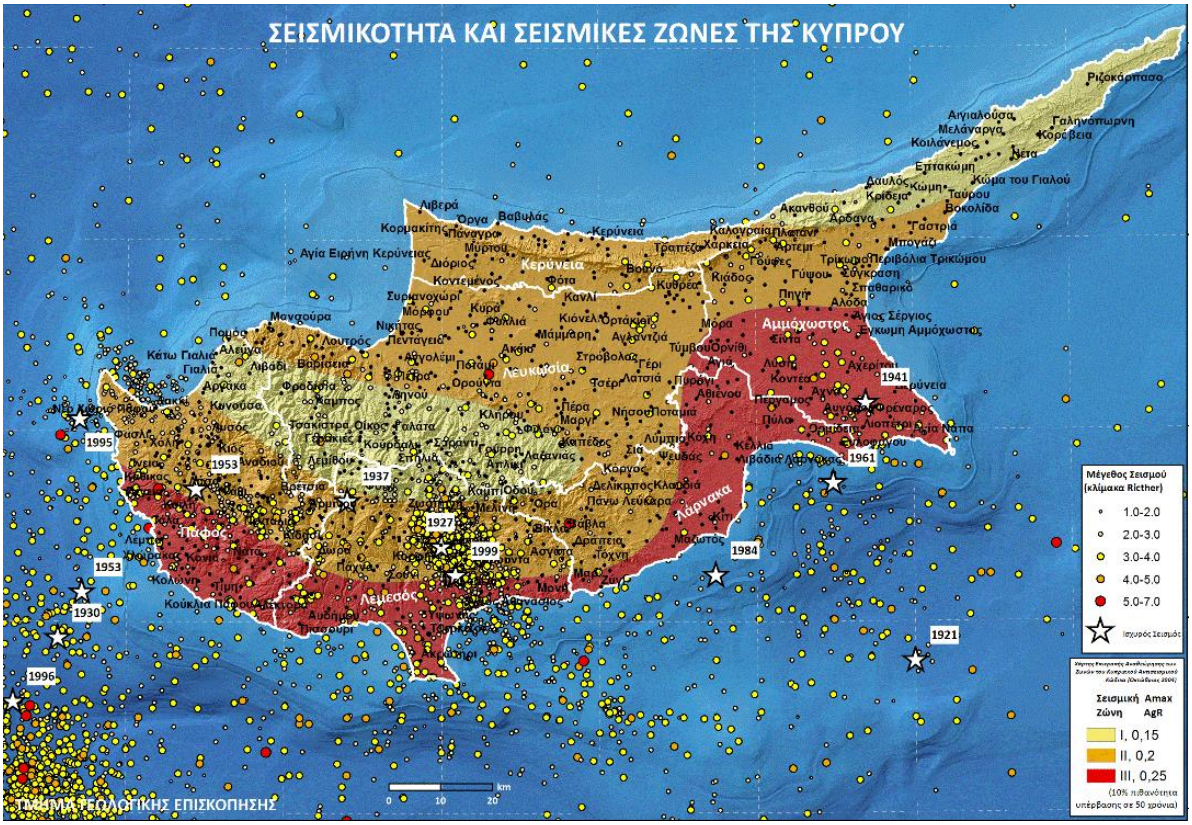


Figure 5: Seismic activity in the broader Limassol area

[Dr. J. P. Soulas, France, December 1999]

4 GROUND INVESTIGATIONS – WORK CARRIED OUT

4.1 Standards and Regulatory Framework

The following reference standards, further to those mentioned in chapter 1.3, were considered for the geotechnical survey:

- BS5390-2015: Code of practice for ground investigations.
- BS1377 – part 1: Methods of test for soils for civil engineering purposes. General requirements and sample preparation.
- Eurocode EC 7 Geotechnical design - part 1 General Rules
- Eurocode EC 7 Geotechnical design - part 2 Ground investigation and testing
- CYS EN ISO 14688-1:2002+A1:2013 -- Geotechnical investigation and testing -- Identification and classification of soil -- Part 1: Identification and description;
- CYS EN ISO 14688-2:2002 Geotechnical investigation and testing -- Identification and classification of soil -- Part 2: Principles for a classification
- ISO 22476-3:2005+A1:2011 Geotechnical investigation and testing -- Field testing -- Part 3: Standard penetration test
- CYS EN ISO 14689-1:2003 Geotechnical investigation and testing -- Identification and classification of rock -- Part 1: Identification and description
- ISO 22475-1:2006 Geotechnical investigation and testing -- Sampling methods and groundwater measurements -- Part 1: Technical principles for execution
- BS 4019-5:1999 Rotary core drilling equipment.
- EN ISO 22476-4. Menard Pressuremeter testing
- BS1377 – part 2: Methods of test for soils for civil engineering purposes. Classification tests.
- ISRM Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses (1978).

4.2 Field Works

4.2.1 Sitting of the boreholes

The boreholes' locations were proposed by the project consulting engineers.

4.2.2 Drilling

Five exploratory boreholes 4 down to 20 and 1 down to 17 meters below ground level, with a total depth of 97 meters, were drilled at the site. The particulars of the boreholes including method of drilling, encountered geological sequence, in situ testing, sampling,

exact location, depth etc. are given in individual records of boring to be found in Appendix 1.

Drilling technique

Drilling was performed applying the destructive method, in combination with the in situ Standard Penetration Tests – SPT, where possible. Limited core drilling was also applied in places so that proper samples for strength testing could be taken.

Drilling Rig

A Schramm track mounted rotary drill was used for drilling, as shown on photo below.

SCHRAMM Drilling Rig used for intrusive investigations

In-Situ Testing

Standard Penetration Test (SPT)

This test measures the resistance offered to the penetration of a standard open-tip sampler, which can be empirically correlated to soil density, strength, and stiffness. It was developed for granular materials but is applied to several types of soils and even very weak, fissured, highly fragmented and weathered rocks. The intervals of SPT were of the range of 1.5 to 3.0 m. It was proved, however, that this type of testing is not applicable for

the rocky section occupying the lower part of the site under study as well for the cemented and gravelly soil horizons.

Permeability tests

Five falling head permeability tests were carried out at several depths, one in each borehole.

4.2.3 Sampling

Sampling was performed during drilling by means of bulk disturbed and cored samples, which were placed in sound, plastic containers/boxes. Selected cored samples were properly wrapped and taken to the Laboratories for testing. Wrapping was performed using a very thin, plastic, tough membrane, which can be stretched and tightly seal the sample, so that the latter is protected from drying out. Undisturbed sampling was also tried at several places, but due to high density no such samples could be taken.

4.2.4 Water Level recording and sampling

Groundwater in amounts that could be detected during drilling were not encountered, but negligible amounts are expected at depths below 15 meters.

4.3 Laboratory Testing

The Laboratory tests were performed in accordance with the relevant European CYS CEN ISO/TS 17892:2004 series, BS EN 1377-3:1990 and BS EN 13925-1:2003 as shown on table 1 and involve:

identification tests, i.e. particle size distribution by means of both wet sieving and hydrometer, Specific Gravity, Bulk and dry density, natural moisture content, Unit Weight, Atterberg Limits and Linear Shrinkage.

Strength tests by means of Unconfined Compressive Strength, and small Shear box tests were also performed on cored samples.

Chemical tests were carried out on selected samples to determine their chemical aggressiveness and any special requirements for the design and construction of buried structures to ensure their durability. Chemical tests involved clhor ions, sulphates, carbonate and pH.

A short description of the tests carried out with reference to the Standards followed is presented below. All the results are presented on the tables throughout the report. The graphic presentation of all tests can be found in Appendix 2.

Natural Moisture Content

The natural moisture content in accordance with CYS CEN ISO/TS 17892-1:2004, was determined for all samples tested.

Particle Size Distribution

Combined wet sieving/hydrometer analyses were carried out in accordance with the requirements of CYS CEN ISO/TS 17892-4:2004. The dispersing agent for the hydrometer was sodium hexametaphosphate and the sample used was oven dried.

Atterberg Limits

Testing was carried out in accordance with the requirements CYS CEN ISO/TS 17892-12:2004. The Cone penetration apparatus (method 2B) was adopted for the liquid limit tests. The results are presented graphically on individual test sheets and on the Casagrande Plasticity Classification Chart. All samples tested for Atterberg Limits were also tested for linear shrinkage.

Unconfined Compression Tests

The Unconfined Compression tests were carried out on undisturbed and cored samples on the ELE-MULTIPLEX 50 triaxial machine. The actual stress - strain curves for each individual sample together with additional information related to the specimen tested and relevant photos, are given in the test sheets enclosed with Volume III. The results are presented also on table 31. The treatment of samples crushed in the ELE-MULTIPLEX 50 machine was in accordance with CYS CEN ISO/TS 17892-7:2004. The orientation of the samples when placed in the testing machine was the same as the one in situ and the rate of strain applied was 1.00 mm/min.

Direct Shear Strength test

For these tests the procedure in accordance with the CEN ISO/TS 17892-10:2004 was followed, on sets of 3 samples, on the EL26-2114 series Digital Direct/Residual Shear Apparatus of ELE INTERNATIONAL. The load used in each specimen is calculated with relation to its overburden and the shearing is applied slowly enough to allow excess pore pressures to dissipate by drainage so that effective stresses are equal to total stresses. Thus, the effective shear strength (cohesion) and the effective angle of internal friction of soils can be determined.

Consolidation Tests

The consolidation tests, in combination with swelling pressure and swelling measurement, were carried out on undisturbed samples. The testing was performed in accordance with the procedure given in CYS CEN ISO/TS 17892-5:2004. The loading steps were in the range of 201 – 1589 kN/m2 with two unloading steps and two reloading to establish the recompression index. Compression Vs Time plots for each loading sequence together with e Vs log P graphs for each test are presented in Appendix 2. Physical properties and dimensions such as initial and final moisture contents, initial bulk density, measured specific gravity, ring dimensions etc. are recorded on these graphs. Values of cv and mv representative of different pressures are given in tabular form on the e Vs log P graph. To estimate overconsolidation ratios, preconsolidation pressures were calculated using the Casagrande method. Physical properties and dimensions such as initial and final moisture contents, initial bulk density, specific gravity, ring dimensions etc. are recorded on these graphs. The swelling pressure and swelling measurement are presented

graphically using the cumulative weight Vs square root of Time, Swelling Vs log Time and Void ratio Vs Pressure (e Vs log P).

4.4 Data Evaluation, Report

All the data gathered from the field and laboratory works have been evaluated and interpreted by the specialists of Geoinvest Ltd. In the previous chapters, the report described all the works and methodology followed and, in the following, presents the results on which all the conclusions and recommendations have been based on.

The results of both the field and desk studies were used to prepare the geological model of the area, which helps to understand the general geology of the area and the geological relationship between the various soil and rock formations.

Table 1: Laboratory tests and the relevant standards

Classification Tests	*Particle Size Distribution by means of both wet sieving and hydrometer*	CYS CEN ISO/TS 17892-4:2004
	Bulk and Dry Density	CYS CEN ISO/TS 17892-2:2004
	Natural Moisture Content	CYS CEN ISO/TS 17892-1:2004
	Atterberg Limits	CYS CEN ISO/TS 17892-12:2004
	Linear Shrinkage	CYS CEN ISO/TS 17892-12:2004
	Specific Gravity/Particle Density	CYS CEN ISO/TS 17892-3:2004
Strength Tests	*Unconfined/Uniaxial Compressive Strength*	CYS CEN ISO/TS 17892-7:2004
	Standards Methods for Compressive Strength and Elastic Moduli of Intact Rock.	*ASTM D7012-13*
	Standard Test Method for determination of the Point Load Strength Index of rock.	*ASTM D5731-08:*
	Splitting Tensile Strength	*ASTM D 3967 – 95a*
	Unconsolidated Undrained Triaxial tests	CYS CEN ISO/TS 17892-8:2004
	Consolidated Undrained triaxial test with pore pressure measurements	
	Direct Shear Strength Tests	CYS CEN ISO/TS 17892-10:2004
Consolidation and Swelling tests	*One Dimensional Consolidation*	CYS CEN ISO/TS 17892-5:2004
	Swelling Pressure	CYS CEN ISO/TS 17892-5:2004
	Swelling Measurement	CYS CEN ISO/TS 17892-5:2004
Electrochemical Tests for Water	*Sulphates*	BS EN 1377-3:1990
	Chlorides	BS EN 1377-3:1990
Chemical Analyses	*$CaCO_3$, Mg^+*	BS EN 1377-3:1990
	Montmorillonite	BS EN 13925-1:2003
	pH	BS EN 1377-3:1990
	EC	BS EN 27888:1993
	TDS	BS EN 1377-3:1990

5 SUBSURFACE GEOLOGICAL AND GEOTECHNICAL CONDITIONS AT THE INVESTIGATED SITE

5.1 Site Geology and Geological relationships

The following paragraphs describe the stratigraphic relationship among the units that compose the geological model. A short description and the stratigraphic relationship of all the units constituting the broader area follows, from the younger to the older.

Formation 1 - Quaternary and Modern Deposits

The sediments of the unit represent the most recent and superficial element of the model and consist of one main soil type from the origin point of view:

- Recent Coastal Accumulations - Alluvial and Marine Deposits

These deposits represent:

- **modern, alluvial**, mostly clayey Silts and Sands accumulations with high stoniness, a reworked product of weathering of the rocks found to the north of the project site, i.e. calcareous sediments of Pakhna and Lefkara formations. The product of the erosion was transported and reworked by surface rainwater during heavy raining and floods. The thickness of these deposits is variable (4.0 to 9.0 m), but generally less than 9 meters. They are underlain by:
- **recent marine** deposits represented by beige, pink and brown colored fine and coarse-grained deposits, with the sandy and gravelly fraction dominating over the clay and silt fraction.

Formation 2 – Pakhna sediments

The Pakhna pelagic marine carbonaceous sediments are known to be present at the site but at depths more than 25 meters, where the intrusive investigation stopped. Several types of sediments were deposited during this time: Limestones, chalks, marly chalks, chalky marls, marls, calcarenites, sandstones, laminated marls rich in planktonic foraminifera.

Table 2: Stratigraphic relationship

Approximate Geological Age	Formal lithostratigraphic classification	General description
Quaternary-Recent (Pleistocene to Present!	Man Made Ground	Made ground in areas of excavations and backfilling
	Recent Alluvium, Colluvium and Residual Soils	Superficial, Alluvial Deposits, mostly clays, silts and sands, rock fragments of gravel and cobble size, all of sedimentary origin
	Recent Beach Deposits	Heterogeneous both fluvial and marine deposits reworked by both the sgtreams and the sea, grey sand, silt, gravel and cobbles of predominantly igneous origin
Quaternary (Pleistocene)	Coastal Accumulaitons (Older Alluvium and River/Marine Terrace Deposits)	Gravelly facies: terrace deposits characterized by a predominant gravel/cobble fraction intercalated with sand either igneous or calcareous, usually cemented. Sandy/silty/clayey facies: terrace deposits characterized by predominant sand, clay and silt fraction with frequent gravel/cobble lenses, all of predominantly sedimentary origin
Tertiary-Quaternary (Pliocene- lower Pleistocene)	Athalassa Formation	Thinly to thickly laminated sandy marl
		Conglomerate and cemented gravel with sand, marl matrix
Tertiary (Pliocene)	Nicosia Formation	Massive to thickly laminated marl and sandy marl
Tertiary (Upper Miocene/ Messinian)	Pakhna/Kalavasos Formation	Gypsum bodies, Marl, sandy marl and chalky marl, locally gypsum bearing
Tertiary (Upper Miocene)	Pakhna/Koronia Limestone	Reef Limestone
Middle to Upper Miocene	Pakhna Upper Sequence	Limestone, Calcarenite Silty Sandstone, Marls, Sandy Limestones, Chalks (Shale – Limestone of Pantazis)
Middle Miocene	Pakhna Chalk and Marl sequence	Chalk and Marl
	Pakhna Lower Sequence	Massive and Cleaved Chalk
Paleocene to Eocene	Lefkara Formation	Upper Marl, Chalk and Marl Upper Chalks Chalk and Chert Lower Marl
Upper Campanian/ Maastricthian	Moni Melange	Olistholiths / Older blocks of quartz sandstone, siltstone, serpentinite and lavas in a bentonitic clay and silty matrix.
Lower Campanian	Troodos Ophiolite Complex	Pillow Lavas

The highlighted formations are found in the area around the study site

Figure 6. Boreholes' and Cross Sections' locations

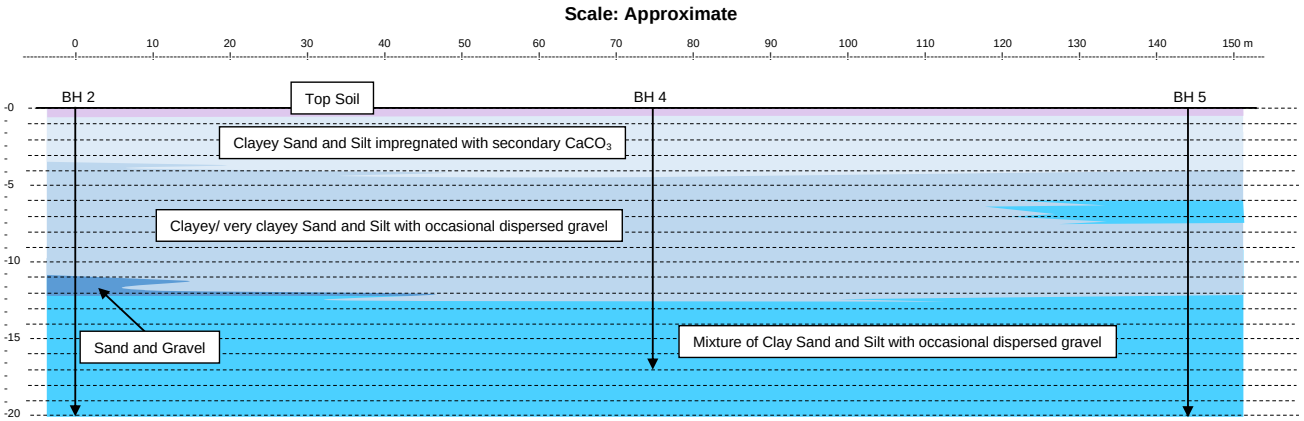


Figure 7. Cross Sections 1-1'

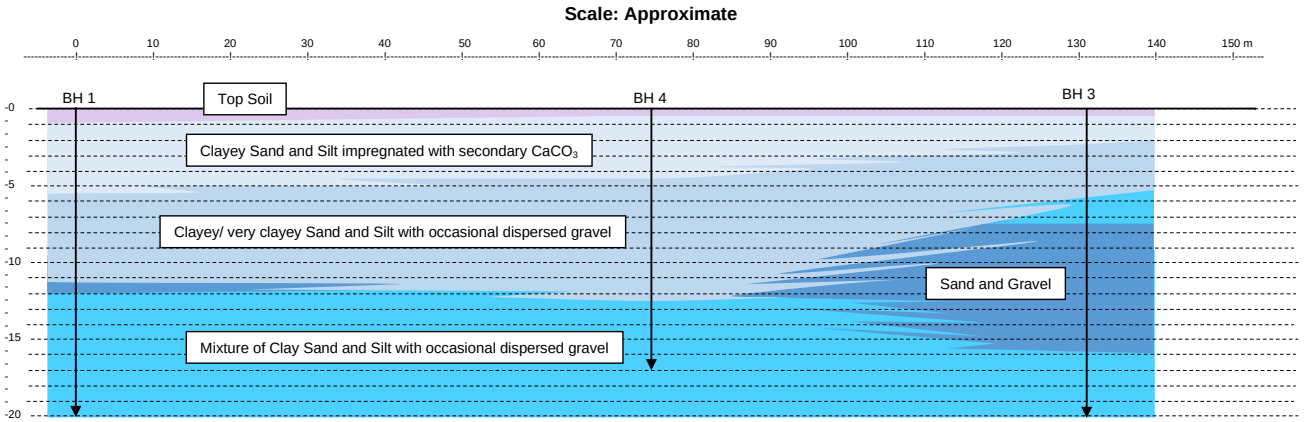


Figure 8. Cross Sections 2 - 2'

5.2 Engineering Characteristics of the rocks/soils at the site under study

From the engineering geotechnical point of view, the soils and rocks along the study area can be grouped into two main geotechnical groups:

- **A**: Superficial Deposits (Recent Alluvium, Colluvium–A1 and Marine Deposits–A2.
  - **A1:** clayey, very silty Sand to Silt and Sand with variable amounts, but generally of high content of gravel/cobbles/boulders
  - **A2:** silty SAND with variable amounts of gravel and occasionally cobbles, usually more than in B1.
  - In both sub-groups variably thick lenses rich in clay and silt are also incorporate in places.
- B. Pakhna Formation deep marine sediments. This formation is known to be present at the site, but it was not encountered down to 20 m.

The engineering parameters of the above materials are presented in the following chapters, classified in four groups as follows:

- Index Properties
- Density and Strength,
- Swelling and Consolidation, and
- Chemistry

Group A – Superficial deposits

Superficial deposits are present everywhere under the Fill material, and are of variable thickness, generally more than 20 m. The uppermost part is represented by, mostly, fine and less coarse material of light colors due to impregnations and cementation with secondary calcium carbonate down to about 2.10 – 5.50 m, with the amount of coarse material gradually increasing with depth. Underneath this group, mostly fine, colorful soils in combination with coarse, gravelly soils, were deposited and reworked by the sea down to more than 20 meters, where the bedrock of the area is present.

Index Properties

They can be classified into two sub-groups, related to their particle size:

A1: clayey, very silty Sand to clayey Silt and Sand with variable amounts of gravel/cobbles/boulders. They are in most of the places impregnated with secondary $CaCO_3$ forming a hard crust due to cementation with the dominant colour being off-white to white gradually turning to pale brown/pale pinkish brown.

A2: clayey/very clayey, sandy/very sandy Silt to silty/very silty SAND with variable amounts of fine to medium grained gravel and occasionally cobbles. They are encountered below sub-horizon B1 and extend down to the bedrock.

Characteristic particle size distribution is presented on the table below.

Table 3: Index Properties – Particle Size Distribution of the fine fractions

Group A	Gravel fraction %	Sand fraction %	Silt fraction %	Clay fraction %
No of tests	9			
Minimum	0	8	24	8
Maximum	17	67	70	33
Average	3,2	33,3	46,2	17,2
Standard Deviation	6,0	20,1	15,3	8,2
COV%	185	60	33	48

The Liquid Limits are of the order of 34 – 47 % and corresponding **PI** of the order of 9 – 25 %. The results of Atterberg Limits tests can characterize this horizon as Inorganic clay of low to intermediate compressibility/plasticity (ML/CL/MI/CI soil type on the Casagrande Plasticity Chart). The **Linear Shrinkage** ranges between 7 and 14%. Based on the relation between Clay Content and PI (Skempton classification) these materials can be classified as inactive to normal and based on South African Expansion classification as low to high (see relevant graphical presentations in Appendix 2).

Table 4: Index Properties - Plasticity Characteristics

Group A	LL %	PL %	PI %	LS %	Soil type	Moisture Content %
No of tests	9					
Minimum	34	18	9	8	ML/CL/MI/CI	9,0 – 20
Maximum	47	28	25	14		
Average	39,3	22,3	17,0	10,3		
Standard Deviation	5,2	3,6	6,4	2,2		
COV%	13	16	38	21		

The range of **moisture content** is of the order of 9 – 20 % and the **Specific Gravity** of the order of 2.604 to 2.688 g/cm^3.

Density and Strength Parameters

The **Bulk Densities** are of the order of 1.762 to 2.045 g/cm^3 and the corresponding **Unit Weight** of the order of 17.3 to 20.1 kN/m^3.

The **SPT** results are of the range of 27 – 60 and when of better cementation >60 blows per 30 cm of penetration. On this basis, the Group can be characterized as medium dense to mostly dense.

The Unconfined Compressive Strength tests yielded results of the order of q_u = 285 – 410 kPa with corresponding undrained cohesion $c=q_u/2$, equal to 143 – 205 kPa.

Due to relatively low cohesion, Triaxial tests under undrained (φ=0) conditions were unsuccessful and the results recorded not reliable (0 to 45 kPa not presented). Direct Shear strength tests in the small shearbox under drained conditions were conducted instead. The effective angle of internal friction, φ', and effective cohesion, c', were found to be of the order of 29 – 35^0 and 42 – 54 kPa respectively.

Table 5: Index Properties–Specific Gravity-Bulk Density – Unit Weight

Group A	SPT	Specific Gravity g/cm³	Bulk Density g/cm³	Unit Weight kN/m³	Unconfined Compressive Strength, qu kPa	Undrained Shear Strength, $c=q_u/2$ kPa	Effective Cohesion, c' (Shearbox) kPa	Effective Friction angle φ' ⁰ (Shearbox)
No of tests	*60*	*4*	*15*	*15*	*7*	*7*	*2*	*2*
Minimum	27	2,604	1,762	17,3	285	143	42	29
Maximum	>60	2,688	2,045	20,1	410	205	54	35
Average	>60	2,645	1,973	19,4	344,9	172,4	48,0	32,0
Standard Deviation		0,04	0,1	0,8	50,0	25,0	8,5	4,2
COV%		2	4	4	15	15	18	13

Consolidation and Swelling

The consolidation in combination with swelling pressure and swelling measurement tests were carried out on samples taken from the clay and silt-rich part (B2). The actual load - unload steps were adjusted to suit the sample. The values of cv and mv representative of different pressures are given in tabular form on the e Vs log P graphs. To estimate overconsolidation ratios, preconsolidation pressures were calculated using the Casagrande method. The OCR is of the order of 1.9 – 2.5 and the possible settlements under a pressure of 200 kPa for example, might be of the order of 3.49 – 3.93 mm/m. The **Swelling Pressure** is of the order of 45 to 54 kPa and the free **Swelling** was measured to be of the order of 0.56 to 0.79 %.

Table 6: Consolidation and swelling characteristics

	Swelling Pressure (kPa)	Swelling (%)	OCR	Settlement at 200 kPa (mm/m)
Group A	45 – 54	0.56 – 0.79	1.9 – 2.5	3.49 – 3.93

Soil chemistry

The soils were also tested for sulfate and chloride content and found to be of the order of 0.012 – 0.034% (SO_4) and 0.004 – 0.009% respectively. The **pH** is high, of the order of 8.6 – 8.9 due to high content of calcium carbonate.

The **montmorillonite** content (a clay mineral with extremely high swelling and shrinking capabilities) was found to be of the order of 3 to 6%, which is considered low. The relationship of the montmorillonite and clay content is shown on the relevant graph in Appendix 2.

Table 7. Soil Chemistry

pH	Chlor Ions %	Sulphates % of SO_4	Montmorillonite %
8.6 – 8.9	0.004 – 0.009	0.012 – 0.034	3 – 6 %

Deformation Parameters

Based on SPT, laboratory tests and in situ Pressuremeter tests in similar formation in the area, Bowles 1986 and Retit, the following parameters could be proposed:

Table 8. Deformation Parameters of fine deposits

Soil Type	E_s, Bowles kN/m^2	K_s* kN/m^3	Poisson's ratio, v
Group A	25-60,000	35-80,000	0.35
Overall proposed	35.000	40.000	0.35

**** Indicative.*** *The Ks values are indicative only. The final computation should be done by the foundation engineers when the depth and shape of foundations as well as the loads to be distributed on the foundation and consequently on the sub-ground are known.*

6 FOUNDATION CONDITIONS AT THE STRUCTURES SITES - GEOTECHNICAL CONSIDERATIONS FOR FOUNDATIONS.

6.1 Introduction

Foundations should be designed to support structural loads with an adequate factor of safety with respect to the soil parameters at each site, so that settlements remain within tolerable limits.

6.2 Typical local civil works and foundation practices

For small structures, shallow foundations are considered suitable and consistent with local practice. Isolated footings, strip foundations, cross beams and raft foundations are in common practice.

6.3 Types of foundations to be applied to this project

For the proposed building, depending on the loads and the way of their distribution, stiff and rigid foundation should be used. In case where the loads of the buildings exceed the allowable bearing pressures of the soils, the foundation should be supported by cast in situ piles.

6.4 Bearing Capacity and Foundation Conditions

The choice of the maximum allowable bearing pressure is not only a matter of computing but mainly of the correct assessment of the overall geological/geotechnical conditions prevailing at the site. The exercise of a general site judgment by the foundation engineer is, therefore, a must and critical conditions like plasticity characteristics, weathering, density variability, rock mass conditions, hydrogeological conditions and geological history of the site should be taken seriously into consideration. Various parameters like Rock Mass Rating based on strength, Rock Quality Designation, spacing and conditions of discontinuities, presence or not of groundwater, are evaluated to establish the foundations condition at the investigated site.

6.4.1 Bearing Capacity of Granular Soils of group A

Geotechnical horizons A1 and A2 could be considered granular materials. It should be noted that the bearing pressures of granular materials are quite high in terms of bearing capacities. However, the choice of the maximum allowable bearing pressures for foundation on granular soils is controlled by settlement rather than by strength. The determination of bearing capacity was based on the empirical methods of TERZACHI-PECK (1948), MEYERHOF (1965, 1968) and PECK, HANSON, THORNBURN (1976), which were slightly modified by later scientists.

All the methods above are based on the relation between the soil pressure, which produces a given settlement and the N values from the SPT. To avoid the problems of the density variability, the Maximum Allowable Bearing Pressure, which can produce 25mm settlement, is determined for the footing to be subjected to the greatest design load using the lowest value of SPT.

For this study the maximum allowable bearing pressures of the fine-grained soils of group A, using the SPT results, were calculated with a factor of safety of 3. The results show a large variability, but they are generally high due to the high density, the cementation, and the presence of gravelly lenses. Allowable bearing pressures of the order of 270 to 600 kPa were calculated using this method, as shown below.

Since a one level basement is envisaged, the structure is to be founded at depths of the order of 4.0 to 5.0 m. Most of the loads, therefore, are to be distributed on soil group A. It is proposed to use a stiff and rigid raft foundation so the the differential settlements are kept below the allowable limits. The static water level is estimated at depths >12-15 m. Due to the fact, however, that the site is located between two streams, considerable seasonal fluctuations of the water table should be considered.

At possible foundation levels, the lower and the average calculated allowable bearing pressures of the fine soils are as follows:

Table 9. Allowable Bearing Pressures – ABP using SPT results (Corrections in accordance with CYS EN 1998-5:2004 (E))

Average at depth 4.5 m	525 kPa	
Lower value recorded at 4.5 m	340 kPa	
Average at depth 7.5 m	388 kPa	
Lower value recorded at 7.5 m	270 kPa	
Average of all ABP recorded in fine soils at 4.5 m	314 kPa	**Overall proposed: 300 kPa**
Average of all ABP recorded in fine soils at 7.5 m	299 kPa	**Overall proposed: 350 kPa**

The allowable bearing pressures of the coarse-grained soils, i.e. gravel, cobbles, as well as the cemented soils with secondary calcium carbonate are quite higher than the above recorded.

The proper way to establish the bearing capacity of the ground is by introducing into the calculations the exact loads of the structures, the shape and depth of the foundation, as well as other parameters. At this stage, within the frame of this investigation, since no exact figures for the above were provided by the client, the values proposed above should be considered as indicative. This task, anyway, is a job that should be undertaken by the foundation engineers of the project, who should be aware of all aspects of the structures.

6.4.2 Design Parameters

The design parameters, summarized below, were established using various methods.

Deformation modulus and modulus of subgrade reaction.

The proposed modulus of subgrade reaction and the deformation modulus, as presented on the table below, have been determined after Bowles1988 using SPT results and experience, taking also into account results of in situ pressuremeter tests executed in similar geological formation in the area as well as the results of laboratory tests.

Table 10: Deformation parameters

Soil Type	Poisson's ratio, v	K_s kN/m^3	E_s kN/m^2
Overall proposed	0.35	40.000	35.000

Friction Angle

The friction angle as established with shearbox testing and SPT is shown on the following table.

Table 11: Angle of internal friction from various methods

Soil Group	φ established	φ proposed
A	29 – 35^0	32^0

Table 12: Specific Gravity, Bulk Density, Unit Weight, and Shear Strength

Specific Density g/cm^3	Bulk Density g/cm^3	Unit Weight kN/m^3	UCS kPa	Shear Strength Cu, (UCS*0.5) kPa	Effective Cohesion, c' (Shearbox) kPa	Effective Friction angle φ' ^{0} (Shearbox)	Shear Strength c (SPT) kPa	Effective sh. Strength c (SPT) kPa
2.645	1.973	19.4	285	143	42	32	160	55

Permeability

The proposed values of these parameter are as follows:

Table 13: Proposed Coefficient of Permeability, Ks

Group	Coefficient of Permeability, Ks cm/sec	Coefficient of Permeability, Ks m/day
A	4.45 x 10^{-4} - 2.51 x 10^{-3}	0,38 - 2,17

7 EXCAVATION CONDITIONS

All excavations will take place in soil group A. Both soil groups are of the soft type of excavation and can be excavated by any conventional machinery of the proper capacity.
As far as the slope stability is concerned, it should be pointed out, that the uppermost, cemented part of the A1 group is of quite high stability.

Generally, the permanent cut slope angles of excavations should be of the order of 1V:1H. For temporary slopes it could be higher for short time. In any case, the excavation procedure should be supervised by the project's engineers, who must decide whether preliminary support might be necessary.

8 HYDROGEOLOGICAL CONDITIONS

Ground water was not encountered in amounts that could be observed during drilling. In some of the boreholes, however, high moisture content between 15 and 17 meters was observed indicating that some water might be present at this depth. No worth noting aquifer is developed/was observed during drilling down to the drilled depth. It should be mentioned, however, that due to the proximity of the site to two streams, as well as to a retention storm water pond upstream, considerable seasonal fluctuations of the static water level should be considered at the site. In situ permeability tests with the falling head method in accordance with BS 5930 were performed with the aid of which the following permeabilities were calculated.

Table 14: Coefficient of permeability

BH/depth m	Soil/rock Group	Coefficient of Permeability, Ks cm/sec	Coefficient of Permeability, Ks m/day
BH1 / 4.0 m	**A1**	1.26×10^{-4}	1.09
BH2 / 4.5 m	**A2**	2.51×10^{-3}	2.17
BH3 / 6.0 m	**A1**	5.28×10^{-4}	0.46
BH4 / 8.0 m	**A1**	4.45×10^{-4}	0.38
BH5 / 7.50 m	**A2**	2.38×10^{-3}	2.06

The permeability of group A was calculated to be moderate, and it depends on the degree of cementation and the amount of fine material.

Table 15: Permeability and drainage characteristics of soil (Terzaghi et al., 1996)

cm/s	10^{0}	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	
					B2	B1						
Drainage	**Good**								**Poor**		**Practically Impervious**	
Soil types	Clean Gravel		Clean sands, clean sand and gravel mixtures			Mixtures of clay, silt and sand			Very fine sands, organic and inorganic silts, mixtures of sand silt and clay, glacial till, stratified clay deposits etc		"Impervious" soils, e.g. homogenous clays below zone of weathering.	
						"Impervious" soils modified by effects of vegetation and weathering.						

9 GEOLOGICAL HAZARDS

The main geological hazards that could be examined for the site under study are the following:

- Liquefaction
- seismic hazard
- flood hazard
- karst hazard
- landslide hazard
- Swelling/Shrinking

Liquefaction Potential, Swelling/Shrinking

No such hazards are envisaged.

Seismic Risk

In accordance with the National Annex of Eurocode CYS EN 1998-1: 2004, the area is found within seismic zone 3 with peak ground acceleration 0.25. Based on table 3.1 of the above Eurocode, the Superficial deposits (Recent Alluvial and Marine) in the investigated area could be classified as Ground Type C, as shwn on the table below.

Table 16: Ground Types in accordance with CYS EN 1998-1

Ground Type	Description of Soil Horizon and depth	Parameters		
		V_{s30} (m/s)	NSPT	c_u (kPa)
C	Superficial Deposits down to 25 m	180 – 800	27 - >60	143 – 205

It should also be noted that the area is not far from the active seismic zone trending NW/SE between Trimiklini and Ayios Tychonas. The active Yerasa Fault, the Yermasogia and Episkopi faults also close to the project area. The area of Limassol in general, is influenced by the high seismic activity of the southern Cyprus. The earthquakes are, usually, of low to medium intensity with epicenters in depths of a few to about 30 km. The antiseismic design of the project's structures is, therefore, a must.

The relevant codes that should be taken into consideration for the foundation and generally the building design is: CYS National Annex to CYS EN 1998-1:2004, Eurocode 8: Design of structures for earthquake resistance, Parts 1, 3, 5, 6.

Flood hazard

No high hazard is envisaged since no big rivers with large catchment areas are present in the surroundings of the project area. Effective storm water management, however, is necessary since the site is found very close to the junction of two streams of Vathias and downstream of a stormwater retention pond, which is located some 800 m to the north of the site, as shown on figure 9.

Figure 9. Stormwater retention pond location

Karst hazard

The development of karst conditions might be caused by the dissolution of carbonate rocks (e.g. limestone, chalks) and evaporitic rocks, usually Gypsum. Karstification is a term related with the development of extensive cavities within the above rocks due to surface and groundwater circulation of fresh, usually storm water. These cavities, if geological conditions are favorable, may eventually promote collapsing that could result to ground surface subsidence and development of sink-holes or linear fractures accompanied with subsidence. Based on Cyprus experiences, the rocks that can be affected by significant karst phenomena is the gypsum of Kalavasos Formation and extensive bodies of Limestone of Koronia and Terra Limestones.

In the project site no such rocks were encountered, thus the Karstification hazard is limited.

Landslide hazard

No such risk exists. Care should be taken, however, during the design of the basements, and the relevant excavations. Permanent cut slopes, if any, should be less than 1V:1H in superficial deposits. In the case of vertical or sub-vertical slopes retaining walls should be designed.

10 CONCLUSIONS

Two geological formations are found along the site under study.

- **The Quaternary Superficial Deposits**, which consist of fine (clayey/very clayey, very silty, Sand to Silt and Sand) and coarse material. The upper part is impregnated with secondary $CaCO_3$ and exhibit some degree of cementation and generally light colors. With depth, the amount of the coarse materials increases, and fine materials turn in places to sandy, very clayey Silts with variable amounts of gravel in dispersed form. These soils are pikinsh brown to brown colors.
- **Pakhna Formation**

The dominating rock types are the Marls and chalky Marls and less the Clacarenites, Limestones and marly Sandstones. This formation, however, was not encountered down to 25 meters, although expected to be very close.

The area is covered with a variably thick layer of imported materials, usually from 0.40 to 1.50 m thick, which were placed at the site in an uncontrolled manner and were not compacted. All these materials should be removed from all structures' footprints (roads, parking places, buildings etc).

No worth mentioning problems are anticipated along the project site as far as the foundation conditions is concerned. Good and reliable foundation conditions are offered all over the area with high bearing capacities, provided that all imported materials are removed from the structures' footprint.

All buildings' foundations will be placed within the Quaternary soils, which are dense and weakly cemented, offering thus reliable foundation conditions even for heavy structures, like the planned one. Settlements might take place but should be within tolerable limits if the allowable bearing pressures, as proposed in the relevant chapter, are not exceeded and the natural moisture content is kept constant. Stiff and rigid raft foundation could be a good solution to this case. In the case where the loads of the building exceed the allowable bearing pressures, not likely, or if the horizontal acting forces on the buildings are high enough to cause overturning, the combination of raft foundation and piles should be considered. The pile should be bored and cast in-situ in depths of several meters below the existing ground surface. The depth depends on the load to be transferred and on pile diameter.

The excavation of the soils is considered easy to moderate and can be performed using powerful excavators, ~ 45 tons.

During the excavation of the basements, slopes of the order of 1,5V:1H should be used to avoid failures, and provided that the loose Fill material is removed. Moreover, if the excavation walls will be vertical, the excavations should be examined for their stability

and, if necessary, temporary stability measures to be applied so that excavation walls collapsing is avoided, until the permanent retaining wall is constructed.

The main geological hazards that could be considered in the area are:

- The relatively high seismic risk
- The existence of potentially active Yerasa and Yermasogia faults, could also be taken as a hazard, that should be taken into consideration during the foundation and generally the structures design.
- It should also be noted that the area is not far from the active seismic zone trending NW/SE between Trimiklini and Ayios Tychonas. The area of Limassol in general, is influenced by the high seismic activity of the southern Cyprus. The earthquakes are, usually, of low to medium intensity with epicenters in depths of a few to about 30 Km.

In accordance with the National Annex of Eurocode 8 CYS EN 1998-1: 2004, the area is found within seismic zone 3 with peak ground acceleration 0.25. Based on table 3.1 of the Eurocode 8, the soils/rocks encountered at the site are classified as Ground Type C.

No problems are expected from the presence of groundwater in depths of the order of >12 m. The permeability of the sub-ground is moderate.

An effective storm water management should also be designed.

No liquefaction, extreme swelling/shrinking, karst or slope stability hazards are envisaged.

Table 17. Geotechnical Characteristics of the soils

PARAMETERS	Group A
	Superficial deposits
SPT	27 – >60
φ	29 – 35^0 Proposed 32^0
LIQUID LIMITS	34 – 47 %
PLASTICITY INDEX	9 – 26 %
LINEAR SHRINKAGE	8 – 14 %
ACTIVITY CLASSIFIC. (SKEMPTON)	Inactive to Normal
Expansion Class (South African stds)	Low to high
ALLOWABLE BEARING PRESSURE - PROPOSED	As per table 9
MODULUS OF SUBGRADE REACTION Ks	Overall proposed 40.000 kN/m^3
ELASTIC MODULUS Es	Overall proposed 35.000 kN/m^2
COHESION C_u (Triaxial) CEN ISO/TS 17892-8	Testing not possible
UNCONFINED COMPRESSIVE STRENGTH (UCS)	285 – 410 kPa
Shear Strength (Based on UCS)	143 – 205 kPa
Shear Strength (Based on SPT)	160 kPa
Effective Shear Strength (Based on SPT)	55 kPa
Effective Shear Strength (Based on Shearbox test)	42 kPa
POISON RATIO (μ)	Overall proposed 0.35
pH	8.6 – 8.9
SO_4 (%)	0.012 – 0.034
Cl^- (%)	0.004 – 0.009
Montmorillonite	3 – 6
Moisture Content (%)	9 – 20 %
Bulk Density (g/cm^3)	1.762 – 2.045
Unit weight (kN/m^3)	17.3 – 20.1
Specific Gravity (g/cm^3)	2.604 – 2.688
Swelling Pressure (kPa)	45 – 54
Swelling Measurement (%)	0.56 – 0.79
OCR	1.9 – 2.5

Table 18: Unconfined Compressive Strength CEN ISO/TS 17892-7: 2004

BH	Depth (m)	DESCRIPTION	Length (mm)	Diameter (mm)	M. C. (%)	Bulk Density g/cm3	U.C.S. (kPa)	ES (MPa)
1	4.00-4.50	Clayey Sand and Silt	171.2	85.6	11.2	1.982	310	14
2	5.50-6.00	Clayey to very clayey Silt and Sand	170.4	85.2	16.8	1.995	328	22
2	11.50-12.00	Gravelly, clayey to very clayey Silt and Sand	170.8	85.4	17.2	2.022	402	13
3	5.50-6.00	Sand, clayey Silt	170.4	85.2	19.1	1.974	285	15
4	7.00-7.50	Clayey Sand and Silt	173.9	85.1	13.3	2.045	410	13
4	11.50-12.00	Clayey Sand and Silt	174.6	84.9	16.4	2.001	374	29
5	7.00-7.50	Sandy, clayey Silt	171.4	85.7	18.9	2.010	305	21
Performed on Multiplex Triaxial Machine								

Figure 10. Seismic Zones of Cyprus

Table 3.1: Ground Types

Ground Type	Description of stratigraphic profile	Parameters		
		v_s30 (m/s)	N_{SPT} (Blows/30cm)	Cu (kPa)
A	Rock or other rock-like geological formation, including at most 5m of weaker material at the surface.	>800	-	-
B	Deposits of very dense sand, gravel, or very stiff clay at least several tens of metres in thickness, characterized by a gradual increase of mechanical properties with depth.	360-800	>50	>250
C	Deep deposits of dense or medium-dense sand, gravel or stiff clay with thickness from several tens to many hundreds of metres.	180-360	15-50	70-250
D	Deposits of loose-to-medium cohesionless soil (with or without some soft cohesive layers), or of predominantly soft-to-firm cohesive soil.	<180	<15	<70
E	A soil profile consisting of a surface alluvium layers with v_s values of type C or D and thickness varying between about 5m and 20m, underlain by stiffer material with v_s >800m/s.			
S_1	Deposits consisting, or containing a layer at least 10m thick, of soft clays/silts with a high plasticity index (PI>40) and high water content.	<100 (indicative)	-	10-20
S_2	Deposits of liquefiable soils, of sensitive clays, or any other soil profile not included in types A-E or S_1.			

National Annex to CYS EN 1998-1:2004 Eurocode 8: Design of Structures for Earthquake Resistance
Part1: General Rules, Seismic Actions and Rules for Buildings

Table 3.2 (CYS): Values of the parameters describing the Type 1 elastic response spectrum

Ground Type	S	T_B (S)	T_C (S)	T_D (S)
A	1.0	0.15	0.4	2.0
B	1.2	0.15	0.5	2.0
C	1.15	0.20	0.6	2.0
D	1.35	0.20	0.8	2.0
E	1.4	0.15	0.5	2.0

APPENDIX 1

GEOLOGICAL DESCRIPTIONS OF BOREHOLES

BOREHOLE LOG BH No1 Sheet No: 1 of 2

Project: *MALL OF LIMASSOL*
Client:*J+A PHILIPPOU ARCH. – ENG. LLC*
Location: MESA GEITONIA/LIMASSOL
Coordinates:
Elevation: a.m.s.l.

Drilling method /Drilling Tool type/Diam
Open Hole: From 0.0 to 20.00m/125 mm
Destructive open hole technique
in combination with SPT
Total Depth: 20.00 m

Date started: 25/01/2023
Date Com/ted:25/01/2023
Orientation: Vertical
Flushing system: air
Casing**:** Not used

Depth b.g.l m	Soil type	DESCRIPTION OF STRATA	SPT/M.C. GRAPHIC PRESENTATION 10* 20 30 40	SPT TEST
0.90		Cultivated, sandy, clayey, silty TOPSOIL with high stoniness.		
1.0		Dense, off-white to beige, weakly cemented, calcareous, clayey SAND and SILT with some gravel. It is impregnated with white secondary CaCO3 (Havarized)		1.50-1.95 21-28-32 N=60 (300mm)
2.0				
3.0		As above, gradual weakening of CaCO3 impregnations. The color turns gradually to beige and pale brownish yellow.		3.00-3.45 20-24-27 N=51 (300mm)
4.0				
				4.50-4.90 12-23-23
5.0				N=46 (300mm)
5.50		Off-white layer of better cementation.		
6.0		Medium dense to dense, poorly cemented (cementation is weaker than above), pale brownish yellow, clayey SILT and SAND of calcareous composition.		6.00-6.45 11-15-18 N=33 (300mm)
7.0				
				7.50-7.95 12-20-26
8.0				N=46 (300mm)
9.0				9.00-9.45 10-12-16
				N=28 (300mm)
10.0				

Logged by: A.S
G/W observations: No ground water in observable amounts. Estimated to be at ~ 16-18 m b.g.l.
REMARKS: * Number of Blows/30cm penetration → , % of Natural Moisture Content →

GEOINVEST
ISO/IEC 17025:2005
geoinvest@cytanet.com.cy
http://www. geoinvest.com.cy

BOREHOLE LOG BH No1

Project: *MALL OF LIMASSOL*
Client: *J+A PHILIPPOU ARCH. – ENG. LLC*
Location: MESA GEITONIA/LIMASSOL
Coordinates:
Elevation: a.m.s.l.

Drilling method /Drilling Tool type/Diam
Open Hole: From 0.0 to 20.00m/125 mm
Destructive open hole technique
in combination with SPT
Total Depth: 20.00 m

Date started:25/01/2023
Date Com/ted:25/01/2023
Orientation: Vertical
Flushing system: air
Casing**:** Not used

Depth b.g.l m	Soil type	DESCRIPTION OF STRATA	SPT/M.C. GRAPHIC PRESENTATION 10* 20 30 40	SPT TEST
		Medium dense to dense, poorly cemented (cementation is weaker than above), pale brownish yellow, clayey SILT and SAND of calcareous composition.		10.50-10.95
				15-22-29
				N=51 (300mm)
11.0				
11.30				
		Lense of dense, sedimentary GRAVEL		
12.0				12.00-12.45
				15-23-30
				N=53 (300mm)
13.0				
				13.50-13.95
				12-14-15
				N=29 (300mm)
14.0				
		Medium dense to dense, pale brown to pinkish and yellowish brown, poorly cemented mixture of CLAY, SILT and SAND in variable proportions.		
15.0		Intercalations of thin/very thin layers rich in clay and silt with layers rich in silt and sand. Occasionally some dispersed sedimentary gravel		15.00-15.45
				11-13-14
				N=27 (300mm)
16.0				
				16.50-16.95
				12-16-21
17.0				N=37 (300mm)
18.0				18.00-18.45
				14-20-27
				N=47 (300mm)
19.0				
20.0				
		END OF BH AT 20.00 m bgl		

Logged by: A.S
G/W observations: No ground water in observable amounts. Estimated to be at ~ 16-18 m b.g.l.
REMARKS: * Number of Blows/30cm penetration → , % of Natural Moisture Content →

GEOINVEST
ISO/IEC 17025:2005
geoinvest@cytanet.com.cy
http://www. geoinvest.com.cy

BH1 (0.00 – 20.00m)

BOREHOLE LOG BH No2

Project: *MALL OF LIMASSOL*
Client:*J+A PHILIPPOU ARCH. – ENG. LLC*
Location: MESA GEITONIA/LIMASSOL
Coordinates:
Elevation: a.m.s.l.

Drilling method /Drilling Tool type/Diam
Open Hole: From 0.0 to 20.00m/125 mm
Destructive open hole technique
in combination with SPT
Total Depth: 20.00 m

Date started: 25/01/2023
Date Com/ted:25/01/2023
Orientation: Vertical
Flushing system: air
Casing**:** Not used

Depth b.g.l m	Soil type	DESCRIPTION OF STRATA	SPT/M.C. GRAPHIC PRESENTATION 10* 20 30 40	SPT TEST
		Cultivated, sandy, clayey, silty TOPSOIL with high stoniness Red TOPSOIL.		
0.50				
1.0		Dense, off-white to beige, weakly cemented, calcareous, clayey SAND and SILT with some gravel. It is impregnated with white secondary CaCO3 (Havarized)		1.50-1.95 24-29-34 N=63 (300mm)
2.0				
3.0				3.00-3.45 22-25-28 N=53 (300mm)
3.50		As above, gradual weakening of CaCO3 impregnations. The color turns gradually to beige and pale brownish yellow.		
4.0		As above, pale yellow		
4.20		.		
5.0				4.50-4.90 10-13-14 N=27 (300mm)
6.0		Medium dense to dense, poorly cemented (cementation is weaker than above), poorly stratified due to slight color changes (pale brownish yellow, brown, reddish brown) clayey to very clayey SILT and SAND of calcareous composition. Occasionally some dispersed Gravel.		6.00-6.45 11-14-17 N=31 (300mm)
7.0				
8.0				7.50-7.95 12-15-21 N=36 (300mm)
9.0		As above, of mostly yellowish brown color		9.00-9.45 10-11-16 N=27 (300mm)
10.0				

Logged by: A.S
G/W observations: No ground water in observable amounts. Estimated to be at ~ 16-18 m b.g.l.
REMARKS: * Number of Blows/30cm penetration → , % of Natural Moisture Content →

GEOINVEST
ISO/IEC 17025:2005
geoinvest@cytanet.com.cy
http://www. geoinvest.com.cy

BOREHOLE LOG BH No2

Project: *MALL OF LIMASSOL*
Client: *J+A PHILIPPOU ARCH. – ENG. LLC*
Location: MESA GEITONIA/LIMASSOL
Coordinates:
Elevation: a.m.s.l.

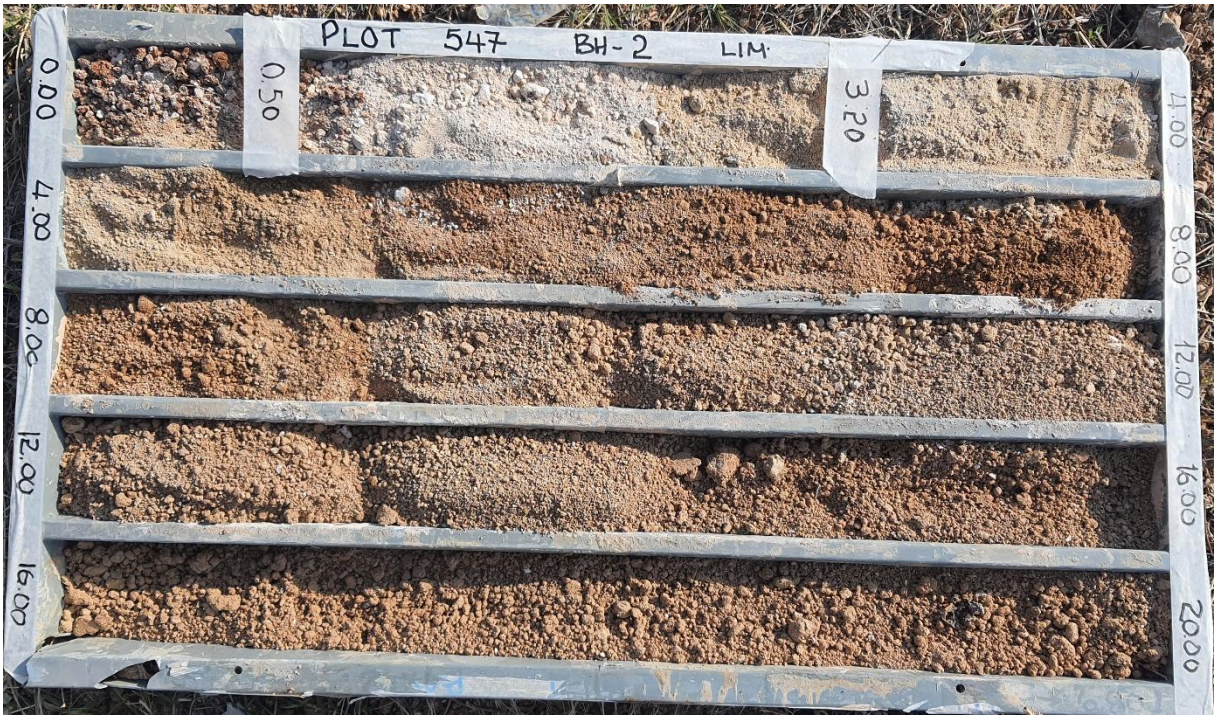
Drilling method /Drilling Tool type/Diam
Open Hole: From 0.0 to 20.00m/125 mm
Destructive open hole technique
in combination with SPT
Total Depth: 20.00 m

Date started:25/01/2023
Date Com/ted:25/01/2023
Orientation: Vertical
Flushing system: air
Casing**:** Not used

Depth b.g.l m	Soil type	DESCRIPTION OF STRATA	SPT/M.C. GRAPHIC PRESENTATION 10* 20 30 40	SPT TEST
		As above, of mostly yellowish brown color.		10.50-10.95
				11-14-19
				N=33 (300mm)
11.0				
		As above with lots of sedimentary gravel		
12.0				12.00-12.45
				12-20-23
				N=43 (300mm)
13.0				
				13.50-13.95
		Medium dense to dense, pale brown to pinkish and yellowish brown, poorly cemented mixture of CLAY, SILT and SAND in variable proportions.		12-13-15
				N=28 (300mm)
14.0				
		Intercalations of thin/very thin layers rich in clay and silt with layers rich in silt and sand. Occasionally some dispersed sedimentary gravel		
15.0				15.00-15.45
				14-15-18
				N=33 (300mm)
16.0				
				16.50-16.95
				15-19-24
17.0				N=43 (300mm)
18.0				18.00-18.45
				16-22-28
				N=50 (300mm)
19.0				
				19.50-19.95
				16-21-32
20.0				N=53 (300mm)
		END OF BH AT 20.00 m bgl		

Logged by: A.S
G/W observations: No ground water in observable amounts. Estimated to be at ~ 16-18 m b.g.l.
REMARKS: * Number of Blows/30cm penetration → , % of Natural Moisture Content →

GEOINVEST
ISO/IEC 17025:2005
geoinvest@cytanet.com.cy
http://www. geoinvest.com.cy



BH2 (0.00 – 20.00m)

BOREHOLE LOG BH No3

Project: *MALL OF LIMASSOL*
Client:*J+A PHILIPPOU ARCH. – ENG. LLC*
Location: MESA GEITONIA/LIMASSOL
Coordinates:
Elevation: a.m.s.l.

Drilling method /Drilling Tool type/Diam
Open Hole: From 0.0 to 20.00m/125 mm
Destructive open hole technique
in combination with SPT
Total Depth: 20.00 m

Date started: 26/01/2023
Date Com/ted:26/01/2023
Orientation: Vertical
Flushing system: air
***Casing*:** Not used

Depth b.g.l m	Soil type	DESCRIPTION OF STRATA	SPT/M.C. GRAPHIC PRESENTATION 10* 20 30 40	SPT TEST
0.50		Cultivated, sandy, clayey, silty TOPSOIL with high stoniness ,		
2.10		Dense, off-white to beige, weakly cemented, calcareous, clayey SAND and SILT with some gravel. It is impregnated with white secondary CaCO3 (Havarized).		1.50-1.95 28-48 >60 N=48 (150mm)
5.40		As above, gradual weakening of CaCO3 impregnations. The color turns gradually to beige and pale brownish yellow.		3.00-3.45 22-26-30 N=50 (300mm) 4.50-4.90 20-22-23 N=45 (300mm)
7.30		Medium dense, reddish brown, sandy, clayey SILT		6.00-6.45 12-14-15 N=29 (300mm)
10.0		Dense, sandy GRAVEL of sedimentary origin and no cementation		7.50-7.80 32-42 8.0 >60 N=42 (150mm) 9.00-9.30 24-31 >60 N=31 (150mm)

Logged by: A.S
G/W observations: No ground water in observable amounts. Estimated to be at ~ 16-18 m b.g.l.
REMARKS: * Number of Blows/30cm penetration → , % of Natural Moisture Content →

GEOINVEST
ISO/IEC 17025:2005
geoinvest@cytanet.com.cy
http://www. geoinvest.com.cy

BOREHOLE LOG BH No3

Project: *MALL OF LIMASSOL*
Client: *J+A PHILIPPOU ARCH. – ENG. LLC*
Location: MESA GEITONIA/LIMASSOL
Coordinates:
Elevation: a.m.s.l.

Drilling method /Drilling Tool type/Diam
Open Hole: From 0.0 to 20.00m/125 mm
Destructive open hole technique
in combination with SPT
Total Depth: 20.00 m

Date started:26/01/2023
Date Com/ted:26/01/2023
Orientation: Vertical
Flushing system: air
Casing**:** Not used

Depth b.g.l m	Soil type	DESCRIPTION OF STRATA	SPT/M.C. GRAPHIC PRESENTATION 10* 20 30 40	SPT TEST
		Dense, sandy GRAVEL of sedimentary origin and no cementation		10.50-10.95
				17-26-33
				N=59 (300mm)
11.0				
11.30				
		Medium dense to dense intercalaations of pale yellowish brown silty SAND and fine to medium sedimentary GRAVEL		
12.0				12.00-12.45
				11-14-28
				N=42 (300mm)
13.0				
				13.50-13.95
				22-10-17
				N=27 (300mm)
14.0				
15.0				15.00-15.30
				41-33
			>60	N=33 (150mm)
16.0				
		Intercalations of dense thin/very thin layers rich in CLAY and SILT with layers rich in silt and sand and GRAVEL.		
				16.50-16.95
				14-26-31
17.0				N=57 (300mm)
17.30				
		Intercalations of dense thin/very thin layers rich in clay and silt with layers rich in silt and sand. Occasionally some dispersed sedimentary gravel		
18.0				18.00-18.45
				15-20-25
				N=45 (300mm)
19.0				
20.0				
		END OF BH AT 20.00 m bgl		

Logged by: A.S
G/W observations: No ground water in observable amounts. Estimated to be at ~ 16-18 m b.g.l.
REMARKS: * Number of Blows/30cm penetration → , % of Natural Moisture Content →

GEOINVEST
ISO/IEC 17025:2005
geoinvest@cytanet.com.cy
http://www. geoinvest.com.cy

BH3 (0.00 – 20.00m)

BOREHOLE LOG BH No4

Project: *MALL OF LIMASSOL*
Client:*J+A PHILIPPOU ARCH. – ENG. LLC*
Location: MESA GEITONIA/LIMASSOL
Coordinates:
Elevation: a.m.s.l.

Drilling method /Drilling Tool type/Diam
Open Hole: From 0.0 to 17.00m/125 mm
Destructive open hole technique
in combination with SPT
Total Depth: 17.00 m

Date started: 26/01/2023
Date Com/ted:26/01/2023
Orientation: Vertical
Flushing system: air
Casing**:** Not used

Depth b.g.l m	Soil type	DESCRIPTION OF STRATA	SPT/M.C. GRAPHIC PRESENTATION 10* 20 30 40	SPT TEST
0.40		Cultivated, sandy, clayey, silty TOPSOIL with high stoniness.		
1.0		Dense, off-white to beige, weakly cemented, calcareous, clayey SAND and SILT with some gravel. It is impregnated with white secondary CaCO3 (Havarized)		1.50-1.95 15-22-32 N=54 (300mm)
2.0				
2.70				
3.0		As above, gradual weakening of CaCO3 impregnations. The color turns gradually to beige and pale brownish yellow		3.00-3.45 18-23-24 N=47 (300mm)
4.0				
4.50				4.50-4.90
5.0		Medium dense to dense, brown to reddish brown, clayey SAND and SILT of very poor cementation		14-22-23 N=45 (300mm)
6.0				6.00-6.45
6.20				10-11-16 N=27 (300mm)
7.0		As above, in places thin lenses of off-white color, impregnated with secondary CaCO3.		
8.0				7.50-7.95 14-24-26 N=50 (300mm)
8.50				
9.0		As above, of slightly lighter color		9.00-9.45 12-17-21 N=38 (300mm)
10.0				

Logged by: A.S
G/W observations: No ground water in observable amounts. Estimated to be at ~ 16-18 m b.g.l.
REMARKS: * Number of Blows/30cm penetration → , % of Natural Moisture Content →

GEOINVEST
ISO/IEC 17025:2005
geoinvest@cytanet.com.cy
http://www. geoinvest.com.cy

BOREHOLE LOG BH No4 Sheet No: 2 of 2

Project: *MALL OF LIMASSOL*
Client: *J+A PHILIPPOU ARCH. – ENG. LLC*
Location: MESA GEITONIA/LIMASSOL
Coordinates:
Elevation: a.m.s.l.

Drilling method /Drilling Tool type/Diam
Open Hole: From 0.0 to 17.00m/125 mm
Destructive open hole technique
in combination with SPT
Total Depth: 17.00 m

Date started:26/01/2023
Date Com/ted:26/01/2023
Orientation: Vertical
Flushing system: air
Casing**:** Not used

Depth b.g.l m	Soil type	DESCRIPTION OF STRATA	SPT/M.C. GRAPHIC PRESENTATION 10* 20 30 40	SPT TEST
		Off-white beige, silty, clayey SAND Medium dense to dense, brown to reddish brown, clayey SAND and SILT of very poor cementation In places thin lenses of off-white color, impregnated with secondary $CaCO_3$ and of better cementation		10.50-10.95
				13-20-28
				N=48 (300mm)
11.0				
12.0				12.00-12.45
		As above reddish brown		11-13-17
				N=30 (300mm)
12.50				
		Medium dense to dense, pale brown, poorly cemented mixture of CLAY, SILT and SAND in variable proportions.		
13.0				
				13.50-13.95
				12-15-19
				N=34 (300mm)
14.0				
15.0				15.00-15.45
		As above, increase of clay and silt content		13-16-21
				N=37 (300mm)
16.0				
				16.50-16.95
				14-18-22
17.0				N=40 (300mm)
		END OF BH AT 17.00 m bgl		
18.0				
19.0				
20.0				

Logged by: A.S
G/W observations: No ground water in observable amounts. Estimated to be at ~ 16-18 m b.g.l.
REMARKS: * Number of Blows/30cm penetration → , % of Natural Moisture Content →

GEOINVEST
ISO/IEC 17025:2005
geoinvest@cytanet.com.cy
http://www. geoinvest.com.cy

BH4 (0.00 – 17.00m)

BOREHOLE LOG BH No5 Sheet No: 1 of 2

Project: *MALL OF LIMASSOL*
Client:*J+A PHILIPPOU ARCH. – ENG. LLC*
Location: MESA GEITONIA/LIMASSOL
Coordinates:
Elevation: a.m.s.l.

Drilling method /Drilling Tool type/Diam
Open Hole: From 0.0 to 20.00m/125 mm
Destructive open hole technique
in combination with SPT
Total Depth: 20.00 m

Date started: 27/01/2023
Date Com/ted:27/01/2023
Orientation: Vertical
Flushing system: air
Casing**:** Not used

Depth b.g.l m	Soil type	DESCRIPTION OF STRATA	SPT/M.C. GRAPHIC PRESENTATION 10* 20 30 40	SPT TEST
		Cultivated, sandy, clayey, silty TOPSOIL with high stoniness		
0.50		.		
1.0		Dense, off-white to beige, weakly cemented, calcareous, clayey SAND and SILT with some gravel. It is impregnated with white secondary CaCO3 (Havarized)		1.50-1.80
				30-39
			>60	N=39 (150mm)
2.0				
2.30				
3.0		As above, gradual weakening of CaCO3 impregnations. The color turns gradually to beige and pale brownish yellow.		3.00-3.45
				24-28-33
				N=61 (300mm)
4.0				
		Medium dense to dense, pale brown to brown clayey to very clayey, SAND and SILT of calcareous composition.		4.50-4.90
				14-24-32
5.0				N=56 (300mm)
6.0				6.00-6.45
		Medium dense, reddish brown, sandy, clayey SILT		11-13-15
				N=28 (300mm)
7.0				
7.50				
		Medium dense to dense, poorly cemented (cementation is weaker than above), poorly stratified due to slight color changes (pale brownish yellow, brown, reddish brown) clayey to very clayey SILT and SAND of calcareous composition. Occasionally some dispersed Gravel.		7.50-7.95
				12-12-16
8.0				N=28 (300mm)
8.50				
9.0				9.00-9.45
				13-15-18
				N=33 (300mm)
10.0				

Logged by: A.S
G/W observations: No ground water in observable amounts. Estimated to be at ~ 16-18 m b.g.l.
REMARKS: * Number of Blows/30cm penetration → , % of Natural Moisture Content →

GEOINVEST
ISO/IEC 17025:2005
geoinvest@cytanet.com.cy
http://www. geoinvest.com.cy

BOREHOLE LOG BH No5

Project: *MALL OF LIMASSOL*
Client: *J+A PHILIPPOU ARCH. – ENG. LLC*
Location: MESA GEITONIA/LIMASSOL
Coordinates:
Elevation: a.m.s.l.

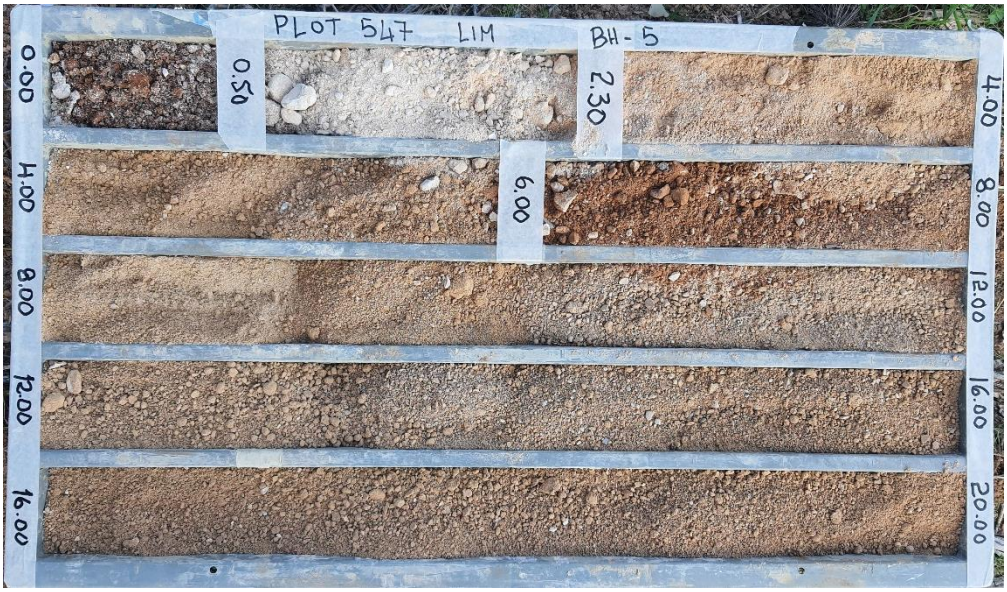
Drilling method /Drilling Tool type/Diam
Open Hole: From 0.0 to 20.00m/125 mm
Destructive open hole technique
in combination with SPT
Total Depth: 20.00 m

Date started:27/01/2023
Date Com/ted:27/01/2023
Orientation: Vertical
Flushing system: air
Casing**:** Not used

Depth b.g.l m	Soil type	DESCRIPTION OF STRATA	SPT/M.C. GRAPHIC PRESENTATION 10* 20 30 40	SPT TEST
		Medium dense to dense, poorly cemented (cementation is weaker than above), poorly stratified due to slight color changes (pale brownish yellow, brown, reddish brown) clayey to very clayey SILT and SAND of calcareous composition. Occasionally some dispersed Gravel.		10.50-10.95
				14-17-22
				N=39 (300mm)
11.0				
12.0				12.00-12.45
				15-20-23
				N=43 (300mm)
13.0				
				13.50-13.95
		More gravel between 13 and 15 m.		12-13-15
				N=28 (300mm)
14.0				
15.0		Medium dense to dense, pale brown to pinkish and yellowish brown, poorly cemented mixture of CLAY, SILT and SAND in variable proportions.		15.00-15.45
				13-16-21
				N=37 (300mm)
16.0		Intercalations of thin/very thin layers rich in clay and silt with layers rich in silt and sand. Occasionally some dispersed sedimentary gravel .		
				16.50-16.95
				12-16-24
17.0				N=40 (300mm)
18.0				18.00-18.45
				13-18-28
				N=46 (300mm)
19.0				
20.0				
		END OF BH AT 20.00 m bgl		

Logged by: A.S
G/W observations: No ground water in observable amounts. Estimated to be at ~ 16-18 m b.g.l.
REMARKS: * Number of Blows/30cm penetration → , % of Natural Moisture Content →

GEOINVEST
ISO/IEC 17025:2005
geoinvest@cytanet.com.cy
http://www. geoinvest.com.cy



BH5 (0.00 – 20.00m)

APPENDIX 2

LABORATORY RESULTS

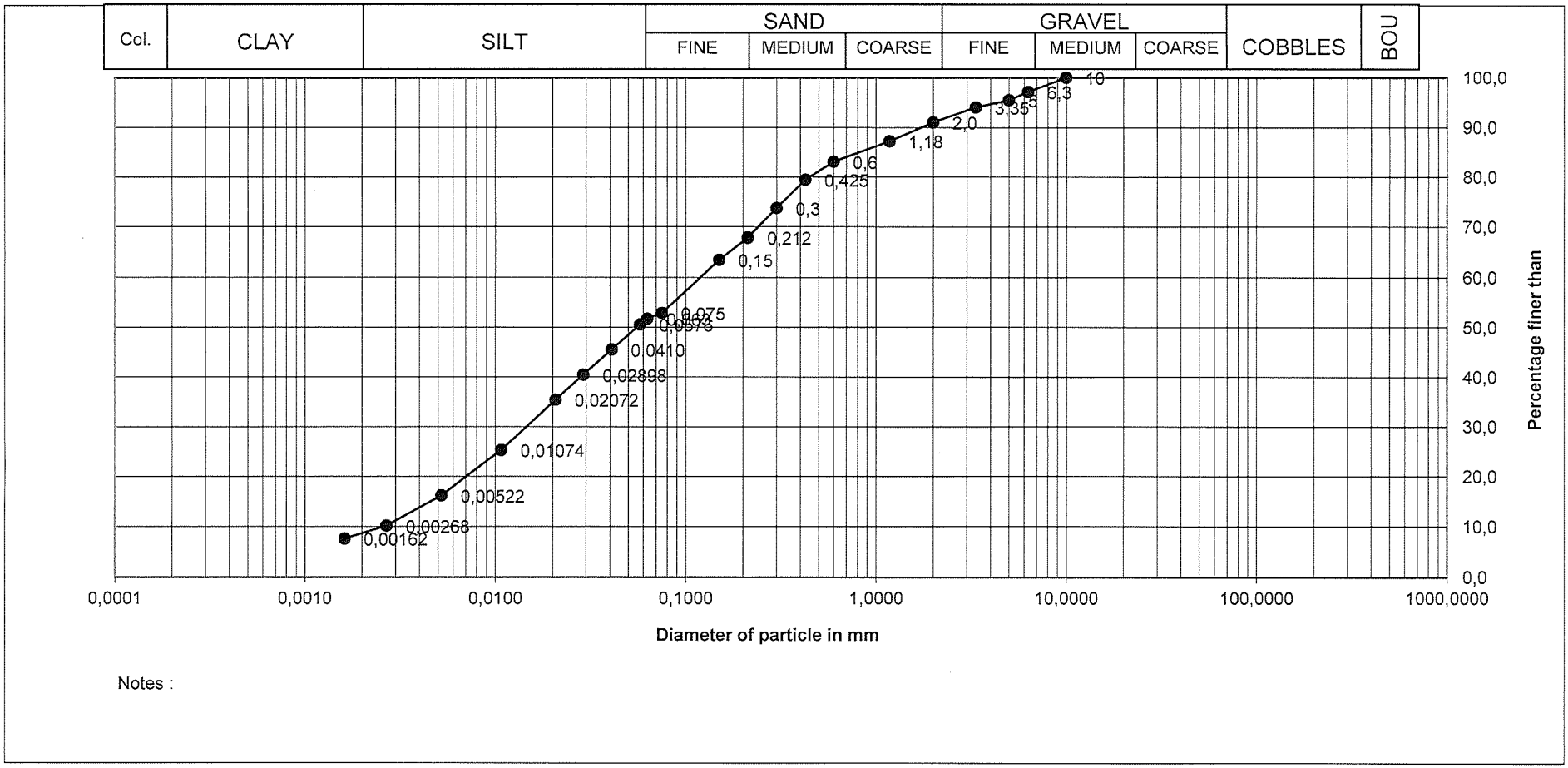
PARTICLE SIZE DISTRIBUTION

CEN ISO/TS 17892-4: 2004

Client: J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol
Site : Mesa Yitonia/Limassol

Operator : L.P.
Date of test completion : 01/02/2023
Description of material : Clayey, gravelly Sand and Silt

BH No. : 1
Depth : 6,00-6,50 m



Notes :

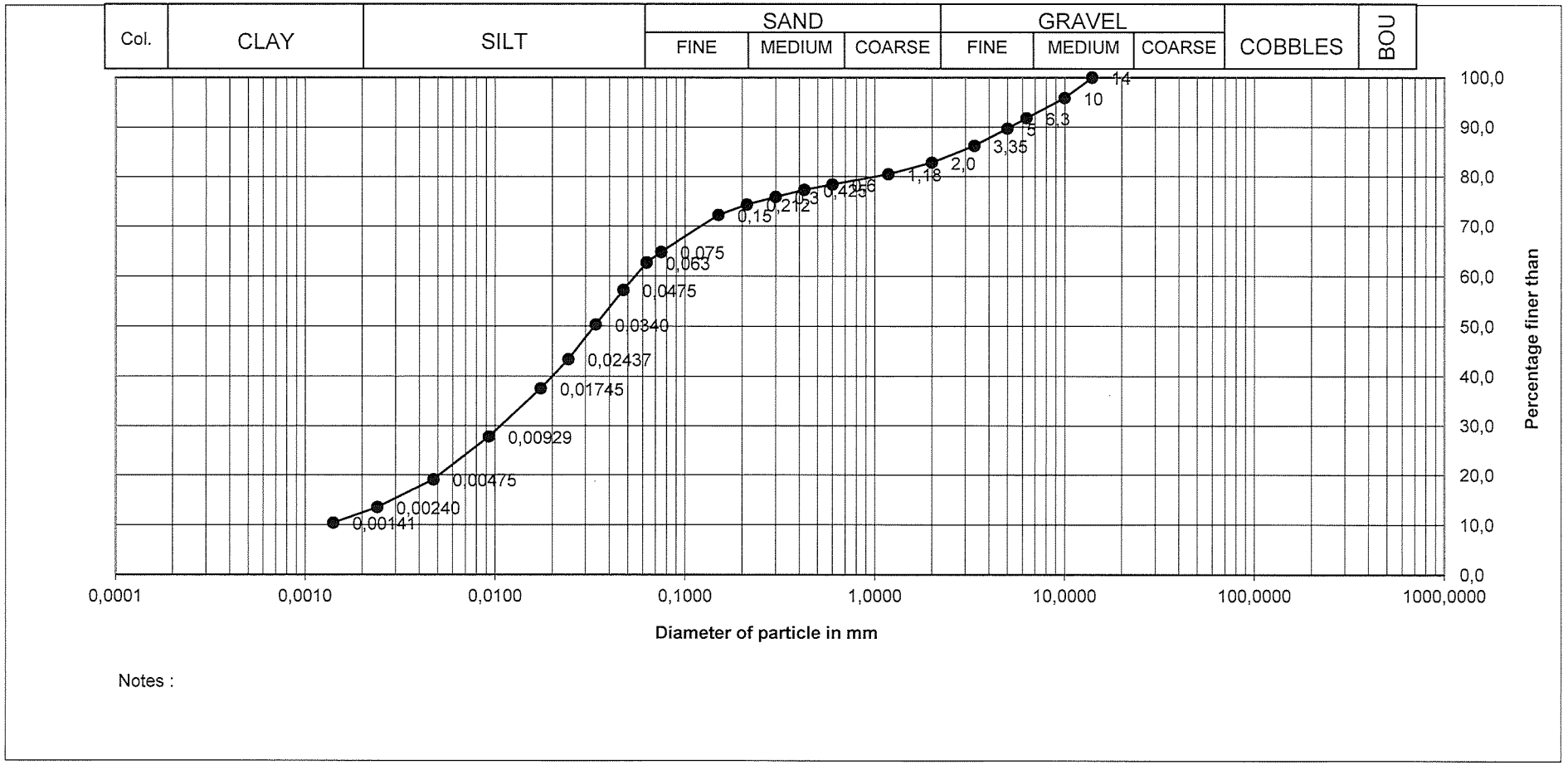
PARTICLE SIZE DISTRIBUTION

CEN ISO/TS 17892-4: 2004

Client: J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol
Site : Mesa Yitonia/Limassol

Operator : L.P.
Date of test completion : 01/02/2023
Description of material : Clayey, gravelly, sandy to very sandy Silt

BH No. : 1
Depth : 12,50-13,00 m



Notes :

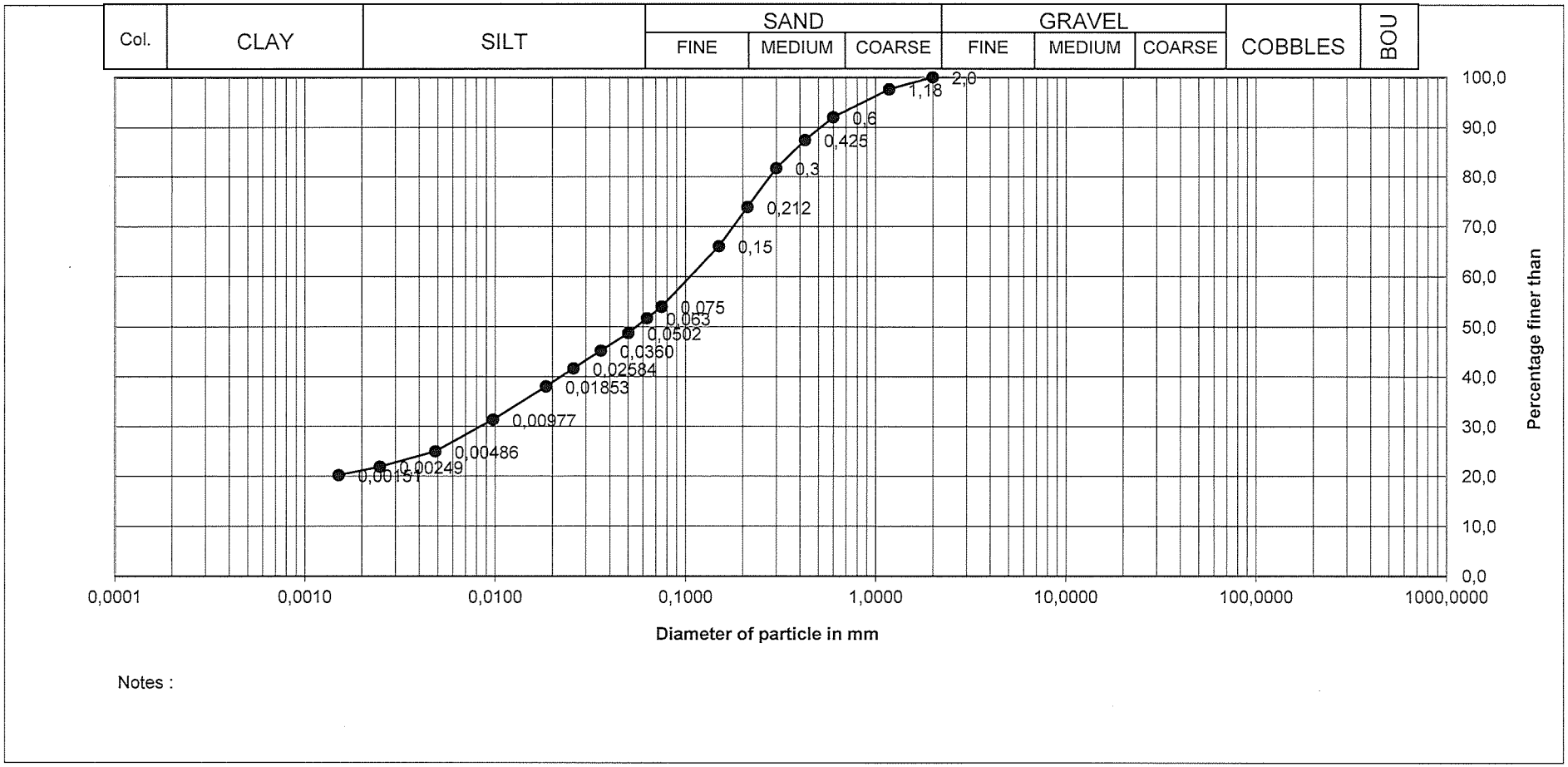
PARTICLE SIZE DISTRIBUTION

CEN ISO/TS 17892-4: 2004

Client: J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol
Site : Mesa Yitonia/Limassol

Operator : L.P.
Date of test completion : 01/02/2023
Description of material : Very clayey, very silty Sand

BH No. : 2
Depth : 4,50-5,00 m



Notes :

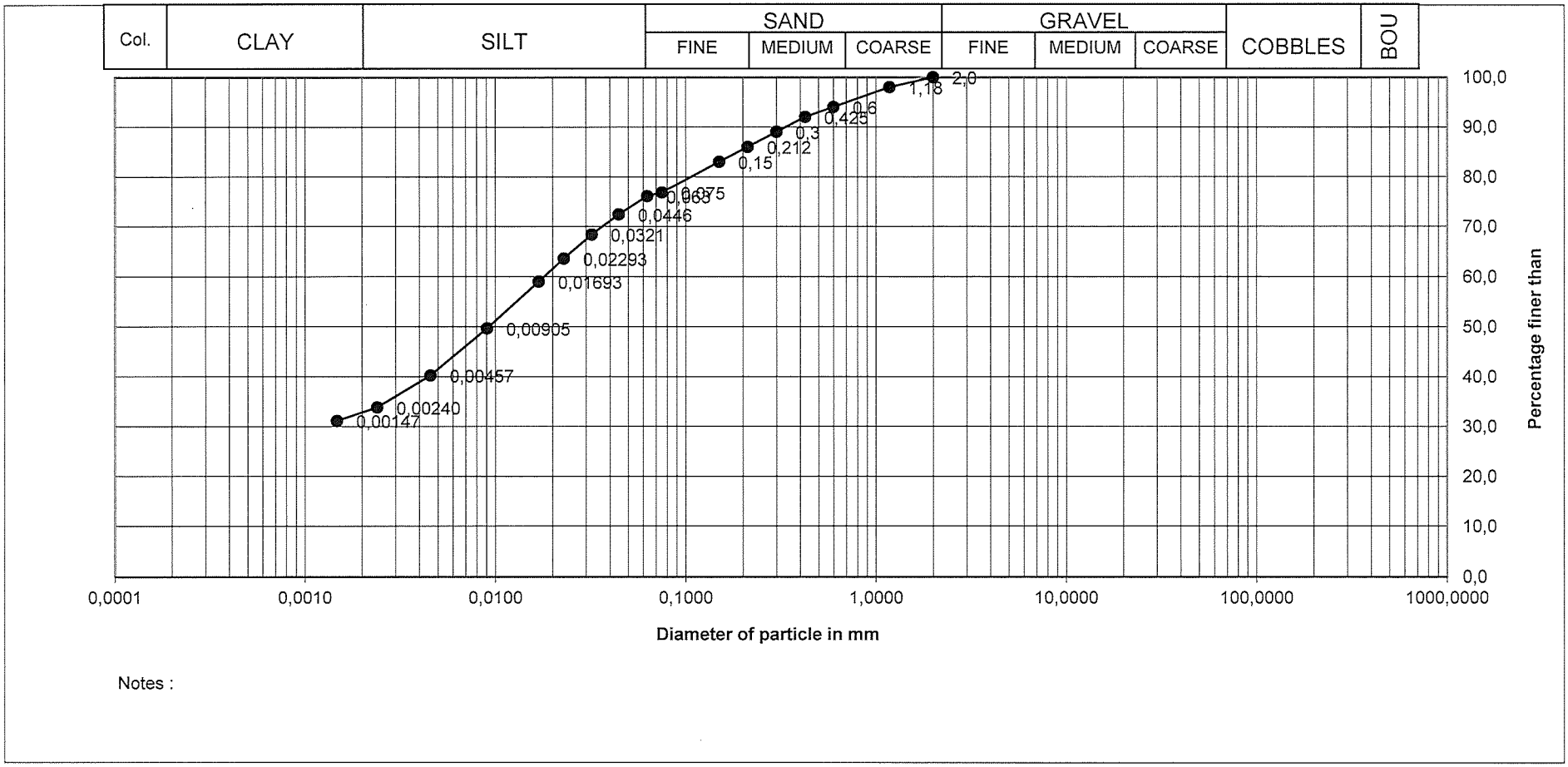
PARTICLE SIZE DISTRIBUTION

CEN ISO/TS 17892-4: 2004

Client: J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol
Site : Mesa Yitonia/Limassol

Operator : L.P.
Date of test completion : 01/02/2023
Description of material : Very sandy, very clayey Silt

BH No. : 2
Depth : 10,00-10,50m



Notes :

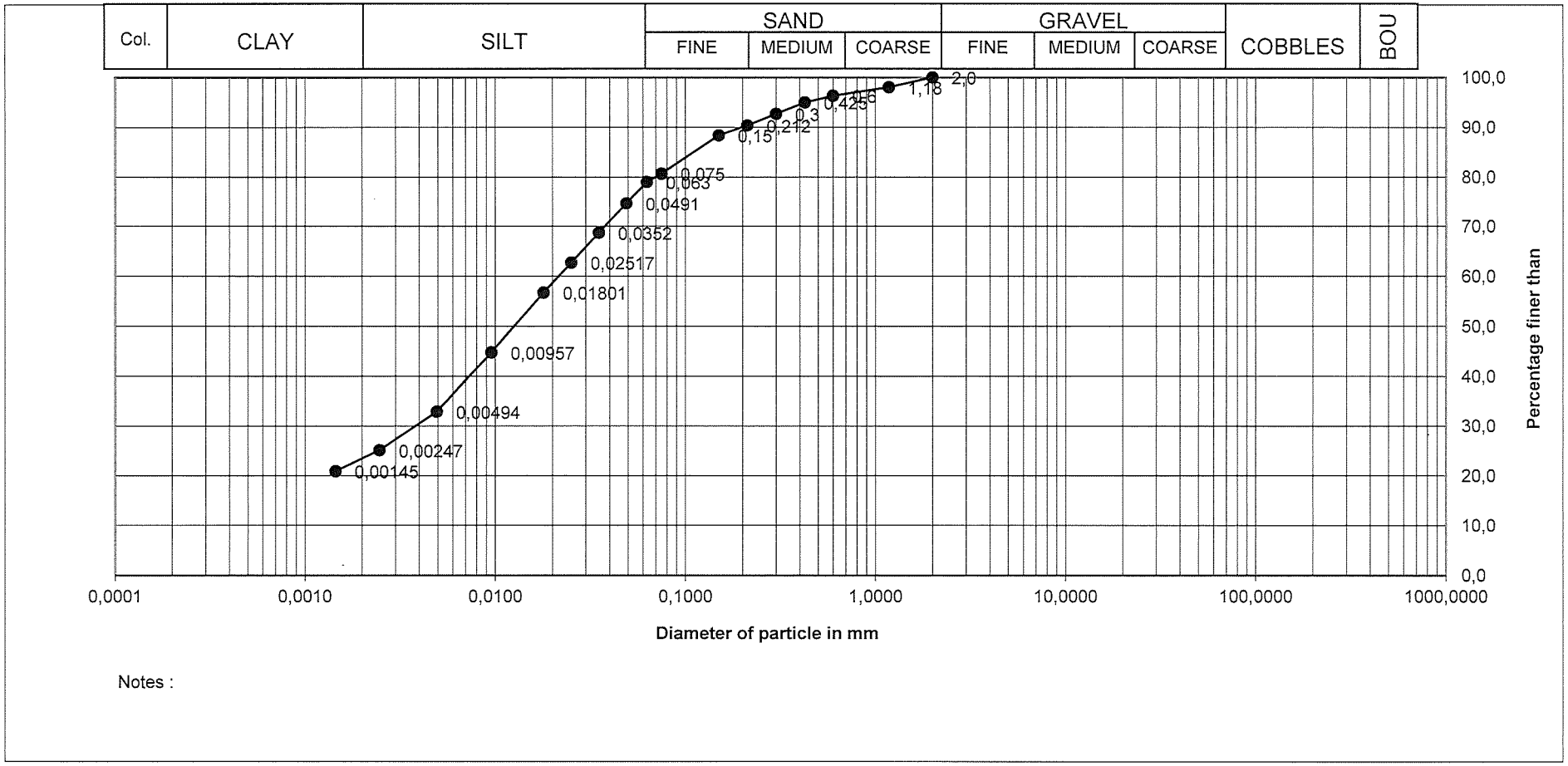
PARTICLE SIZE DISTRIBUTION

CEN ISO/TS 17892-4: 2004

Client: J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol
Site : Mesa Yitonia/Limassol

Operator : L.P.
Date of test completion : 01/02/2023
Description of material : Very sandy, very clayey Silt

BH No. : 3
Depth : 6,00-6,50 m



Notes :

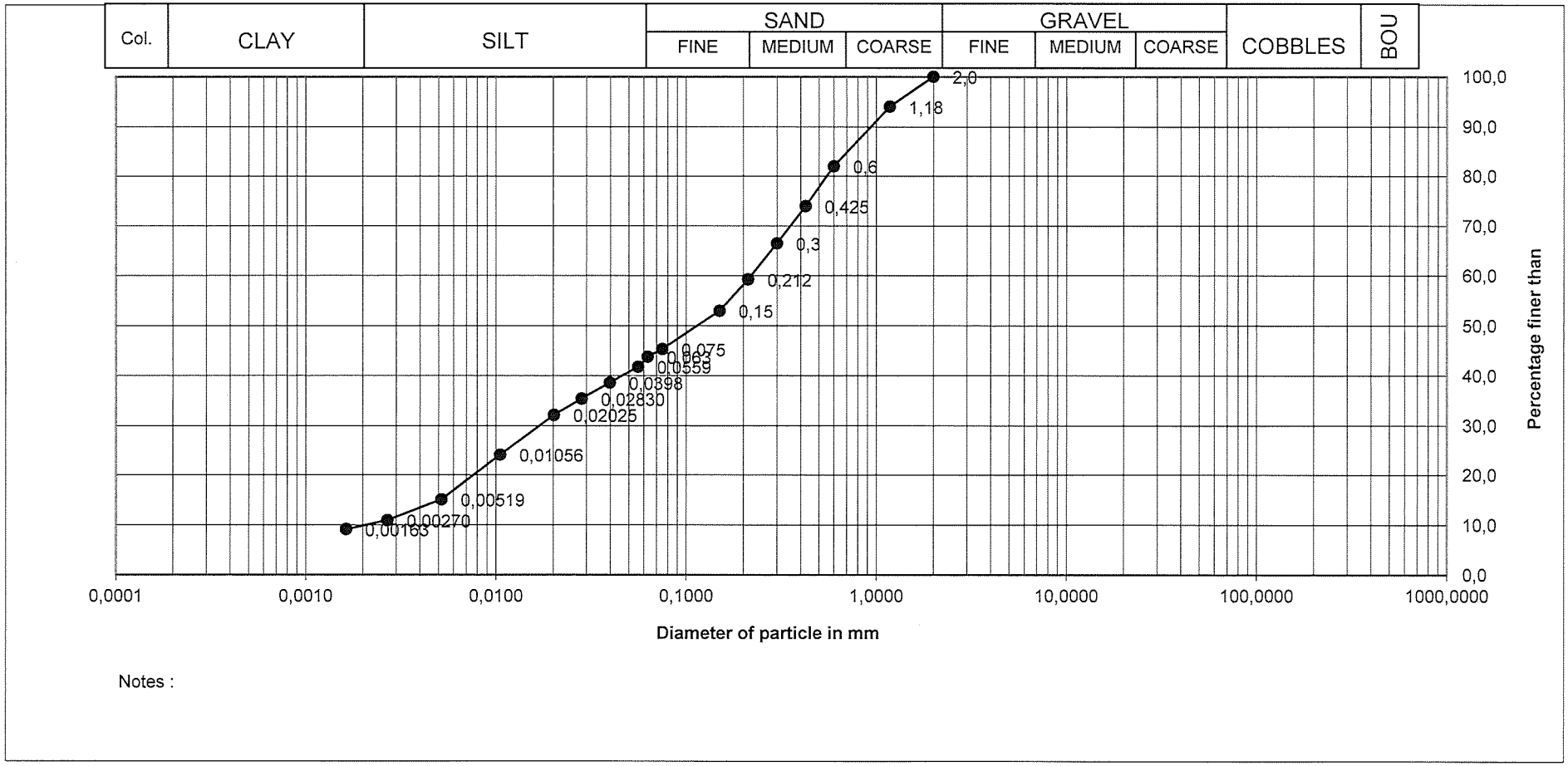
PARTICLE SIZE DISTRIBUTION

CEN ISO/TS 17892-4: 2004

Client: J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol
Site : Mesa Yitonia/Limassol

Operator : L.P.
Date of test completion : 01/02/2023
Description of material : Clayey, very silty Sand

BH No. : 4
Depth : 8,00-8,50 m



Notes :

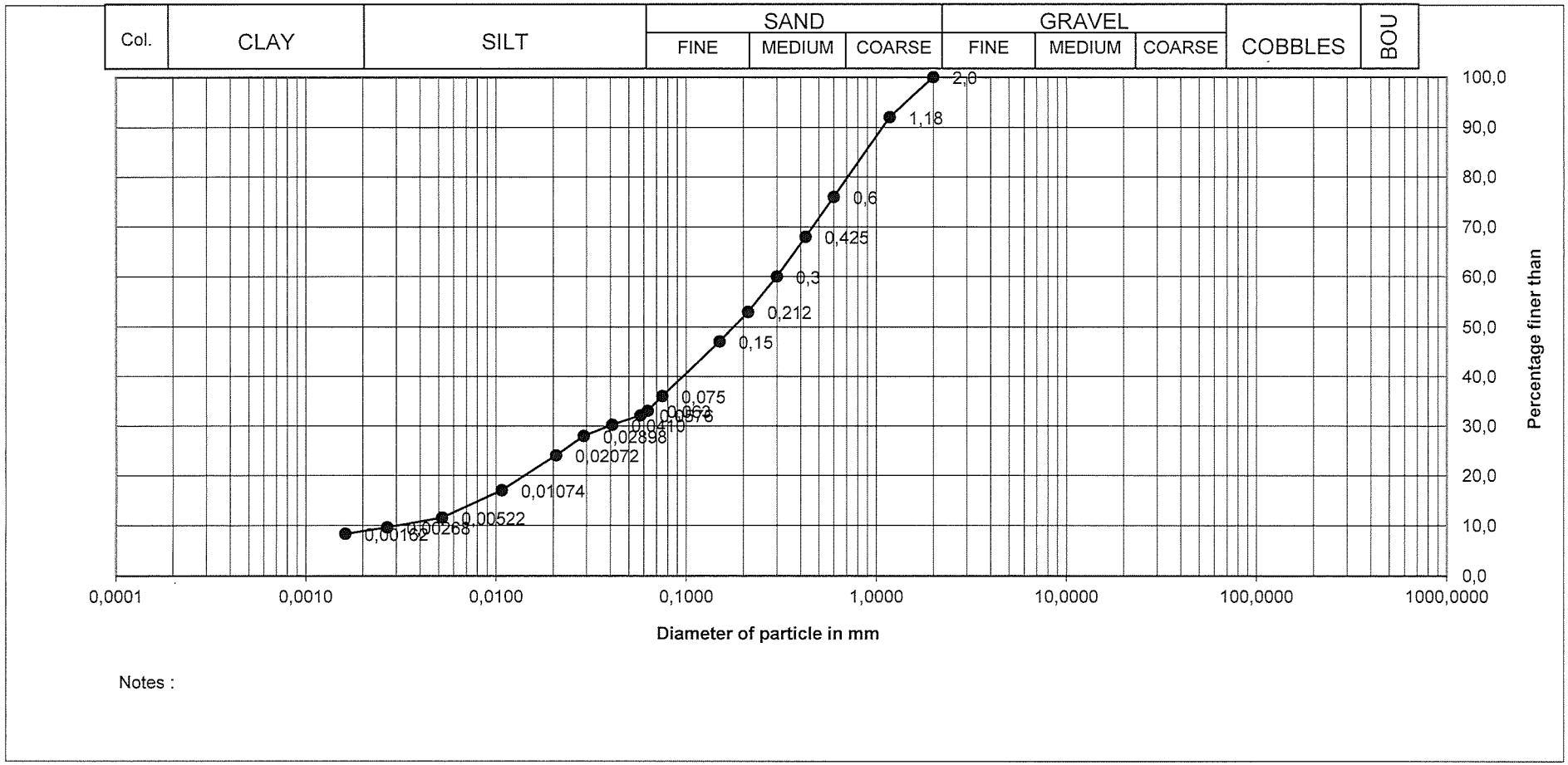
PARTICLE SIZE DISTRIBUTION

CEN ISO/TS 17892-4: 2004

Client: J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol
Site : Mesa Yitonia/Limassol

Operator : L.P.
Date of test completion : 01/02/2023
Description of material : Clayey, very silty Sand

BH No. : 4
Depth : 12,00-12,50 m



Notes :

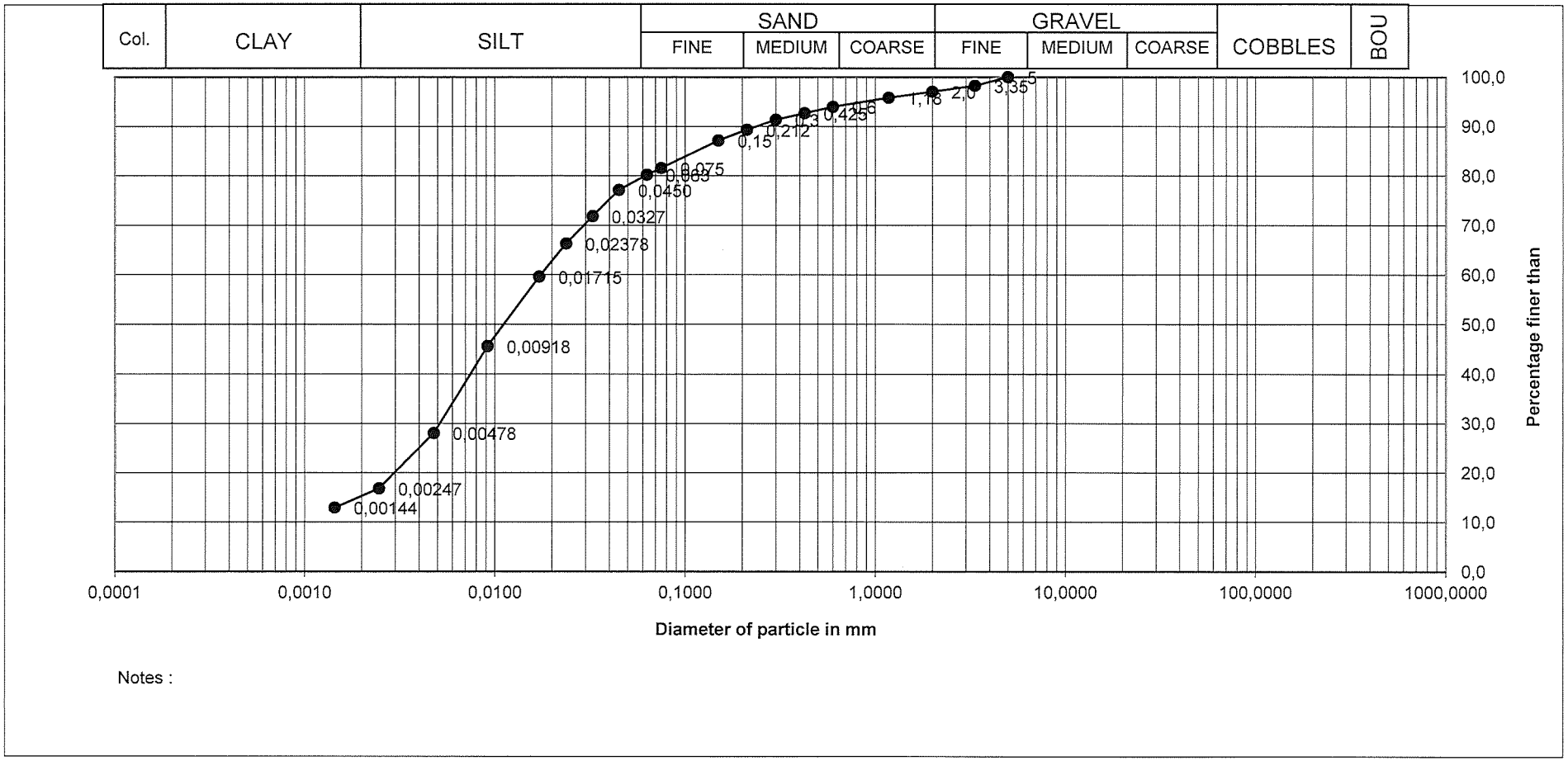
PARTICLE SIZE DISTRIBUTION

CEN ISO/TS 17892-4: 2004

Client: J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol
Site : Mesa Yitonia/Limassol

Operator : L.P.
Date of test completion : 01/02/2023
Description of material : Slightly gravelly, clayey, sandy Silt

BH No. : 5
Depth : 6,00-7,00m



Notes :

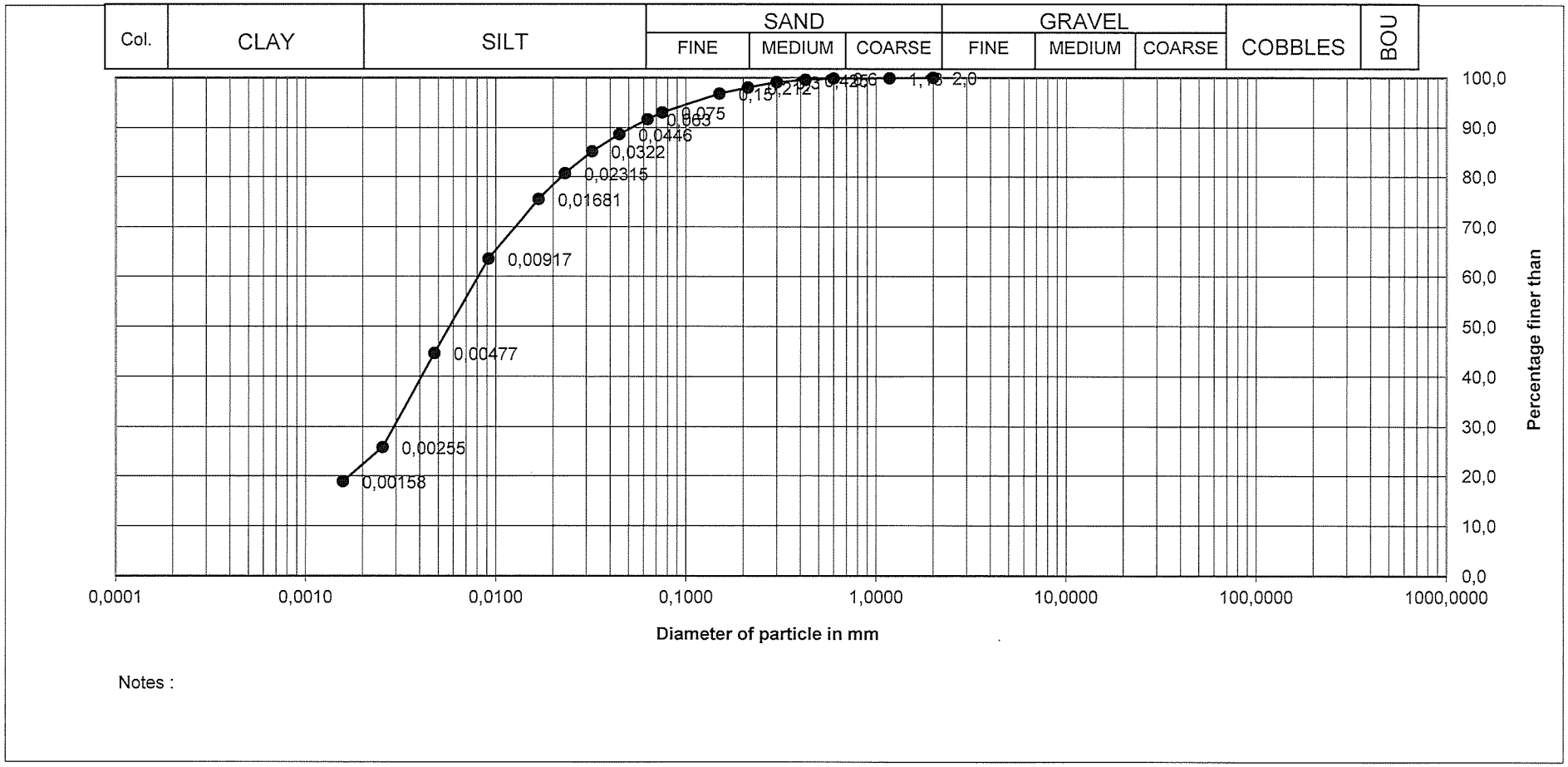
PARTICLE SIZE DISTRIBUTION

CEN ISO/TS 17892-4: 2004

Client: J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol
Site : Mesa Yitonia/Limassol

Operator : L.P.
Date of test completion : 01/02/2023
Description of material : Sandy, very clayey Silt

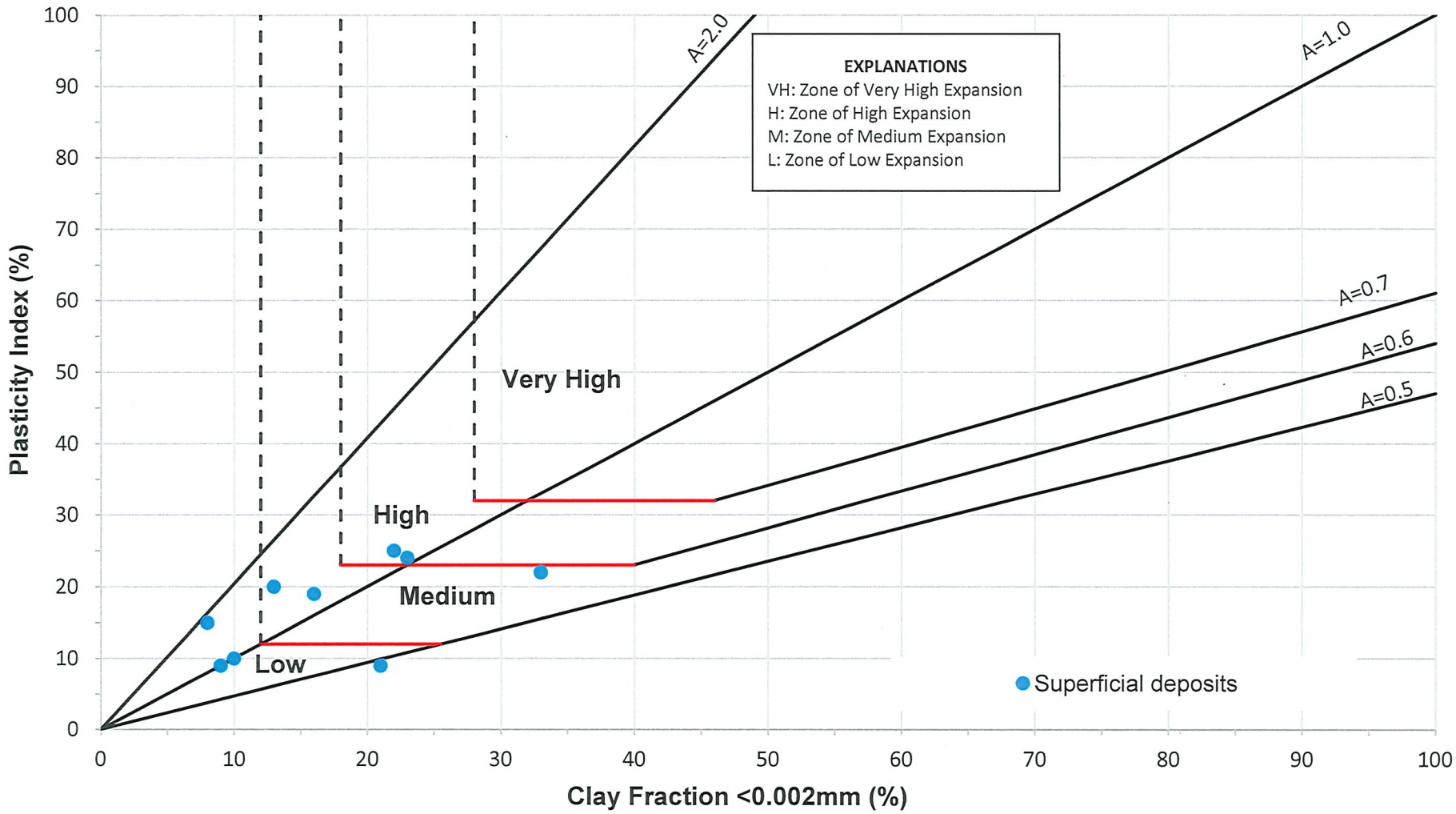
BH No. : 5
Depth : 7,50-8,00 m



Notes :

SOUTH AFRICAN EXPANSIVE CLAY CLASSIFICATION CHART

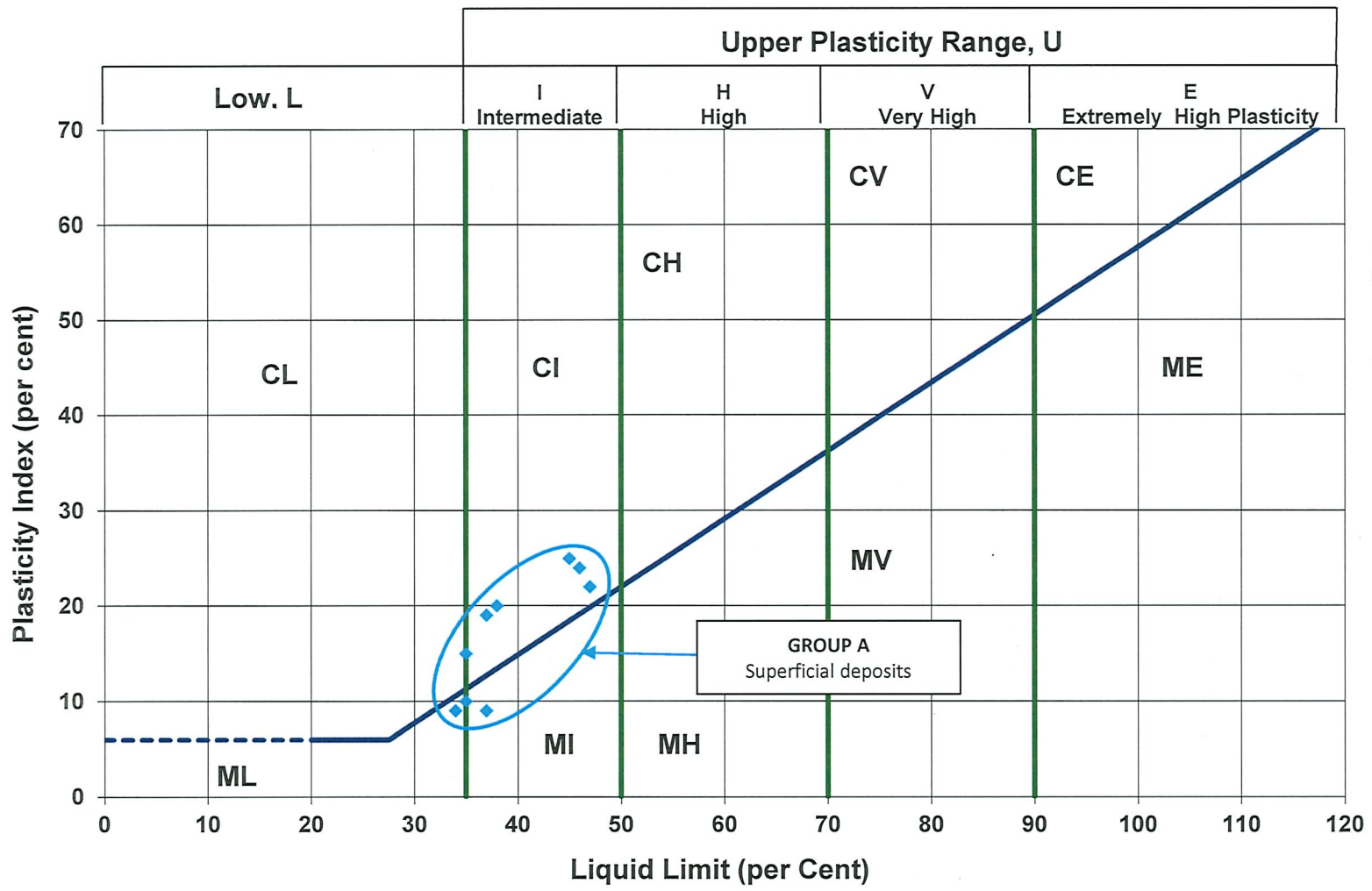
ΝΟΤΙΟΑΦΡΙΚΑΝΙΚΟ ΔΙΑΓΡΑΜΜΑ ΚΑΤΑΤΑΞΗΣ (ΔΥΝΗΤΙΚΟΤΗΤΑΣ) ΔΙΟΓΚΩΣΗΣ ΑΡΓΙΛΟΥ



Plasticity Chart for the Classification of Fine Soils and Finer Part of Coarse Soils

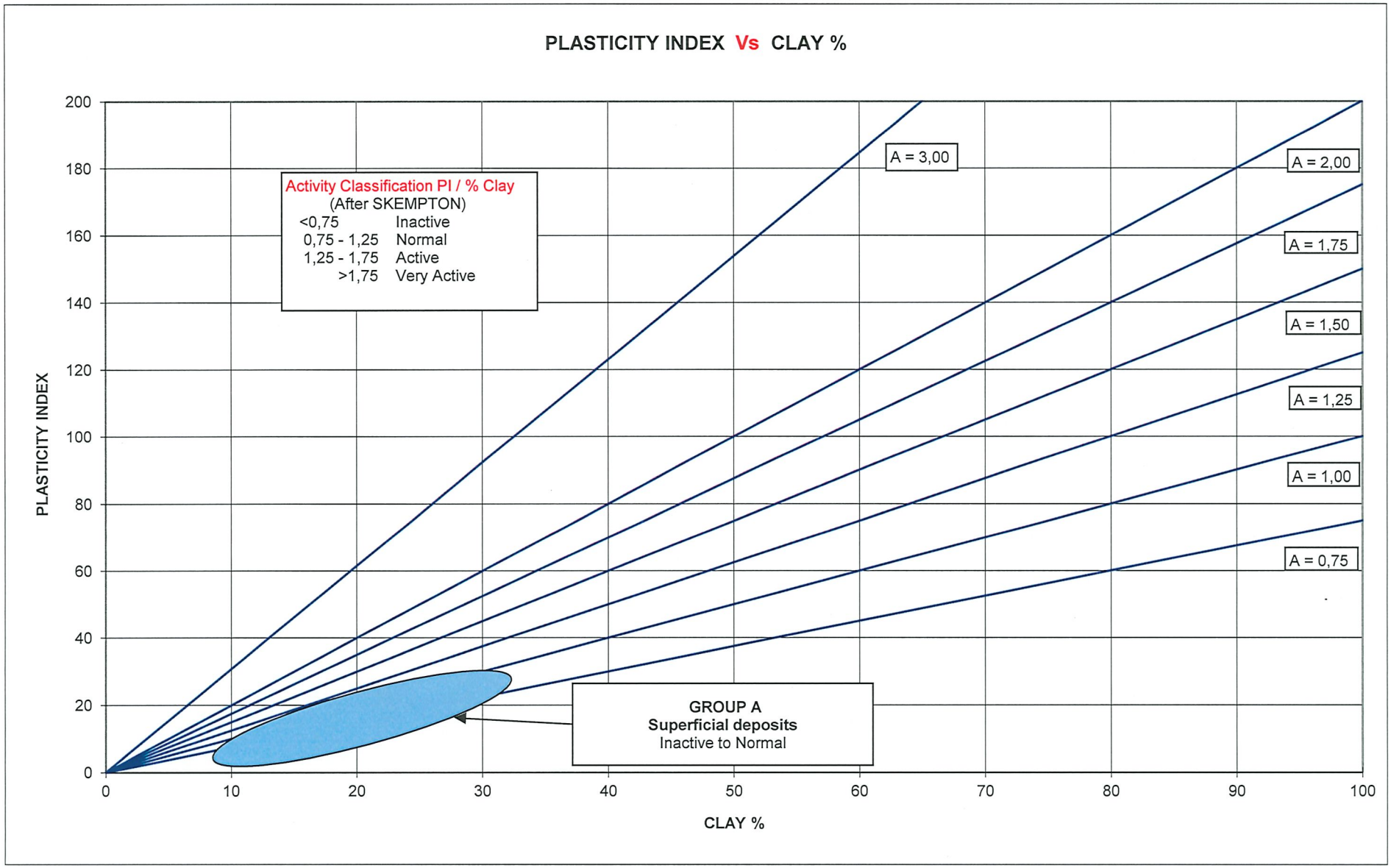
According to BS 5930:1999

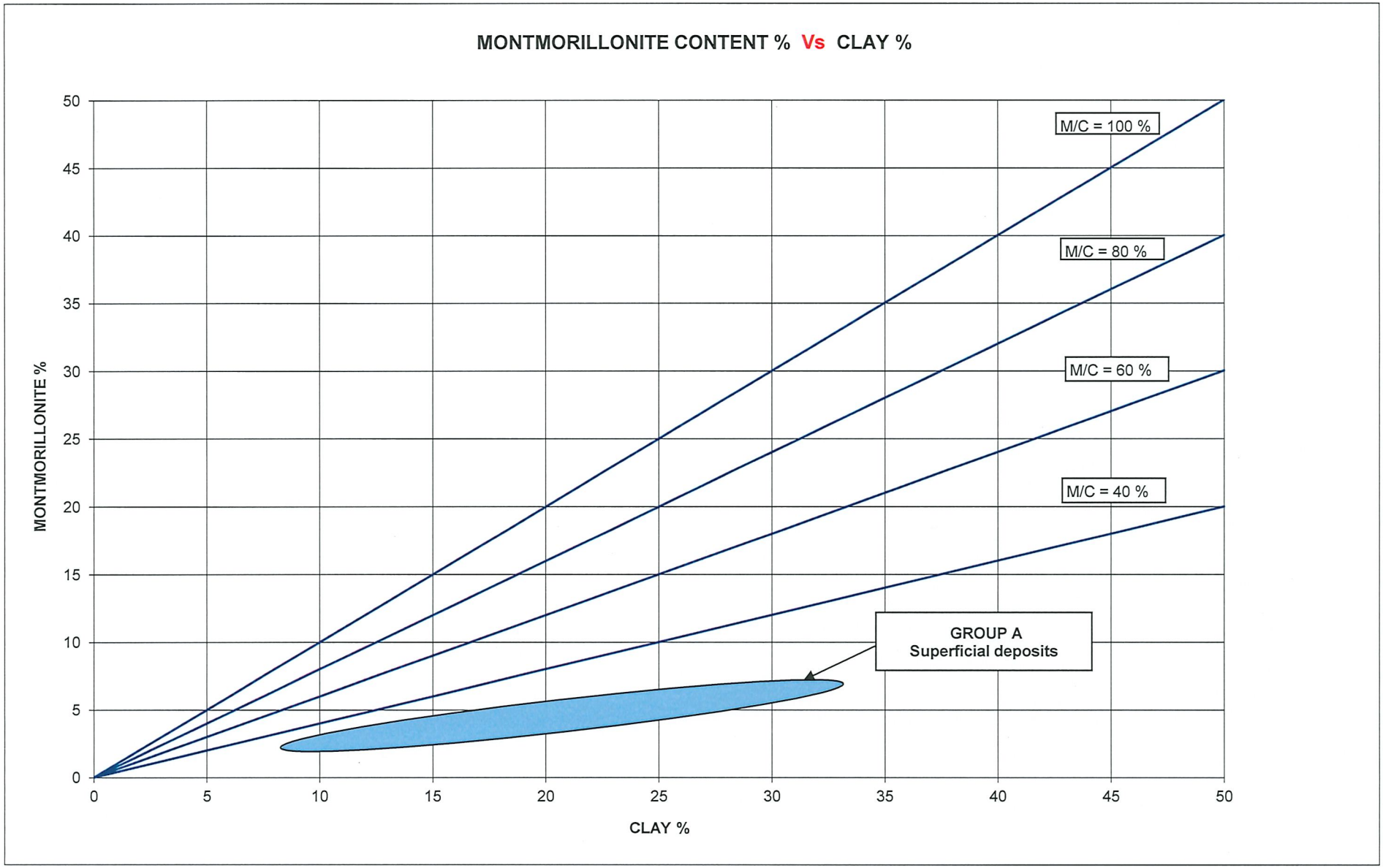
M Silt (M-Soil) - Below A-Line
C Clay - Above A-Line
} M and C may be combined as F, FINE SOIL



Note: The letter O is added to the symbol of any material containing a significant proportion of organic matter e.g. MHO

GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
Applied Geology - Materials Testing - Geotechnics - Environmental Engineering
Tel.: 22 33 00 93, Fax.: 22 33 01 18, P.O.BOX: 20476, 2152 Aglantzia


PLASTICITY INDEX Vs CLAY %
PLASTICITY INDEX
CLAY %
0
20
40
60
80
100
120
140
160
180
200
0
10
20
30
40
50
60
70
80
90
100
Activity Classification PI / % Clay
(After SKEMPTON)
<0,75 Inactive
0,75 - 1,25 Normal
1,25 - 1,75 Active
>1,75 Very Active
A = 3,00
A = 2,00
A = 1,75
A = 1,50
A = 1,25
A = 1,00
A = 0,75
GROUP A
Superficial deposits
Inactive to Normal


MONTMORILLONITE CONTENT % Vs CLAY %
MONTMORILLONITE %
CLAY %
0
5
10
15
20
25
30
35
40
45
50
M/C = 100 %
M/C = 80 %
M/C = 60 %
M/C = 40 %
GROUP A
Superficial deposits

DETERMINATION OF ATTERBERG LIMITS

CEN ISO/TS 17892-12: 2004

Fall Cone Method - 80g/30°

Client: J+A Philippou architects-engineers L.L.C

Project: MALL of Limassol

Site : Mesa Yitonia/Limassol

Sampler : GEOINVEST L.T.D.

Date of sampling :

Description of material : Clayey, gravelly Sand and Silt

Proportion of sample passing 425 μm BS test sieve, %

Soil equilibrated with water for 24 h.

Borehole No : 1

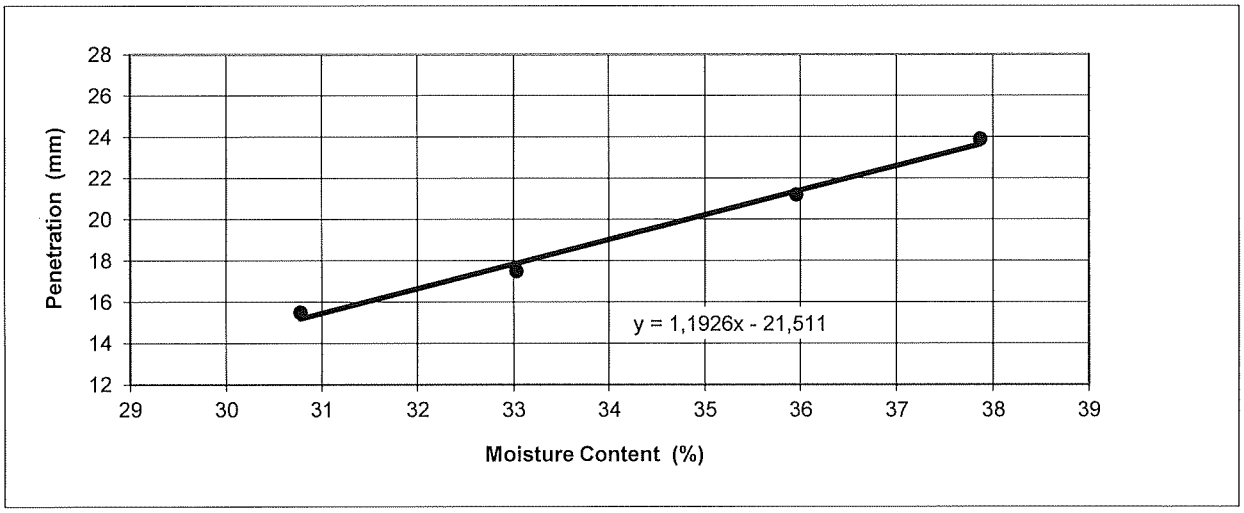
Depth : 6,00-6,50 m

Condition of sample : Natural State

Date of test completion : 31/01/2023

Operator : L.P.

Test No.	1	2	3	4	5	6
Mass of wet soil + container g	49,90	58,26	59,42	52,79	29,21	30,81
Mass of dried soil + container g	43,92	50,22	50,48	45,36	28,65	30,05
Mass of container g	24,49	25,88	25,62	25,74	25,81	26,35
Mass of moisture g	5,98	8,04	8,94	7,43	0,56	0,76
Mass of dry soil g	19,43	24,34	24,86	19,62	2,84	3,70
Moisture content (w) %	30,78	33,03	35,96	37,87	19,72	20,54
Cone Penetration mm	15,5	17,5	21,2	23,9		
P.L.					**20,1**	



L.L. = (y+b)/a		P.I. = L.L.-P.I.		CLASSIFICATION	MOISTURE CONTENT
y =	20	**L.L. =**	**35**	CL/CI	
a =	1,1926	**P.L. =**	**20**	Inorganic clay	
b =	21,511	**P.I. =**	**15**	of low to intermediate plasticity	
LINEAR SHRINKAGE %			10		

GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
Applied Geology Geotechnics-Environmental Engineering
TEL. : 22 - 330093, 330097, 330113 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

DETERMINATION OF ATTERBERG LIMITS

CEN ISO/TS 17892-12: 2004

Fall Cone Method - 80g/30°

Client: J+A Philippou architects-engineers L.L.C

Project: MALL of Limassol

Site : Mesa Yitonia/Limassol

Sampler : GEOINVEST L.T.D.

Date of sampling :

Borehole No : 1

Depth : 12,50-13,00 m

Condition of sample : Natural State

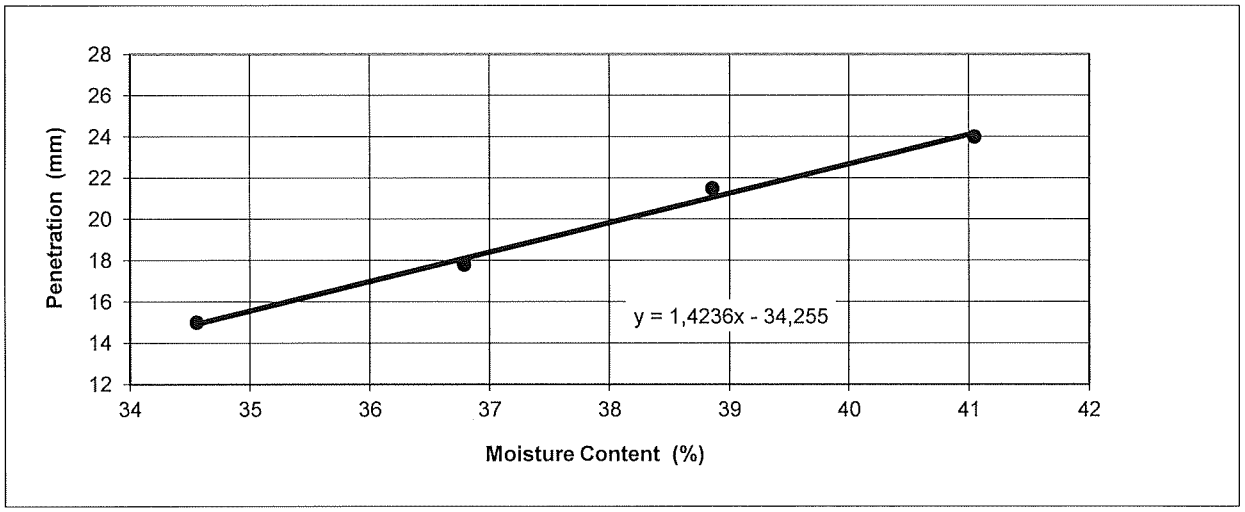
Date of test completion : 31/01/2023

Description of material : Clayey, gravelly, sandy to very sandy Silt

Proportion of sample passing 425 μm BS test sieve, % **Operator :** L.P.

Soil equilibrated with water for 24 h.

Test No.	1	2	3	4	5	6
Mass of wet soil + container g	47,07	54,15	53,15	55,15	28,88	27,44
Mass of dried soil + container g	41,61	46,52	45,65	46,69	28,39	27,00
Mass of container g	25,81	25,78	26,35	26,08	25,63	24,61
Mass of moisture g	5,46	7,63	7,50	8,46	0,49	0,44
Mass of dry soil g	15,80	20,74	19,30	20,61	2,76	2,39
Moisture content (w) %	34,56	36,79	38,86	41,05	17,75	18,41
Cone Penetration mm	15,0	17,8	21,5	24,0		
P.L.					**18,1**	



L.L. = (y+b)/a		P.I. = L.L.-P.I.		CLASSIFICATION	MOISTURE CONTENT
y =	20	**L.L. =**	**38**	CI	
a =	1,4236	**P.L. =**	**18**	Inorganic clay	
b =	34,255	**P.I. =**	**20**	of intermediate plasticity	
LINEAR SHRINKAGE %			10		

GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
Applied Geology Geotechnics-Environmental Engineering
TEL. : 22 - 330093, 330097, 330113 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

DETERMINATION OF ATTERBERG LIMITS

CEN ISO/TS 17892-12: 2004

Fall Cone Method - 80g/30°

Client: J+A Philippou architects-engineers L.L.C

Project: MALL of Limassol

Site : Mesa Yitonia/Limassol

Sampler : GEOINVEST L.T.D.

Date of sampling :

Description of material : Very clayey, very silty Sand

Proportion of sample passing 425 μm BS test sieve, %

Soil equilibrated with water for 24 h.

Borehole No : 2

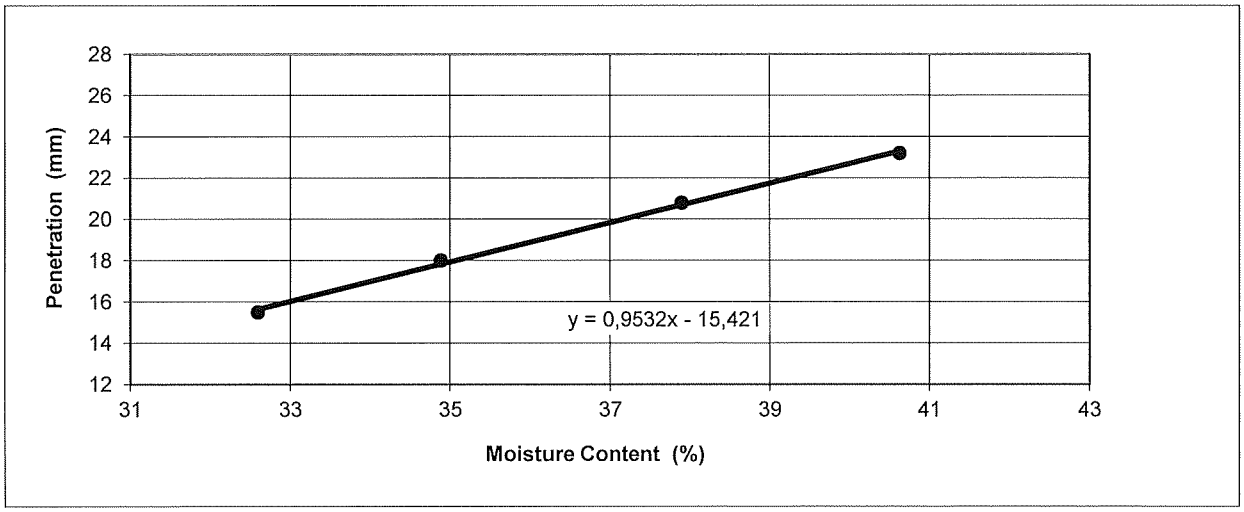
Depth : 4,50-5,00 m

Condition of sample : Natural State

Date of test completion : 31/01/2023

Operator : L.P.

Test No.	1	2	3	4	5	6
Mass of wet soil + container g	46,84	53,78	52,97	55,02	29,18	27,68
Mass of dried soil + container g	41,68	46,54	45,67	46,67	28,39	26,99
Mass of container g	25,85	25,79	26,41	26,12	25,59	24,52
Mass of moisture g	5,16	7,24	7,30	8,35	0,79	0,69
Mass of dry soil g	15,83	20,75	19,26	20,55	2,80	2,47
Moisture content (w) %	32,60	34,89	37,90	40,63	28,21	27,94
Cone Penetration mm	15,5	18,0	20,8	23,2		
P.L.					**28,1**	



L.L. = (y+b)/a		P.I. = L.L.-P.I.		CLASSIFICATION	MOISTURE CONTENT
y =	20	**L.L. =**	**37**	MI	
a =	0,9532	**P.L. =**	**28**	Inorganic silt	
b =	15,421	**P.I. =**	**9**	of intermediate compressibility	
LINEAR SHRINKAGE %			9		

GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
Applied Geology Geotechnics-Environmental Engineering
TEL. : 22 - 330093, 330097, 330113 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

DETERMINATION OF ATTERBERG LIMITS

CEN ISO/TS 17892-12: 2004

Fall Cone Method - 80g/30°

Client: J+A Philippou architects-engineers L.L.C

Project: MALL of Limassol

Site : Mesa Yitonia/Limassol

Sampler : GEOINVEST L.T.D.

Date of sampling :

Description of material : Very sandy, very clayey Silt

Proportion of sample passing 425 µm BS test sieve, %

Soil equilibrated with water for 24 h.

Borehole No : 2

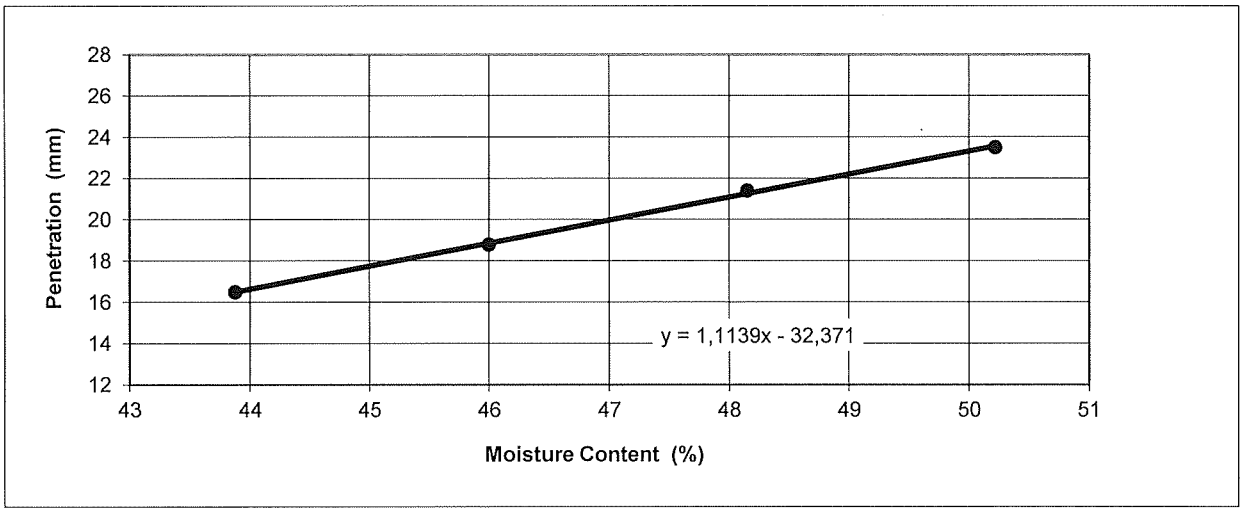
Depth : 10,00-10,50 m

Condition of sample : Natural State

Date of test completion : 31/01/2023

Operator : L.P.

Test No.	1	2	3	4	5	6
Mass of wet soil + container g	39,40	40,39	40,78	43,69	26,11	27,95
Mass of dried soil + container g	34,85	35,85	36,22	38,05	25,74	27,56
Mass of container g	24,48	25,98	26,75	26,82	24,29	25,99
Mass of moisture g	4,55	4,54	4,56	5,64	0,37	0,39
Mass of dry soil g	10,37	9,87	9,47	11,23	1,45	1,57
Moisture content (w) %	43,88	46,00	48,15	50,22	25,52	24,84
Cone Penetration mm	16,5	18,8	21,4	23,5		
P.L.					**25,2**	



L.L. = (y+b)/a		P.I. = L.L.-P.I.		CLASSIFICATION	MOISTURE CONTENT
y =	20	**L.L. =**	**47**	CI	
a =	1,1139	**P.L. =**	**25**	Inorganic clay	
b =	32,371	**P.I. =**	**22**	of intermediate plasticity	
LINEAR SHRINKAGE %			13		

GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
Applied Geology Geotechnics-Environmental Engineering
TEL. : 22 - 330093, 330097, 330113 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

DETERMINATION OF ATTERBERG LIMITS

CEN ISO/TS 17892-12: 2004

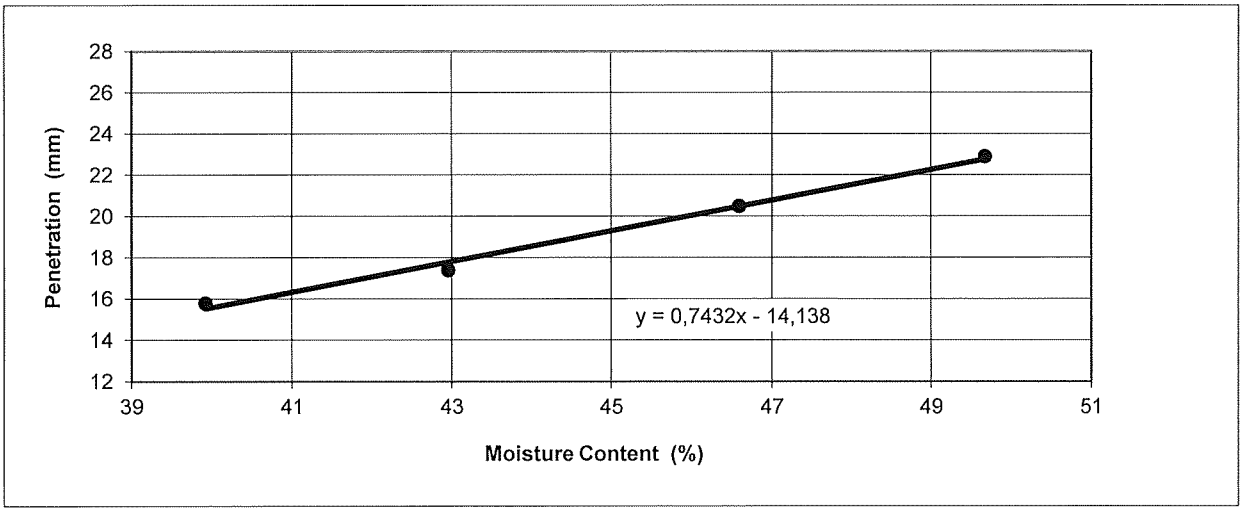
Fall Cone Method - 80g/30°

Client: J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol
Site : Mesa Yitonia/Limassol
Sampler : GEOINVEST L.T.D.
Date of sampling :
Description of material : Very sandy, very clayey Silt
Proportion of sample passing 425 µm BS test sieve, %
Soil equilibrated with water for 24 h.

Borehole No : 3
Depth : 6,00-6,50 m
Condition of sample : Natural State
Date of test completion : 31/01/2023

Operator : L.P.

Test No.	1	2	3	4	5	6
Mass of wet soil + container g	38,25	42,65	43,60	40,56	28,14	28,74
Mass of dried soil + container g	35,16	37,80	38,19	35,19	27,84	28,23
Mass of container g	27,42	26,51	26,58	24,38	26,46	25,91
Mass of moisture g	3,09	4,85	5,41	5,37	0,3	0,51
Mass of dry soil g	7,74	11,29	11,61	10,81	1,38	2,32
Moisture content (w) %	39,92	42,96	46,60	49,68	21,74	21,98
Cone Penetration mm	15,8	17,4	20,5	22,9		
P.L.					**21,9**	



L.L. = (y+b)/a		P.I. = L.L.-P.I.		CLASSIFICATION	MOISTURE CONTENT
y =	20	**L.L. =**	**46**	CI	
a =	0,7432	**P.L. =**	**22**	Inorganic clay	
b =	14,138	**P.I. =**	**24**	of intermediate plasticity	
LINEAR SHRINKAGE %			12		

GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
Applied Geology Geotechnics-Environmental Engineering
TEL. : 22 - 330093, 330097, 330113 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

DETERMINATION OF ATTERBERG LIMITS

CEN ISO/TS 17892-12: 2004

Fall Cone Method - 80g/30°

Client: J+A Philippou architects-engineers L.L.C

Project: MALL of Limassol

Site : Mesa Yitonia/Limassol

Sampler : GEOINVEST L.T.D.

Date of sampling :

Description of material : Clayey, very silty Sand

Proportion of sample passing 425 μm BS test sieve, %

Soil equilibrated with water for 24 h.

Borehole No : 4

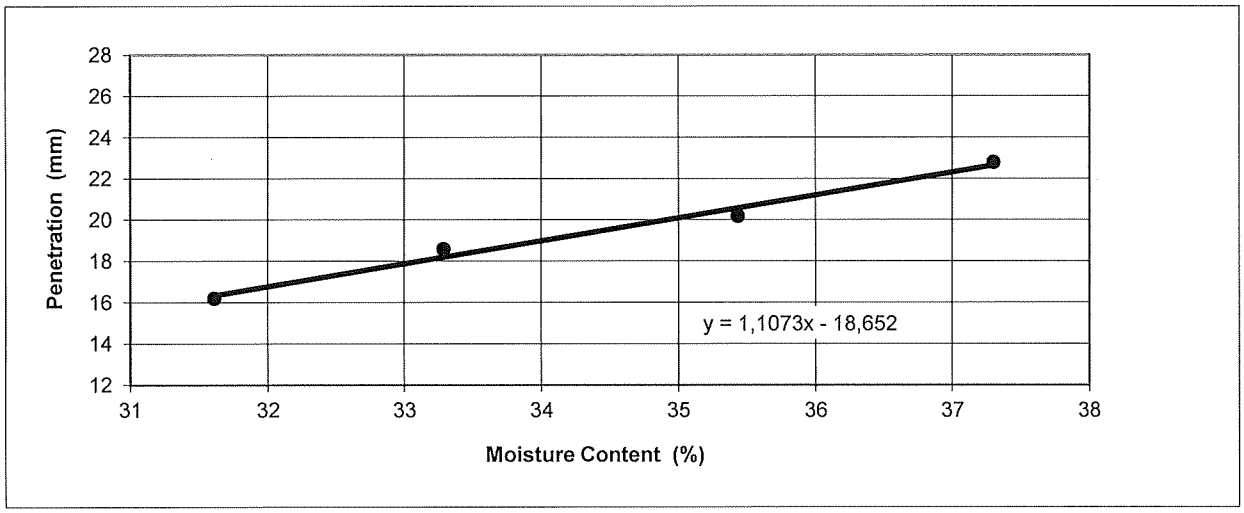
Depth : 8,00-8,50m

Condition of sample : Natural State

Date of test completion : 01/02/2023

Operator : L.P.

Test No.	1	2	3	4	5	6
Mass of wet soil + container g	43,75	54,68	57,42	55,62	30,58	30,31
Mass of dried soil + container g	39,41	47,29	48,94	47,51	29,78	29,42
Mass of container g	25,68	25,09	25,01	25,77	26,55	25,91
Mass of moisture g	4,34	7,39	8,48	8,11	0,80	0,89
Mass of dry soil g	13,73	22,20	23,93	21,74	3,23	3,51
Moisture content (w) %	31,61	33,29	35,44	37,30	24,77	25,36
Cone Penetration mm	16,2	18,6	20,2	22,8		
P.L.					**25,1**	



L.L. = (y+b)/a		P.I. = L.L.-P.I.		CLASSIFICATION	MOISTURE CONTENT
y =	20	**L.L. =**	**35**	ML/MI	
a =	1,1073	**P.L. =**	**25**	Inorganic silt	
b =	18,652	**P.I. =**	**10**	of low to intermediate compressibility	
LINEAR SHRINKAGE %			9		

GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ

Applied Geology Geotechnics-Environmental Engineering

TEL. : 22 - 330093, 330097, 330113 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

DETERMINATION OF ATTERBERG LIMITS

CEN ISO/TS 17892-12: 2004

Fall Cone Method - 80g/30°

Client: J+A Philippou architects-engineers L.L.C

Project: MALL of Limassol

Site : Mesa Yitonia/Limassol

Sampler : GEOINVEST L.T.D.

Date of sampling :

Description of material : Clayey, very silty Sand

Proportion of sample passing 425 μm BS test sieve, %

Soil equilibrated with water for 24 h.

Borehole No : 4

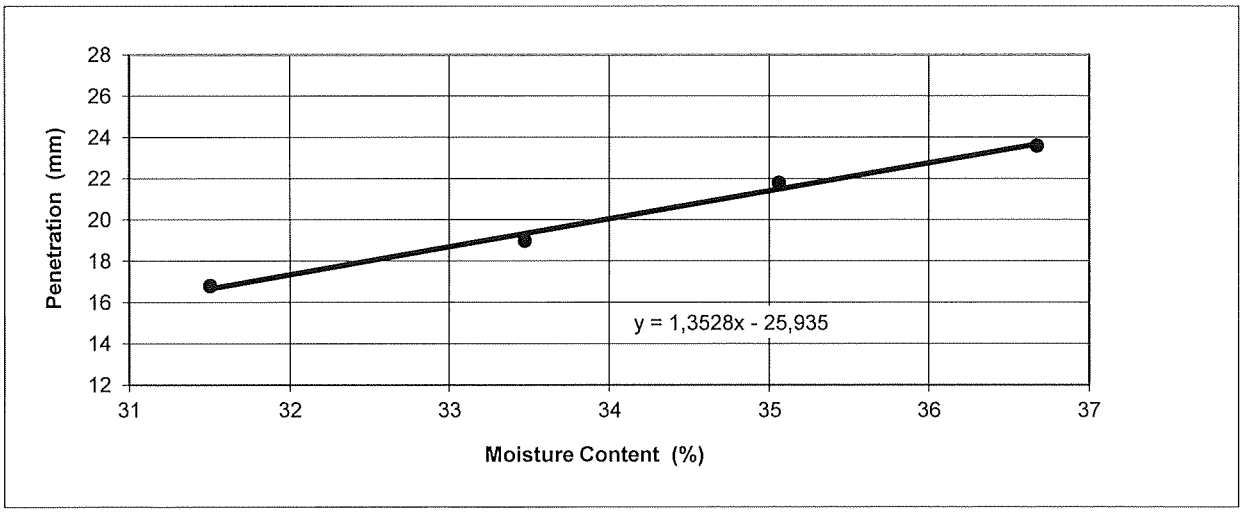
Depth : 12,00-12,50 m

Condition of sample : Natural State

Date of test completion : 01/02/2023

Operator : L.P.

Test No.	1	2	3	4	5	6
Mass of wet soil + container g	46,12	46,52	54,08	46,69	28,65	29,35
Mass of dried soil + container g	41,02	41,01	46,31	41,09	28,02	28,59
Mass of container g	24,83	24,55	24,15	25,82	25,51	25,57
Mass of moisture g	5,10	5,51	7,77	5,60	0,63	0,76
Mass of dry soil g	16,19	16,46	22,16	15,27	2,51	3,02
Moisture content (w) %	31,50	33,48	35,06	36,67	25,10	25,17
Cone Penetration mm	16,8	19,0	21,8	23,6		
P.L.					**25,1**	



L.L. = (y+b)/a		P.I. = L.L.-P.I.		CLASSIFICATION	MOISTURE CONTENT
y =	20	**L.L. =**	**34**	ML	
a =	1,3528	**P.L. =**	**25**	Inorganic silt	
b =	25,935	**P.I. =**	**9**	of low compressibility	
LINEAR SHRINKAGE %			8		

GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ

Applied Geology Geotechnics-Environmental Engineering

TEL. : 22 - 330093, 330097, 330113 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

DETERMINATION OF ATTERBERG LIMITS

CEN ISO/TS 17892-12: 2004

Fall Cone Method - 80g/30°

Client: J+A Philippou architects-engineers L.L.C

Project: MALL of Limassol

Site : Mesa Yitonia/Limassol

Sampler : GEOINVEST L.T.D.

Date of sampling :

Borehole No : 5

Depth : 6,00-7,00m

Condition of sample : Natural State

Date of test completion : 01/02/2023

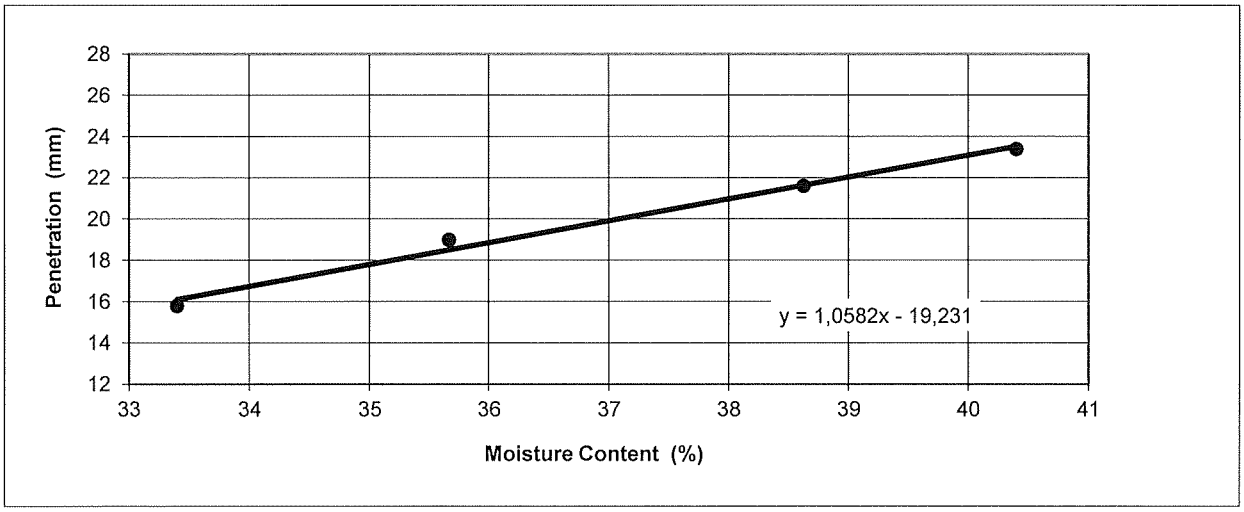
Description of material : Slightly gravelly, clayey, sandy Silt

Proportion of sample passing 425 μm BS test sieve, **%**

Operator : L.P.

Soil equilibrated with water for 24 h.

Test No.	1	2	3	4	5	6
Mass of wet soil + container g	45,12	56,15	49,75	51,79	29,64	29,19
Mass of dried soil + container g	40,32	47,95	43,11	43,94	29,03	28,69
Mass of container g	25,95	24,96	25,92	24,51	25,67	25,97
Mass of moisture g	4,80	8,20	6,64	7,85	0,61	0,50
Mass of dry soil g	14,37	22,99	17,19	19,43	3,36	2,72
Moisture content (w) %	33,40	35,67	38,63	40,40	18,15	18,38
Cone Penetration mm	15,8	19,0	21,6	23,4		
P.L.					**18,3**	



L.L. = (y+b)/a		P.I. = L.L.-P.I.		CLASSIFICATION	MOISTURE CONTENT
y =	20	**L.L. =**	**37**	CI	
a =	1,0582	**P.L. =**	**18**	Inorganic clay	
b =	19,231	**P.I. =**	**19**	of intermediate plasticity	
LINEAR SHRINKAGE %			8		

GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ

Applied Geology Geotechnics-Environmental Engineering

TEL. : 22 - 330093, 330097, 330113 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

DETERMINATION OF ATTERBERG LIMITS

CEN ISO/TS 17892-12: 2004

Fall Cone Method - 80g/30°

Client: J+A Philippou architects-engineers L.L.C

Project: MALL of Limassol

Site : Mesa Yitonia/Limassol

Sampler : GEOINVEST L.T.D.

Date of sampling :

Description of material : Sandy, very clayey Silt

Proportion of sample passing 425 µm BS test sieve, %

Soil equilibrated with water for 24 h.

Borehole No : 5

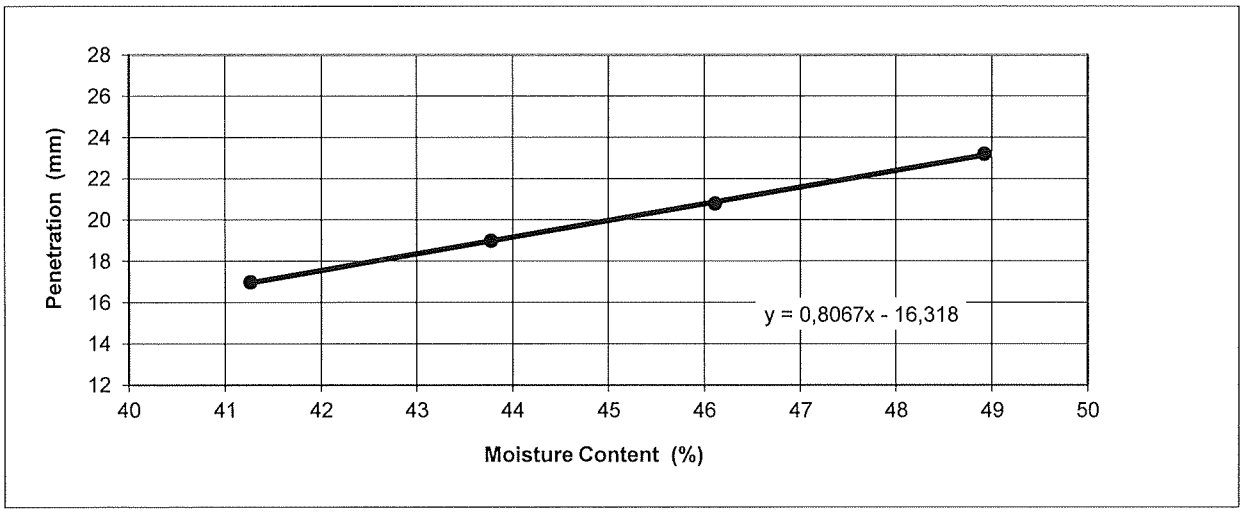
Depth : 7,50-8,00 m

Condition of sample : Natural State

Date of test completion : 01/02/2023

Operator : L.P.

Test No.	1	2	3	4	5	6
Mass of wet soil + container g	52,67	45,29	57,05	56,23	30,39	29,72
Mass of dried soil + container g	45,11	39,31	47,38	46,00	29,73	29,11
Mass of container g	26,79	25,65	26,41	25,09	26,51	25,90
Mass of moisture g	7,56	5,98	9,67	10,23	0,66	0,61
Mass of dry soil g	18,32	13,66	20,97	20,91	3,22	3,21
Moisture content (w) %	41,27	43,78	46,11	48,92	20,50	19,00
Cone Penetration mm	17,0	19,0	20,8	23,2		
P.L.					**19,8**	



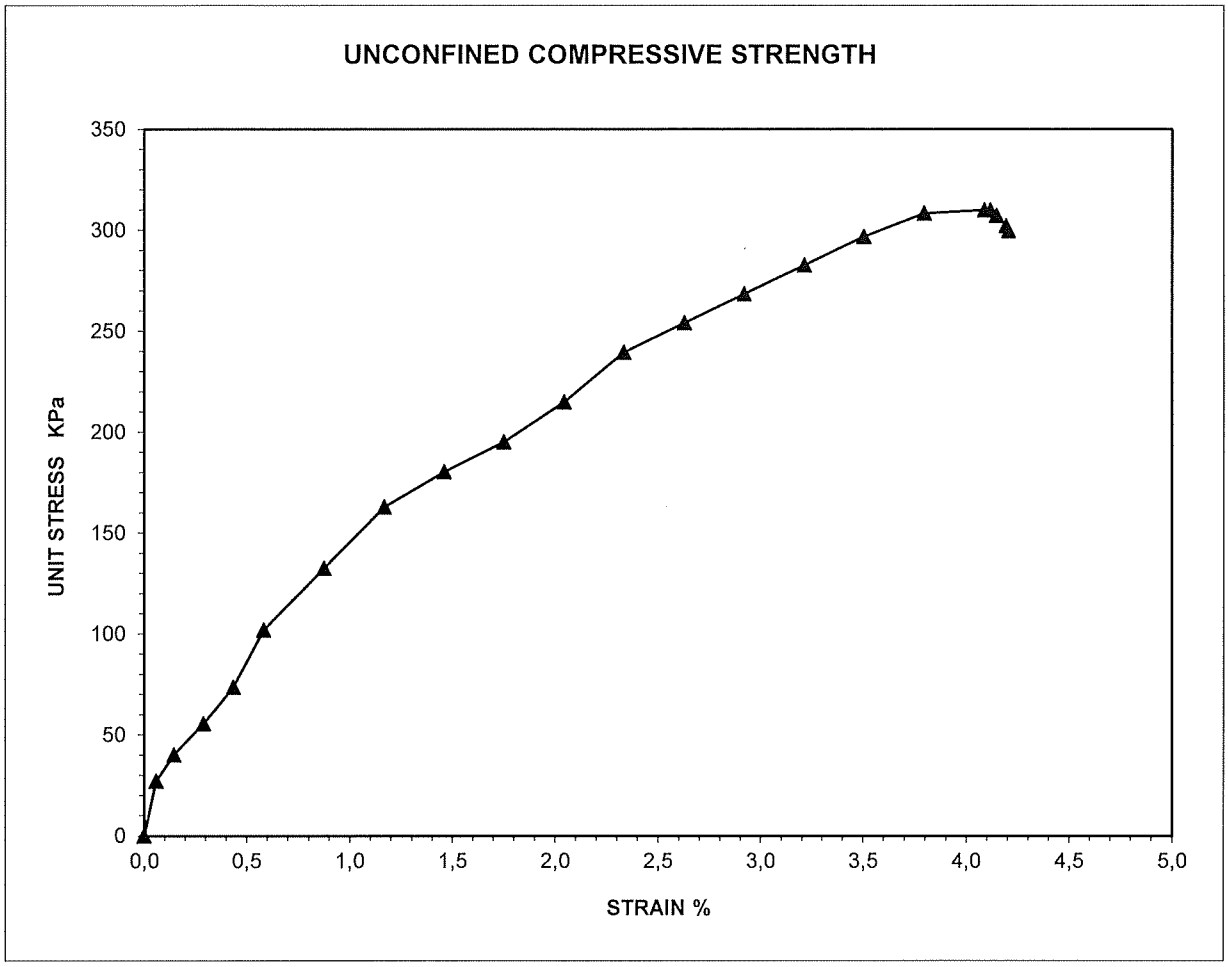
L.L. = (y+b)/a		P.I. = L.L.-P.I.		CLASSIFICATION	MOISTURE CONTENT
y =	20	**L.L. =**	**45**	CI	
a =	0,8067	**P.L. =**	**20**	Inorganic clay	
b =	16,318	**P.I. =**	**25**	of intermediate plasticity	
LINEAR SHRINKAGE %			14		

GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
Applied Geology Geotechnics-Environmental Engineering
TEL. : 22 - 330093, 330097, 330113 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

UNCONFINED COMPRESSIVE STRENGTH

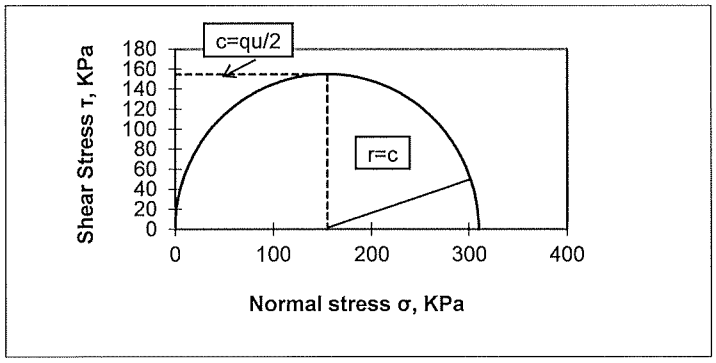
CEN ISO/ TS 17892-7: 2004

Client: J+A Philippou archit-enginL.L.C	**Borehole No.:** 1	**Dia.**(mm)= 85,6		**Moist.Cont:**	11,2%
Project: MALL of Limassol	**Depth:** 4,00-4,50 m	**Length** (mm) = 171,2		**Strain (ε) :**	4,1%
Site : Mesa Yitonia/Limassol	**Equipment used:** MultiPlex 50		**σ1:**	0,31	N/mm^2
Date of test compl. : 30/01/2023	**Max Compression:** 10kN		**Bulk Density:**	1,982	gr/cm^3
Rate of strain: 1mm/min	**Operator :** L.P.		**Dry Density:**	1,783	gr/cm^3
	Description of material : Clayey Sand and Silt				

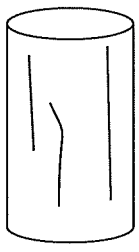


Unc. Compr. Strength **qu=** 310 KPa **cohesion** = qu/2 = 155 kPa

Stess - Strain Modulus, **Es=** 14 MPa



Mode of failure



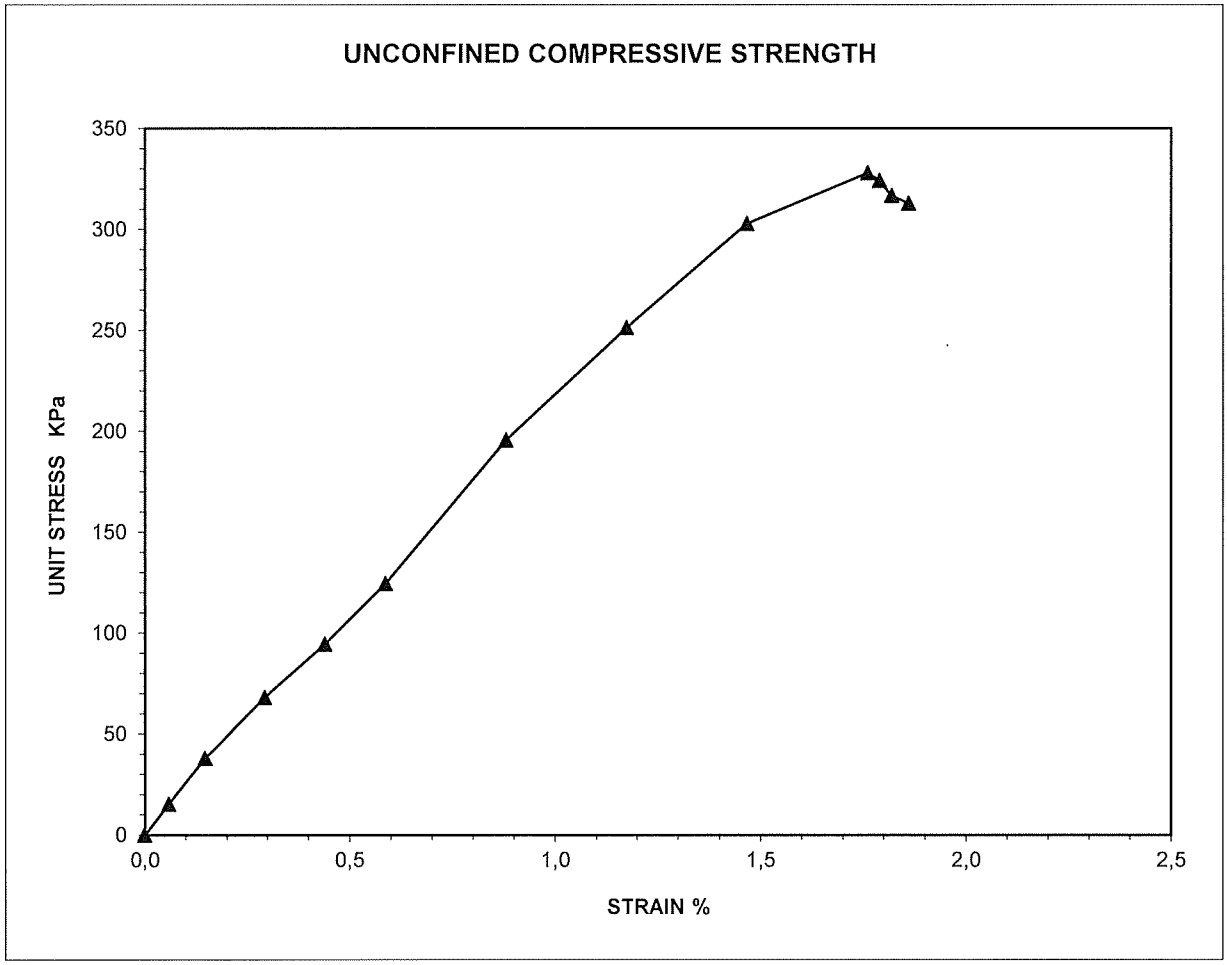
GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
TEL. : 22 - 330093, 330097 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

UNCONFINED COMPRESSIVE STRENGTH

CEN ISO/ TS 17892-7: 2004

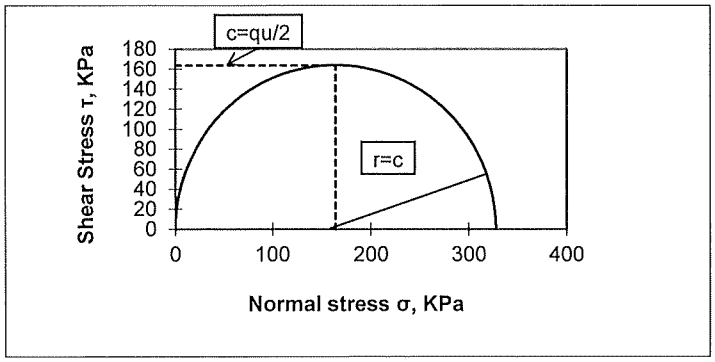
Client: J+A Philippou archit-enginL.L.C	**Borehole No.:** 2	**Dia.**(mm)= 85,2		**Moist.Cont:**	16,8%
Project: MALL of Limassol	**Depth:** 5,50-6,00 m	**Length** (mm) = 170,4		**Strain (ε) :**	1,8%
Site : Mesa Yitonia/Limassol	**Equipment used:** MultiPlex 50		**σ1:**	0,33	N/mm^2
Date of test compl. : 30/01/2023	**Max Compression:** 10kN		**Bulk Density:**	1,995	gr/cm^3
Rate of strain: 1mm/min	**Operator :** L.P.		**Dry Density:**	1,708	gr/cm^3

Description of material : Clayey to very clayey Silt and Sand

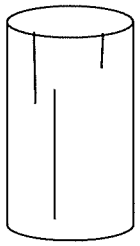


Unc. Compr. Strength **qu=** 328 KPa **cohesion** = qu/2 = 164 kPa

Stess - Strain Modulus, **Es=** 22 MPa



Mode of failure

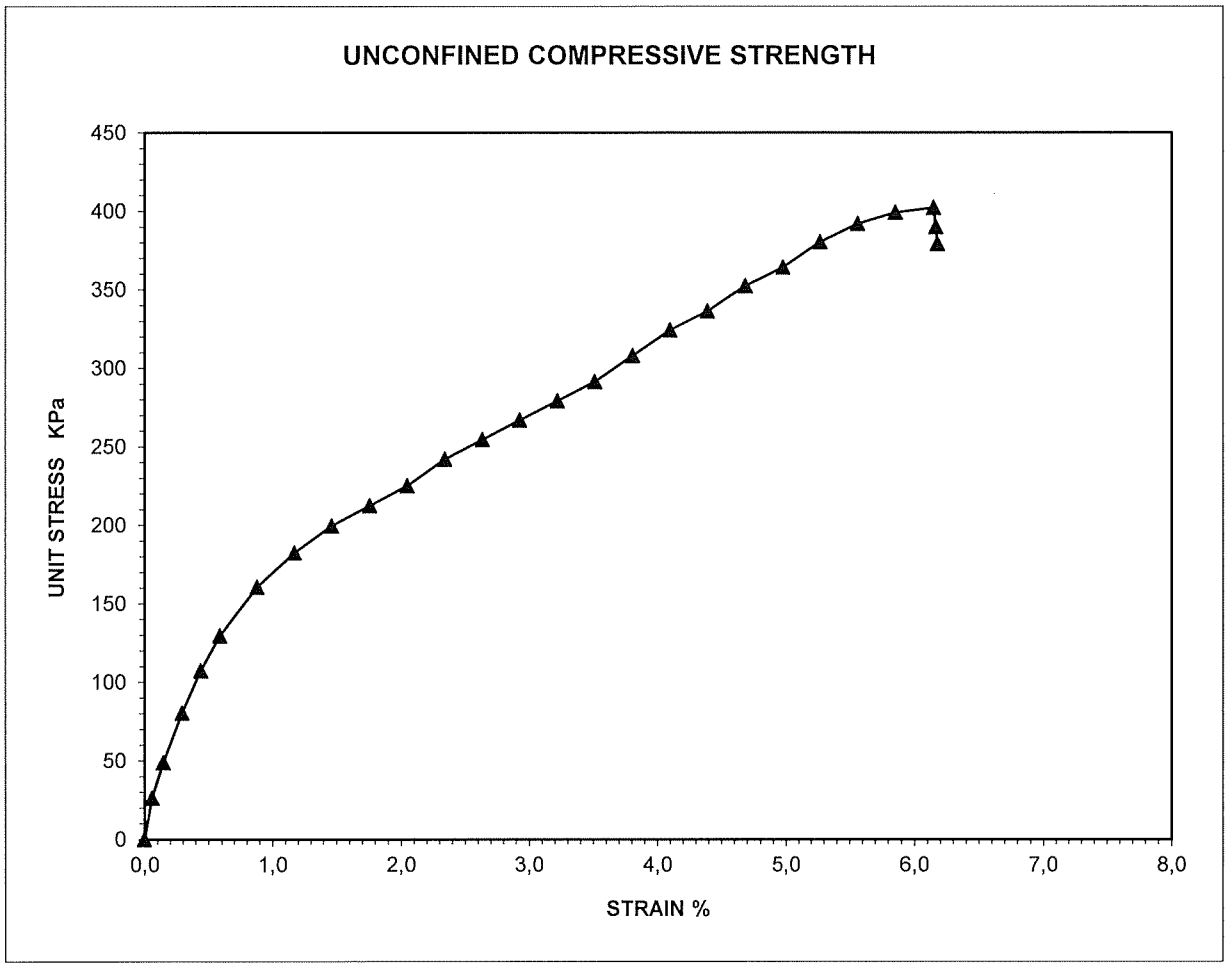


GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
TEL. : 22 - 330093, 330097 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

UNCONFINED COMPRESSIVE STRENGTH
CEN ISO/ TS 17892-7: 2004

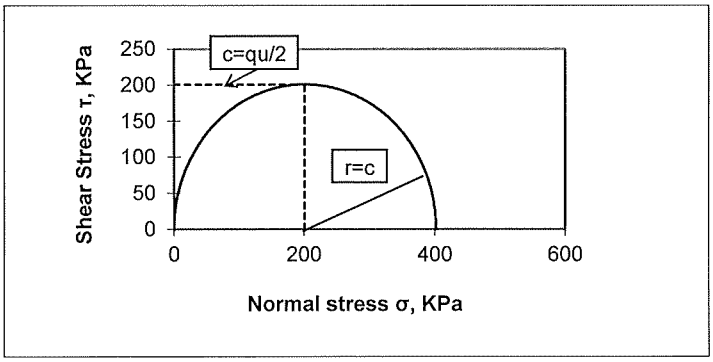
Client: J+A Philippou archit-enginL.L.C	**Borehole No.:** 2	**Dia.**(mm)= 85,4		**Moist.Cont:**	17,2%
Project: MALL of Limassol	**Depth:** 11,50-12,00m	**Length** (mm) = 170,8		**Strain (ε) :**	6,1%
Site : Mesa Yitonia/Limassol	**Equipment used:** MultiPlex 50		**σ1:**	0,40	N/mm^2
Date of test compl. : 30/01/2023	**Max Compression:** 10kN		**Bulk Density:**	2,022	gr/cm^3
Rate of strain: 1mm/min	**Operator :** L.P.		**Dry Density:**	1,726	gr/cm^3

Description of material : Gravelly, clayey to very clayey Silt and Sand

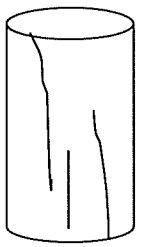


Unc. Compr. Strength **qu=** 402 KPa **cohesion** = qu/2 = 201 kPa

Stess - Strain Modulus, **Es=** 13 MPa



Mode of failure

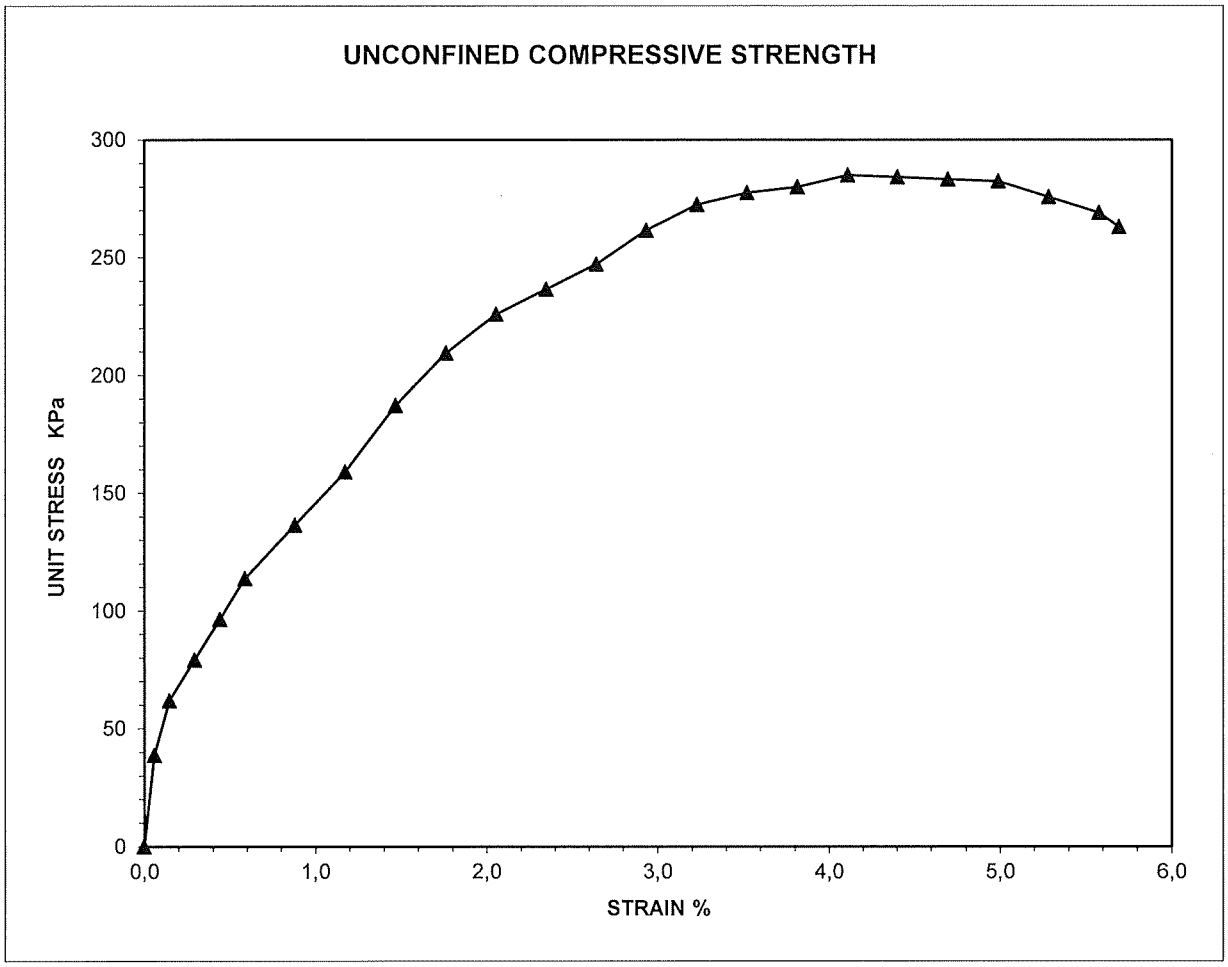


GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
TEL. : 22 - 330093, 330097 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

UNCONFINED COMPRESSIVE STRENGTH

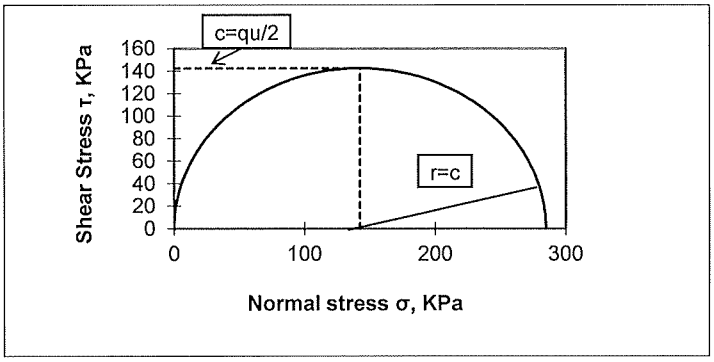
CEN ISO/ TS 17892-7: 2004

Client: J+A Philippou archit-enginL.L.C	**Borehole No.:** 3	**Dia.**(mm)= 85,2		**Moist.Cont:**	19,1%
Project: MALL of Limassol	**Depth:** 5,50-6,00 m	**Length** (mm) = 170,4		**Strain (ε) :**	4,1%
Site : Mesa Yitonia/Limassol	**Equipment used:** MultiPlex 50		**σ1:**	0,29	N/mm^2
Date of test compl. : 30/01/2023	**Max Compression:** 10kN		**Bulk Density:**	1,974	gr/cm^3
Rate of strain: 1mm/min	**Operator :** L.P.		**Dry Density:**	1,657	gr/cm^3
	Description of material : Sandy, clayey Silt				

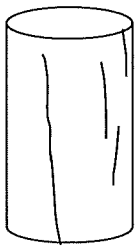


Unc. Compr. Strength **qu=** 285 KPa **cohesion** = qu/2 = 143 kPa

Stess - Strain Modulus, **Es=** 15 MPa



Mode of failure

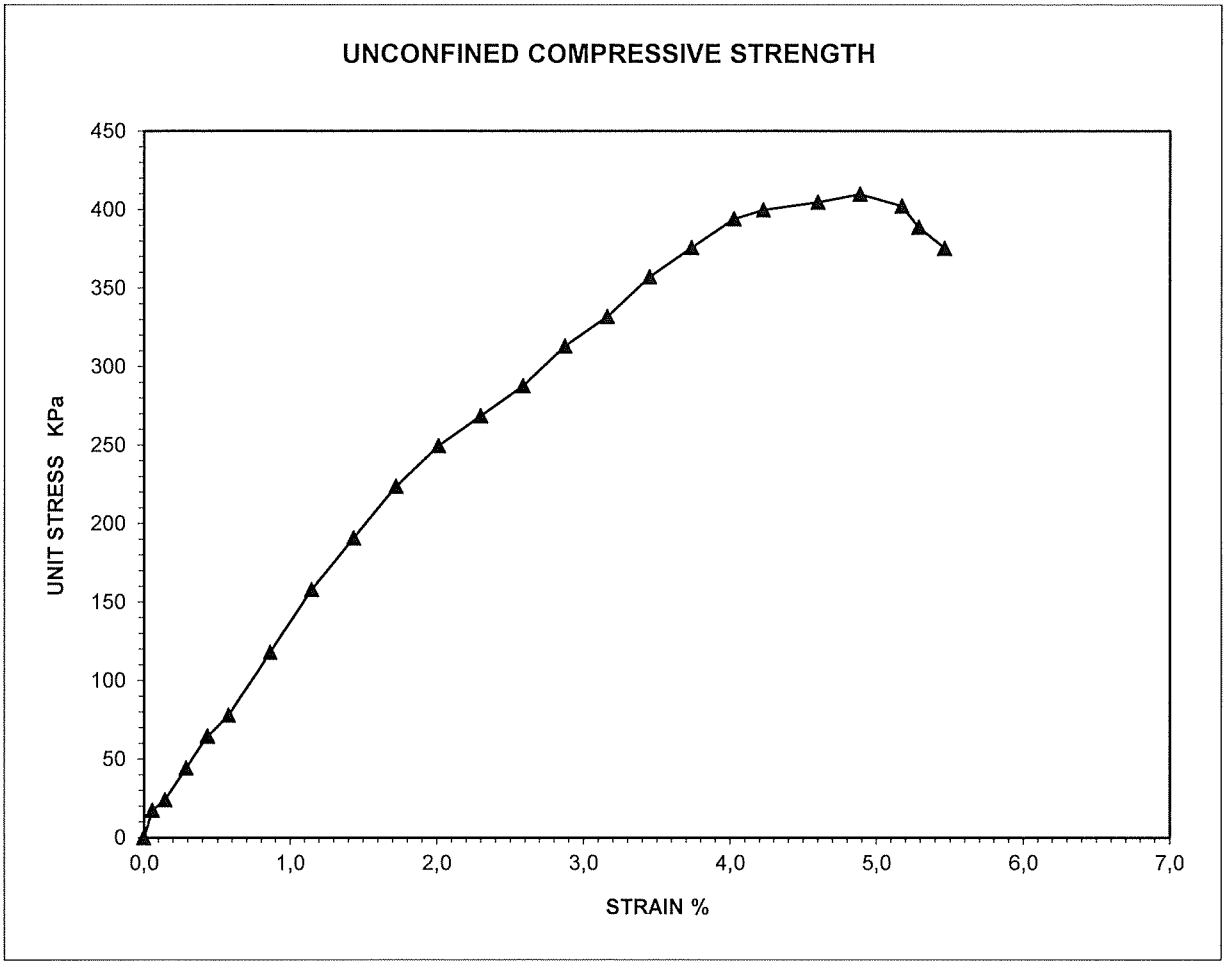


GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
TEL. : 22 - 330093, 330097 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

UNCONFINED COMPRESSIVE STRENGTH

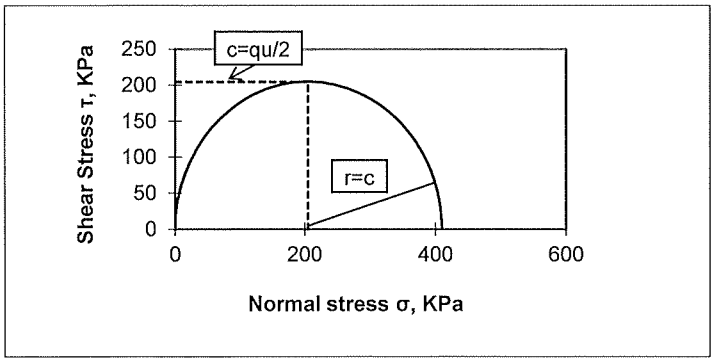
CEN ISO/ TS 17892-7: 2004

Client: J+A Philippou archit-enginL.L.C	**Borehole No.:** 4	**Dia.**(mm)= 85,05		**Moist.Cont:**	13,3%
Project: MALL of Limassol	**Depth:** 7,00-7,50 m	**Length** (mm) = 173,93		**Strain (ε) :**	4,9%
Site : Mesa Yitonia/Limassol	**Equipment used:** MultiPlex 50		**σ1:**	0,41	N/mm^2
Date of test compl. : 30/01/2023	**Max Compression:** 10kN		**Bulk Density:**	2,045	gr/cm^3
Rate of strain: 1mm/min	**Operator :** L.P.		**Dry Density:**	1,804	gr/cm^3
	Description of material : Clayey Sand and Silt				

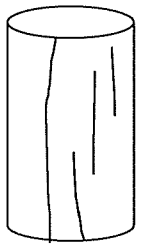


Unc. Compr. Strength **qu=** 410 KPa **cohesion** = qu/2 = 205 kPa

Stess - Strain Modulus, **Es=** 13 MPa



Mode of failure

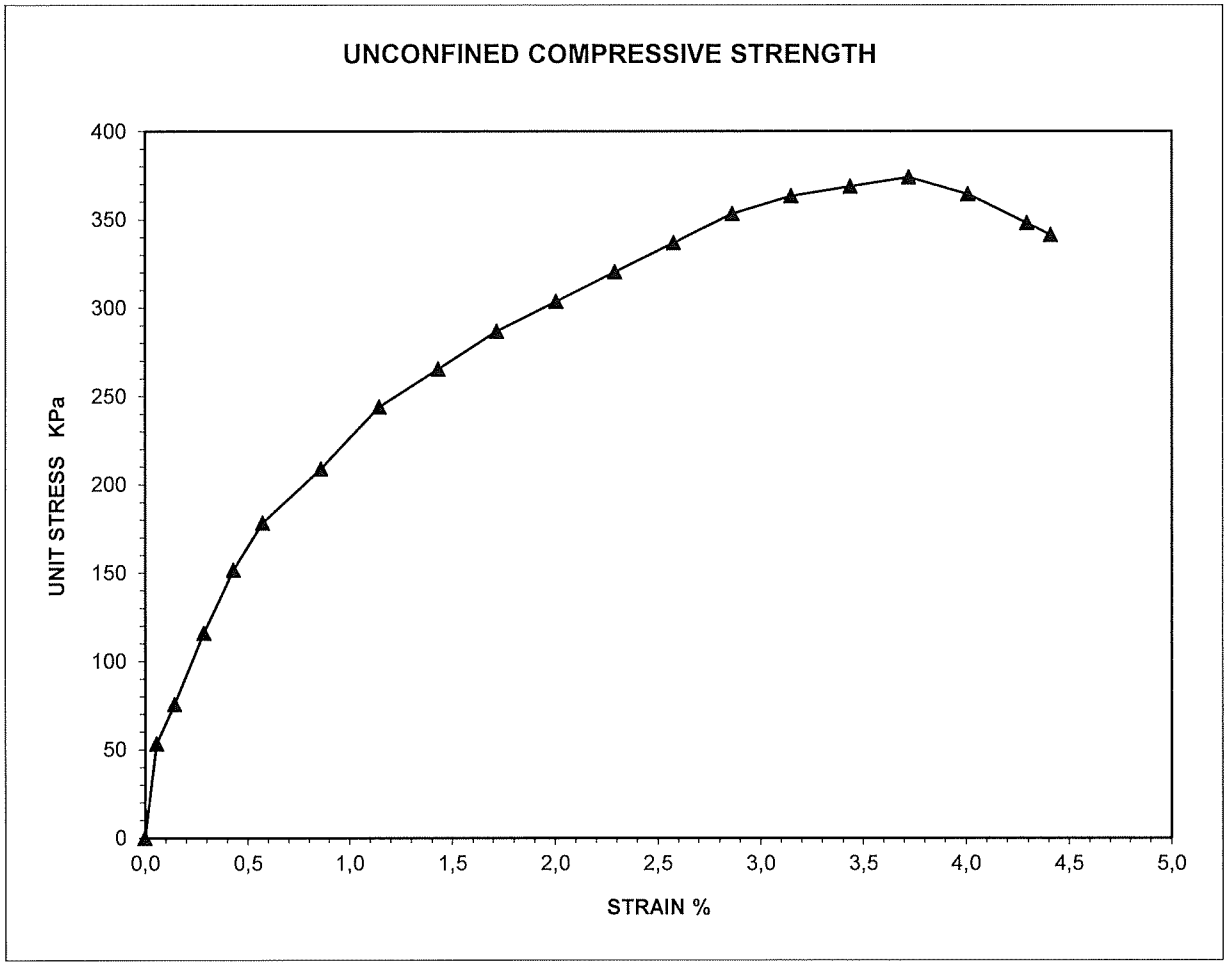


GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
TEL. : 22 - 330093, 330097 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

UNCONFINED COMPRESSIVE STRENGTH

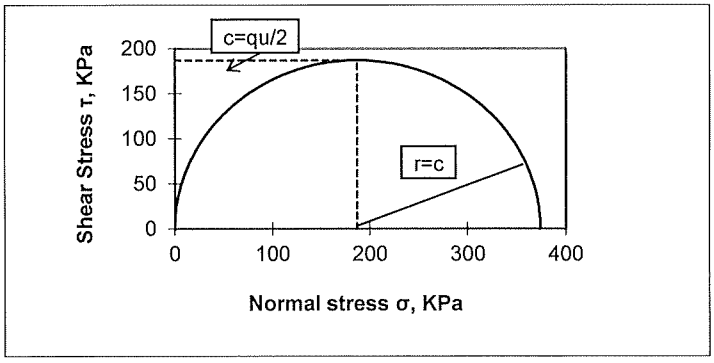
CEN ISO/ TS 17892-7: 2004

Client: J+A Philippou archit-enginL.L.C	**Borehole No.:** 4	**Dia.**(mm)= 84,95		**Moist.Cont:**	16,4%
Project: MALL of Limassol	**Depth:** 11,50-12,00 m	**Length** (mm) = 174,64		**Strain (ε) :**	3,7%
Site : Mesa Yitonia/Limassol	**Equipment used:** MultiPlex 50		**σ1:**	0,37	N/mm^2
Date of test compl. : 30/01/2023	**Max Compression:** 28kN		**Bulk Density:**	2,001	gr/cm^3
Rate of strain: 1mm/min	**Operator :** L.P.		**Dry Density:**	1,720	gr/cm^3
	Description of material : Clayey Sand and Silt				

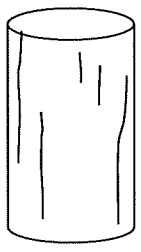


Unc. Compr. Strength **qu=** 374 KPa **cohesion** = qu/2 = 187 kPa

Stess - Strain Modulus, **Es=** 29 MPa



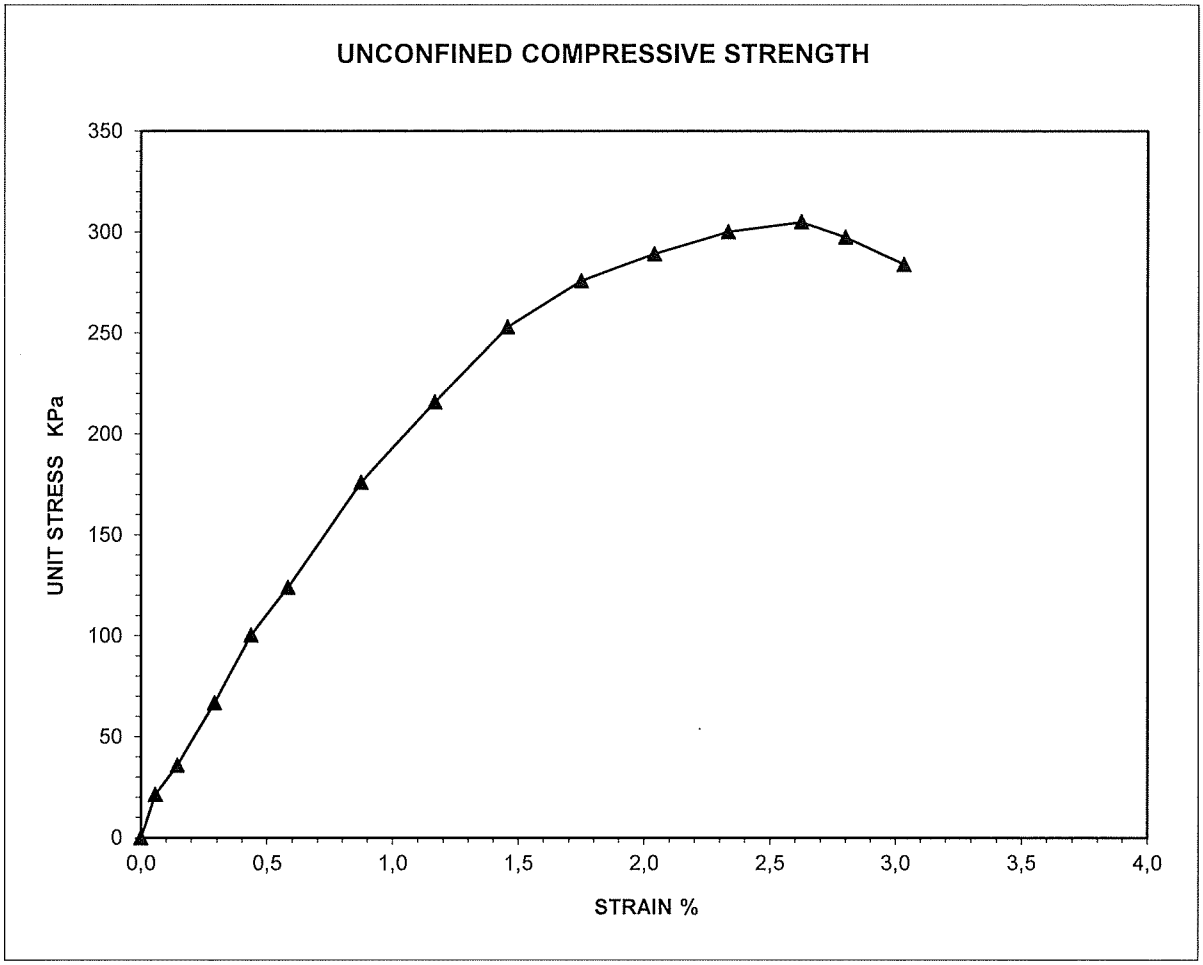
Mode of failure



GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
TEL. : 22 - 330093, 330097 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

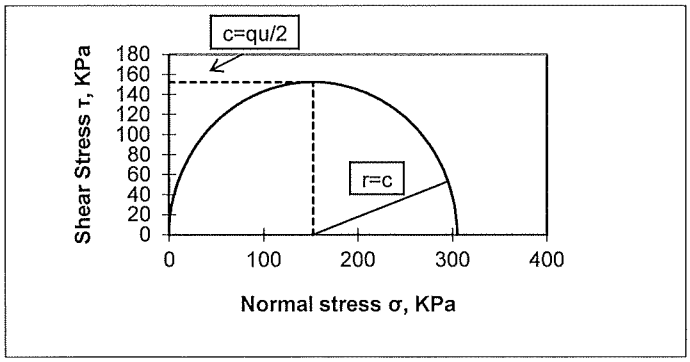
UNCONFINED COMPRESSIVE STRENGTH
CEN ISO/ TS 17892-7: 2004

Client: J+A Philippou archit-enginL.L.	**Borehole No.:** 5	**Dia.**(mm)= 85,7		**Moist.Cont:**	18,9%
Project: MALL of Limassol	**Depth:** 7,00-7,50 m	**Length** (mm) = 171,4		**Strain (ε) :**	2,6%
Site : Mesa Yitonia/Limassol	**Equipment used:** MultiPlex 50		**σ1:**	0,31	N/mm^2
Date of test compl. : 30/01/2023	**Max Compression:** 10kN		**Bulk Density:**	2,010	gr/cm^3
Rate of strain: 1mm/min	**Operator :** L. P.		**Dry Density:**	1,691	gr/cm^3
	Description of material : Sandy, clayey Silt				

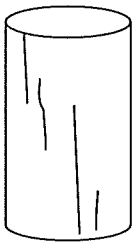


Unc. Compr. Strength **qu=** 305 KPa **cohesion** = qu/2 = 153 kPa

Stess - Strain Modulus, **Es=** 21 MPa



Mode of failure



GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ
TEL. : 22 - 330093, 330097 FAX. : 22 - 330118 P.O.BOX : 20476 NICOSIA

Shear Strength by direct shear (small shearbox)
CEN ISO/TS 17892-10: 2004

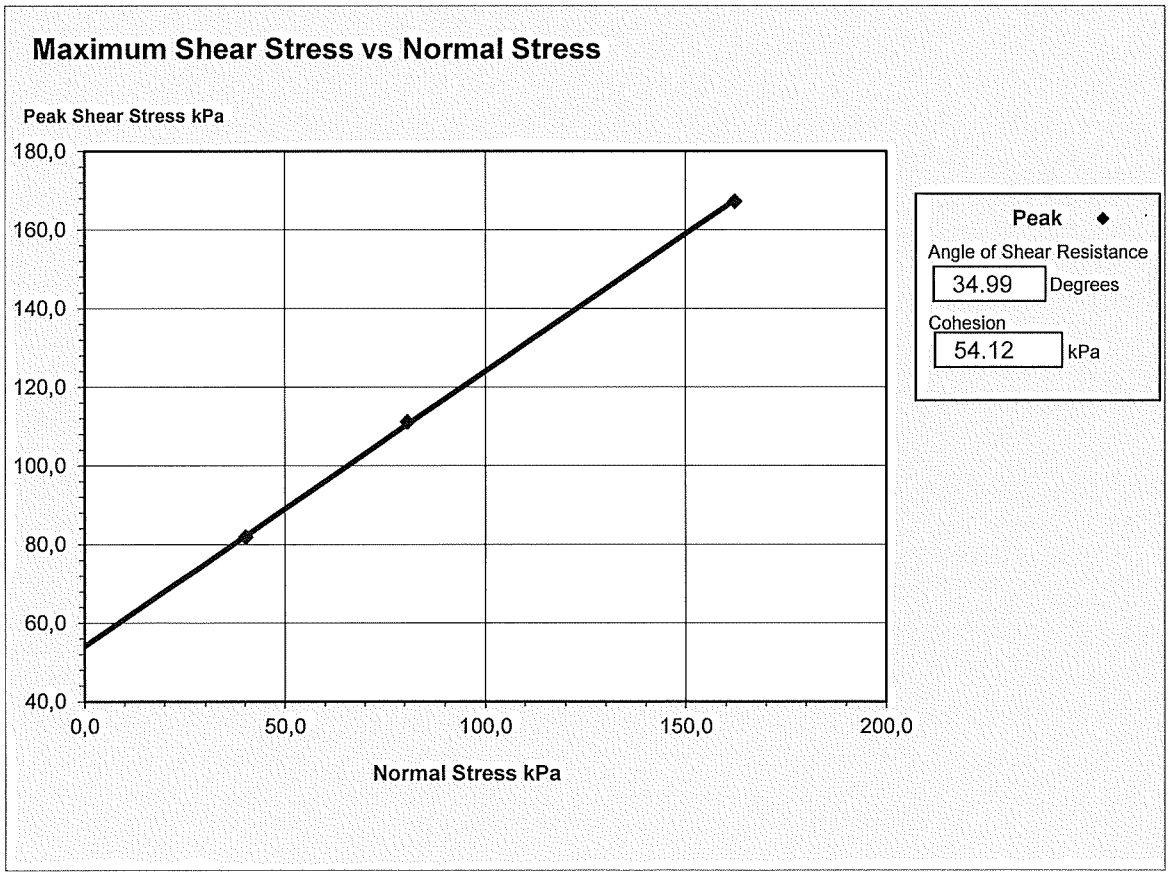
GEOINVEST

Client: J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol
Site : Mesa Yitonia/Limassol
Sampler : GEOINVEST LTD
Operator : A.S.

Borehole No. : 1
Depth : 4,00-4,50 m
Description of material: Clayey Sand and Silt
Date of test completion: 02/02/2023

Reference	A	B	C
Applied Normal Stress	40,2 kPa	80,8 kPa	162,2 kPa
Peak Strength	82,0 kPa	111,3 kPa	167,4 kPa
Residual Shear Stress			
Rate(s) of Shear Displacement	Stage 1: 0,8711mm/min	Stage 1: 0,8902mm/min	Stage 1: 0,8815mm/min
Final Height	19,96 mm	19,91 mm	19,95 mm
Bulk Density	1,969 Mg/m^3	1,975 Mg/m^3	1,984 Mg/m^3
Dry Density	1,771 Mg/m^3	1,776 Mg/m^3	1,786 Mg/m^3
Moisture Content	11,2 %	11,2 %	11,1
Number of Traverses	1	1	1

Condition of sample: Core
Area : 60 mm x 60 mm



Shear Strength by direct shear (small shearbox)
CEN ISO/TS 17892-10: 2004

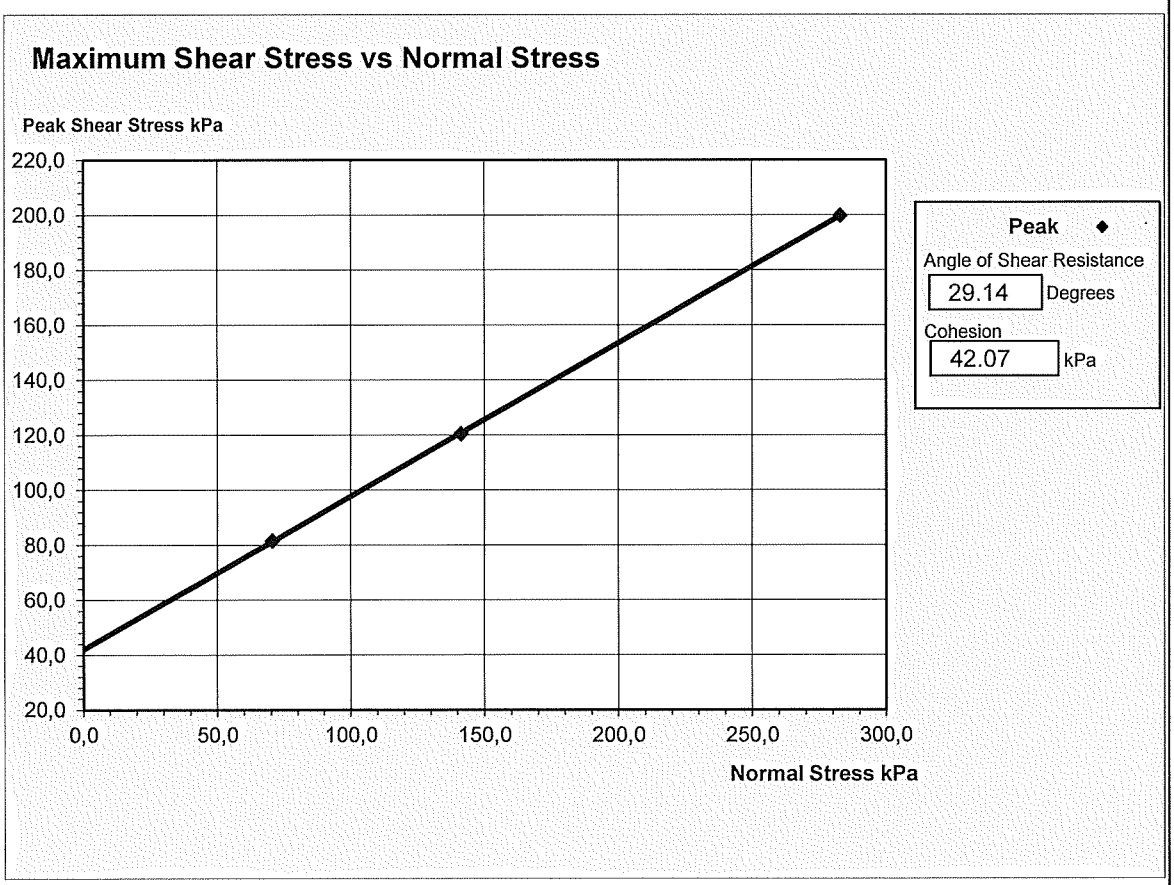
GEOINVEST

Client: J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol
Site : Mesa Yitonia/Limassol
Sampler : GEOINVEST LTD
Operator : A.S.

Borehole No. : 5
Depth : 7,00-7,50m
Description of material: Sandy, clayey Silt
Date of test completion: 03/02/2023

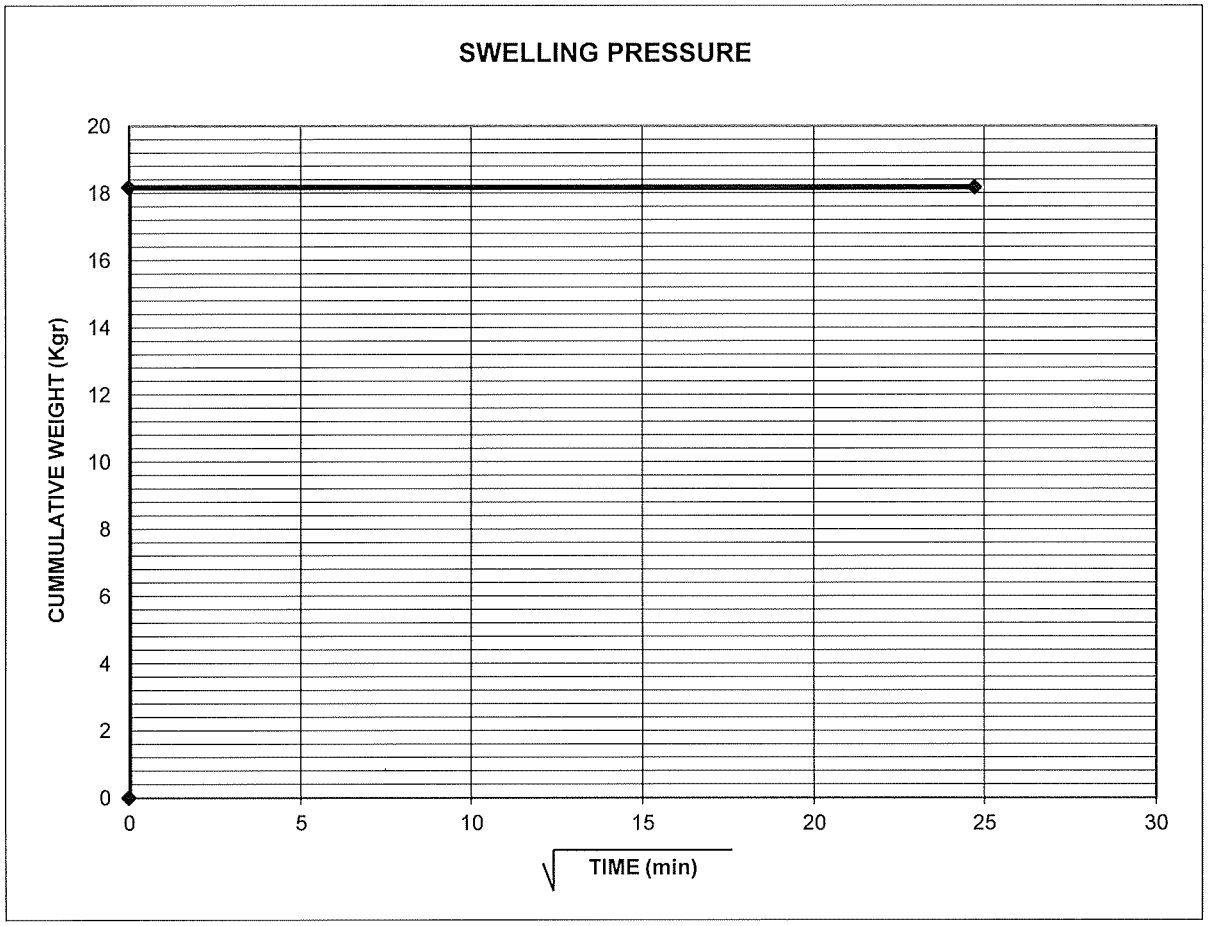
Reference	A	B	C
Applied Normal Stress	70,4 kPa	141,2 kPa	282,8 kPa
Peak Strength	81,6 kPa	120,5 kPa	199,8 kPa
Residual Shear Stress			
Rate(s) of Shear Displacement	Stage 1: 0,8509mm/min	Stage 1: 0,8674mm/min	Stage 1: 0,8593mm/min
Final Height	19,89 mm	19,81 mm	19,86 mm
Bulk Density	2,031 Mg/m^3	2,018 Mg/m^3	2,027 Mg/m^3
Dry Density	1,708 Mg/m^3	1,699 Mg/m^3	1,706 Mg/m^3
Moisture Content	18,9 %	18,8 %	18,8 %
Number of Traverses	1	1	1

Condition of sample: Core
Area : 60 mm x 60 mm



SWELLING PRESSURE

Client:J+A Philippou architects-engineers L.L.C **Operator :** A.S. **BH.:** 2
Project: MALL of Limassol **Date of test compl.:** 30/01/2023 **Depth:** 5,50-6,00m
Site : Mesa Yitonia/Limassol **Descr. of material:** Clayey to very clayey Silt and Sand
Condition of sample: Core



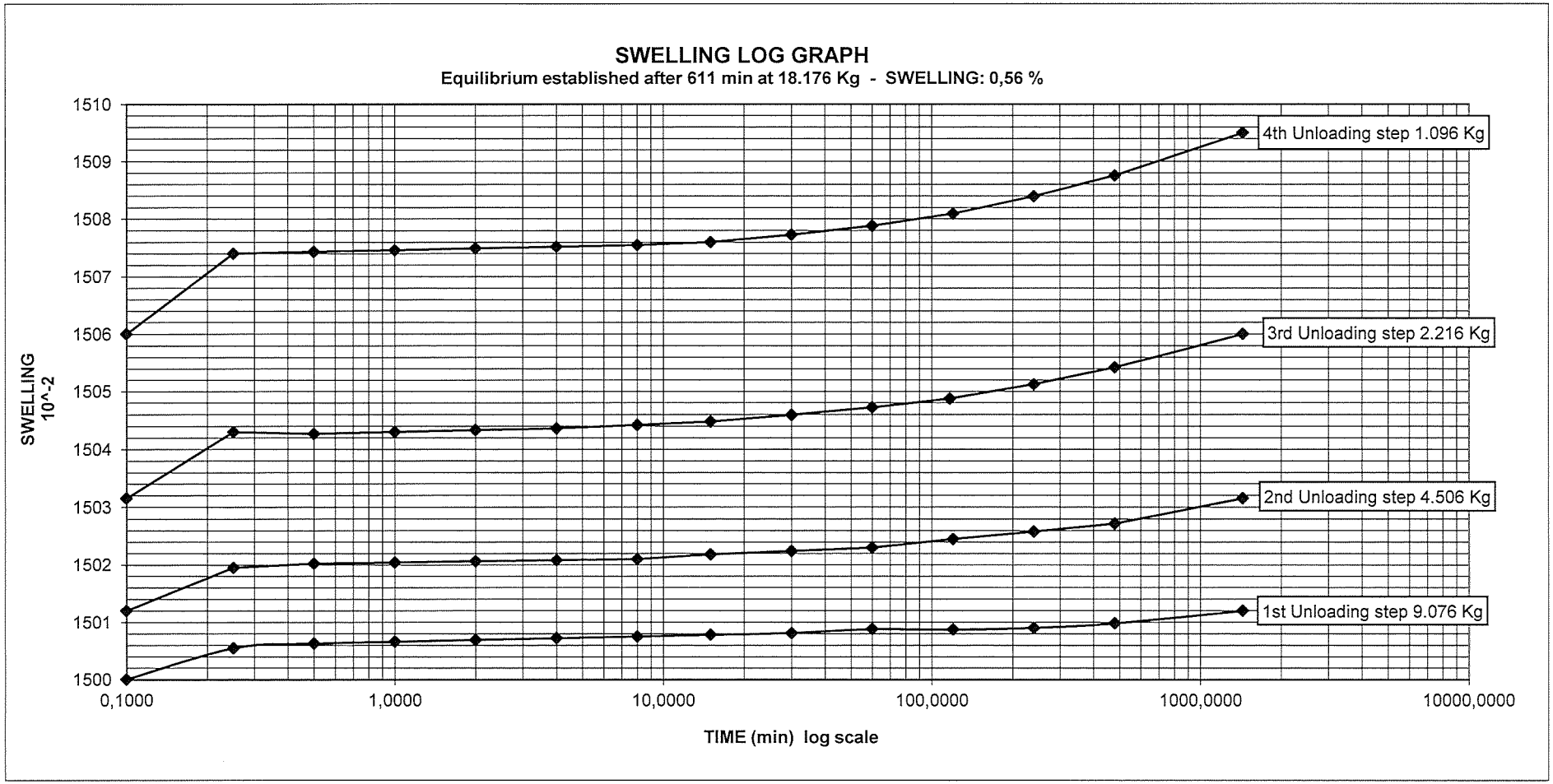
SWELLING PRESSURE :	45	KPa

SWELLING MEASUREMENT

Client:J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol

Operator : A.S.
Date of test completion: 23/01-01/02/2023

BH.: 2
Depth: 5,50-6,00 m

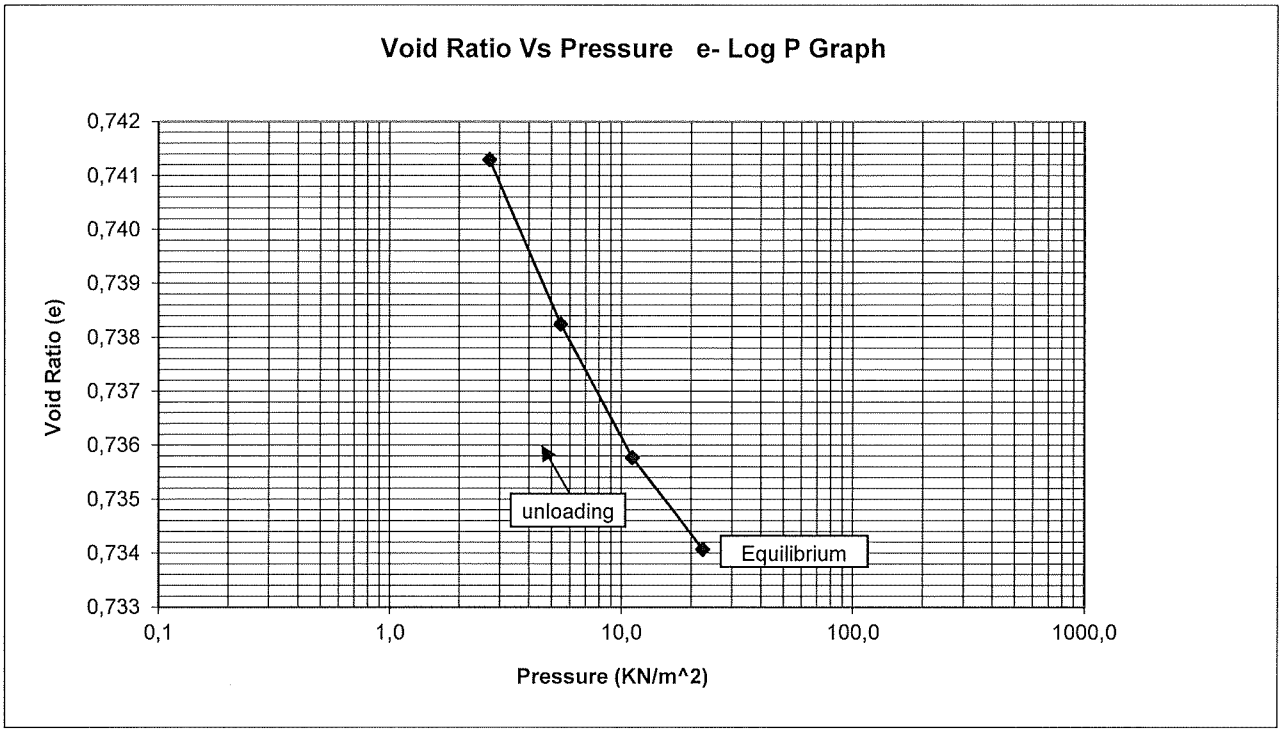


GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ Tel. : 22-330093 , Fax : 22-330118, P.O.BOX : 20476, NICOSIA

SWELLING MEASUREMENT

Client:J+A Philippou architects-engineers L.I **BH No:** 2 **Date of testing:** 30/01-07/02/2023

Project: MALL of Limassol **DEPTH:**5,50-6,00m **Descr. of material:** Cl to very clayey Silt and San



Equilibrium conditions established after 611 min at 18.176 Kg

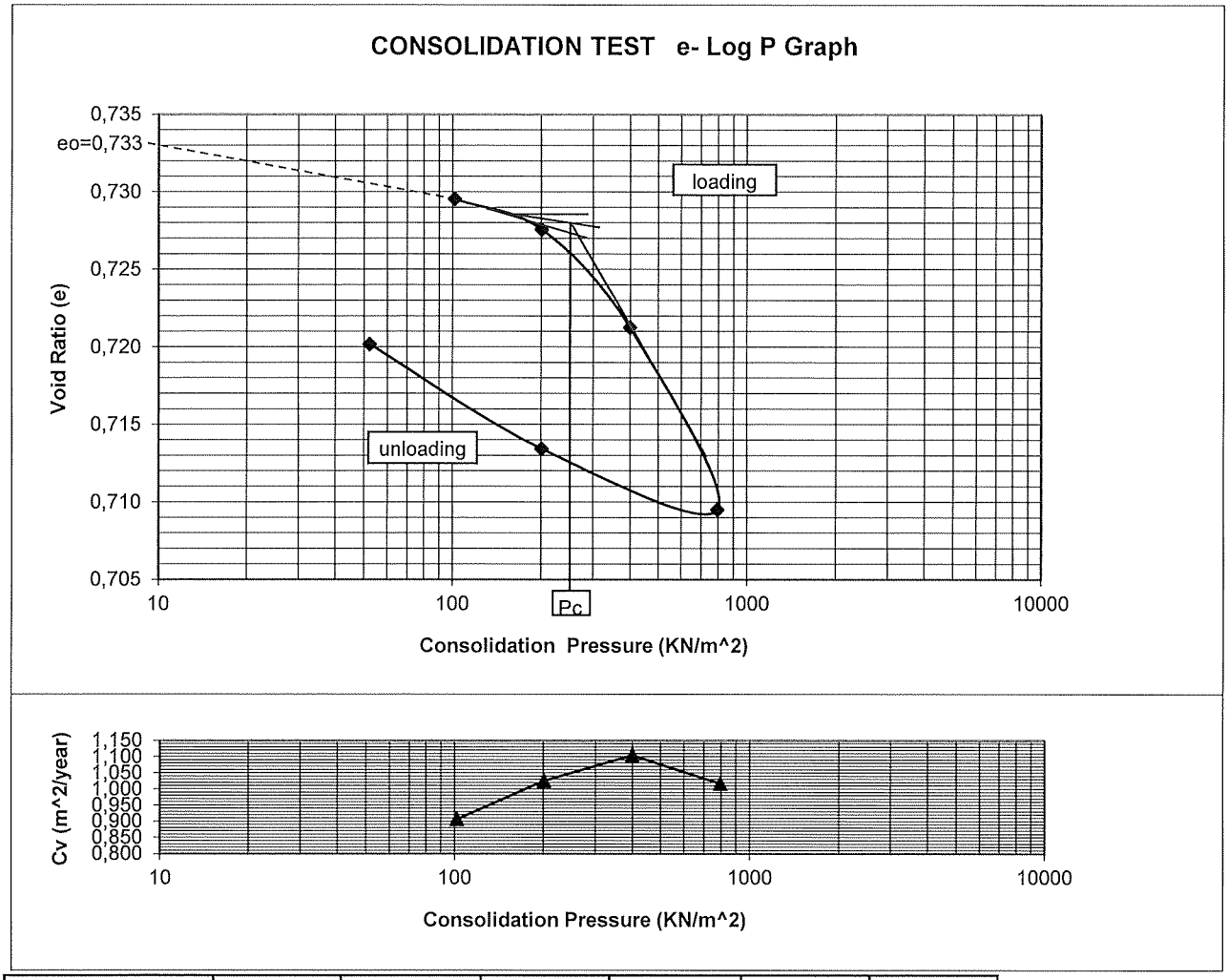
Unload * (Kg) (KN/m^2)	0,798 22	0,341 11	0,112 5	0 3
Swelling (mm)	-0,012	-0,0195	-0,0285	-0,035
Net Total Swelling (ΔH)	-0,012	-0,0315	-0,06	-0,095

* Initial loading (1,096 Kg) not included

Initial moisture content	:	16,8	%
Final moisture content	:	18,5	%
Initial Bulk Density	:	1,762	Mg/m^3
Sp. Gravity	:	2,615	
Diameter of sample	:	71,1	mm
Thickness of sample	:	17,9	mm
Condition of sample	:	Core	

CONSOLIDATION TEST
According to CEN ISO/TS 17892-5:2004

Client:J+A Philippou architects-engineers L.L. **BH No:** 2 **Date of testing:** 30/01-07/02/2023
Project: MALL of Limassol **DEPTH:**5,50-6,00m **Descr. of material:** Cl to very clayey Silt and S



Load &Unload(Kg)	4	8	16	32	8	2
(KN/m^2)	102	201	399	796	201	52
Settlement (mm)	0,04	0,0225	0,0725	0,135	-0,045	-0,0775
Net Total Settlement (ΔH)	0,04	0,0625	0,135	0,27	0,225	0,1475
Settlement(mm/m	2,23	3,49	7,54	15,08		
Μέτρο Συμπίεσης Es (MPa)	46	58	53	53		

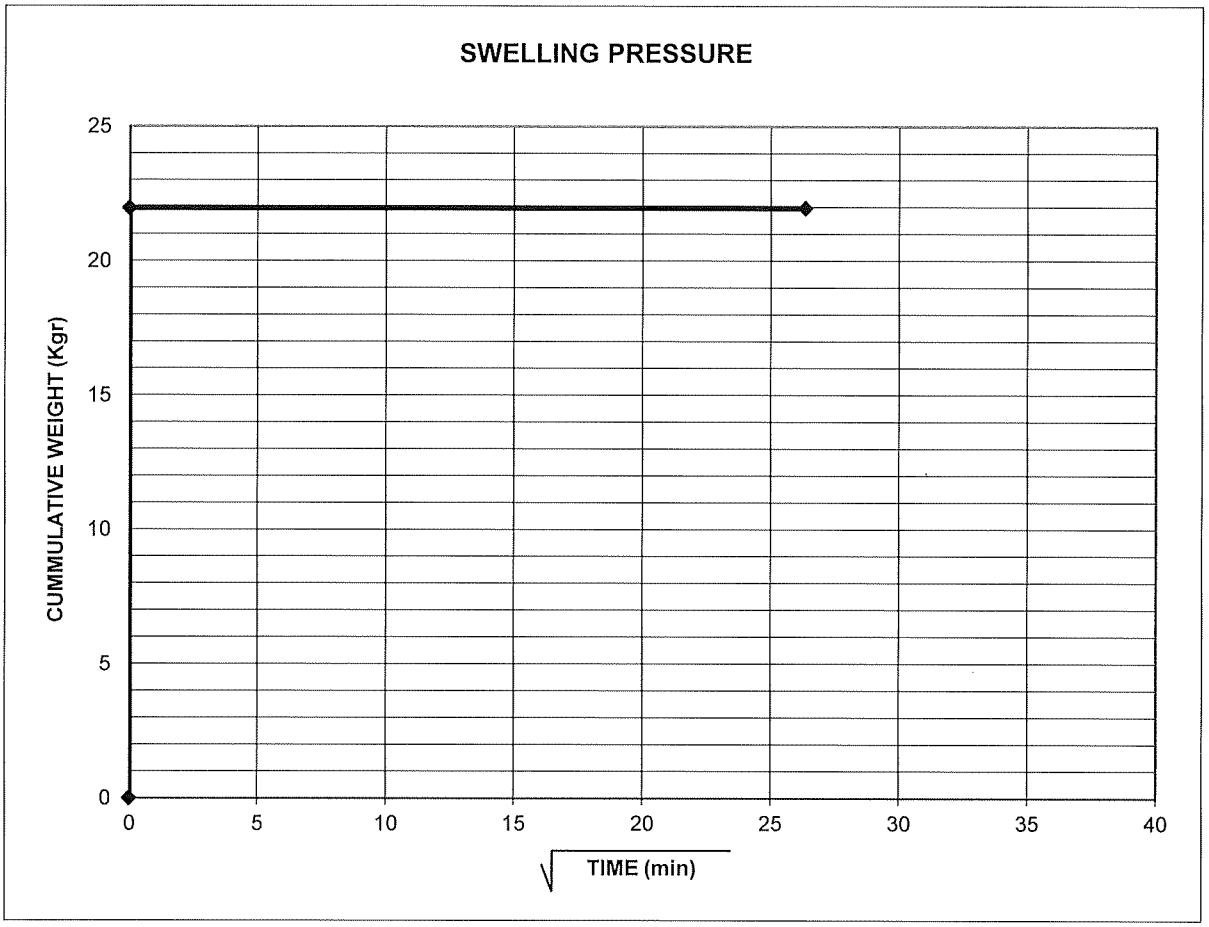
PRESSURE P (KN/m^2)	Coefficients of Mv (m^2/MN)	Coefficients of Cv (m^2/year)
102	0,020	0,907
201	0,011	1,025
399	0,018	1,106
796	0,017	1,017
201	unload	unload
52	unload	unload

Initial moisture content (%)	16,8
Final moisture content (%)	18,5
Initial Bulk Density (Mg/m^3)	1,762
Sp. Gravity	2,615
Diameter of sample (mm)	71,1
Thickness of sample (mm)	17,9
O.C.R.	**2,5**

Mv: Coefficient of volume compressibility
Cv: Coefficient of consolidation
Condition of Sample: Core

SWELLING PRESSURE

Client:J+A Philippou architects-engineers L.L **Operator :** A.S. **BH.:** 5
Project: MALL of Limassol **Date of test compl.:**30/01/2023 **Depth:**7,00-7,50m
Site : Mesa Yitonia/Limassol **Descr. of material:** Sandy, clayey Silt
Condition of sample: Core

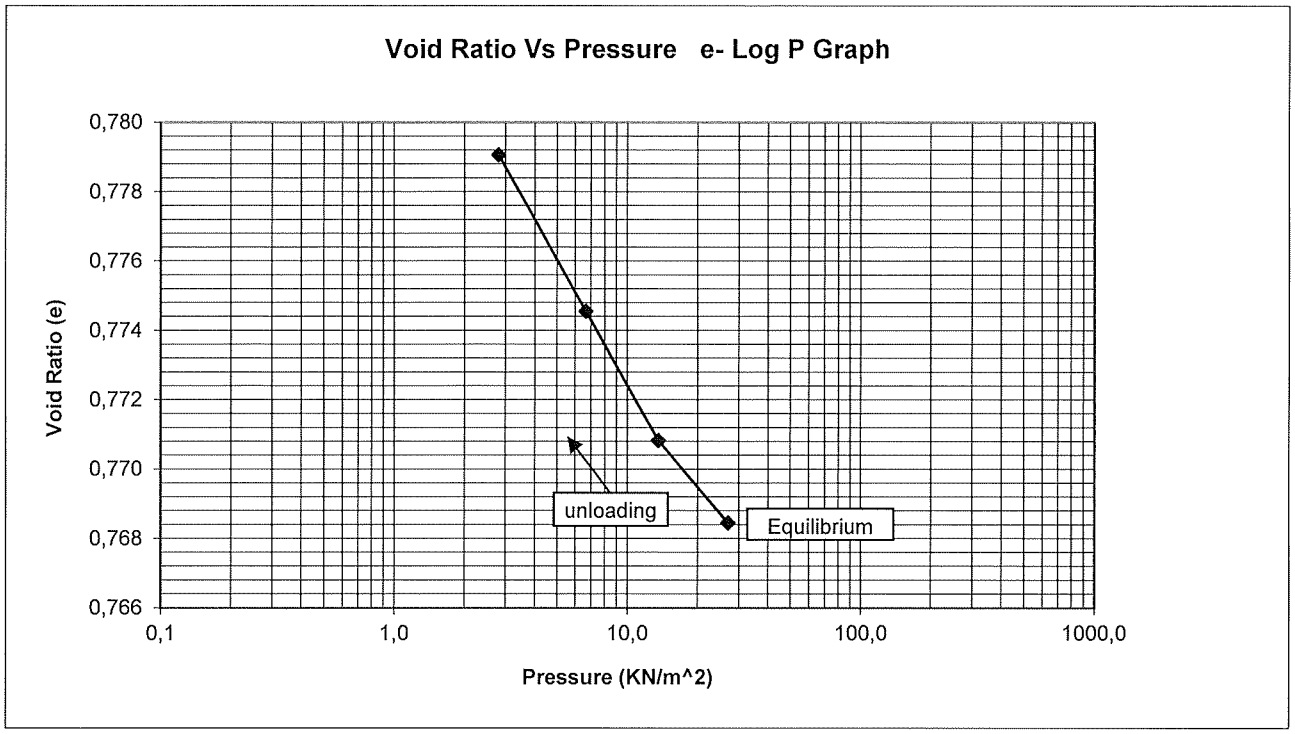


SWELLING PRESSURE :	54	kPa

SWELLING MEASUREMENT

Client:J+A Philippou architects-engineers L.L. **BH No:** 5 **Date of testing:** 30/01-07/02/2023

Project: MALL of Limassol **DEPTH:**7,00-7,50m **Descr. of material:** Sandy, clayey Silt



Equilibrium conditions established after 695 min at 21,972 Kg

Unload * (Kg) (KN/m^2)	0,978 27	0,429 14	0,156 7	0 3
Swelling (mm)	-0,016	-0,0265	-0,0415	-0,0503
Net Total Swelling (ΔH)	-0,016	-0,0425	-0,084	-0,1343

* Initial loading (1,132 Kg) not included

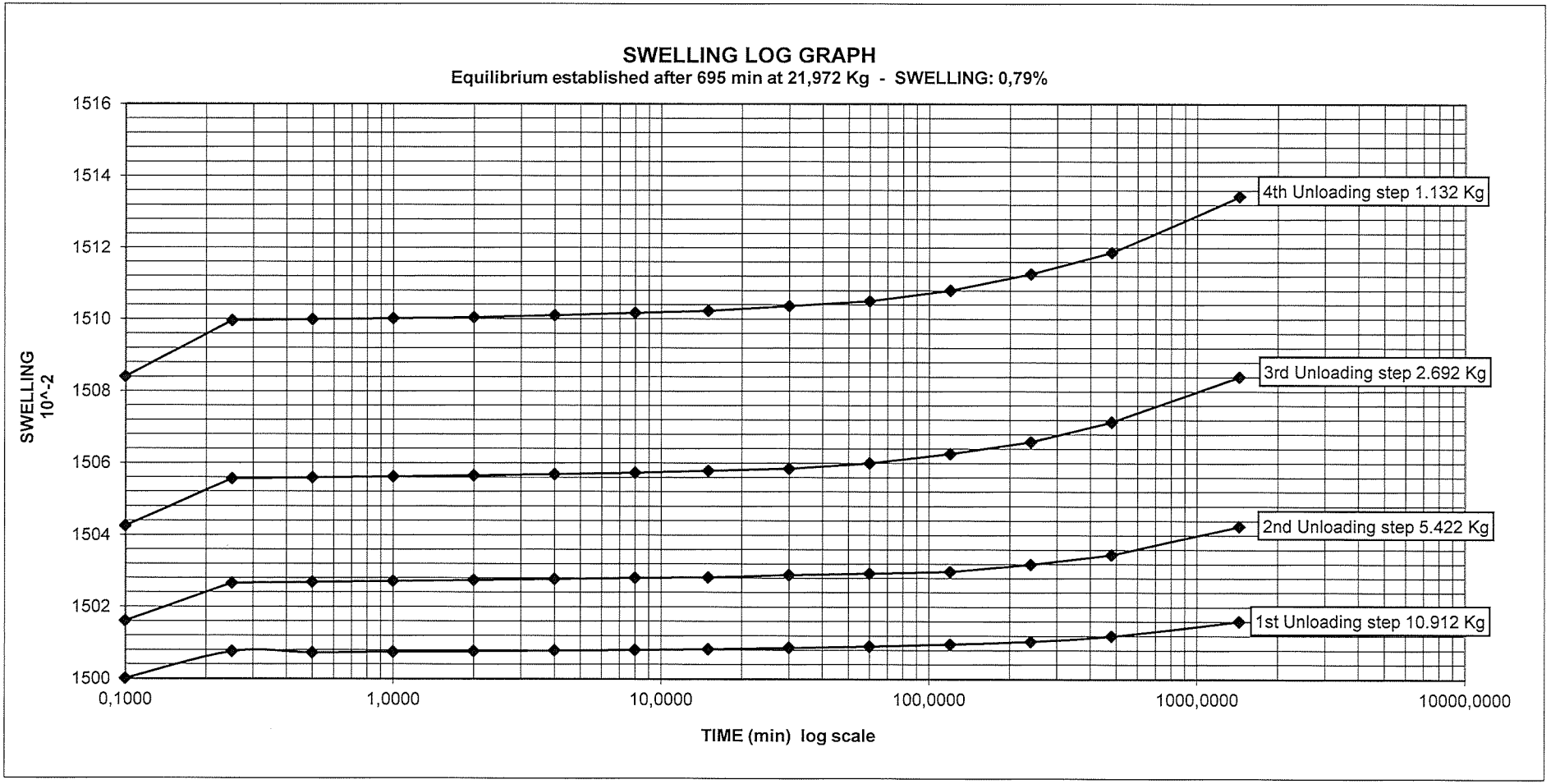
Initial moisture content	:	18,9	%
Final moisture content	:	19,6	%
Initial Bulk Density	:	1,799	Mg/m^3
Sp. Gravity	:	2,674	
Diameter of sample	:	71,3	mm
Thickness of sample	:	19,7	mm
Condition of Sample	:	Core	

SWELLING MEASUREMENT

Client:J+A Philippou architects-engineers L.L.C
Project: MALL of Limassol

Operator : A.S.
Date of test completion: 30/01-07/02/2023

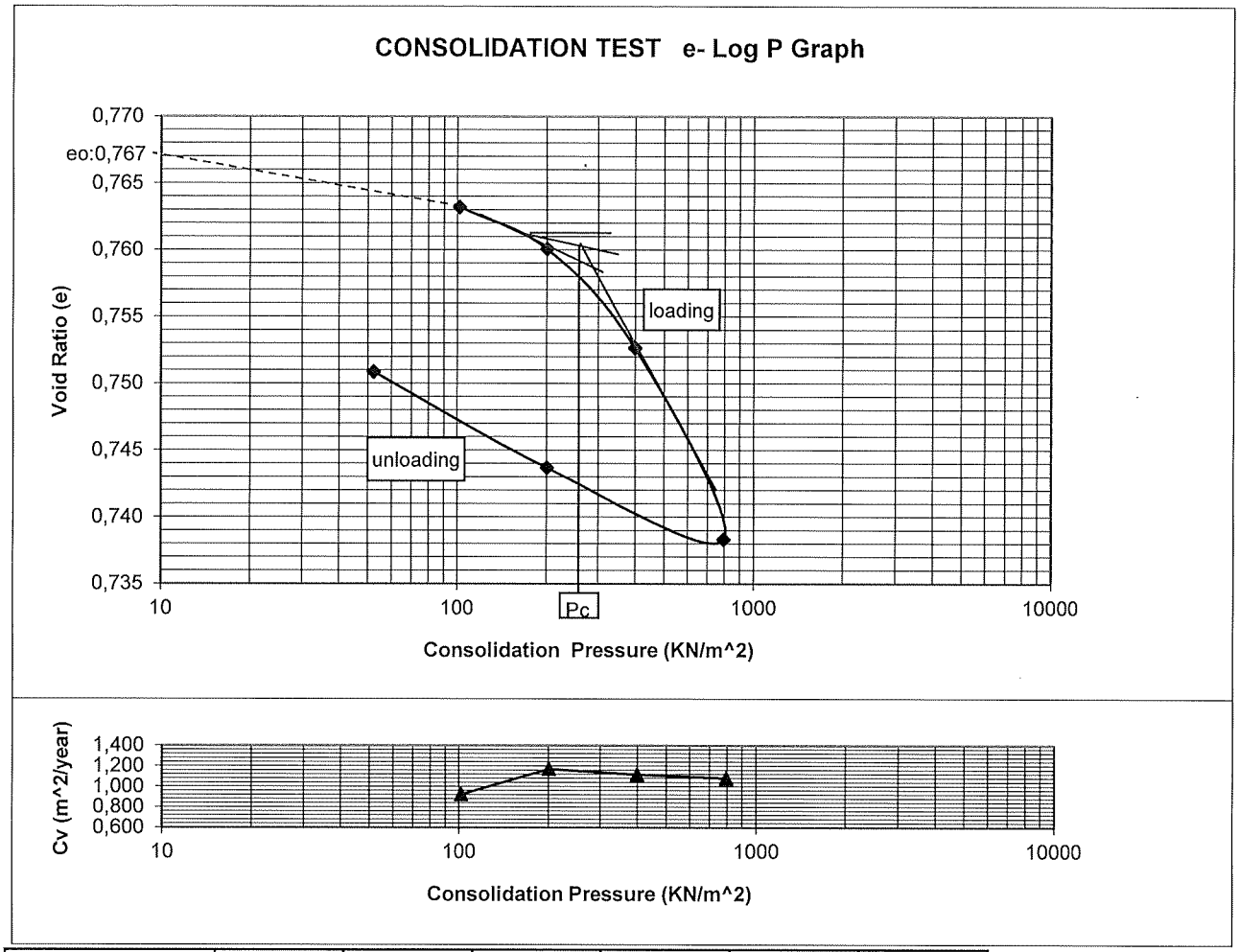
BH.: 5
Depth: 7,00-7,50m



GEOINVEST LTD - ΓΕΩΕΡΕΥΝΑ Tel. : 22-330093 , Fax : 22-330118, P.O.BOX : 20476, NICOSIA

CONSOLIDATION TEST
According to CEN ISO/TS 17892-5:2004

Client:J+A Philippou architects-engineers L.l **BH No:** 5 **Date of testing:** 30/01-07/02/2023
Project: MALL of Limassol **DEPTH:**7,00-7,50m **Descr. of material:** Sandy, clayey Silt



Load &Unload(Kg)	4	8	16	32	8	2
(KN/m^2)	102	201	399	796	201	52
Settlement (mm)	0,0425	0,035	0,0825	0,16	-0,06	-0,08
Net Total Settlement (ΔH)	0,0425	0,0775	0,16	0,32	0,26	0,18
Settlement(mm/m)	2,16	3,93	8,12	16,24		
Μέτρο Συμπίεσης (MPa)	47	51	49	49		

PRESSURE P (KN/m^2)	Coefficients of Mv (m^2/MN)	Cv (m^2/year)
102	0,021	0,924
201	0,018	1,173
399	0,021	1,115
796	0,021	1,080
201	unload	unload
52	unload	unload

Initial moisture content (%)	18,9
Final moisture content (%)	19,6
Initial Bulk Density (Mg/m^3)	1,799
Sp. Gravity	2,674
Diameter of sample (mm)	71,3
Thickness of sample (mm)	19,7
O.C.R.	**1,9**

Mv: Coefficient of volume compressibility
Cv: Coefficient of consolidation
Condition of sample: Core