ANNEXURE-I

HYDROLOGICAL ASSESSMENT

C O N T E N T S

Page / Plan No.

APPENDICES

REPORT ON SUB-SOIL INVESTIGATION OF THE PROPOSED OVER HEAD & UNDERGROUND WATER TANK AT BLOCK-L, GULBERG- III ISLAMABAD

SWIS-TECH

ENGINEERS & CONTRACTORS
Plot No. A-336, Ittefaq Town, Bahadur Khan Road
Chour Depot, Peshawar Road
Rawalpindi

Phone: 051 – 5474550
Fax: 051 – 5492983
E-mail: raisagha@gmail.com

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REPORT ON SUB-SOIL INVESTIGATION OF THE PROPOSED OVER HEAD & UNDERGROUND WATER TANK AT BLOCK-L, GULBERG-III ISLAMABAD

INTRODUCTION:

The IB Employee's Cooperative Housing Society, IBECHS, the Client, is developing a landmark housing project named Gulberg Islamabad located at Islamabad Expressway. Messrs Urban Planning and Design (Pvt) Ltd, Islamabad, is rendering the planning and designing services. As a part of the project, various residential blocks are being developed and to fulfill the Water requirement of these blocks, Overhead and Underground Water Tanks of One Lac Gallons capacity are proposed to be constructed in each block. One such facility is proposed in BLOCK-A also. Prior to the structural design and construction of the proposed structures, it is required to carry-out detailed sub-soil investigation of the proposed site. The object of this investigation is to ascertain the allowable bearing capacity of the soil and other geological features to design a safe, sound and an economical foundation for the proposed structures.

For the purpose, the work of sub-soil investigation was entrusted to Messrs SWIS-TECH, Engineers & Contractors, Rawalpindi, by Al kamal enterprises.

On the basis of field and laboratory work of the proposed site, this detailed report is being submitted respectfully which gives full account of field and laboratory testing activities, describes subsurface conditions and incorporates engineering recommendation regarding the design of foundation of the proposed structures.

SCOPE OF WORK:

The foreseen work was comprised of the following:

1. Drilling of two (3) boreholes of 30-ft depth at the location of Underground Water Tank.
2. Execution of Standard Penetration Test (SPT) at 5-ft interval or as selected by the Geo-technical Engineer.
3. Collection of disturbed and undisturbed soil samples.
4. Execution of necessary laboratory tests.
5. Elaboration and submission of FINAL REPORT stating type of foundation and bearing capacity of soils.

LOCATIONS OF BOREHOLES:

Location of site and boreholes were provided by the Project Manager of Al-Kamal International. Locations of these boreholes can be seen from the appended Plan No. 4911 – 01.

FIELD WORK:

Progress of fieldwork, bore by bore, can be seen from the following table:

Progress of Work

BH. No.	Location	Date of Starting	Date of Completion	Depth
1.	O/H Water Tank	21-01-2013	22-01-2013	50-ft
2.	O/H Water Tank	22-01-2013	22-01-2013	50-ft
3.	U/G Water Tank	23-01-2013	23-01-2013	35-ft
4.	U/G Water Tank	23-01-2013	23-01-2013	35-ft

Standard Penetration Tests were performed at an interval of 5-ft. S.P.T. / disturbed soil samples were collected and preserved for visual inspection and conducting the laboratory testing. All collected samples were properly preserved, labeled and transported to SWIS-TECH laboratory. The entire fieldwork was carried out under the direct supervision of Project Manager and an experienced Geo-technical Engineer on the behalf of the firm.

IN-SITU TESTING:
STANDARD PENETRATION TEST:

The standard penetration test (ASTM D – 1586) is a sounding method of sub-surface exploration with the general purpose of evaluating the characteristics, firmness and density of soils. Besides the empirical application of foundation investigation another important advantage of this test is that a sample is retained for visual inspection, classification or laboratory testing. The sampler is also called a split spoon, consists of a thick walled steel tube, split lengthwise. To the lower end is attached a cutting shoe, to the upper end, a check valve and connector to the drill rods. The standard size $1^3/_8$ in. ID and 2 in. OD, is generally used. The hole is drilled upto the desired depth or until a change in the soil is detected. The drill tool is removed and the sampler lowered to the bottom of the hole. It is first driven 6 in. into the soil to ensure that the cutting edge is seated in virgin material. It is then driven 12 in. in 6 in. increments with a 63.5 kg (140 lbs) hammer of falling 30 in. The number of blows for each 6 in. of penetration is recorded. The standard penetration resistance, N, is the sum of the second and third increments.

S.P.T. blows and N-values as encountered at site in four (4) boreholes are given on appended Bore Logs and also on the following page for a quick reference and comparison:

COMPARISON OF S.P.T. BLOWS & N-VALUES ENCOUNTERED AT SITE IN '4' BOREHOLES

Depth	BH – 1		BH – 2		BH – 3		BH – 4	
	SPT Blows	N-Value	SPT Blows	N-Value	SPT Blows	N-Value	SPT Blows	N-Value
5'-0"	3 + 4 + 6	10	3 + 5 + 7	12	3 + 4 + 7	11	3 + 4 + 5	9
10'-0"	7 + 12 + 19	31	7 + 6 + 8	14	5 + 5 + 7	12	30 + 20/1"	Refusal
15'-0"	5 + 5 + 6	11	3 + 4 + 7	11	2 + 3 + 4	7	2 + 3 + 4	7
20'-0"	4 + 5 + 6	11	2 + 3 + 5	8	2 + 3 + 4	7	2 + 3 + 4	7
25'-0"	3 + 3 + 5	8	3 + 3 + 3	6	3 + 5 + 5	10	2 + 2 + 3	5
30'-0'	3 + 3 + 7	10	9 + 5 + 6	11	11 + 5 + 5	10	4 + 4 + 6	10
35'-0"	4 + 6 + 6	12	4 + 6 + 6	12	3 + 3 + 4	7	3 + 4 + 5	9
40'-0"	4 + 5 + 8	13	3 + 4 + 7	11	-	-	-	-
45'-0"	6 + 6 + 8	14	5 + 7 + 10	17	-	-	-	-
50'-0"	8 + 11 + 11	22	6 + 9 + 12	21	-	-	-	-

BH-1 and BH-2 were drilled upto 50 feet at the location of OHWT and BH-3 and BH-4 were drilled upto 35 feet at the location of UGWT.

LABORATORY TEST:

The laboratory tests on the selected soil samples were performed on the basis of sub-soil encountered at the site to classify sub-soil properly and to obtain the design parameters for the determination of soil bearing capacity. Following laboratory tests were conducted in the laboratory:

1. Natural Moisture Content.
2. Grain Size Distribution by Sieve Analysis.
3. Grain Size Distribution by Hydrometer Analysis.
4. Atterberg's Limits.
5. Bulk Density.
6. Unconfined Compression Test.
7. Consolidation Test.

The above tests were performed in the SWIS-TECH laboratory under the supervision of Mr. Rais Agha, B.E. (Civil), as per ASTM and AASHTO standard procedures of testing. Results of the same are appended in the report as Abstract Data On Laboratory Test Results Plan No: 4645 – 06/09.

NATURE OF SUB-SURFACE:

Total Four (4) boreholes were located at the proposed site, two each at the locations of Overhead and Underground Water Tank. BH-1 and BH-2 were located at the proposed site for Overhead Tank and drilled upto 50-ft depth and BH-3 and BH-4 were located at the site of Underground Tank and drilled upto 35-ft. These both sites are located at the junction of L-15 (40 feet) and L-16 (40 feet) roads in Block-L of Gulberg-III. Locations of these boreholes can be seen from the appended location plan No. 4645 - 01. This site has a bit undulated topography with a variation of 3 to 4 feet, but for simplicity Reduced Level for all boreholes has been taken as 872.16 feet as provided by the Project manager. The study of Bore Logs, field and laboratory test results reveals almost uniform sub-soil conditions in all four boreholes, which are explained as follows:

BH - 1:

0'-0" / 10'-0": Brown to slightly reddish brown, moist, firm, medium plastic, LEAN CLAY (CL) / SILTY CLAY (CL-ML) trace sand. Borderline soil. N-value is found as 10 at 5-ft with reasonably stiff samples.

10'-0" / 14'-0": Brown to slightly reddish brown, slightly moist, hard, low plastic, SANDY SILTY CLAY (CL-ML). With N = 31 and more sand content, this is a good and suitable load bearing stratum, but low liquid limits with 33% sand. This stratum can imbibe water easily.

14'-0" / 20'-0": Brown to slightly reddish brown, moist, firm to stiff, low plastic, LEAN CLAY (CL) trace sand. This is a moderate load bearing stratum with N = 11 and q_u value on 12-ft UDS is noted as 1.273 kg/cm^2. Sub-soils upto this depth is quite favourable for foundation placement of an Overhead Tank, but problematic soils started after this depth.

20'-0" / 50'-0": In-situ moistures increase after 20-ft and soil becomes soft and compressible. N-values vary from 8 to 13. Excessive seepage is found at 17-ft, which virtually accumulated at the same depth and GWT can be said maintained at the same depth. Now, this has affect soil strength and compressibility a lot. Samples recovered are relatively softer as compare to N-values. Fortunately, two UDS were collected from this stratum and produced q_u values around 0.75 kg/cm^2. This is a lower strength as compare to upper stratum; moreover compressibility in this stratum would also affect the maximum safe allowable bearing. Strength of soil improved at 50'-0", but most unfortunately that was the depth of termination of borehole.

BH - 2:

0'-0" / 11'-0": Brown to reddish brown, slightly moist to moist, stiff, low to low-medium plastic, LEAN CLAY (CL) / SILTY CLAY (CL-ML) trace sand. Borderline soil.

11'-0" /15'-0": Brown to reddish brown, slightly moist, stiff, low plastic, SANDY SILT (ML).

15'-0" / 20'-0": Brown to slightly reddish brown, slightly moist, firm to stiff, low plastic, LEAN CLAY (CL) trace sand.

20'-0" / 24'-0": Brown to slightly reddish brown, moist to wet, firm, low plastic, LEAN CLAY (CL) trace sand & clay nodules. Soft and compressible stratum.

24'-0" / 30'-0": Brown to slightly reddish brown, moist to wet, loose, fine-grained, SILTY SAND (SM). High fine content (46%). Soft and compressible stratum.

30'-0" / 36'-0": Brown to slightly reddish brown, moist to wet, loose to medium dense, fine-grained, SILTY CLAYEY SAND (SC-SM). At 30'-0" a thin 6" layer of soft SANDSTONE is encountered.

36'-0" / 40'-0": Brown to slightly reddish brown, moist to wet, stiff, low plastic, SILTY CLAY with sand (CL-ML) trace clay nodules. Soft and compressible stratum.

40'-0" / 43'-0": Brown to slightly reddish brown, moist, firm to stiff, low plastic, SANDY SILTY CLAY (CL-ML). Soft and compressible stratum.

43'-0" / 50'-0": Brown to slightly reddish brown, slightly moist, very stiff to medium hard, low plastic, SANDY LEAN CLAY (CL) trace clay nodules. Pockets of dark brown colour are also found at 45'-0".

BH - 3:

0'-0" / 8'-0": Brown to slightly reddish brown, slightly moist, firm to stiff, low to medium plastic, LEAN CLAY (CL) / SILTY CLAY (CL-ML) trace sand.

8'-0" /14'-0": Brown to slightly reddish brown, dry to slightly moist, stiff, low plastic, SANDY SILT (ML) trace clay nodules.

14'-0" / 18'-0": Brown to slightly reddish brown, moist, soft to firm, low plastic, SILTY CLAY (CL-ML) trace sand.

18'-0" / 24'-0": Brown to slightly reddish brown, moist, soft to firm, low to low-medium plastic, SILT (ML) trace sand. Soft and compressible stratum.

24'-0" / 30'-0": Brown to slightly reddish brown to slightly greyish brown, wet, loose, fine-grained, SILTY SAND (SM). High fine content (47%). Problematic stratum.

30'-0" / 35'-0": Thin layer of gravel (~3") is encountered at 30'-0" followed by brown, slightly reddish to slightly greyish, wet, firm, low plastic, SANDY SILTY CLAY (CL-ML).

BH - 4:

0'-0" / 6'-0": Brown to reddish brown, slightly moist, firm, low to low-medium plastic, LEAN CLAY (CL) trace to little sand.

6'-0" / 10'-0": Same stratum as above, but sand content is increased: Brown to reddish brown, slightly moist, firm, low to low-medium plastic, LEAN CLAY with sand (CL).

10'-0" / 10'-8": Greyish brown, soft, SANDSTONE.

10'-8" / 17'-0": Brown to slightly reddish brown, slightly moist to moist, soft to firm, low plastic, LEAN CLAY (CL) trace sand.

17'-0" / 24'-0": Same stratum as above, but moisture content increased considerably i.e. Brown to slightly reddish brown, moist to wet, soft to firm, low plastic, LEAN CLAY (CL) trace sand. Soft and compressible stratum.

24'-0" / 30'-0": Brown, slightly reddish to slightly greyish, moist to wet, soft to firm, low plastic, SANDY SILT (ML). Soft and compressible stratum.

30'-0" / 35'-0": A very thin layer of Gravel is encountered at 30'-0" followed by brown to slightly reddish brown, moist to wet, firm, low plastic, SANDY SILTY CLAY (CL-ML). Sand content reduces at 35'-0": SILTY CLAY with sand (CL-ML) trace mica.

GROUND WATER TABLE:

Ground Water Table is encountered in all four boreholes at the depth mentioned as follows:

Location	Borehole No.	Depth
Overhead Tank	BH-1	30'-0"
	BH-2	27'-0"
Underground Tank	BH-3	27'-0"
	BH-4	27'-0"

FOUNDATION REQUIREMENTS:

Foundation is considered satisfactory if it fulfills the following requirements:

a) It must be adequately safe against shear failure.
b) It must not undergo excessive differential settlement.
c) It must be placed at a depth un-affected by the influence of weather.

FOUNDATION DESIGN:

This site reveals almost uniform sub-soil conditions in all four boreholes with slight variation in classification and strength. Values of cohesion 'c' vary in four boreholes from 947 to 779 psf within the influence zone with an average of 871 psf, which would be rounded to 870 psf in design analyses. Considering the proposed structure i.e. an Overhead and Underground Water Tank, RAFT seems to be the most suitable type of foundation until or unless some other constrains could not be followed.

Design analysis of a RAFT foundation comprises of the following:

1) Estimation of an allowable soil pressure based on shear strength consideration.

2) That soil design pressure and footing geometry are then checked to assure that the settlement under the prescribed load / pressure lies within tolerable ranges for the structures, and if required refine or possibly further limit the assigned bearing pressure.

Alternatively, safe soil pressures are estimated both for shear failure and for the maximum settlements allowed (upto 3" for raft) and lower of the two is used as the safe allowable bearing capacity. This approach will be used here in foundation analysis.

Shear strength analysis is based on the Bearing Capacity equations proposed by Terzaghi and J.B. Hansen, whereas, immediate settlement analysis, which predominates in this case, will be carried out accordingly though a margin for Consolidation Settlements should also be kept.

ULTIMATE BEARING CAPACITY ANALYSIS:

Bearing capacity equations as proposed by Professor Karl Terzaghi and J.B. Hansen have been used in the shear strength analysis. However, details of Hansen's bearing equation are only being given as under:

$q_u = c \cdot N_c \cdot s_c \cdot d_c + \gamma \cdot D_f \cdot N_q \cdot s_q \cdot d_q + 0.5\ \gamma\ B N_\gamma\ s_\gamma\ d_\gamma$

where,

q_u = ultimate bearing capacity.

c = cohesion of soil (measured from Lab. Test) = ½ qu

$\varnothing$ = angle of internal friction = 0 for Clay

N_c, N_q, N_γ = bearing capacity factor depends on $\varnothing$.

$N_q = e^{\pi \tan \varnothing} \cdot \tan^2 (45 + \varnothing/2)$

$Nc = (N_{q-1}) \cot \varnothing$

$N_\gamma = 1.5\ (N_{q-1}) \tan \varnothing$

γ = effective unit weight of soil (from field test).

B = width of foundation = varies.

D_f = depth of foundation = 10'-0" from NSL.

$s_c = 1.0 + N_q / N_c \cdot B/L$ = 1for strip foundation

$d_c = 1.0 + 0.4\ k$ where $k = D/B$ for $D/B \leq 1$

or $k = \tan^{-1} D/B$ for $D/B > 1$

$s_q = 1.0 + B/L \cdot \text{Sin}\varnothing$ = 1 for strip foundation.

$D_q = 1.0 + 2 \tan \varnothing (1 - \text{Sin}\varnothing)^2 \cdot k$; k as above.

$s_\gamma = 1.0 - 0.4\ B/L \geq 0.6$ = 1 for strip foundation.

$d\gamma$ = 1.0 for all $\varnothing$.

On the basis of above equations, we have calculated the ultimate bearing capacity of different types of shallow footings, though for this particular case, analysis only for square footings could be sufficient. However, for a comparison and some future use, detailed analysis for different types of footings are done, using the design parameters obtained from laboratory. A F.O.S. '3' is applied to the calculated ultimate bearing capacity values to obtain safe net allowable soil pressure. Summarized results are given on the following page.

DESIGN PARAMETERS AND NET ALLOWABLE BEARING CAPACITY ON THE BASIS OF SHEAR FAILURE

Design Parameters		**Average Parameters**	
c		870 psf	
∅		0	
Equation		**T**	**H**
Nc		5.7	5.14
Nq		1	1
Nγ		0	0
CIRCULAR / SQUARE RAFT	B = 42'-0"	0.975	0.876
	B = 52'-0"		0.864

T = Terzaghi's Equation H = Hansen's Equation. Above $q_{allowable}$ are in Tsf with a FOS '3'.

To simplify, we can summarize the results of allowable bearing capacities against shear failure as a single value of **0.90 Tsf**, which must be checked against the settlement.

SETTLEMENT ANALYSIS:

Settlements are generally made up of immediate, consolidation and secondary compression components.

In cohesionless soil and unsaturated clays the immediate settlement predominates whereas in fine grained saturated cohesive formation consolidation settlement predominates; with other components do also contribute. At the proposed site, upper soils generally comprised of unsaturated cohesive soils, but underneath soils just after 15 to 20 feet have high moisture, in fact water Table is present at 27 to 30 feet, thus, both immediate and consolidation settlement contribute in total settlement.

Following equations are used for settlement analyses:

Immediate Settlement Analysis:

$\Delta Hi = q_o B' (1 - \mu^2/E_s) m I_s I_F$ and

where,

q_o = safe soil contact pressure against shear failure.

B' = effective width of foundation = varies

μ = poisson's ratio = 0.35

E_s = modulus of deformation = varies

m = 4 at center.

I_s, I_F = Steinbrenner and Fox influence factors.

Consolidation Settlement Analysis:

$\Delta Hc = Cc\ H\ /\ 1+e_o\ [\ \log p'_o\ +\ \Delta p/p_o\ ]$

where,

C_c = consolidation index (lab. test)

H = stratum thickness

e_o = void ratio (lab. test)

p'_o = effective overburden pressure at mid height of H.

Δp = average increase in pressure from $q_{allowable}$.

RESULTS OF SETTLEMENT ANALYSIS:

SETTLEMENT VALUES:

Conservatively, analyses are carried out for D_f = 10'-0", using the average parameters obtained from all boreholes.

Using the allowable bearing capacity value 0.90 Tsf obtained from ultimate bearing analysis, settlement values as obtained are as follows:

SETTLEMENT VALUES

Type of Footing	Size of Footing	ΔH (mm)
RAFT (0.90 Tsf)	B = 42' x 42'	99.8 mm
RAFT (0.90 Tsf)	Dia = 52'	124.7 mm

Settlement values obtained are quite excessive and certainly needs an adjustment in allowable loads or otherwise an increase in foundation size. This can be seen from the above analysis that a larger footing gives a lower bearing value. This is because of the fact that a larger footing settles more as it affects the soil to a greater depth and thus, strain integrated over greater depth produce a larger settlement. On the other hand low bearing value leads to a larger width. These two requirements are opposed to each other, and a compromise is always necessary.

Conversely, safe soil pressures can be estimated for the maximum settlements allowed (3" for raft) are given in the following table:

SAFE ALLOWABLE BEARING PRESSURE BASED ON ALLOWABLE SETTLEMENT

Type of Footing	Size of Footing	q_a (Tsf)
SQUARE RAFT	B = 42' x 42'	0.837
CIRCULAR RAFT	Dia = 52'	0.770

SUMMARY & RECOMMENDATIONS:

- Total Four (4) boreholes were selected at the proposed site, two each at the locations of Underground and Overhead Water Tank. BH-1 and BH-2 were located at the proposed site for Overhead Tank and drilled upto 50-ft depth each, whereas BH-3 and BH-4 were located at the site of Underground Tank and drilled upto 35-ft. These both sites are located at the junction of L-15 (40-ft) and L-16 (40-ft) roads in Block-L of Gulberg-III. Locations of these boreholes can be seen from the appended location plan No. 4645 - 01. This site has slight variation in topography, but for simplicity Reduced Level for these boreholes has been taken as 872.16 ft as proposed by the Project manager.

- The study of Bore Logs, field and laboratory test results reveals simple and uniform sub-soil conditions in all four boreholes. Upper soils upto 17 to 20 feet depth are slightly moist to moist, firm to stiff, of variable plasticity, LEAN CLAY (CL) / SILTY CLAY (CL-ML) with variable sand content. N-values are found varying from 7 to 12 with one exceptionally higher value of 31 at 10 ft of BH-1. Unconfined compression results vary from 1.273 to 0.779 kg/cm^2. Sub-soils upto this depth is quite favourable for foundation placement of an Underground even for an Overhead Tank also, but problematic soils started after this depth. In-situ moistures increase and soil becomes soft and compressible. N-values vary from 8 to 13. Excessive seepage is found at 17-ft, which virtually accumulated at the same depth and GWT can be said maintained at the same depth. Now, this has affect soil strength and compressibility a lot. Samples recovered are relatively softer as compare to N-values. Fortunately, UDS were collected from underneath strata and produced q_u values as low as 0.482 and 0.566 kg/cm^2. These are low strength strata and compressibility in this stratum would badly affect the maximum safe allowable bearing. Strength of soil improved at 50'-0", but most unfortunately that was the depth of termination of boreholes.

- Generally RAFT foundation is adopted for Overhead and Underground Water Tank with its certain advantages over other types of foundations. There is no substitute of RAFT for underground tank and it must be provided at the proposed site as well. However, for Overhead Tanks, other types of foundations may also be adopted depending on design requirements and of course soil conditions. Compression of soil is a primary requirement of all foundations, but legs of elevated water tanks are subjected to uplift or tension forces. Uplift may be the principal mode of resistance or may be among several possible load combinations. Drilled shafts with or without enlarged base are most commonly used to resist uplift because they are the safest foundations in compression as well as in uplift or tension. In special cases, they may be most economical also. In case of shallow foundations, most Tension Foundations are either round or square. Whatever be the selected foundation, it must be checked against uplift or tension.

- In the light of the above discussion, it is recommended to adopt following as the safe net allowable bearing capacity at or around 10'-0" from the existing ground surface:

OVERHEAD & UNDERGROUND WATER TANK

Proposed Structure	Depth of RAFT from Existing Ground Level	Reduced Level	Net Allowable Bearing Capacity
Underground Tank	10'-0"	862.00 ft	0.85 Tonne/ft^2
Overhead Tank	10'-0"	862.00 ft	0.80 Tonne/ft^2

- Above-mentioned bearing values are critically calculated and these values should be used as it is without doing any correction. Slight change in foundation depth can be done to accommodate some architectural / structural constraints. If area allocation permits, foundation sizes can be increased. In the worst case, when there is no alternate, the most suitable alternative is the provision of RCC Bored Cast-in-Situ Pile Foundations, but that would require at least one deep borehole upto 100 feet at the centre of Overhead Tank foundation for the finalization of Pile Design.

- As mentioned previously, uplift resistance heavily depends upon weight of foundation plus the weight of the soil that will be uplifted when the base is pulled up, thus, all re-fill material must be compacted under the controlled engineering practices. For guidance, this can be said that all Re-fill material must be placed in loose 8" layers with proper compaction i.e. at least upto 95% of the maximum dry density obtained in a soil laboratory from Proctor Test at optimum moisture content. Re-fill soils around and above the footings upto floor level with the proper compaction wherever required. This is essential.

- Sub-soil conditions at this site are such that vertical stability of cuts will not be any problem, but still some care will be required in foundation excavation, particularly during rains.

- Concrete floor at the Ground surface and also a concrete apron, at least 5-ft wide, must be provided along the outside perimeter of the proposed underground tank and at least 10-ft along the outside perimeter of the proposed Overhead tank to avoid any ingress of surface or rain water. For the same reason, proper arrangement for overflowing water is must.

- Proper lean concrete must be placed under the proposed foundations and before laying it all loose excavated material must be removed.

- Depth and Size of the proposed foundation must be checked against seismic loads, uplift forces or overturning moments.

Engr. Rais Agha
B.E. Civil; P.E. (Pak.)
Civil / 12099

SWIS-TECH
Engineers & Contractors
Rawalpindi.

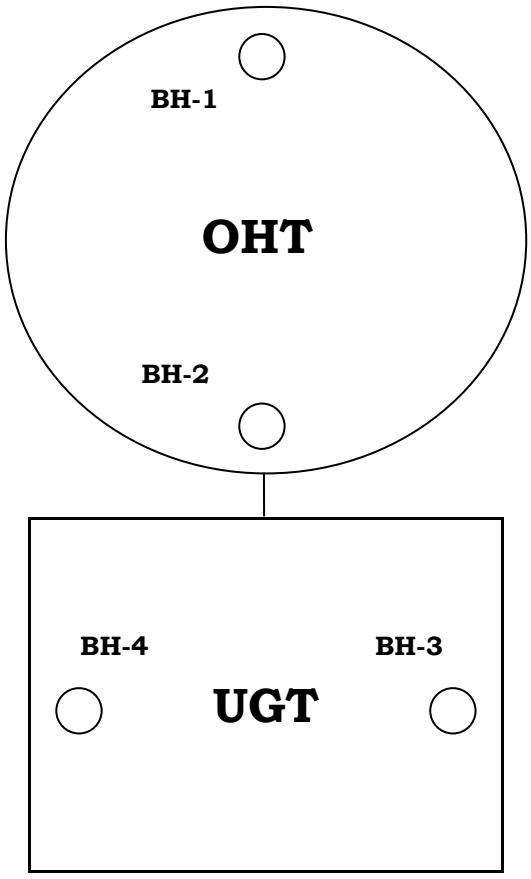
Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL **ISLAMABAD**	**AL-KAMAL INTERNATIONAL** **ISLAMABAD**

PROPOSED OVERHEAD & UNDERGROUND WATER TANK AT BLOCK-L, GULBERG-III ISLAMABAD

L – 15 (40 Feet)



L - 16
(40 Feet)

Approximate Locations of Boreholes

SWIS-TECH
ENGINEERS & CONTRACTORS
RAWALPINDI

PLAN NO. 4645 - 01

Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL **ISLAMABAD**	**AL-KAMAL INTERNATIONAL** **ISLAMABAD**

Site:

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-L, GULBERG-III
ISLAMABAD

Location: Overhead Tank **BH. No: 1 (1/2)**

DATE	REDUCED ELEVATION	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIAMETER OF BORING	STANDARD PENETRATION TESTS Blows / each 6" N-value 10 30 50 70 90	SCALE	SAMPLES DISTB.	SAMPLES UN-DISTB	SAMPLES WATER
	∇ 872.16 ft										
21-01-2013			10'-0"	Brown to slightly reddish brown, moist, firm, medium plastic, LEAN CLAY (CL) / SILTY CLAY (CL-ML) trace sand. Borderline soil		6" DIA PERCUSSION DRILLING	3 + 4 + 6 N = 10	5			
	862.16	10'-0"					7 + 12 + 19	10			
			4'-0"	Brown to slightly reddish brown, slightly moist, hard, low plastic, SANDY SILTY CLAY (CL-ML).			N = 31				
	858.16	14'-0"					5 + 5 + 6	15			
			6'-0"	Brown to slightly reddish brown, moist, firm to stiff, low plastic, LEAN CLAY (CL) trace sand.			N = 11				
	852.16	20'-0"					4 + 5 + 6	20			
			6'-0"	Brown to slightly reddish brown, moist to wet, firm, low plastic, SILTY CLAY (CL-ML) trace to little sand & clay nodules.			N = 11				
	846.16	26'-0"					3 + 3 + 5 N = 8	25			
			4'-0"	Brown to slightly reddish brown, moist to wet, firm low plastic, LEAN CLAY (CL) trace to little sand. Soft and compressible stratum.			3 + 3 + 7	30			
	842.16	30'-0"					N = 10				
			5'-0"	Brown to slightly reddish brown, moist, firm to stiff, low plastic, SILTY CLAY with sand (CL-ML) trace mica. Soft and compressible stratum.			4 + 6 + 6 N = 12	35			
	837.16	35'-0"									

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Excessive seepage is encountered & finally G.W.T. is also maintained at 30'-0".

PLAN NO. 4645 – 02 (1/2)

Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL **ISLAMABAD**	**AL-KAMAL INTERNATIONAL** **ISLAMABAD**

Site:

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-L, GULBERG-III
ISLAMABAD

Location: Overhead Tank **BH. No: 1 (2/2)**

DATE	REDUCED ELEVATION	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIAMETER OF BORING	STANDARD PENETRATION TESTS Blows / each 6" N-value 10 30 50 70 90	SCALE	SAMPLES DISTB.	SAMPLES UN-DISTB	SAMPLES WATER
	∇ 837.16 ft										
22-01-2013	832.16	40'-0"	5'-0"	Same stratum as above; but sand content reduces soil becomes; SILTY CLAY (CL-ML) trace sand & clay nodules. Soft and compressible stratum.		6" DIA PERCUSSION DRILLING	4 + 5 + 8	40			
	827.16	45'-0"	5'-0"	Brown to slightly reddish brown, moist to wet, stiff, low plastic, SANDY SILTY CLAY (CL-ML) trace clay nodules. Soft and compressible stratum.			N = 13 6 + 6 + 8	45			
	822.16	50'-0"	5'-0"	Brown to slightly reddish brown, slightly moist, stiff, low plastic, SANDY LEAN CLAY (CL). Sand content slightly reduces at 50'-0" soil becomes, LEAN CLAY with sand (CL). Black spots are found occasionally.			N = 14 8 + 11 + 11	50			
				END OF BOREHOLE			N = 22	55 60 65 70			

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Excessive seepage is encountered & finally G.W.T. is also maintained at 30'-0".

PLAN NO. 4645 – 02 (2/2)

Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL **ISLAMABAD**	**AL-KAMAL INTERNATIONAL** **ISLAMABAD**

Site:

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-L, GULBERG-III
ISLAMABAD

Location: Overhead Tank **BH. No: 2 (1/2)**

DATE	REDUCED ELEVATION	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIAMETER OF BORING	STANDARD PENETRATION TESTS Blows / each 6" N-value (10 30 50 70 90)	SCALE	SAMPLES DISTB.	SAMPLES UN-DISTB	SAMPLES WATER
	∇ 872.16 ft										
22-01-2013			11'-0"	Brown to reddish brown, slightly moist to moist, stiff, low to low-medium plastic, LEAN CLAY (CL) / SILTY CLAY (CL-ML) trace sand. Borderline soil.		6" DIA PERCUSSION DRILLING	3 + 5 + 7 N = 12 7 + 6 + 8 N = 14	5 10			
	861.16	11'-0"									
			4'-0"	Brown to reddish brown, slightly moist, stiff, low plastic, SANDY SILT (ML).			3 + 4 + 7 N = 11	15			
	857.16	15'-0"									
			5'-0"	Brown to slightly reddish brown, slightly moist, firm to stiff, low plastic, LEAN CLAY (CL) trace sand.			2 + 3 + 5 N = 8	20			
	852.16	20'-0"									
			4'-0"	Brown to slightly reddish brown, moist to wet, firm, low plastic, LEAN CLAY (CL) trace sand & clay nodules. Soft and compressible stratum.			3 + 3 + 3 N = 6	25			
	848.16	24'-0"									
			6'-0"	Brown to slightly reddish brown, moist to wet, loose, fine-grained, SILTY SAND (SM). High fine content (46%). Soft and compressible stratum.			9 + 5 + 6 N = 11	30			
	842.16	30'-0"									
			5'-0"	Brown to slightly reddish brown, moist to wet, loose to medium dense, fine-grained, SILTY CLAYEY SAND (SC-SM). At 30'-0" a thin 6" layer of soft SANDSTONE is encountered.			4 + 6 + 6 N = 12	35			
	837.16	35'-0"									

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ENGINEERS & CONTRACTORS
Rawalpindi

Excessive seepage is encountered & finally G.W.T. is also maintained at 27'-0".

PLAN NO. 4645 – 03 (2/2)

Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL **ISLAMABAD**	**AL-KAMAL INTERNATIONAL** **ISLAMABAD**

Site:

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-L, GULBERG-III
ISLAMABAD

Location: Overhead Tank **BH. No: 2 (2/2)**

DATE	REDUCED ELEVATION	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIAMETER OF BORING	STANDARD PENETRATION TESTS Blows / each 6" N-value (10 30 50 70 90)	SCALE	SAMPLES DISTB.	SAMPLES UN-DISTB	SAMPLES WATER
	∇ 837.16 ft										
22-01-2013	836.16	36'-0"	1'-0"	Same stratum as above.		6" DIA PERCUSSION DRILLING		40			
	832.16	40'-0"	4'-0"	Brown to slightly reddish brown, moist to wet, stiff, low plastic, SILTY CLAY with sand (CL-ML) trace clay nodules. Soft and compressible stratum.			3 + 4 + 7 N = 11				
	829.16	43'-0"	3'-0"	Brown to slightly reddish brown, moist, firm to stiff, low plastic, SANDY SILTY CLAY (CL-ML). Soft and compressible stratum.			5 + 7 + 10 N = 17	45			
	822.16	50'-0"	7'-0"	Brown to slightly reddish brown, slightly moist, very stiff to medium hard, low plastic, SANDY LEAN CLAY (CL) trace clay nodules. Pockets of dark brown colour are also found at 45'-0".			6 + 9 + 12 N = 21	50			
				END OF BOREHOLE				55 60 65 70			

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Excessive seepage is encountered & finally G.W.T. is also maintained at 27'-0".

PLAN NO. 4645 – 03 (2/2)

Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL **ISLAMABAD**	**AL-KAMAL INTERNATIONAL** **ISLAMABAD**

Site:

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-L, GULBERG-III
ISLAMABAD

Location: Underground Tank **BH. No: 3 (1/1)**

DATE	REDUCED ELEVATION	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIAMETER OF BORING	STANDARD PENETRATION TESTS Blows / each 6" N-value 10 30 50 70 90	SCALE	SAMPLES DISTB.	SAMPLES UN-DISTB	SAMPLES WATER
	∇ 872.16 ft										
23-01-2013	864.16	8'-0"	8'-0"	Brown to slightly reddish brown, slightly moist, firm to stiff, low to medium plastic, LEAN CLAY (CL) / SILTY CLAY (CL-ML) trace sand.		6" DIA PERCUSSION DRILLING	3 + 4 + 7 N = 11	5			
	858.16	14'-0"	6'-0"	Brown to slightly reddish brown, dry to slightly moist, stiff, low plastic, SANDY SILT (ML) trace clay nodules.			5 + 5 + 7 N = 12	10			
	854.16	18'-0"	4'-0"	Brown to slightly reddish brown, moist, soft to firm, low plastic, SILTY CLAY (CL-ML) trace sand.			2 + 3 + 4 N = 7	15			
	848.16	24'-0"	6'-0"	Brown to slightly reddish brown, moist, soft to firm, low to low-medium plastic, SILT (ML) trace sand. Soft and compressible stratum.			2 + 3 + 4 N = 7	20			
	842.16	30'-0"	6'-0"	Brown to slightly reddish brown to slightly greyish brown, wet, loose, fine-grained, SILTY SAND (SM). High fine content (47%). Problematic stratum.			3 + 5 + 5 N = 10	25			
	837.16	35'-0"	5'-0"	Thin layer of gravel (~3") is encountered at 30'-0" followed by brown, slightly reddish to slightly greyish, wet, firm, low plastic, SANDY SILTY CLAY (CL-ML).			11 + 5 + 5 N = 10 3 + 3 + 4 N = 7	30 35			

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Excessive seepage is encountered & finally G.W.T. is also maintained at 27'-0".

PLAN NO. 4645 – 04

Client:

IBECHS
GULBERG - ISLAMABAD

Consultant:	*Contractor:*
UPDL ISLAMABAD	**AL-KAMAL INTERNATIONAL ISLAMABAD**

Site:

PROPOSED OVERHEAD & UNDERGROUND WATER TANK AT BLOCK-L, GULBERG-III ISLAMABAD

Location: Underground Tank **BH. No: 4 (1/1)**

DATE	REDUCED ELEVATION	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIAMETER OF BORING	STANDARD PENETRATION TESTS Blows / each 6" N-value 10 30 50 70 90	SCALE	SAMPLES DISTB.	SAMPLES UN-DISTB	SAMPLES WATER
	∇ 872.16 ft										
23-01-2013			6'-0'	Brown to reddish brown, slightly moist, firm, low to low-medium plastic, LEAN CLAY (CL) trace to little sand.		6" DIA PERCUSSION DRILLING	3 + 4 + 5	5			
	866.16	6'-0"					N = 9				
			4'-0"	Same stratum as above, but sand content is increased: Brown to reddish brown, slightly moist, firm, low to low-medium plastic, LEAN CLAY with sand (CL).							
	862.16	10'-0"					30 + 20/1"	10			
	861.49	10'-8"	0'-8"	Greyish brown, soft, SANDSTONE.			Refusal				
			6'-4"	Brown to slightly reddish brown, slightly moist to moist, soft to firm, low plastic, LEAN CLAY (CL) trace sand.			2 + 3 + 4	15			
	855.16	17'-0"					N = 7				
			7'-0"	Same stratum as above, but moisture content increased considerably i.e. Brown to slightly reddish brown, moist to wet, soft to firm, low plastic, LEAN CLAY (CL) trace sand. Soft and compressible stratum.			2 + 3 + 4	20			
	848.16	24'-0"					N = 7				
			6'-0"	Brown, slightly reddish to slightly greyish, moist to wet, soft to firm, low plastic, SANDY SILT (ML). Soft and compressible stratum.			2 + 2 + 3	25			
	842.16	30'-0"					N = 5				
			5'-0"	A very thin layer of Gravel is encountered at 30'-0" followed by brown to slightly reddish brown, moist to wet, firm, low plastic, SANDY SILTY CLAY (CL-ML). Sand content reduces at 35'-0": SILTY CLAY with sand (CL-ML) trace mica.			4 + 4 + 6	30			
	837.16	35'-0"					N = 10				
							3 + 4 + 5	35			
							N = 9				

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Excessive seepage is encountered & finally G.W.T. is also maintained at 27'-0".

PLAN NO. 4645 – 05

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-L, GULBERG-III
ISLAMABAD

ABSTRACT DATA ON LABORATORY TEST RESULTS

BOREHOLE NO.		BH – 1									
DEPTH (ft)		5'-0" 6'-6"	12'-0" 13'-0"	15'-0" 16'-6"	22'-0" 23'-0"	25'-0" 26'-6"	32'-0" 33'-0"	35'-0" 36'-6"	40'-0" 41'-6"	45'-0" 46'-6"	50'-0" 51'-6"
TYPE OF SAMPLE		SPT	UDS	SPT	UDS	SPT	UDS	SPT	SPT	SPT	SPT
SPECIFIC GRAVITY		-	2.695	-	2.690	-	2.683	-	-	-	-
MOISTURE CONTENT %		22.4	12.6	21.1	20.1	22.6	18.2	24.0	23.2	19.4	8.7
BULK DENSITY lbs/ft³		-	114.2	-	121.5	-	2.683	-	-	-	-
GRAIN SIZE ANALYSIS	GRAVEL %	-	-	-	-	-	-	01	07	-	-
	SAND %	03	33	03	11	11	22	09	26	35	20
	FINES -200 %	97	67	97	89	89	78	90	67	65	80
ATTERBERG'S LIMITS	LIQUID LIMIT	35.2	21.3	28.5	22.1	29.7	21.7	27.8	25.5	30.2	33.1
	PLASTIC LIMIT	23.9	16.7	20.6	16.9	21.5	17.4	21.4	19.4	21.1	23.0
	PLASTIC INDEX	11.3	4.7	7.9	5.2	8.2	4.3	6.4	6.1	9.1	10.1
UNCONFINED COMPRESSION TEST	STRESS kg/cm²	-	1.273	-	0.779	-	0.723	-	-	-	-
	STRAIN %	-	3.644	-	6.084	-	3.953	-	-	-	-
CONSOLIDATION TEST	INITIAL SATURATION %	-	-	-	-	-	-	-	-	-	-
	INITIAL VOID RATIO e_o	-	-	-	-	-	-	-	-	-	-
	COMPRESSION INDEX Cc	-	-	-	-	-	-	-	-	-	-

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PLAN NO. 4645 – 06

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-L, GULBERG-III
ISLAMABAD

ABSTRACT DATA ON LABORATORY TEST RESULTS

BOREHOLE NO.		BH – 2									
DEPTH (ft)		5'-0" 6'-6"	10'-0" 11'-6"	18'-0" 19'-0"	20'-0" 21'-6"	25'-0" 26'-6"	32'-0" 33'-0"	35'-0" 36'-6"	42'-0" 43'-0"	45'-0" 46'-6"	50'-0" 51'-6"
TYPE OF SAMPLE		SPT	SPT	UDS	SPT	SPT	UDS	SPT	UDS	SPT	SPT
SPECIFIC GRAVITY		-	-	2.699	-	-	2.671	-	2.679	-	-
MOISTURE CONTENT %		22.2	12.1	21.7	25.5	17.8	17.3	23.8	18.7	19.4	20.1
BULK DENSITY lbs/ft³		-	-	120.3	-	-	121.7	-	122.2	-	-
GRAIN SIZE ANALYSIS	GRAVEL %	-	-	-	-	-	22	-	-	01	01
	SAND %	05	37	05	05	54	40	17	38	40	38
	FINES -200 %	95	63	95	95	46	38	83	62	59	61
ATTERBERG'S LIMITS	LIQUID LIMIT	32.6	20.0	29.9	30.5	19.0	20.5	27.3	22.5	30.0	30.3
	PLASTIC LIMIT	23.4	16.4	22.0	22.6	16.5	16.4	21.0	18.3	21.3	21.7
	PLASTIC INDEX	9.2	3.6	7.9	7.9	2.5	4.1	6.3	4.2	8.7	8.6
UNCONFINED COMPRESSION TEST	STRESS kg/cm²	-	-	0.936	-	-	1.088	-	0.566	-	-
	STRAIN %	-	-	4.797	-	-	6.415	-	4.895	-	-
CONSOLIDATION TEST	INITIAL SATURATION %	-	-	-	-	-	-	-	-	-	-
	INITIAL VOID RATIO e_o	-	-	-	-	-	-	-	-	-	-
	COMPRESSION INDEX Cc	-	-	-	-	-	-	-	-	-	-

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PLAN NO. 4645 – 07

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-L, GULBERG-III
ISLAMABAD

ABSTRACT DATA ON LABORATORY TEST RESULTS

BOREHOLE NO.		BH – 3							
DEPTH (ft)		3'-0" 4'-6"	6'-0" 7'-6"	10'-0" 11'-6"	14'-0" 15'-0"	20'-0" 21'-6"	24'-0" 25'-0"	30'-0" 31'-6"	34'-0" 35'-0"
TYPE OF SAMPLE		SPT	SPT	SPT	UDS	SPT	UDS	SPT	UDS
SPECIFIC GRAVITY		-	-	-	2.693	-	2.674	-	2.706
MOISTURE CONTENT %		16.4	18.1	9.0	21.5	23.6	18.1	19.4	22.2
BULK DENSITY lbs/ft³		-	-	-	122.4	-	120.0	-	123.6
GRAIN SIZE ANALYSIS	GRAVEL %	-	-	-	-	-	-	15	-
	SAND %	03	08	38	04	03	53	23	30
	FINES -200 %	97	92	62	96	97	47	62	70
ATTERBERG'S LIMITS	LIQUID LIMIT	34.4	30.8	18.0	26.9	29.4	17.6	21.0	22.5
	PLASTIC LIMIT	23.9	22.6	16.5	20.5	22.6	15.5	16.8	17.2
	PLASTIC INDEX	10.5	8.2	1.5	6.4	6.8	2.1	4.2	5.3
UNCONFINED COMPRESSION TEST	STRESS kg/cm²	-	-	-	0.951	-	φ	-	0.832
	STRAIN %	-	-	-	4.332	-	-	-	7.098
CONSOLIDATION TEST	INITIAL SATURATION %	-	-	-	86.7	-	-	-	89.8
	INITIAL VOID RATIO e_o	-	-	-	0.6677	-	-	-	0.6692
	COMPRESSION INDEX Cc	-	-	-	0.1640	-	-	-	0.1331

φ Sample is too soft to perform q_u test.

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PLAN NO. 4645 – 08

PROPOSED OVERHEAD & UNDERGROUND WATER TANK
AT BLOCK-L, GULBERG-III
ISLAMABAD

ABSTRACT DATA ON LABORATORY TEST RESULTS

BOREHOLE NO.		BH – 4						
DEPTH (ft)		8'-0" 9'-0"	10'-0" 11'-6"	15'-0" 16'-6"	18'-0" 19'-0"	28'-0" 29'-0"	30'-0" 31'-6"	35'-0" 36'-6"
TYPE OF SAMPLE		UDS	SPT	SPT	UDS	UDS	SPT	SPT
SPECIFIC GRAVITY		2.727	-	-	2.716	2.678	-	-
MOISTURE CONTENT %		21.6	6.9	20.7	23.4	18.1	22.5	21.6
BULK DENSITY lbs/ft³		119.0	-	-	122.7	122.9	-	-
GRAIN SIZE ANALYSIS	GRAVEL %	-	61	-	-	-	09	01
	SAND %	10	20	05	06	48	21	22
	FINES -200 %	90	19	95	94	52	70	77
ATTERBERG'S LIMITS	LIQUID LIMIT	32.8	-	30.0	29.9	20.0	26.2	23.7
	PLASTIC LIMIT	21.9	-	21.7	22.5	16.6	20.6	17.6
	PLASTIC INDEX	10.9	-	8.3	7.4	3.4	5.6	6.1
UNCONFINED COMPRESSION TEST	STRESS kg/cm²	1.255	-	-	0.815	0.482	-	-
	STRAIN %	5.495	-	-	5.776	5.611	-	-
CONSOLIDATION TEST	INITIAL SATURATION %	-	-	-	90.2	80.1	-	-
	INITIAL VOID RATIO e_o	-	-	-	0.7048	0.6054	-	-
	COMPRESSION INDEX Cc				0.1229	0.1013		

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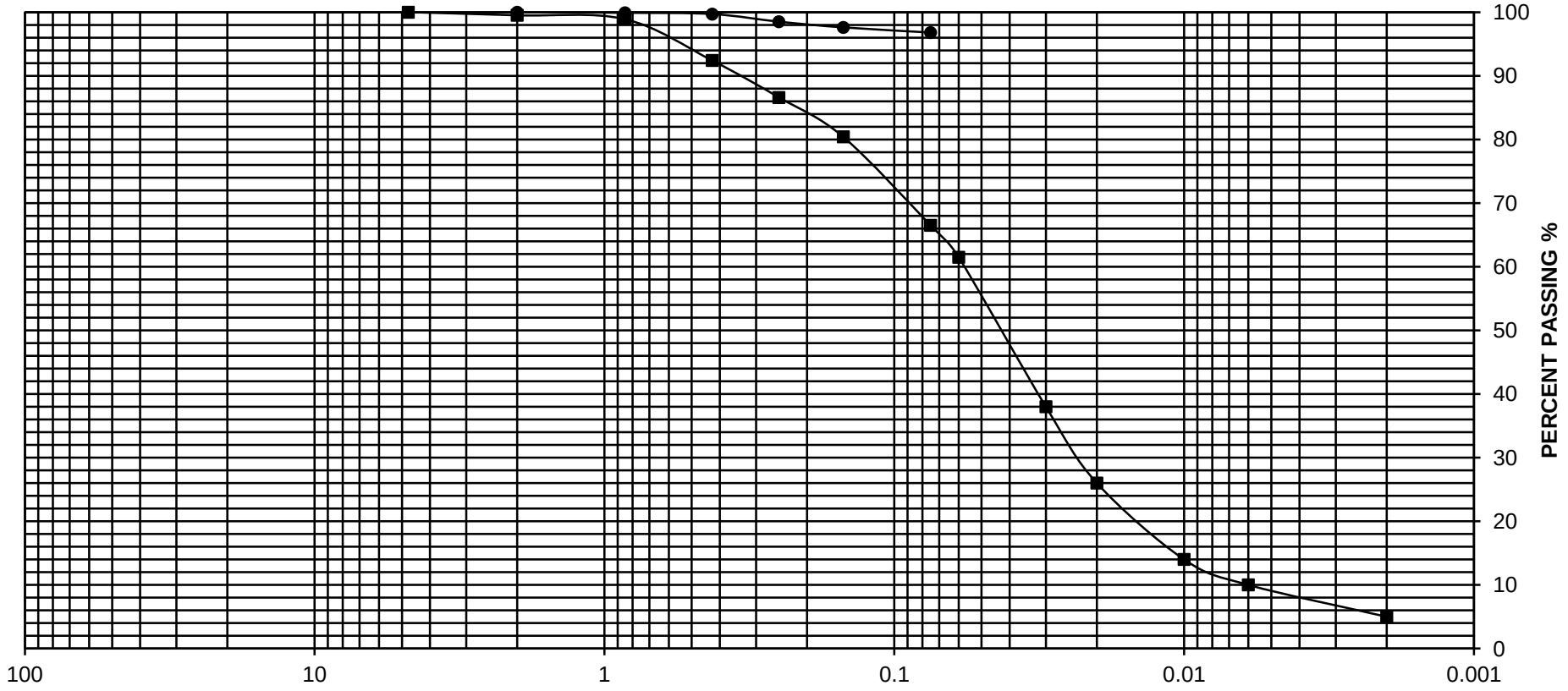
PLAN NO. 4645 – 09

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-L, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



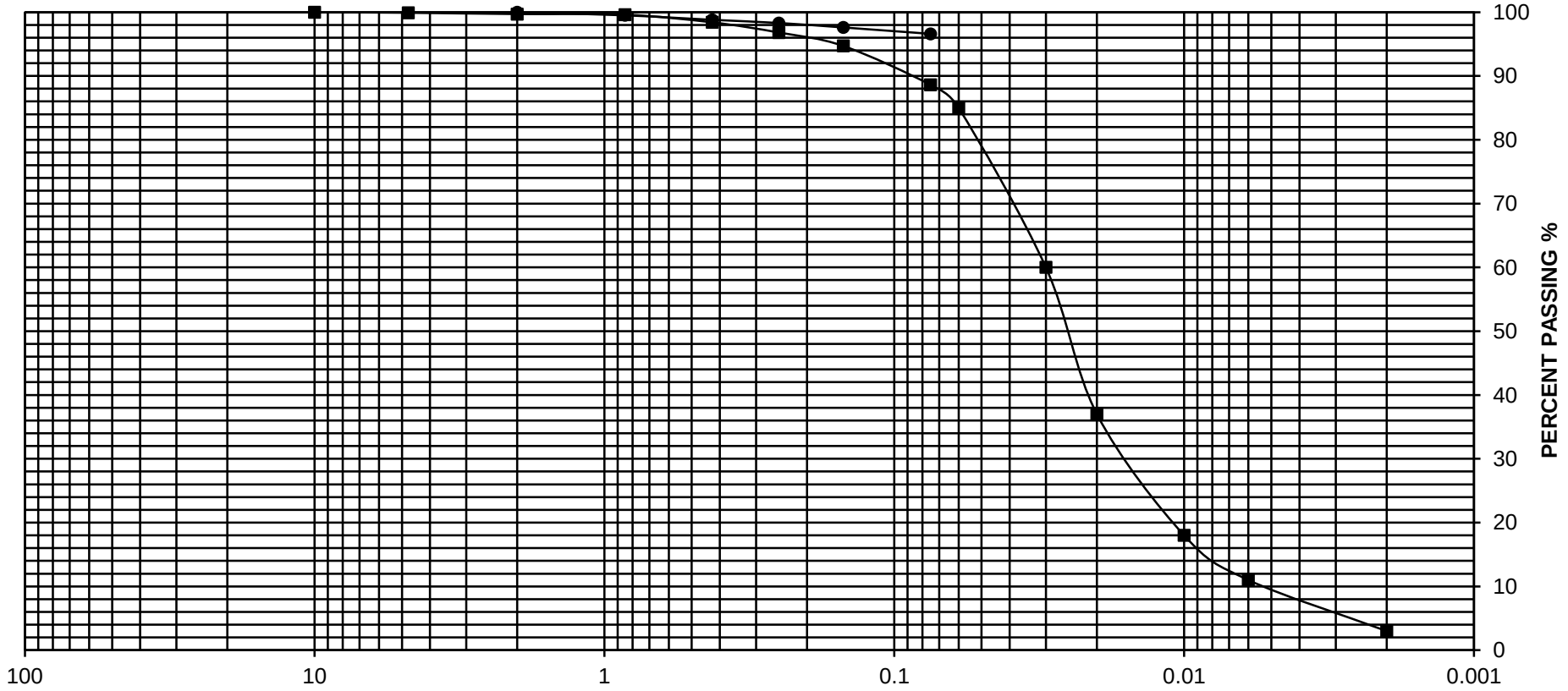
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
●	1	SPT	5'-0" / 6'-6"	SILT	-	3	*97			35.2	23.9	11.3	CL
■	1	UDS	12'-0" / 13'-0"	SANDY SILTY CLAY	-	33	67			21.3	16.7	4.7	CL-ML

* Hydrometer analysis was not performed.

PLAN NO: 4645 - 10

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-L, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



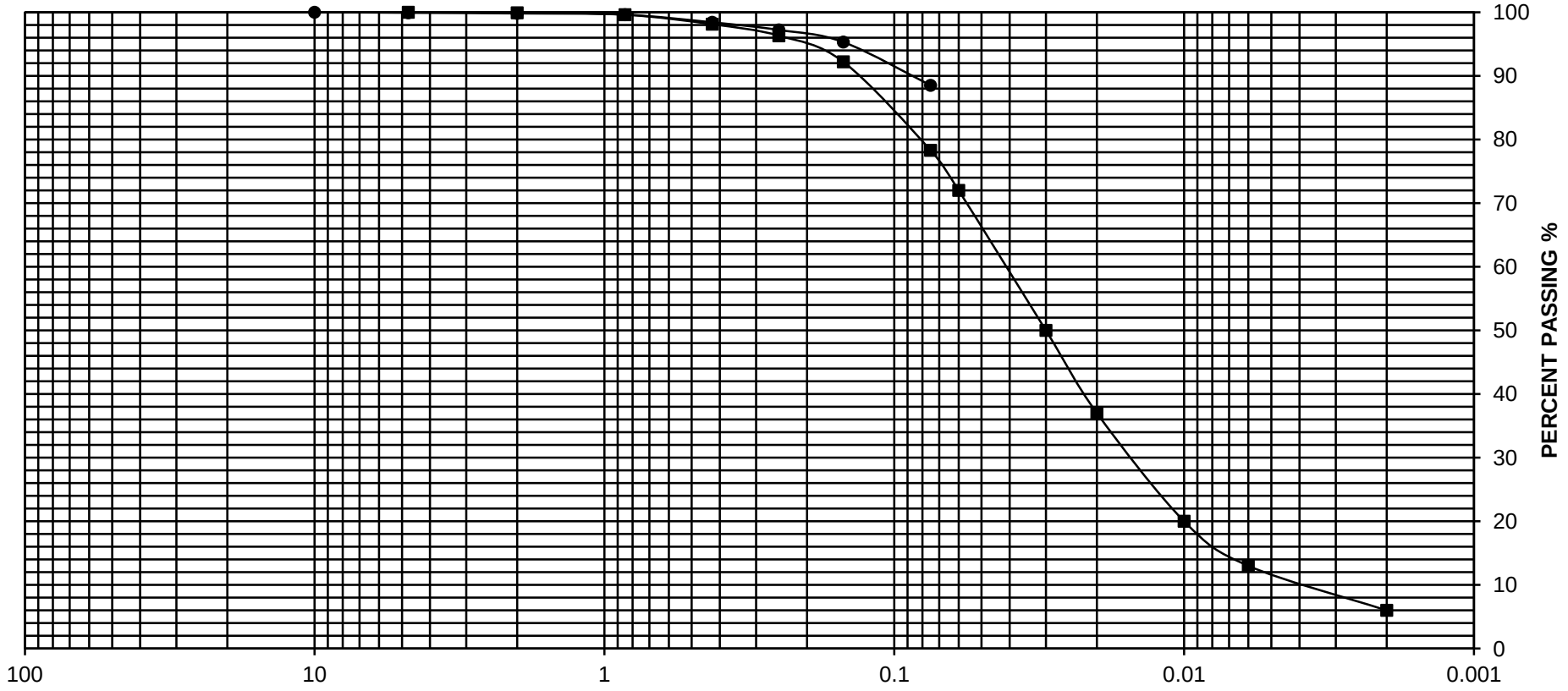
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
●	1	SPT	15'-0" / 16'-6"	LEAN CLAY	-	3	*97			28.5	20.6	7.9	CL
■	1	UDS	22'-0" / 23'-0"	SILTY CLAY	-	11	89			22.1	16.9	5.2	CL-ML

* Hydrometer analysis was not performed.

PLAN NO: 4645 - 11

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-L, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
●	1	SPT	25'-0" / 26'-6"	SILTY CLAY	-	11	*89			29.7	21.5	8.2	CL-ML
■	1	UDS	32'-0" / 33'-0"	SILTY CLAY with sand	-	22	78			21.7	17.4	4.3	CL-ML

* Hydrometer analysis was not performed.

PLAN NO: 4645 - 12

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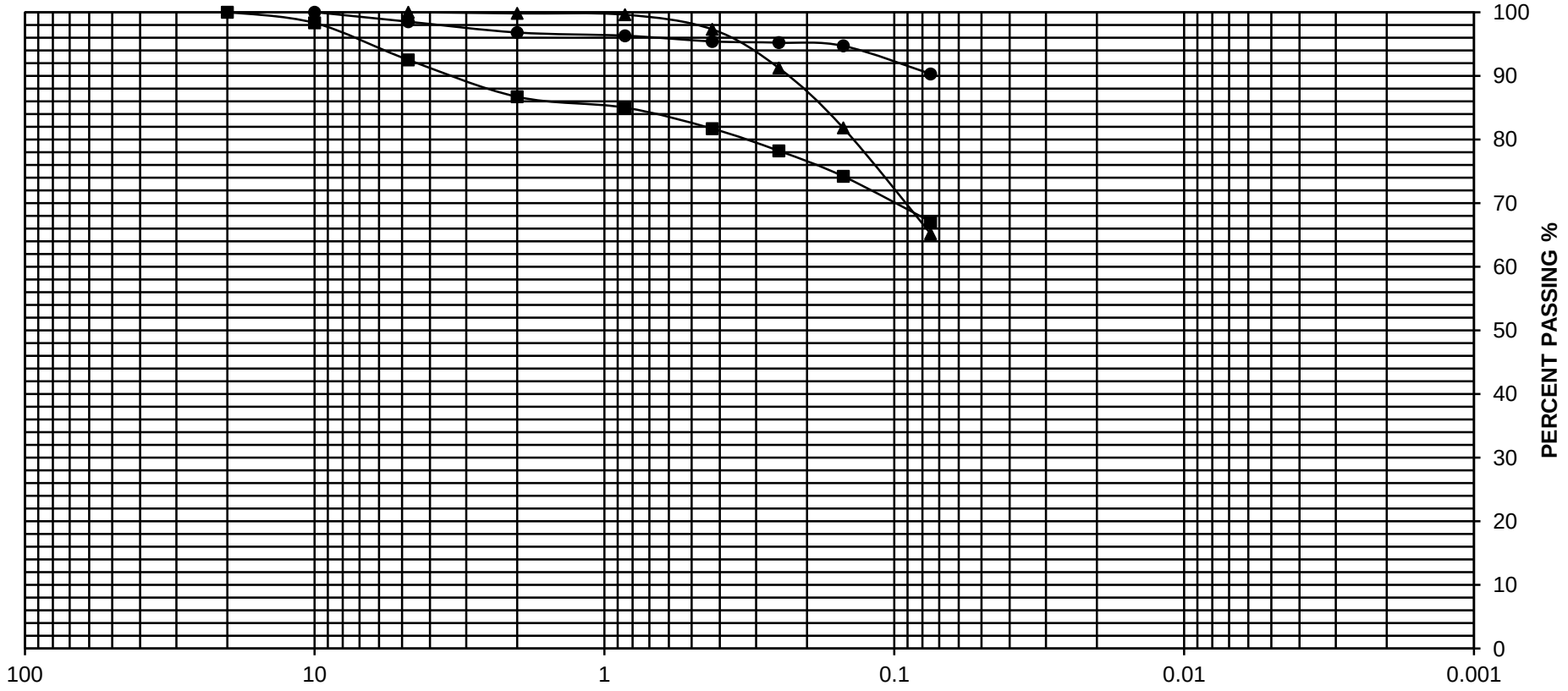
GRAIN SIZE DISTRIBUTION

PROPOSED O/H & U/G WATER TANK
BLOCK-L, GULBERG-III
ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



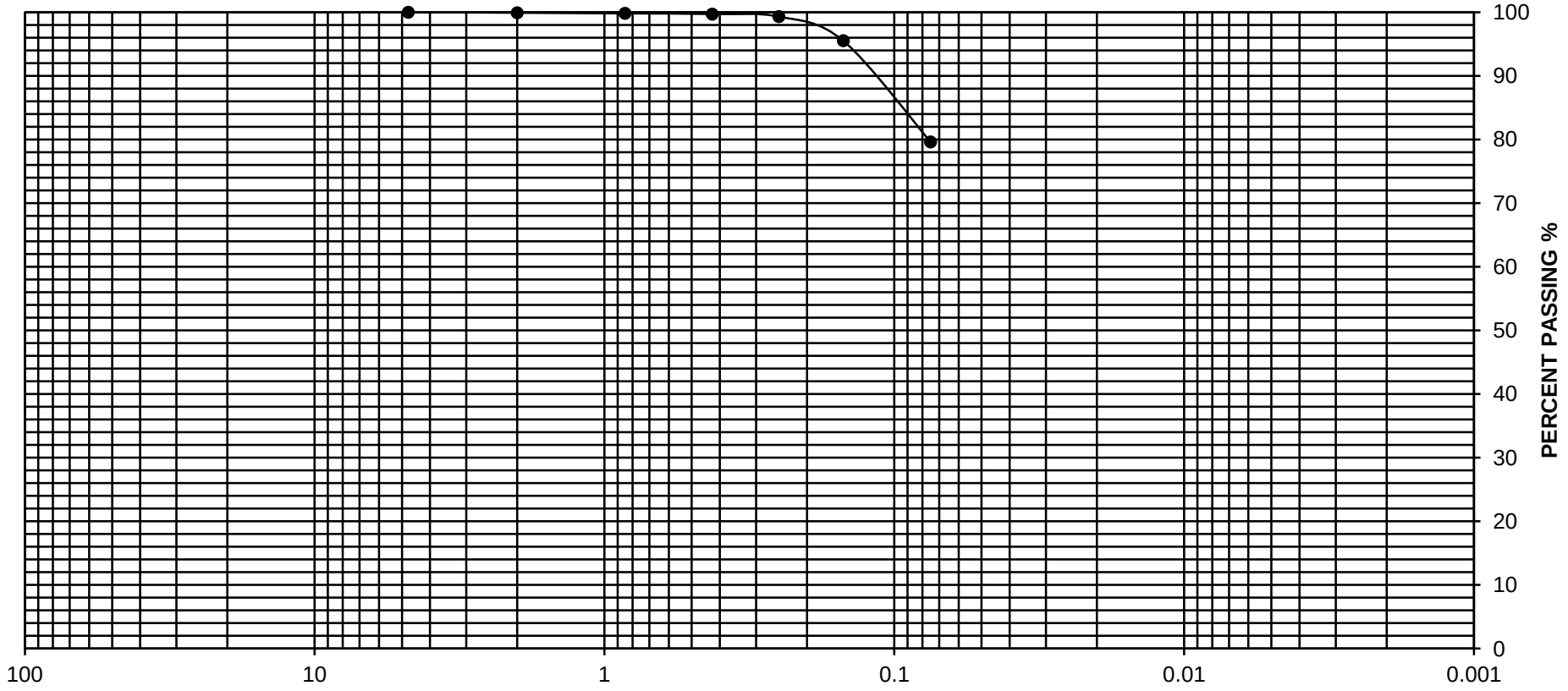
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
●	1	SPT	35'-0" / 36'-6"	SILTY CLAY	1	9	90			27.8	21.4	6.4	CL-ML
■	1	SPT	40'-0" / 41'-6"	SANDY SILTY CLAY	7	26	67			25.5	19.4	6.1	CL-ML
▲	1	SPT	45'-0" / 46'-6"	SANDY LEAN CLAY	-	35	65			30.2	21.1	9.1	CL

* Hydrometer analysis was not performed.

PLAN NO: 4645 - 13

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-L, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



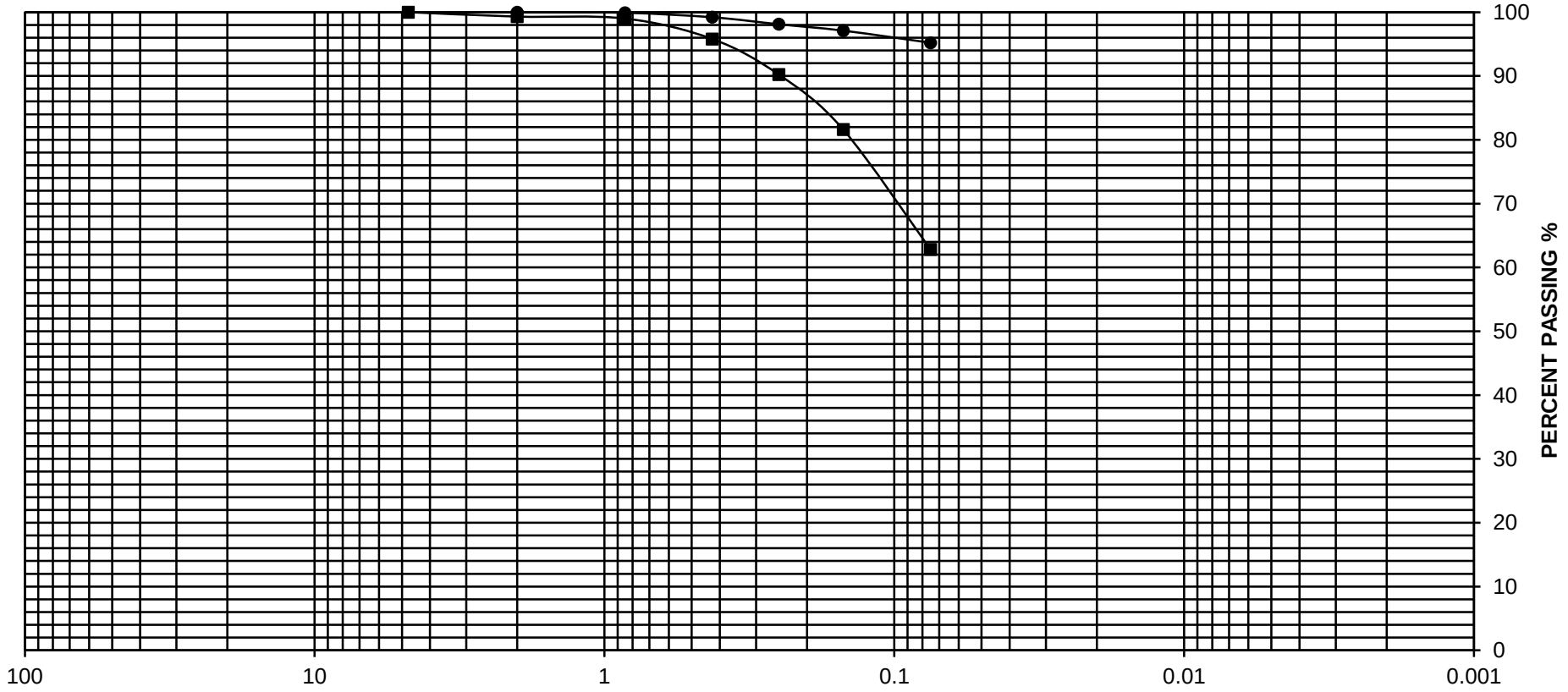
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
●	1	SPT	50'-0" / 51'-6"	LEAN CLAY with sand	-	20	*80			33.1	23.0	10.1	CL

* Hydrometer analysis was not performed.

PLAN NO: 4645 - 14

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-L, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
●	2	SPT	5'-0" / 6'-6"	LEAN CLAY / SILTY CLAY	-	5	*95			32.6	23.4	9.2	CL / CL-ML
■	2	SPT	10'-0" / 11'-6"	SANDY SILT	-	37	*63			20.0	16.4	3.6	ML

* Hydrometer analysis was not performed.

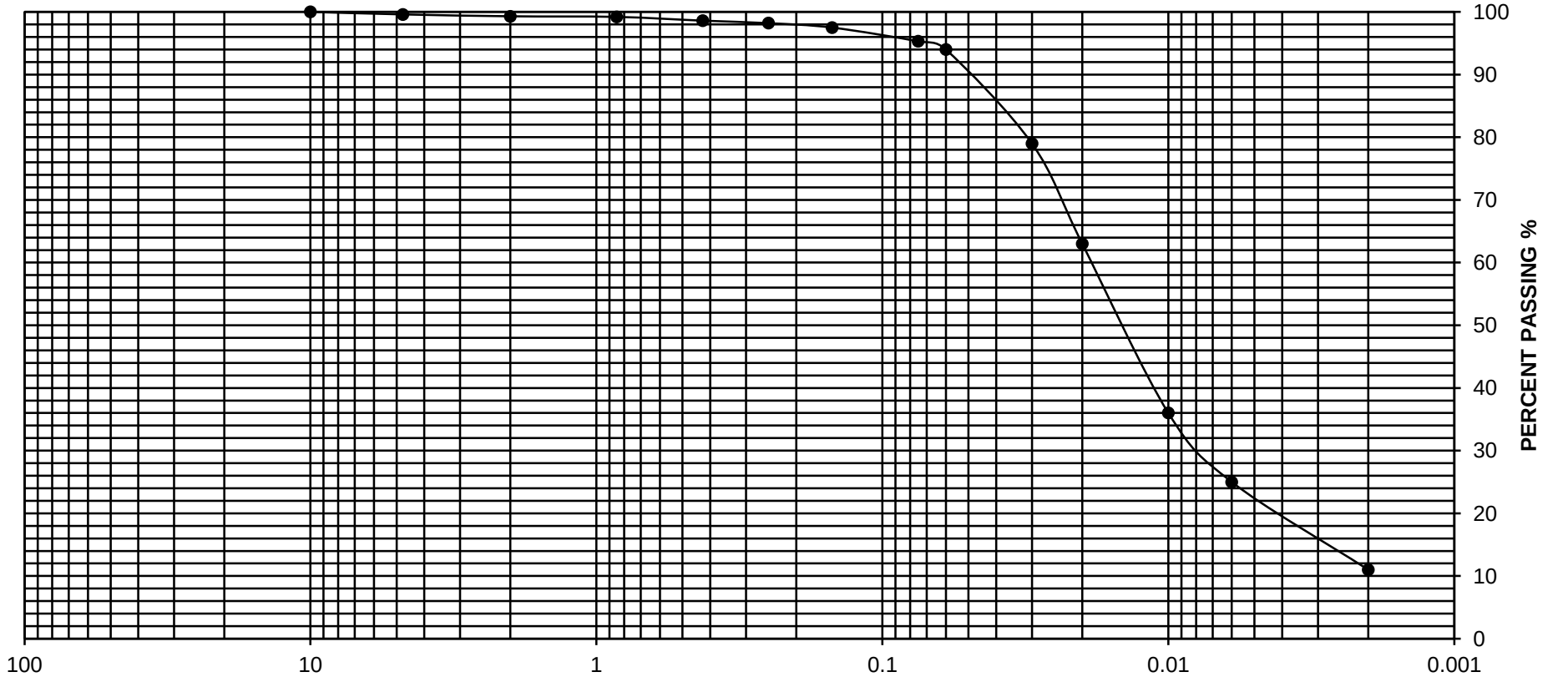
PLAN NO: 4645 - 15

SWIS-TECH
ENGINEERS & CONTRACTORS
RAWALPINDI

GRAIN SIZE DISTRIBUTION

PROPOSED O/H & U/G WATER TANK
BLOCK-L, GULBERG-III
ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
●	2	UDS	18'-0" / 19'-0"	LEAN CLAY	-	5	95			29.9	22.0	7.9	CL

* Hydrometer analysis was not performed.

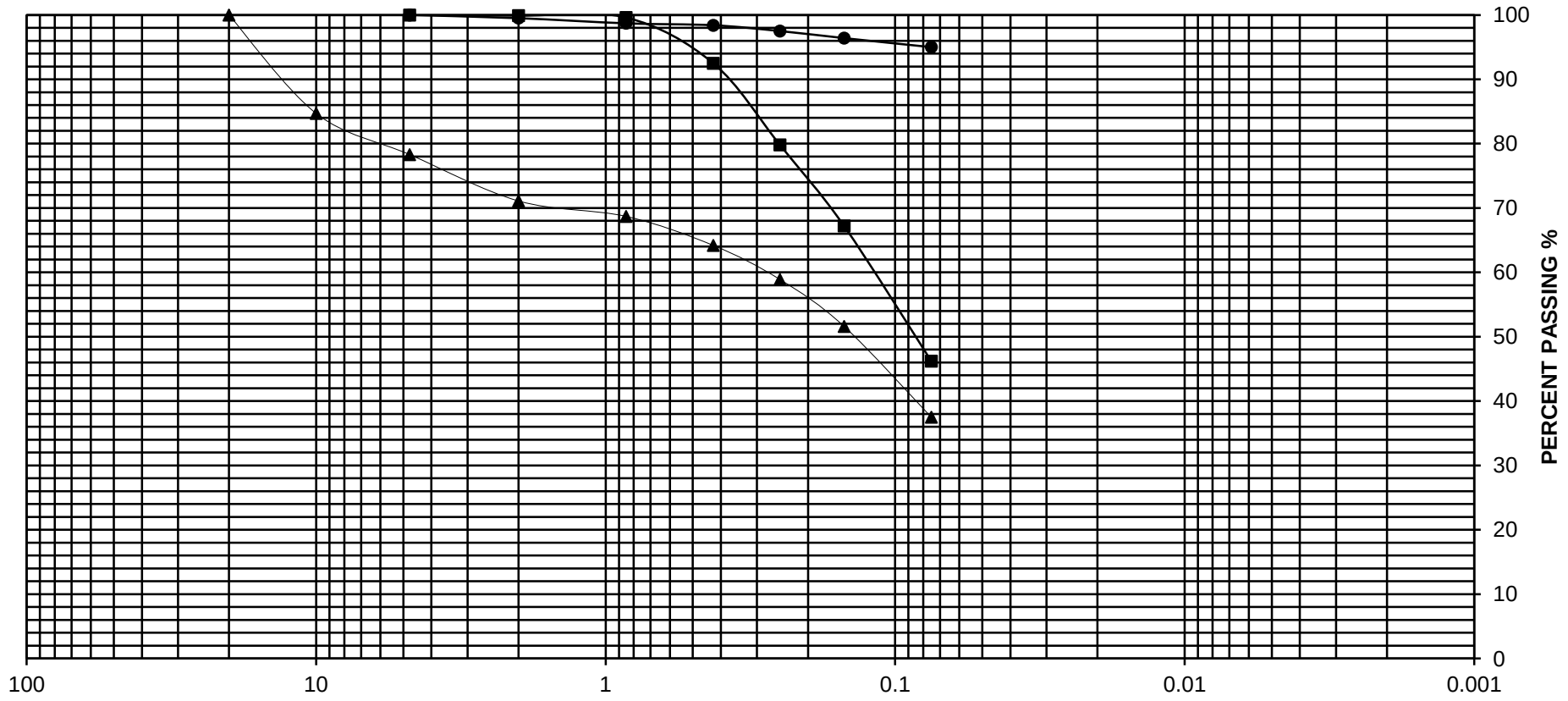
PLAN NO: 4645 - 16

SWIS-TECH
ENGINEERS & CONTRACTORS
RAWALPINDI

GRAIN SIZE DISTRIBUTION

PROPOSED O/H & U/G WATER TANK
BLOCK-L, GULBERG-III
ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



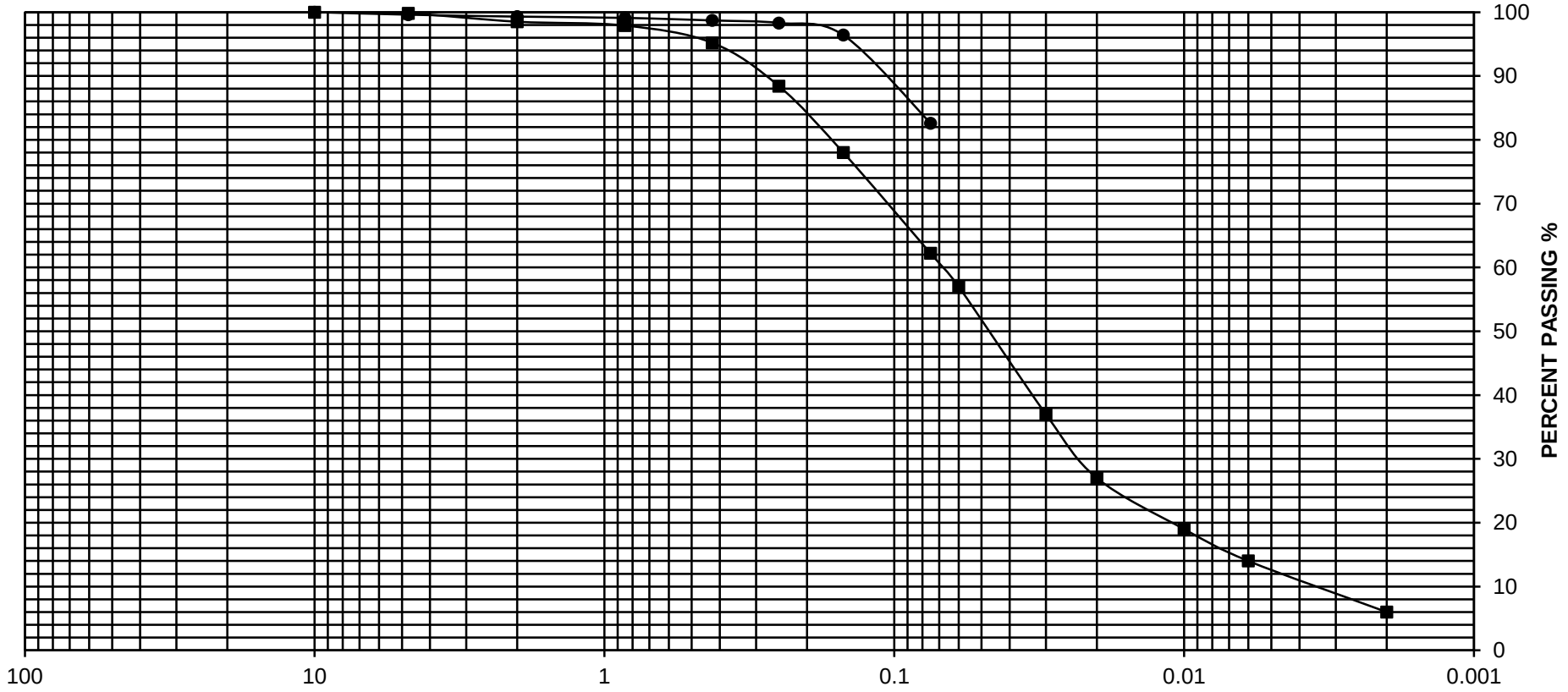
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
●	2	SPT	20'-0" / 21'-6"	LEAN CLAY	-	5	*95			30.5	22.6	7.9	CL
■	2	SPT	25'-0" / 26'-6"	SILTY SAND	-	54	*46			19	16.5	2.5	SM
▲	2	UDS	32'-0" / 33'-0"	SILTY CLAYEY SAND with gravel	22	40	*38			20.5	16.4	4.1	SC-SM

* Hydrometer analysis was not performed.

PLAN NO: 4645 - 17

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-L, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



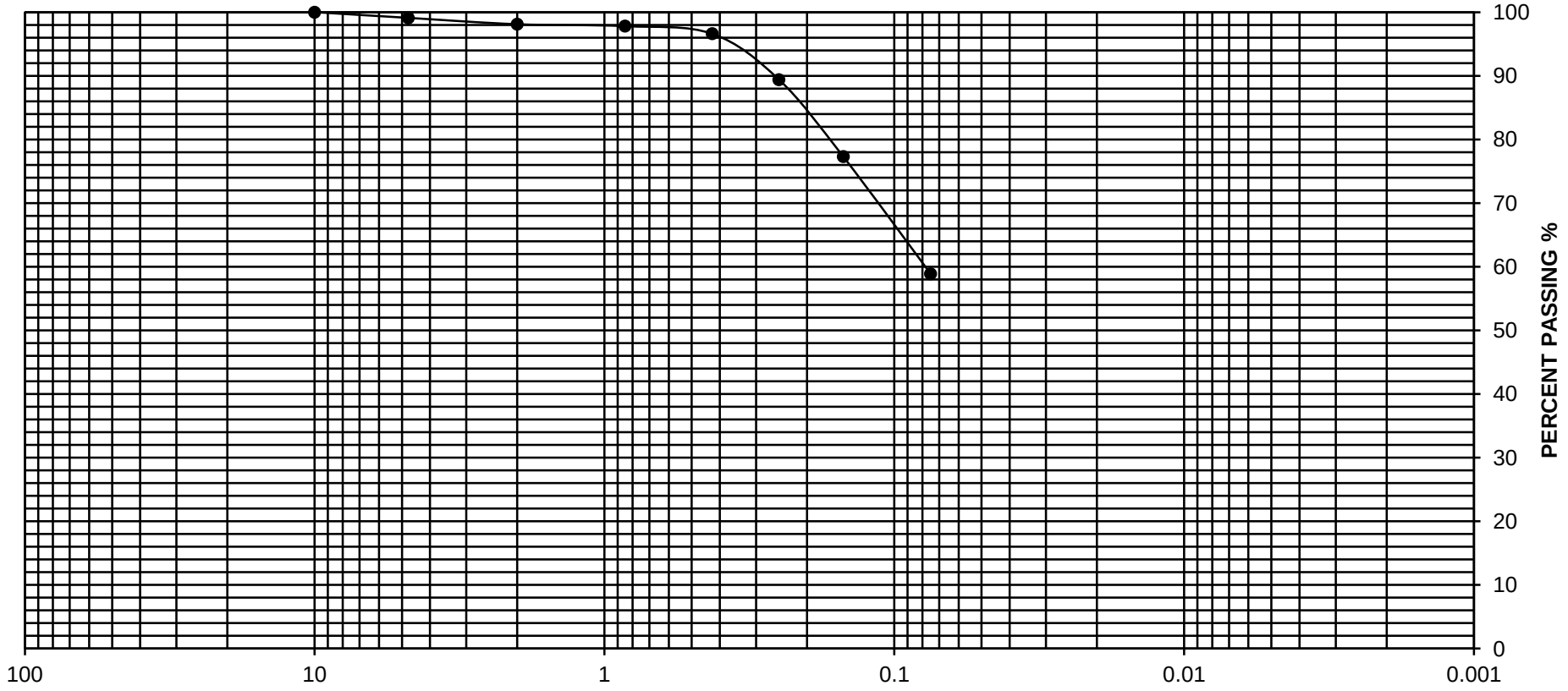
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
●	2	SPT	35'-0" / 36'-6"	SILTY CLAY with sand	-	17	*83			27.3	21.0	6.3	CL-ML
■	2	UDS	42'-0" / 43'-0"	SANDY SILTY CLAY	-	38	62			22.5	18.3	4.2	CL-ML

* Hydrometer analysis was not performed.

PLAN NO: 4645 - 18

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-L, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



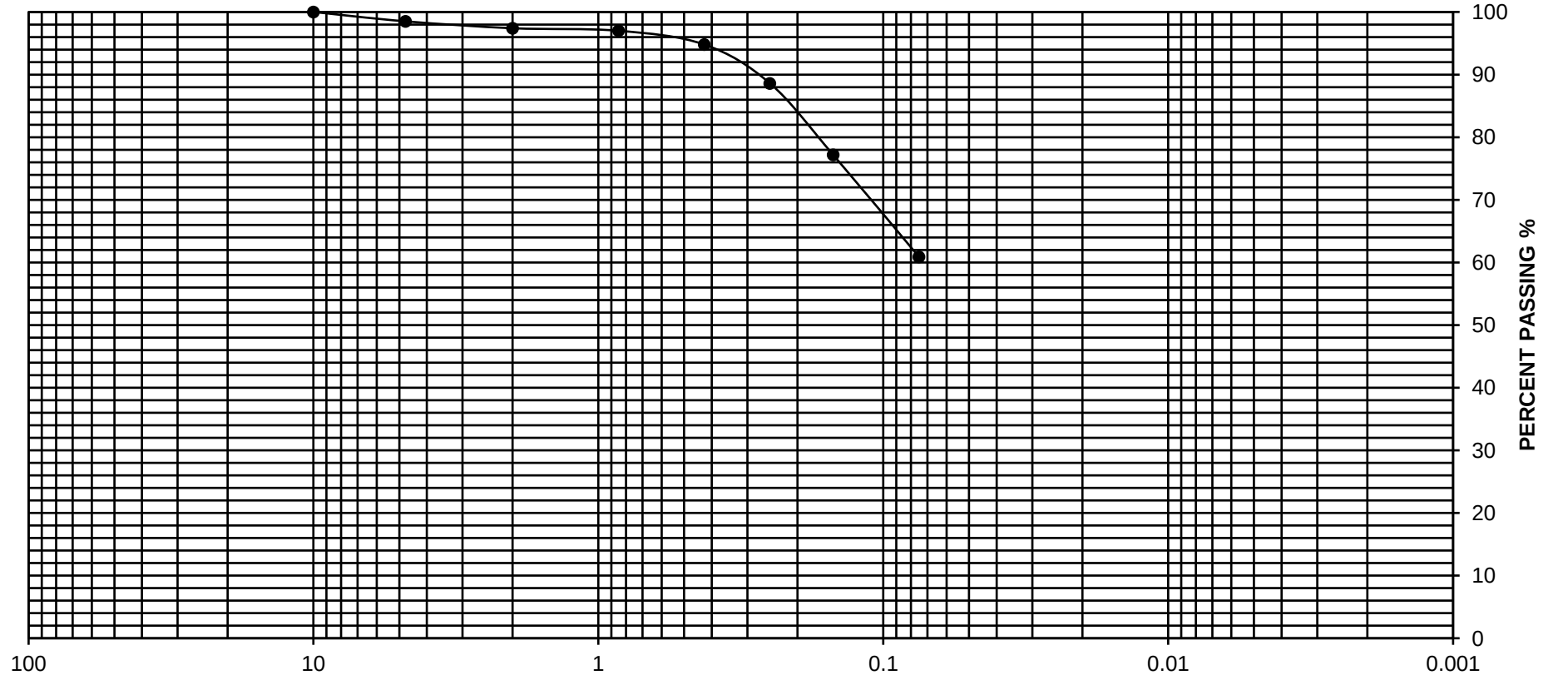
Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
●	2	SPT	45'-0" / 46'-6"	SANDY LEAN CLAY	1	40	*59			30.0	21.3	8.7	CL

* Hydrometer analysis was not performed.

PLAN NO: 4645 - 19

SWIS-TECH ENGINEERS & CONTRACTORS RAWALPINDI	GRAIN SIZE DISTRIBUTION	PROPOSED O/H & U/G WATER TANK BLOCK-L, GULBERG-III ISLAMABAD

COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	



Symb	Bore No.	Sample	Depth	Group Name	Gravel %	Sand %	Fines -200%	C_u	C_c	w_L	w_P	I_p	Group Symbol
●	2	SPT	50'-0" / 51'-6"	SANDY LEAN CLAY	1	38	*61			30.3	21.7	8.6	CL

* Hydrometer analysis was not performed.

PLAN NO: 4645 - 20

SWIS-TECH

ENGINEERS & CONTRACTORS

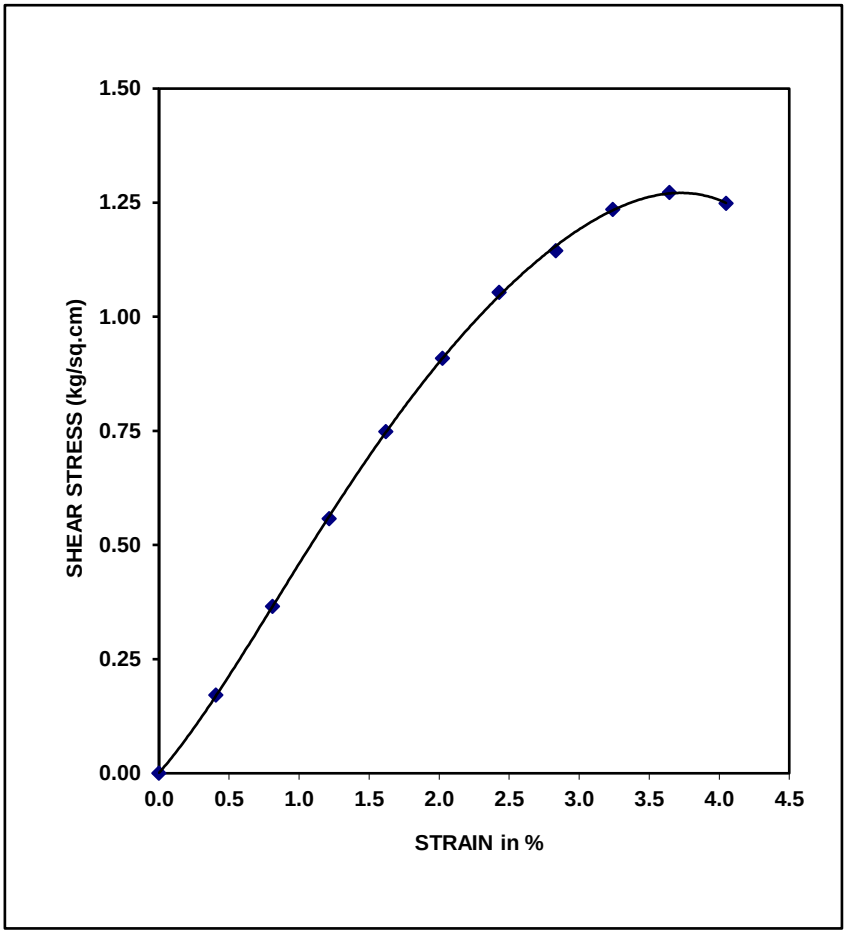
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Consultant:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-L, Gulberg-III, Islamabad.				
Bore No:	1	Depth:	12'-0" / 13'-0"	Type of Sample:	UDS
Soil Material:	Brown to slightly reddish brown, SANDY SILTY CLAY (CL-ML).				

Diameter :	6.900 cm	Wet Weight :	845.2 gm
Height :	12.350 cm	Moisture Content :	12.600 %
Area :	37.393 sq.cm	Wet Density :	1.830 g/cc
Volume :	461.802 cu.cm	Dry Density :	1.625 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:			0.0918 Kg/div		

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.405	0.171
0.810	0.365
1.215	0.558
1.619	0.749
2.024	0.909
2.429	1.054
2.834	1.145
3.239	1.235
3.644	**1.273**
4.049	1.248



Remarks:

1) H/D = 1.790

Plan No. 4645 - 28

SWIS-TECH

ENGINEERS & CONTRACTORS

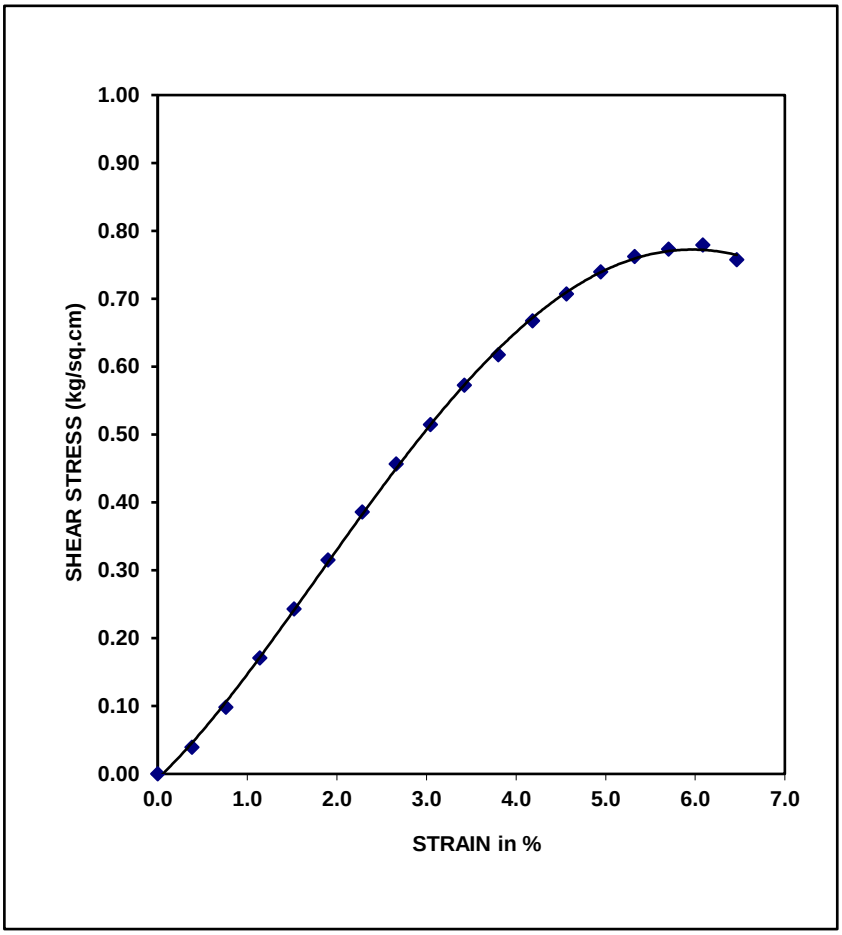
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Consultant:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-L, Gulberg-III, Islamabad.				
Bore No:	1	Depth:	22'-0" / 23'-0"	Type of Sample:	UDS
Soil Material:	Brown to slightly reddish brown, SILTY CLAY (CL-ML).				

Diameter :	6.880 cm	Wet Weight :	951.9 gm
Height :	13.150 cm	Moisture Content :	20.100 %
Area :	37.176 sq.cm	Wet Density :	1.947 g/cc
Volume :	488.870 cu.cm	Dry Density :	1.621 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:			0.0918 Kg/div		

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.380	0.039
0.760	0.098
1.141	0.171
1.521	0.243
1.901	0.315
2.281	0.386
2.662	0.457
3.042	0.515
3.422	0.572
3.802	0.618
4.183	0.667
4.563	0.707
4.943	0.739
5.323	0.762
5.703	0.773
6.084	**0.779**
6.464	0.758



Remarks:

1) H/D = 1.911

Plan No. 4645 - 29

SWIS-TECH

ENGINEERS & CONTRACTORS

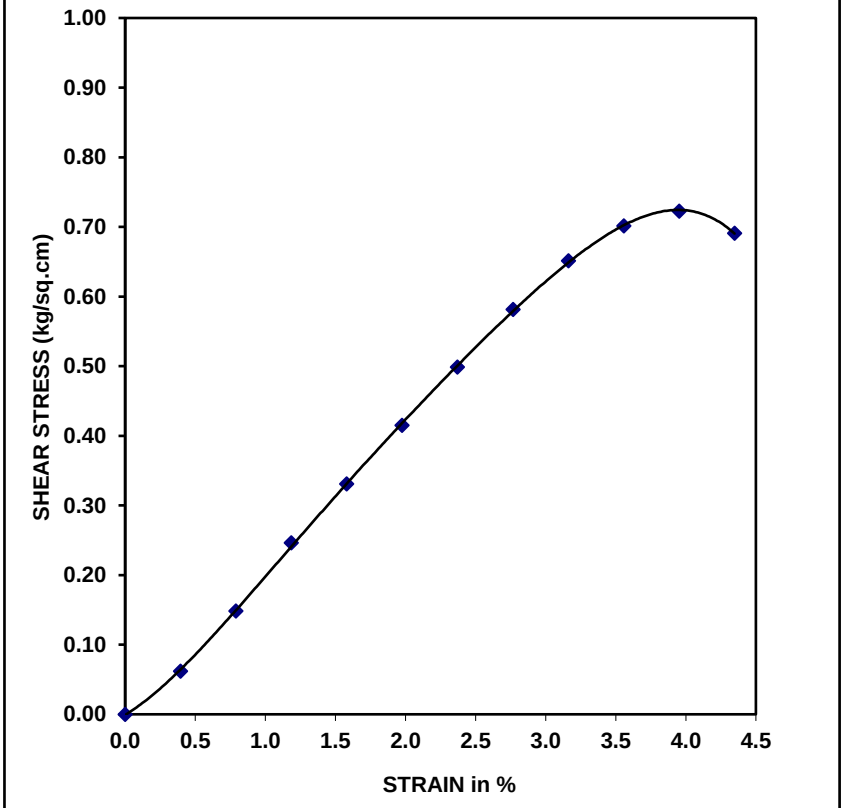
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Consultant:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-L, Gulberg-III, Islamabad.				
Bore No:	1	Depth:	32'-0" / 33'-0"	Type of Sample:	UDS
Soil Material:	Brown to slightly reddish brown, SILTY CLAY with sand (CL-ML).				

Diameter :	6.850 cm	Wet Weight :	916.7 gm
Height :	12.650 cm	Moisture Content :	18.200 %
Area :	36.853 sq.cm	Wet Density :	1.966 g/cc
Volume :	466.190 cu.cm	Dry Density :	1.664 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:			0.0918 Kg/div		

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.395	0.062
0.791	0.148
1.186	0.246
1.581	0.331
1.976	0.415
2.372	0.499
2.767	0.581
3.162	0.651
3.557	0.701
3.953	**0.723**
4.348	0.691



Remarks:

1) H/D = 1.847

Plan No. 4645 - 30

SWIS-TECH

ENGINEERS & CONTRACTORS

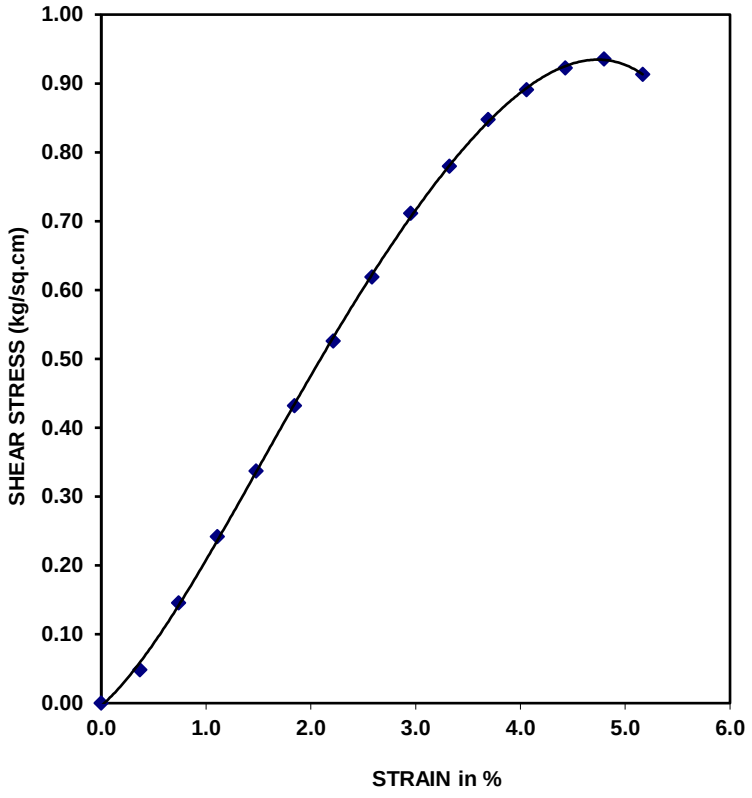
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Consultant:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-L, Gulberg-III, Islamabad.				
Bore No:	2	Depth:	18'-0" / 19'-0"	Type of Sample:	UDS
Soil Material:	Brown to slightly reddish brown, LEAN CLAY (CL).				

Diameter :	6.915 cm	Wet Weight :	981.1 gm
Height :	13.550 cm	Moisture Content :	21.700 %
Area :	37.556 sq.cm	Wet Density :	1.928 g/cc
Volume :	508.879 cu.cm	Dry Density :	1.584 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:			0.0918 Kg/div		

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.369	0.049
0.738	0.146
1.107	0.242
1.476	0.337
1.845	0.432
2.214	0.526
2.583	0.619
2.952	0.712
3.321	0.780
3.690	0.848
4.059	0.891
4.428	0.923
4.797	**0.936**
5.166	0.913



Remarks:

1) H/D = 1.960

Plan No. 4645 - 31

SWIS-TECH

ENGINEERS & CONTRACTORS

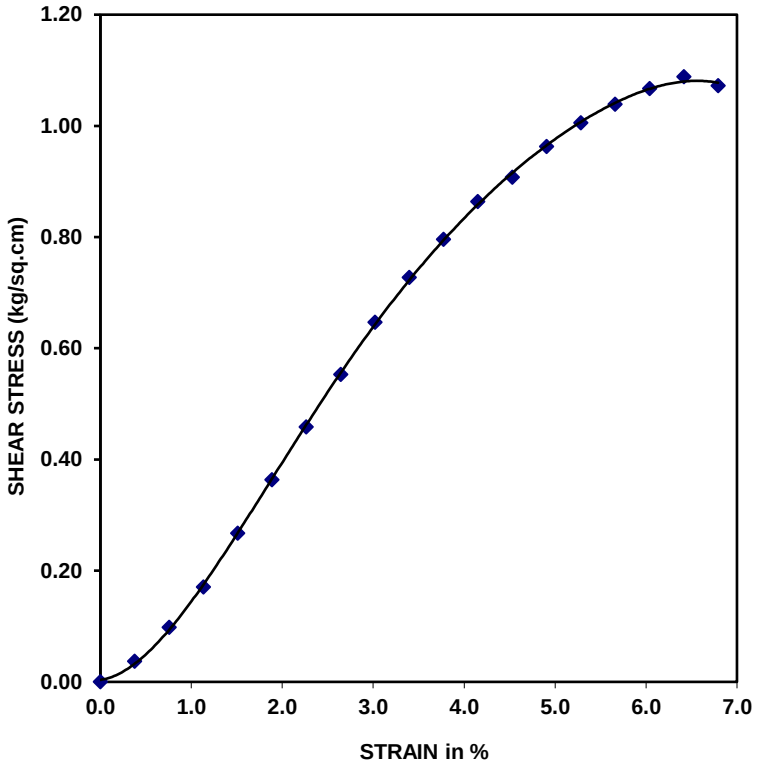
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Contractor:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-L, Gulberg-III, Islamabad.				
Bore No:	2	Depth:	32'-0" / 33'-0"	Type of Sample:	UDS
Soil Material:	Brown to slighlty reddish brown, SILTY CLAYEY SAND (SC-SM).				

Diameter :	6.880 cm	Wet Weight :	960.7 gm
Height :	13.250 cm	Moisture Content :	17.300 %
Area :	37.176 sq.cm	Wet Density :	1.950 g/cc
Volume :	492.588 cu.cm	Dry Density :	1.663 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:			0.0918 Kg/div		

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.377	0.037
0.755	0.098
1.132	0.171
1.509	0.268
1.887	0.363
2.264	0.459
2.642	0.553
3.019	0.647
3.396	0.728
3.774	0.796
4.151	0.864
4.528	0.908
4.906	0.963
5.283	1.006
5.660	1.039
6.038	1.067
6.415	**1.088**
6.792	1.073



Remarks:

1) H/D = 1.926

Plan No. 4645 - 32

SWIS-TECH

ENGINEERS & CONTRACTORS

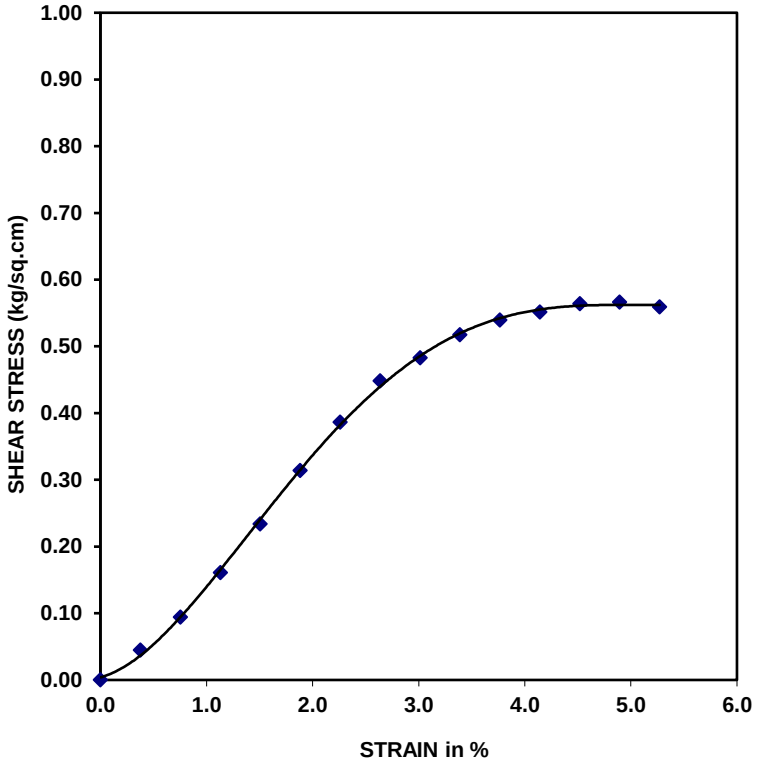
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Contractor:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-L, Gulberg-III, Islamabad.				
Bore No:	2	Depth:	42'-0" / 43'-0"	Type of Sample:	UDS
Soil Material:	Brown to slighlty reddish brown, SANDY SILTY CLAY (CL-ML).				

Diameter :	6.835 cm	Wet Weight :	954.2 gm
Height :	13.280 cm	Moisture Content :	18.700 %
Area :	36.692 sq.cm	Wet Density :	1.958 g/cc
Volume :	487.266 cu.cm	Dry Density :	1.650 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:			0.0918 Kg/div		

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.377	0.045
0.753	0.094
1.130	0.161
1.506	0.234
1.883	0.314
2.259	0.386
2.636	0.448
3.012	0.483
3.389	0.517
3.765	0.539
4.142	0.552
4.518	0.564
4.895	**0.566**
5.271	0.559



Remarks:

1) H/D = 1.943

Plan No. 4645 - 33

SWIS-TECH

ENGINEERS & CONTRACTORS

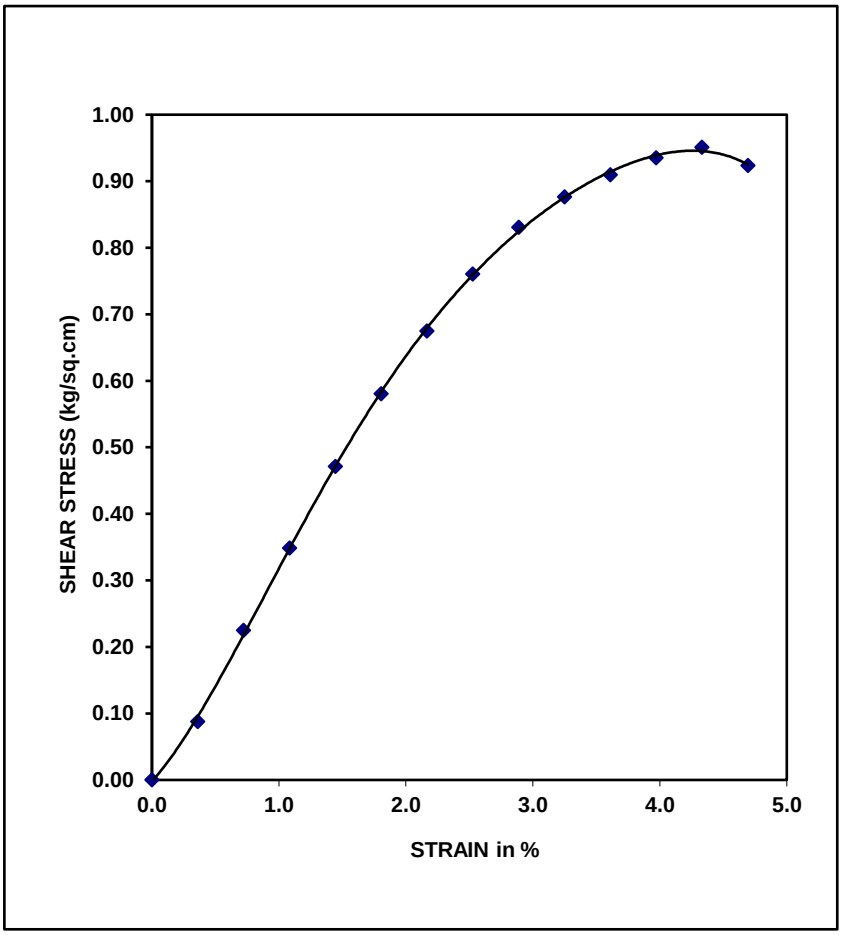
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Contractor:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-L, Gulberg-III, Islamabad.				
Bore No:	3	Depth:	14'-0" / 15'-0"	Type of Sample:	UDS
Soil Material:	Brown to slightly reddish brown, SILTY CLAY (CL-ML).				

Diameter :	6.815 cm	Wet Weight :	991.0 gm
Height :	13.850 cm	Moisture Content :	21.400 %
Area :	36.477 sq.cm	Wet Density :	1.962 g/cc
Volume :	505.211 cu.cm	Dry Density :	1.616 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:			0.0918 Kg/div		

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.361	0.088
0.722	0.225
1.083	0.349
1.444	0.471
1.805	0.581
2.166	0.675
2.527	0.760
2.888	0.831
3.249	0.877
3.610	0.910
3.971	0.935
4.332	**0.951**
4.693	0.923



Remarks:

1) H/D = 2.032

Plan No. 4645 - 34

SWIS-TECH

ENGINEERS & CONTRACTORS

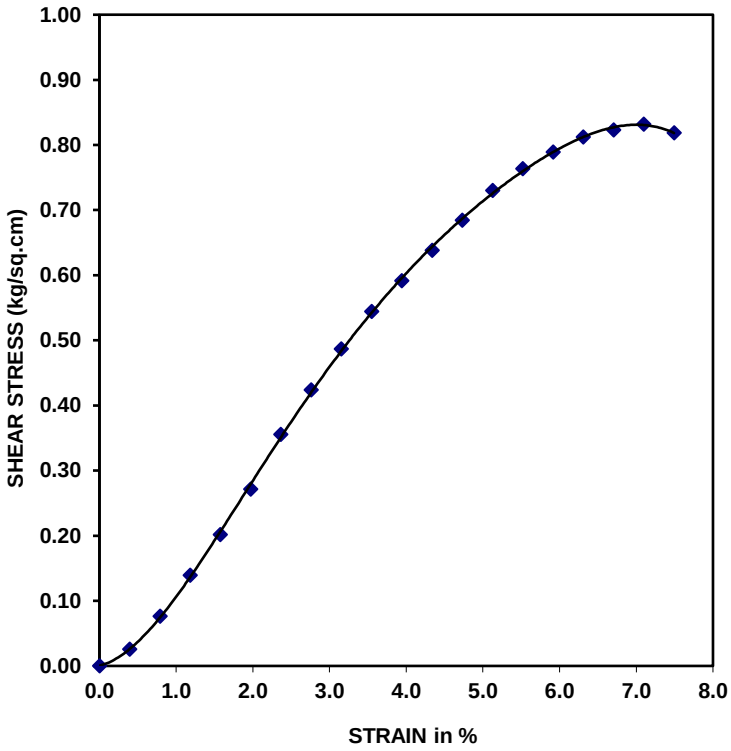
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Contractor:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-L, Gulberg-III, Islamabad.				
Bore No:	3	Depth:	34'-0" / 35'-0"	Type of Sample:	UDS
Soil Material:	Brown, slightly reddish to slightly greyish, SANDY SILTY CLAY (CL-ML).				

Diameter :	6.750 cm	Wet Weight :	898.8 gm
Height :	12.680 cm	Moisture Content :	22.200 %
Area :	35.785 sq.cm	Wet Density :	1.981 g/cc
Volume :	453.751 cu.cm	Dry Density :	1.621 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:	0.0918 Kg/div				

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.394	0.026
0.789	0.076
1.183	0.139
1.577	0.202
1.972	0.272
2.366	0.356
2.760	0.424
3.155	0.487
3.549	0.544
3.943	0.591
4.338	0.638
4.732	0.684
5.126	0.730
5.521	0.763
5.915	0.789
6.309	0.812
6.703	0.823
7.098	**0.832**
7.492	0.819



Remarks:

1) H/D = 1.879

Plan No. 4645 - 35

SWIS-TECH

ENGINEERS & CONTRACTORS

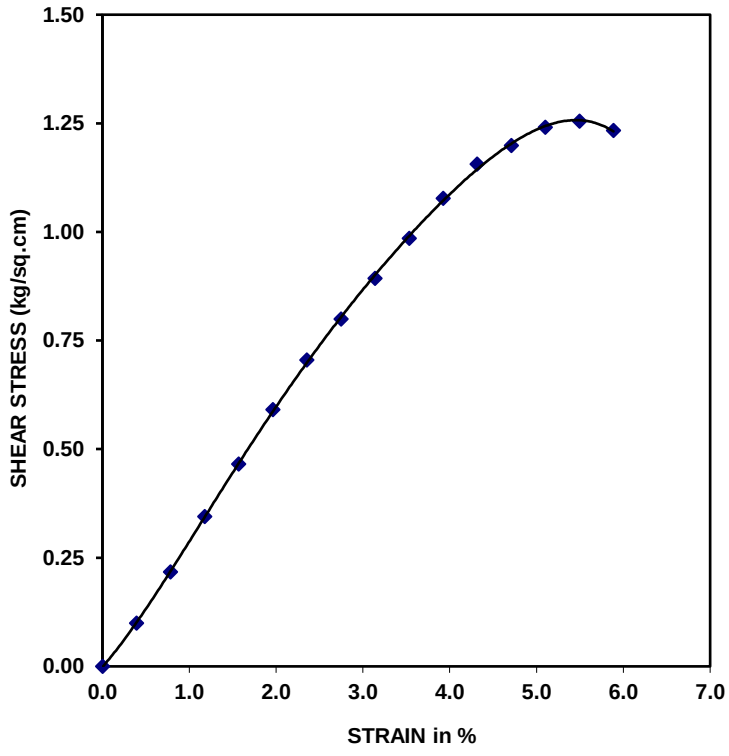
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Contractor:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-L, Gulberg-III, Islamabad.				
Bore No:	4	Depth:	8'-0" / 9'-0"	Type of Sample:	UDS
Soil Material:	Brown to reddish brown, LEAN CLAY with sand (CL).				

Diameter :	6.850 cm	Wet Weight :	895.4 gm
Height :	12.740 cm	Moisture Content :	21.600 %
Area :	36.853 sq.cm	Wet Density :	1.907 g/cc
Volume :	469.506 cu.cm	Dry Density :	1.568 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:			0.0918 Kg/div		

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.392	0.099
0.785	0.217
1.177	0.345
1.570	0.466
1.962	0.591
2.355	0.705
2.747	0.799
3.140	0.893
3.532	0.985
3.925	1.077
4.317	1.156
4.710	1.199
5.102	1.241
5.495	**1.255**
5.887	1.233



Remarks:

1) H/D = 1.860

Plan No. 4645 - 36

SWIS-TECH

ENGINEERS & CONTRACTORS

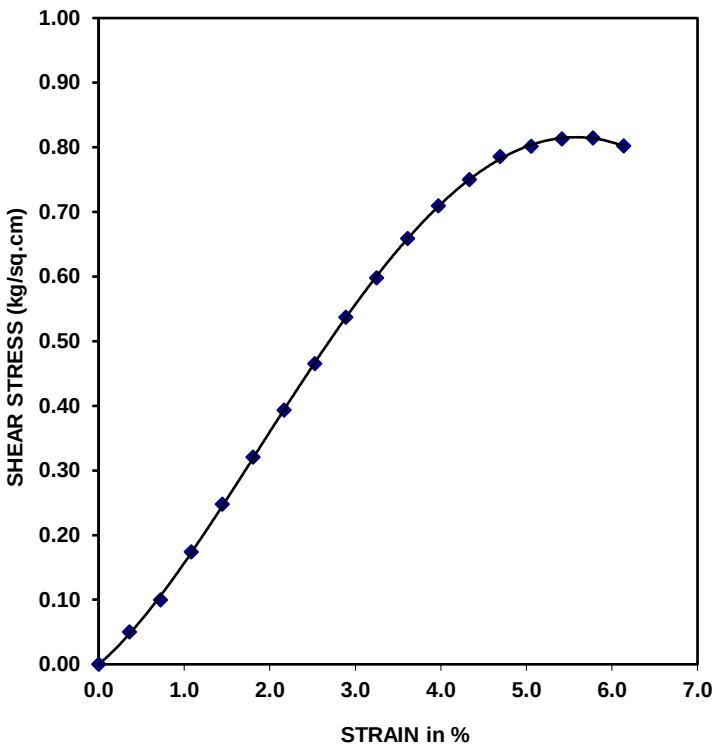
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Contractor:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-L, Gulberg-III, Islamabad.				
Bore No:	4	Depth:	18'-0" / 19'-0"	Type of Sample:	UDS
Soil Material:	Brown to slightly reddish brown, LEAN CLAY (CL).				

Diameter :	6.820 cm	Wet Weight :	994.9 gm
Height :	13.850 cm	Moisture Content :	23.400 %
Area :	36.531 sq.cm	Wet Density :	1.966 g/cc
Volume :	505.952 cu.cm	Dry Density :	1.593 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:			0.0918 Kg/div		

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.361	0.050
0.722	0.100
1.083	0.174
1.444	0.248
1.805	0.321
2.166	0.393
2.527	0.465
2.888	0.537
3.249	0.598
3.610	0.659
3.971	0.709
4.332	0.750
4.693	0.786
5.054	0.802
5.415	0.813
5.776	**0.815**
6.137	0.802



Remarks:

1) H/D = 2.031

Plan No. 4645 - 37

SWIS-TECH

ENGINEERS & CONTRACTORS

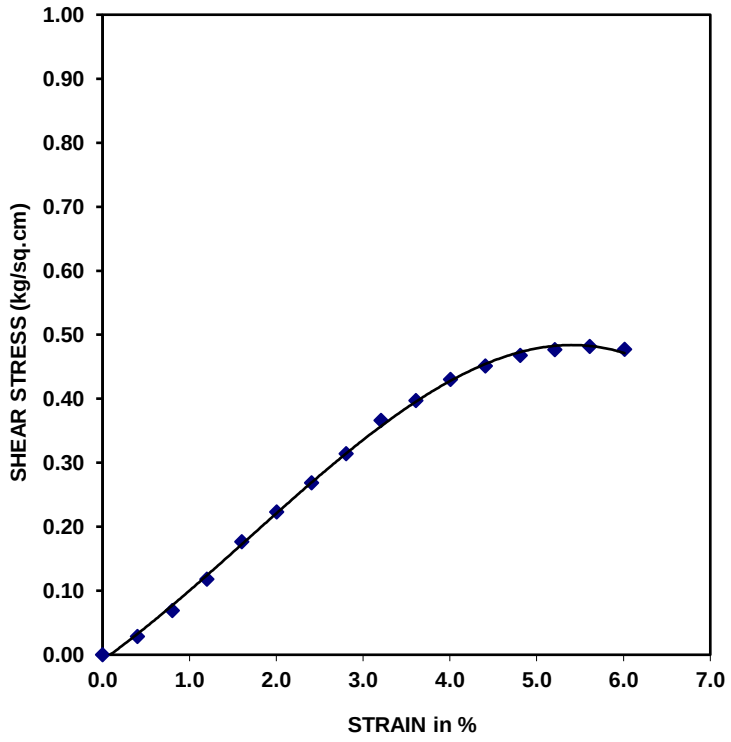
UNCONFINED COMPRESSION TEST

Client:	IBECHS, Gulberg - Islamabad				
Contractor:	UPDL, Islamabad				
Project:	Proposed Overhead & Underground Water Tank at Block-L, Gulberg-III, Islamabad.				
Bore No:	4	Depth:	28'-0" / 29'-0"	Type of Sample:	UDS
Soil Material:	Brown, slightly reddish to slighlty greyish, SANDY SILT (ML).				

Diameter :	6.985 cm	Wet Weight :	941.5 gm
Height :	12.475 cm	Moisture Content :	18.100 %
Area :	38.320 sq.cm	Wet Density :	1.970 g/cc
Volume :	478.040 cu.cm	Dry Density :	1.668 g/cc

Proving Ring No:	1	Capacity:	100 Kg	Strain Dial:	0.01 mm
Proving Ring Constant:			0.0918 Kg/div		

% STRAIN	SHEAR STRESS Kg/Sq.cm
0	0
0.401	0.029
0.802	0.069
1.202	0.118
1.603	0.177
2.004	0.223
2.405	0.269
2.806	0.314
3.206	0.366
3.607	0.397
4.008	0.430
4.409	0.451
4.810	0.467
5.210	0.477
5.611	**0.482**
6.012	0.477



Remarks:

1) H/D = 1.786

Plan No. 4645 - 38