PORT ON SOIL INVESTIGATION AND RECOMMENDATION ON FOUNDATION FOR THE CONSTRUCTION OF STILT+8 STOREYED MIG FLATS AT ZONE 'M1' OF PERUMBAKKAM PROJECT

Job No: SF/KI-47/ Perumbakkam/Zone 'M1'/TNSCB/2013

Client: The Executive Engineer,
ETRP (C-II) Division, TNSCB
25/7/14 Semmenchery, Chennai-600 119.

Faculty of Civil Engineering
Anna University
Chennai – 600 025

Office : 2235 7544
2235 7546
Fax : 2220 0847

Dr. K. ILAMPARUTHI
Project Coordinator
&
Professor and Chairman (Civil)

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1. Introduction

The Executive Engineer, ETRP (CII) Division of TNSCB has sent a request to conduct soil investigation in their housing project site at Perumbakkam TNSCB scheme area through Lr.No:203/E.C/ETRP CII/2012, dt: 03.01.2013 for the construction of MIG and FIG Flats. The Board proposed to construct residential flats in their housing scheme area as detailed below:

Sl.No	Detail	Number of blocks	Area of each unit (m^2)	Number of units
1.	MIG Flats (Stilt + 8 Floors)	12 (64 units in block each)	73.9	768
2.	FIG Flats (Stilt + 8 Floors)	4 (64 units in each block)	97.3	256

To construct these residential blocks an area of 7.13 Hectares is allotted covering survey Nos: 539/2, 540/1, 540/2 and part of 537. The area earmarked for the said purpose is shown in key map (Fig.1a) of the TNSCB Perumbakkam scheme.

The proposal of the Board comprises of building nine storeyed (Stilt + 8 floors) framed structures.

The Perumbakkam village is located at a distance of about two kilometer towards western direction from OMR. A road of 18m wide is connecting this village with OMR. On the Southern side of this road and adjacent to existing TNSCB scheme at Semmencherry, the Executive Engineer (Div VI) of TNSCB executed similar project over an area of 30 Acres covering S.Nos: 542 to 544 during 2009. At this area eight storied framed structures were constructed and they are ready for occupation. These buildings are supported on raft foundation and the depth of foundation of all the buildings is around 4m. The Fig A1 shows the land allotted for the proposed construction including the area where project is completed.

On allocation of land by the Government, The Executive Engineer (Div.II), TNSCB took initiative to implement the project and requested the services of Department of Civil Engineering to conduct Soil Investigation for the construction of Block 12 to 18 (S.No: 528) and constructions of Blocks covering area coming under S.Nos:479/2 and 482 to 485. These two locations are marked as Zone 'A 'and Zone 'B' in layout plan (Fig A1) and they lie in the south and north west part of the land allotted for the project.

At Zone 'A' investigation was conducted at 5 locations during April 2010. The top layer is expansive clay of 1.5m thick followed by clayey sand of 1m. Weathered rock was met at the depth of 2.75m invariably and fairly good rock was seen at depth around 4m. The water table was met at the depth of 2.5m. Based on the soil condition of the area, it was recommended to adopt raft foundation at the minimum depth of foundation of 3m (RL -1.45m).

At Zone 'B' investigation was carried out during the second week of June 2010 by drilling eight boreholes. The deposit of this area composed of highly plastic clay of 2m to 2.7m thick followed by residual soil (weathered rock reduced to soil) of 1m to 1.5m thick. However the deposit below 4.5m was fractured rock. At this area the water table was at the depth of 3m. The foundation recommended for the eight storeyed structures was raft foundation and minimum depth of foundation was 2.75m (i.e. RL -1.35m) from

the lowest ground level. Recommended bearing capacity was 200kN/m^2. The board commenced the construction work at Zone 'A' and 'B' in the second week of May 2012.

In the remaining part of allotted land of Perumbakkam village, the Executive Engineer, JNNURM Division sent a request through Lr.No:171/JNNURM Dn/A1/2011, dt:28.3.2012 to inspect and conduct subsurface investigation covering survey nos: 509,510,511,516,517,518,536,537 & 538 for the construction of eight storeyed residential block in these location. Accordingly investigation was conducted at 40 locations covering 125 acres of land. Since the area was large, it was divided conveniently in to Zone 'C', Zone 'D', Zone 'E' and Zone 'F' as indicated in Fig A1.

The sub-surface investigation in all these areas was commenced on 25th April 2012 and completed on 19th May 2012. The report was released for each zone independently. The recommended foundation was raft for the eight storeyed buildings irrespective of the Zones in which buildings are proposed to locate. The recommended depth of foundation at different Zones is as below.

Zone	RL of Foundation (m)	Bearing capacity
C	between – 1.0m and -1.2m	220kN/m^2
D	between – -1.9m and -2.6m	220kN/m^2
E	between – -1.1m and -1.6m	220kN/m^2
F	between – 0.9m and -1.2m	220kN/m^2

Foundations of buildings were located at depths as recommended without difficulty except one or two blocks. As stated in the first paragraph of the report the board has drawn a proposal to construct MIG and HIG Flats in this area for the public, since the area lies within a distance of 2km from OMR and demand for house is more in this area.

The board has earmarked the area for this proposal, which lies in the south east part of the Perumbakkam scheme, which is about 7.13 Hectares. The project site was inspected

along with the Executive Engineer of ETRP Division and other officials on 28.02.2013. Since the project area is large (total extent is 7.13 Hectares) the buildings are nine storeyed framed structure and this area comes under zone III as per IS IS1893-2002(Part-1), it is decided to investigate over entire area covering all the 16 blocks. At the end of investigation it is proposed to explore at two locations for each MIG block and at three locations for each HIG block. This proposal is been accepted by the Executive Engineer. Accordingly locations of boreholes for each block were selected and mutually agreed to investigate at 36 locations as detailed below:

Zone	Number of Blocks	Boreholes
M1	M1 to M6	BH1 to BH12
M2	M7 to M12	BH13 to BH24
H	H1 to H4	BH1 to BH12

Since large part of Perumbakkam Housing Project area was covered in earlier investigations, over all soil condition of this area is known to consultant. In this area, the hard stratum with good bearing resistance occurs within a depth of 4.5m; therefore it is felt sufficient to investigate to a depth of 9m. However one or two boreholes were drilled beyond the depth of 9m to know relative degree of weathering of rock deposit and its quality. The soil investigation work in all the three zones is commenced on 04.03.2013 simultaneously and completed on 9.4.2014.

2. Details of the project

The project to be executed in this area is construction of multi-storeyed blocks for the middle and high income group people under Rajiv Awas Yojana scheme.

In this project the Board is proposed to construct 9 storeyed (Stilt + 8 Floors) framed structure by adopting two different type design; one is for MIG and the other is for HIG. Apart from residential buildings they develop other amenities like club house, Gym, Park etc. However the soil investigation carried out is mainly for the construction of multi-storeyed buildings. Each block of MIG is designed to accommodate eight

families in each floor with plinth area of 73.9m^2/ family. Similarly the HIG flats are also designed to accommodate eight families in a block with plinth area of 97.3m^2/unit.

The structure is nine storeyed building and the area of construction is located within 20km distance from Chennai. The Chennai and its neighboring areas is coming under Zone III, hence the structure of this area is to be designed for Zone III conditions. Moreover in the recent past Chennai has experienced mild tremors and the earthquakes occurred in Sumatra islands and Pondicherry coast also felt in some parts of Chennai. Therefore the board has analyzed the building for the Zone III condition. The minimum and maximum load at the foundation level for the critical load combination was reported as 869kN and 1890kN respectively. Since the soil is in the heterogeneous condition and in hard layer (i.e. weathered rock) clay lumps are seen during investigation, which is not conducive for isolated footing. Therefore the average load at the foundation level for the raft was obtained for the critical combination of load, which is 219kN/m^2.

3. Preliminary Inspection of the project area

Perumbakkam area has experienced fast development within a period of four years. The land of Perumbakkam area covering survey numbers as per the key plan (Fig. 1a) was occupied by the local people of the area. This entire area was covered with thatched roof houses, semi permanent buildings and permanent buildings. The local Town Panchayat laid temporary roads and provided water and power connections to the houses. In certain houses were provided with soak pits and were connected to toilets. These soak pits are 3.5m to 4m deep from the existing ground level. The area identified for the development of project is covered by 18m road on the south, compound wall of Bollini Hill Housing complex on the west, open private land on north and proposed PWD Drain of 40m wide on the east. This area is at a distance of approximately 2km from the OMR. The ground level of this area though it appears uniform, it is slopping from west to north east direction. The construction of multi-storeyed buildings in this project area was commenced during 2010 in Zone A and covered most part of the area part by part. The part of land, on the south east side of the area covering S.Nos: 537, 539/2, 540/1, 504/2,

541 is vacant and is been identified for the construction of multi-storeyed flats. This area lies within the boundary of 18m wide Semencherry-Perumbakkam road on the south; 30m wide road and PWD drain are on the east, Zone D on north and community facilities of Zone A on the west. The total area is 71330m^2. The ground level of this area is almost uniform and is also free from shrubs and old structures; hence the site is ready for soil investigation. There is a hill at a distance of about a kilometer or more on the western side and the ground is slopping from the foot of the hill towards east. At the proposed construction site the ground level is the lowest while comparing with the ground level of neighboring areas. This area is prone for water logging hence the board is proposed to raise the existing ground level.

As stated in the introduction, the area of Perumbakkam (Zone A to Zone F) was already investigated at different pint of time for the purpose of locating suitable depth for foundation of eight storeyed structures and reported occurrence of hard stratum invariably at the depth below 4.5m and the weathered residual soil at depth of around 2.75m. The weathered residual soil was in hard/dense condition with N values more than 50 blows. However on the east and north east part of the area (Zone D) the deposit over a depth of 3m is soft. Keeping this in mind, it is proposed to investigate up to the depth of occurrence of hard stratum (N>100) at all the 36 boreholes. In a few boreholes rock drilling using single tube core barrel with diamond cutter is also recommended in order to confirm the presence of true hard stratum to a reasonable depth. The officials of TNSCB have agreed for this suggestion and proceeded accordingly.

Since the soil condition at major part of Perumbakkam project area is known from the earlier subsurface investigation carried out for the blocks at Zone 'A' to zone 'F' it is agreed mutually by the consultant and the officials of TNSCB to restrict the number of investigation points as minimum as possible. Since buildings are located as clusters accommodating other amenities for each cluster, it is decided to group at each cluster as individual zone. Thus there are three zones (M1,M2&H) and is mutually agreed to investigate at 12 points in each zone by distributing minimum of two exploratory points

for each block. The subsurface investigation at the proposed construction area was commenced during the fourth week of February 2013. At all the borehole locations, the borehole was advanced using rotary drilling technique and standard penetration tests were conducted in each borehole at spacing of 0.75m using standard split spoon without liner as per IS2731-1972. The subsurface investigation work in this area was executed by M/s. Geotechnical solutions, Chennai under my (Prof.K.Ilamparuthi, Professor and Chairman, Faculty of Civil Engineering) supervision. This report presents salient details of investigation and soil type encountered along with recommendation on foundation for the Zone M1.

4. Site condition

The topography of Zone 'M1' is almost uniform and if at all any difference in the levels within the area of investigation may not be more than 0.3m. The deposit on the surface exhibited honey comb pattern tension cracks, which confirm that the top soil is dominantly clay with shrink and swelling quality. Further there is a hill at a distance about a kilometer or more from the western boundary of proposed construction area. It provides the clue that the rocky stratum will be at a shallow depth in the construction area and the soil cover that lies above is certainly residual deposit. However there is a chance for transported soil deposit on the surface particularly in the eastern part of the area because of a canal and lower ground level.

5. Details of soil investigation

At Zone 'M1' soil investigation was carried out at 12 locations as shown in Fig.1b. It can also be seen that the locations of various blocks. The details of borehole locations and the ground level at each location are presented below:

Bore hole No	Identification	Location	Ground level (RL)	Water Table (RL)
1	BH1	Block M5	+1.289m	+0.289m
2	BH2	Block M5	+1.330m	+0.330m
3	BH3	Block M6	+1.310m	-0.090m
4	BH4	Block M6	+1.314m	+0.114m
5	BH5	Block M4	+1.349m	+0.249m
6	BH6	Block M4	+1.490m	+0.190m
7	BH7	Block M3	+1.532m	+0.532m
8	BH8	Block M3	+1.280m	-0.020m
9	BH9	Block M2	+1.405m	+0.105m
10	BH10	Block M2	+1.262m	+0.062m
11	BH11	Block M1	+1.294m	+0.006m
12	BH12	Block M1	+1.224m	+0.024m

The boreholes were made to collect information on nature of overburden and depth of occurrence of hard stratum. They were drilled using rotary method with bentonite mud circulation. This method is normally adopted to advance the boreholes both in residual and sedimentary deposit. The circulation of drilling fluid was employed through drill rods and letting out through the jets provided in the cutting tool. The jetting action with pressure flow brings the cut material to the surface through the annular space between the sides of boreholes and drill rod. Boreholes of diameter 150mm were drilled by adopting this method. During drilling it was ensured that the borehole was kept full with drilling fluid to avoid disturbance to the sides as well as bottom heave. In the boreholes, standard penetration tests were conducted at required depth or wherever there was a change in the soil layer. This test was conducted using standard dimension split spoon without liner as per the procedure given in IS 2731-1972 using donut type hammer dropped mechanically (2 turns of rope in the cathead arrangement). The energy of impact was around 70%. Thus the field value was N_{70}. However the filed N values were corrected for the installation procedure and the value was very close to N_{60}. Therefore recorded values were taken as N_{60}. The values thus recorded were not corrected for overburden since the top soil to the depth of 2.5m was having fines more than 50%. Further the correction for

saturation was also not applied for the resistance values recorded below water table since the deposit was not fine sand. Further the overburden correction factor is greater than unity for the N values recorded at shallow depths; hence the said conditions will certainly result in conservative resistance of deposit. The soil samples obtained from the split spoon were visually identified and tested in the laboratory for assessing index properties. Soil samples collected in split spoon samplers are subjected to test for index properties. The boring and sampling operations were continued at each location until refusal N value (rebound) was recorded or two consecutive N values were grater then 50 blows and the third N value was more than 100 blows. However at locations wherever rock was encountered, exploration was continued using single tube core barrel with diamond cutter. In the rock stratum drilling was done to a depth not less than 1m and obtained core samples. In all the boreholes level of water table was collected. The depth of ground water table recorded at various locations is presented in the table presented in this section.

6. Soil profile of the proposed site

The investigation at this area was commenced after marking borehole locations and their reduced levels. The reduced levels of borehole locations are almost uniform with maximum variation of 0.3m between BH7 and BH10 and the RL at BH7 is +1.532m. As stated in the previous section, the soil profile is logged at each location based on soil samples obtained using split spoon sampler. The profiles thus logged at 12 locations are presented in Figs 2 to 13 along with N values recorded. The field N values recorded are taken as $(N_1)_{60}$ (i.e. design N values) for the reasons already stated irrespective of the depth and nature of deposit of this area.

The disturbed samples of each borehole are tested for index properties inclusive of swell quality. The index properties such as gradation, Atterberg limits, and free swell index are presented in Table 1 to 12 for the boreholes BH1 to BH12. The gradation curves are presented in Annexure G. The undisturbed samples obtained from the clay layers are tested for strength. The strength is determined from the samples by conducting

unconsolidated undrained test at their natural moisture contents and the respective stress-strain responses are present in Annexure-U along with Mohr-Coulomb envelope. The strength and secant modulus are also presented. The compressibility properties of clay deposits are determined from index properties using established empirical equations including pre-consolidation pressure are presented in Annexure - C. The soil deposits logged at each block are presented and discussed below.

Block M1

The block M1 is located on the north east corner of the Zone M1. At the block M1 two exploratory boreholes (BH11&BH12) were made by locating them diagonally opposite to each other in the north east and south west corners of the block. At these two boreholes exploration was done to a depth of 7.9m and 8.7m respectively and the borehole was terminated in severely jointed rock.

The ground level at both the borehole locations is almost equal, which shows that the terrain is more uniform at Block M1. The soil profile logged at BH11 and BH12 is presented in Fig 12 and 13 respectively along with N values recorded.

At BH11 the top layer to a depth of 2.6m is silty clay. This layer recorded a minimum N value of 4 blows at the depth of 0.75m and a maximum value of 26 blows at the depth of 2.25m. This clay layer is in medium stiff condition and its consistency is increased with depth and is in very stiff condition at depth below 2m. Results of Atterberg limit tests and free swell index show that this layer is high plastic clay (CH) and it possess volume change quality. Its liquid and plastic limits are more than 75% and 25% respectively. The deposit between the depth of 2.6m and 5.0m is a residual deposit. In this residual deposit, clay content is more in top layers and is classified as SC/CI. However content of coarse fraction is increased to 75% at the depth of 3.4m and is classified as silty sand/clayey sand. This intermediate layer is in stiff condition and becomes very dense layer by recording N value > 100 blows. The rock is encountered at the depth of 5.0m, which is highly weathered and further exploration to depth of 7.9m confirms that the rock deposit is becoming strong. However the deposit at the depth of

termination is severely jointed rock with core recovery ratio of 15%, which can be seen from the plate 1 wherein core samples obtained between the depth 6.9m and 7.9m are shown. Thus the deposit at BH11 within the depth of investigation of 8m is three layer system comprises of top layer of high plastic clay (CH), intermediate residual deposit of clayey sand (SC/SM) followed by weathered rock.

The BH12 which is been made at the north east corner of block M1 has also recorded identical soil condition (Three layer system) as that of BH11. The top soil to a depth of 2.8m is silty clay. This layer is in soft consistence at the depth of 0.75m to 1.25m and is becoming medium stiff at depth 1.5m. This layer contains plastic clay which is known from the plastic index values of the clay (I_p>48%). Its free swell index values are also more than 70% (Table 12). Thus the soil is clay of high plastic (CH) and is susceptible for volume change. The layer that follows the clay is clayey sand/silty sand with fines in the range of 15% to 24%. The N values recorded in this layer are between 28 and 100 blows, indicating that the layer is dense to vary dense condition. The deposit that lies below the depth of 5.5m is weathered rock; its degree of weathering is reduced with depth this can be known from the recovery ratio of core samples. The recovery ratio is zero in rock deposit between the depth of 5.6m and 6.7m whereas the value is 13% at depth between 7.7m and 8.7m.

Block M2

The Block M2 is located on the western side of Block M1. In the location of Block M2 two boreholes (BH9&BH10) were made as shown in Fig.1b. BH9 was made on the south west corner whereas BH10 was made at the north east corner of the block. At BH9 exploration was terminated at the depth of 9.6m whereas BH10 was terminated at the depth of 7.8m from the respective ground levels. The ground levels at BH9 and BH10 are +1.405m and +1.262m respectively. The soil profile logged and N values recorded at these two borehole locations are presented in Figs 10&11.

At these two borehole locations top soil to a depth of 2m is silty clay with N values in the range between 2 and 14 blows. The silty clay layer becomes stiff at the

depth of 1.5m. Its index test results are presented in Table 9 and 10. It has higher liquid and plasticity index values, which indicates that the fines of this layer is plastic and the soil is classified as clay of high plastic (CH). The layer that lies below the silty clay layer is clayey sand with fines in the range between 18% and 28%. Thickness of this layer is about 3m and is in dense (N>30) to very dense condition (N>100). The weathered rock is encountered at depth approximately 5.0m, which is highly weathered and fractured. However the presence of strong layer is confirmed by drilling to a depth of 9.6m at BH9 and 7.8m at BH10 where core recovery is 20% and 7% respectively.

Block M3

At Block M3 also exploration was conducted at two locations by locating the boreholes diagonally apposite to each other. The soil profile logged at BH7 and BH8 respectively. The test results conducted on samples of split spoon are presented in Table 7 and 8.

Top layer is silty clay; its thickness is approximately 2m. In this clay layer liquid limit value is more than 50% and FSI values are also more than 60%. These values confirm that the clay layer is active and is susceptible for volume change due to seasonal moisture variation. The N values recorded show that the layer is in medium stiff condition but presence of soft pocket of clay cannot be ruled out.

The deposit between the depth 2m and 5m is residual clayey sand layer with fines between 10% and 25%. This layer is in dense to very dense condition with N values > 50 blows. At these two borehole locations weathered rock layer is met at depth approximately 5.2m and presence of rock deposit is confirmed by drilling to an additional depth of 3m. The borehole was terminated at the depth of 8.2m and 8.1m at BH7 and BH8 respectively, at which the rock is granitic gneiss, which is weathered and jointed. The recovery ratio of core samples is in the range between 12% and 26%.

Block M4

The Block M4 is located on the south side of Block M3 and at the location of Block M4 exploration was done by drilling at two points (BH5&BH6) within the area of the block. The borehole 5 (BH5) is drilled at the south west part of the block whereas borehole (BH6) is drilled at the north east part. The soil profile logged at both the locations is presented in Figs 6 and 7 along with N values recorded. At BH5 the top soil to a depth of 1.7m is silty clay, which is in medium stiff to stiff condition. The deposit that follows the clay is clayey sand of 3m thick with intrusion of weathered rock of 0.5m thick between the depth of 3 and 3.5m. This sand deposit is in very dense condition with N values greater than 87 blows. Weathered rock changes to strong (hard) rock at the depth of 7.1m and the core sample obtained between the depth of 7.1m and 8.1m recorded the recovery ratio of 55% and RQD of 55%. These values confirm that the rock occurring at depth below 7m is hard and is classified as Granitic Gneiss. The core recovered at depth below 7.1m is shown in plate.1.

The laboratory test results of samples of clay layer and clayey sand layer are presented in Table 5. The liquid and plastic limits of clay are in the range between 65% and 72% and 22% and 23% respectively. The samples also recorded FSI values more than 70%. Thus clay fines are active and plastic and the soil is classified as clay of high plastic (CH). In the clayey sand fines are in the range of 18% to 26% and sand fractions are more than 60%. Thus classified as clayey sand / silty sand (SC/SM).

The deposits encountered at BH6 are marginally different from BH5, though the overall condition of the deposits is almost identical. The top layer is clay of high plastic (Table 6) as seen at BH5, but its thickness is 2.5m. However the clay layer has almost identical character as that seen in the clay of BH5. The second layer is sand, its thickness is about 3m and is in very dense condition (N>100m), but there is no intrusion of weathered rock as seen in BH5. However similar intrusion is recorded at BH8. The deposit that follows the sand layer is weathered fractured rock and recorded refusal N value at the depth of 5.4m and 6m. This stratum continues up to 9.0m, at which depth, the borehole was terminated. The rock deposit available at depth between 8m and 9m is

strong and less weathered since recovery ratio and RQD values are 26% and 10% respectively.

Block M5

Borehole 1 and 2 are made at Block M5 which is located on the south west part of the Zone M1. At BH1 exploration was made to a depth of 7.05m and was terminated in weathered rock. The deposit at this borehole location comprises of soft clay layer of 2.2m thick followed by dense sand layer of 1.6m thick. The N value recorded in the clay layer is two blows or less but in the sand layer the resistance is high (N>50) and recorded refusal condition at the depth of 3.75. The weathered rock that follows the sand is highly weathered and it belongs to calcareous sand stone group wherein recovery ratio is between 15% and 21% in the layer between the depth of 5.05m and 7.05m.

The soil profile logged at BH2 (Fig.3) is almost identical to that of BH1. Top layer is soft clay of 2.2m thick with N value less than 3. This layer is underlain by a clayey sand layer of 2.8m thick. The minimum N value in this layer is 43 blows at 2.25m depth and recorded higher values at depth below 2.25m. The refusal condition is encountered at 5m depth where the deposit is highly weathered calcareous sand stone. Its thickness is about 1.2m. A strong rock deposit of granitic family lies below calcareous sand and is found to occur up to the depth 8.30, at which depth borehole is terminated. The granitic gneiss is weathered and jointed but RQD is 10% in the deposit between 7.8m and 8.3m. The test results of soil samples of BH2 are presented in Table 2. The first layer is classified as clay of high plastic (CH) and the intermediate sand layer that lies above calcareous sand stone is classified as clayey sand / silty sand (SC/SM).

Block M6

At Block M6, exploration was done at two locations as shown in Fig.1b. Borehole 3 (BH3) and borehole 4(BH4) are located diagonally opposite to each other. At these two locations the deposits are silty clay followed by clayey sand up to 5.3m from the existing ground level followed by weathered rock up to 8.1m, at which depth; both the boreholes

were terminated (Figs 4 and 5). The clay layer is in soft to medium stiff condition with minimum and maximum N values of 3 and 8 blows. This layer is classified as clay of high plastic since liquid and plasticity index values are more than 50% and 46% respectively. The sand layer that follows the clay is classified as clayey sand in which fines are about 20% and sand fractions are more than 60% (Table 3 & 4). It is in dense to very dense condition with N value much higher than 100 blows. The rock layer that lies below the sand is highly weathered till the depth of 6.1m. However the degree of weathering is reduced with depth and core recovery of 18% to 27% is obtained in the rock between the depth of 7.1m and 8.1m. The RQD of 21% indicates that the rock is sound but jointed.

The overall variation of deposits at locations of each block are combined and presented in Fig 14 to 19 for blocks M1to M6 respectively. From the figures presented and properties given in tables it is clear that the deposit of the area within the depth of investigation comprises of three layer system. The top layer is clay of high plastic (CH) with liquid limit higher than 60% in general. The swelling quality of the clay is critical to high and is confirmed through the free swell index values more than 60% in most of the samples. Its thickness is found to vary between 2.2m and 3.4m and is in medium to stiff condition at most of the locations. The soil of this layer is not even suitable for filling work.

The deposit lies below the clay layer (CH layer) is clayey sand/silty sand. Its average thickness is 3m. This layer is in dense condition with recorded N values are close to 50 blows or more except at BH9 where the value is 28. One limitation in this layer is presence of clay lumps and clay patches. These lumps are part of highly weathered soil derived from the parent material rock. As long as they are intact there may not be change in their property but due to release in pressure and direct contact with water it will become soft. Thus the condition is not favorable for isolated footing. Moreover excavation of this layer in presence of water or below the water table will create a problem to locate the foundation in this layer provided the water table is reduced

well below so that the soil is not losing its strength and provides good environment for construction.

The third layer is weathered rock. In this deposit degree of weathering is decreasing with depth and the thickness of strongly weathered portion is around one meter. However the rock stratum at depth below 5.5m is strong Granitic Gneiss deposit, however it is fractured and severely jointed. This rock mass recorded maximum recovery ratio of 55% at BH5 and the RQD is also 55%. In general recovery ratio of rock deposit is in the range of 7% to 26% and in most of the locations the RQD is nil. In certain locations calcareous deposits are also seen. The rock cores obtained from the boreholes are shown in Plate 1. Rock samples of certain boreholes are tested for strength under unconfined condition and test results are presented in Annexure CS1 to CS5. The unconfined strength of samples is presented below along with secant modulus of samples.

S.NO:	Identification	Depth, (m)	Unconfined Strength, (kN/m^2)	Secant Modulus (kN/m^2)
1	BH2	7.3-8.3	30700	351700
2	BH3	7.1-8.1	34100	351700
3	BH4	7.1-8.1	33900	382900
4	BH5	7.1-8.1	32800	305200
5	BH7	7.2-8.2	17300	287700

The properties of various soil layers both strength and compressibility are obtained from the N values using existing correlations are presented in Table 13. In case of clay Terzaghis' relation is used for obtaining undrained cohesion (C_u) values. The values thus obtained are found to vary between $15kN/m^2$ and $20kN/m^2$ in soft clay and the values are in the range between $40kN/m^2$ and $75kN/m^2$ in medium stiff to stiff clay. The strength obtained from UCC test on UDS of BH6 (Annexure U1) is $34kN/m^2$, which is in comparison with the value obtained by empirical correlation. In silty sand/clayey sand angle of shearing resistance (ϕ) is obtained using Meyerhof recommendations. However the modification suggested by Houch for the percentage fines present in the deposit is applied. The ϕ values obtained are varying between 32° and 42°.

In sand compressibility parameter is obtained by the relation $C=1.9\ q_c/\sigma'_0$, where q_c– cone resistance and σ'_0–effective overburden pressure. This procedure was developed by DeBeer and Martens (1957) and later on modified by Meyerhof to determine the elastic settlement in non plastic cohesionless deposit. IS 8009 (Part I), is also recommends this method to obtain immediate settlement. In the absence of cone resistance (q_c), it is considered equal to 240N to 300N (kN/m^2) since the deposit is SP/SM type. In the absence of consolidation test results, the compressibility parameter, m_v (=1/E) of clay deposit of Zone M1 is obtained from the chart of Stroud (1975) which accounts for the plasticity of clay fines and the value is found to be equal to $1/420N_{60}(m^2/kN)$. The m_v value of clay sample of BH6 is between 0.0003 and $0.00037m^2/kN$ for the pressure range of 50 to $200kN/m^2$. The clay at the depth of 1.5m is overconsolidated with preconsolidation pressure of $138kN/m^2$. This may be due to desiccation of top clay layer. The strength and compressibility parameters thus obtained are summarized in Table 13. The shear strength of rock is obtained from the UCC test conducted on core samples. These values are used for the determination of bearing capacity and settlement.

7. Ground water quality

The ground water table at all the boreholes is monitored and the levels are reported in section 5. Water samples are collected and tested for pH, sulphates and chlorides. Since the water is brackish, it is also decided to test the soil for above properties. The chemical test results are presented below:

Chemical test results of water and soil samples

Location	Sample	Depth,(m)	pH	Sulphate (SO_4) ppm	Chloride ppm	Remarks
Block M1	Water	2.0 (BH11)	6.9	750	16520	Sulphates and chlorides are very high
Block M4		2.0 (BH6)	7.52	810	12750	
Block M6		2.6 (BH3)	7.75	735	12500	
Block M1	Soil	0.75	8.1	400	500	Sulphates and chlorides are high
Block M6		2.25	7.6	340	600	Sulphates and chlorides are high

In water samples tested, pH is close to neutral or marginally on the alkaline side, but chlorides and sulphates are very high and the amount of chlorides present in ground water indicates that the ground water of this area is just like sea water.

In soil, the contents of sulphates and chlorides are more particularly in top clay layer. The results of tests on soil and water are to be reconfirmed. Sulphates and chlorides both in soil and water are more than the permissible limits as per IS 456 (Refer Table 4). Since ground water is very poor in quality suitable measure is to be taken to protect concrete and rebars from sulphate attack and corrosion of reinforcement. The clayey soil is not only plastic but also contains chlorides and sulphates in high quantity, hence not suitable for filling.

8. Summary

1. The top soil is highly plastic clay at all the borehole locations. Its thickness is found to vary between 1.8m and 2.2 m except at BH11 & BH12. In any case not more than 3.5m thick. It is susceptible for volume change due to seasonal variation in the moisture content. Free swell index value is as high as 100 at a few locations indicating clay is active. It is in medium stiff to stiff condition at most of the locations except at a few pockets especially top 1m layer. Native clay soil is not at all suitable for any construction work including back fill of basement and foundations.
2. The deposit below the depth of 2.5m from the existing ground level is residual deposit (highly weathered rock), which is a strong layer. The minimum N value recorded in this layer is 26 blows, which indicates that the deposit is in dense state. Further fines are less than 25% in sand at most of the location except at the transition zone between clay and sand and the balance content is dominantly sand and gravel fractions. This layer is strong enough to support any shallow foundation. However presence of clay lumps and clay patches need to be considered while deciding the foundation type.

3. The deposit below 5m to 5.5m is highly fractured rock which has recorded refusal N value. The recovery ratio of rock samples found to vary between 0 and 15% at most of the depths of rock deposit, which indicates that the rock is jointed and fractured. However as high as 55% is also recorded at certain depth of rock deposit. RQD is generally zero and more than 10% is also recorded in rock samples obtained at depth below 7m particularly at boreholes located on the western side of Zone M1. The maximum RQD is 55%, which is recorded in BH5 at the depth between 7.1m and 8.1m.
4. The water table level is at shallow depth (0.9m to1.5m) from the existing ground level. The maximum level of ground water is -0.09m (RL) during the month of March 2013. The sulphates and chlorides are present in both soil and water samples.

From the summary presented it is evident that the deposit of area is suitable for providing foundation at shallow depth. However the top soil to a depth of 2.5 to 3.0m is poor, hence foundation cannot be located in this layer. Therefore it is felt essential to locate the foundation at depth below 3.0 from the existing ground level. The depth suitable to locate the foundation is 3.0m or below from the existing ground level. The maximum variation in the reduced level of borehole locations is 0.3m (maximum + 1.532m and minimum +1.224m); hence minimum level of foundation shall be -1.8m (RL).

9. Selection of foundation

The subsurface condition of deposit of area is very much suitable for shallow foundation except that the foundation needs to be taken below the top clay layer. In this case it is suggested to locate the foundation at a minimum depth of 3.0m from the existing ground level. In order to decide the depth of foundation of the blocks N value more than 35 blows and location of water table are compared as below:

Borehole No:	Block No:	RL of stratum at N>50, (m)	RL of min.Depth of foundation, (m)	WT RL, (m)	Remarks
BH1	M5	-1.461	-1.711	+0.289m	Water table is above the foundation level
BH2	M5	-1.67	-1.67	+0.330m	Water table is above the foundation level
BH3	M6	-1.84	-1.84	-0.090m	Water table is above the foundation level
BH4	M6	-1.436	-1.836	+0.114m	Water table is above the foundation level
BH5	M4	-1.041	-1.651	+0.249m	Water table is above the foundation level
BH6	M4	-1.21	-1.51	+0.190m	Water table is above the foundation level
BH7	M3	-1.618	-1.618	+0.532m	Water table is above the foundation level
BH8	M3	-2.02	-2.12	-0.020m	Water table is above the foundation level
BH9	M2	-2.495	-2.345	+0.105m	Water table is above the foundation level
BH10	M2	-1.138	-1.838	+0.062m	Water table is above the foundation level
BH11	M1	-2.456	-2.456	+0.006m	Water table is above the foundation level
BH12	M1	-3.276	-3.276	+0.024m	Water table is above the foundation level

From the comparison made it is clear that foundations are to be located below the water table. The water table level reported is obtained from the borehole during investigation; there is a possibility for variation in the water table level. Therefore it is suggested to ascertain the water table level at each block at least at two corners before proceeding with the work of foundation. Normally the actual water level may be higher than recorded in the boreholes. It is suggested to locate the foundation a few centimeters above the water level in order to avoid excavation below the water table otherwise excavation below water table makes the soil to lose its strength. However at Zone M1

area the foundations are to be located below the water table, hence dewatering is essential.

The bearing capacity and settlement of foundation for the minimum depth of foundation given in the table are determined. The bearing capacity is determined for the raft foundation of size 23mx46m (approximate) using Teng (1961) equation and bearing capacity equation given in IS6403. The allowable bearing pressure is obtained for 25mm settlement using Teng equation and it varies between 324kN/m^2 and 410kN/m^2 for the N values between 40 and 50 respectively. The net safe bearing capacity value obtained from IS6403 for ϕ=36° is 1300kN/m^2 for FS=3. The soil at the foundation level of certain boreholes is stiff sandy clay with c_u between 160kN/m^2 and 250kN/m^2. Though thickness of sandy clay layer is less the bearing capacity value is determined by considering the strength of this layer alone for the c_u value of 160kN/m^2, which is 275kN/m^2 with a factor of safety of 3.5. Thus it is sure that the soils at the foundation levels are having good bearing strength and more over raft foundation of large size will provide higher bearing resistance and the settlement is real concern. The recommended bearing capacity is 250kN/m^2. The bearing capacity is reduced from the minimum value of 275kN/m^2 obtained, in order to account for the undesirable condition like presence of soft clay pockets. The average load intensity expected at the foundation level for the combination of load may not exceed 220kN/m^2, which is close to the bearing capacity recommended. The shallow foundation like isolated footing is not considered because of heterogeneous nature of soil (week zones like clay patches and clay lumps). However as an academic exercise the capacity was worked for the isolated footing of 2.5mx2.5m for the ϕ'=36°. The net safe bearing capacity obtained is 190kN/m^2, which is less than the expected average pressure of 220kN/m^2 of raft foundation. However the size of individual footing will be large for the expected load on the column if bearing capacity of 190kN/m^2 is adopted. If the bearing capacity is limited to 190kN/m^2 then foundations of columns are to be combined. Thus only option to support the buildings of stilt+eight storeyed buildings in the Zone 'M1' of Perumbakkam project is raft foundation.

The settlement of raft foundation is also worked out for the soil conditions of individual borehole for the net pressure of 250kN/m^2. The foundation is supported in silty sand / clayey sand layer which is non-plastic with course fractions around 70% followed by weathered/fractured rock. Therefore elastic settlement of foundation is obtained using DeBeer and Martens (1957) equation. The elastic settlement obtained at various locations is less than 15mm. Thus the raft foundation is the ideal choice for supporting the foundations of proposed stilt + eight storeyed blocks M1 to M6 at Zone 'M1'.

The one more issue is depth of foundation of each block can be different because of variation in depth of occurrence of bearing stratum within the Zone M1. Further providing uniform depth of foundation for all the six blocks (M1 to M6) will lead to more excavation at locations of certain blocks. The minimum depth of foundation (RL) at various blocks is varying between -1.75m and -3.0m. In this area the water table level is found to vary between +0.33m and -0.02m, and is above the recommended level of foundation, hence interference of water table cannot be avoided while executing the earthwork excavation to reach proposed level of foundation. The foundation excavation in presence of water is to be avoided. Adopt suitable dewatering method to lower the level of water table at least to a level of 0.5m below the foundation level.

10. Recommendations

The subsurface exploration conducted at Zone 'M1' confirms presence of good bearing stratum at depth of 3.0m from the lowest ground level and soft disintegrated rock at 5.5m depth. The top layer is though fairly strong its volume change characteristics do not permit to locate the foundation in this layer. This layer will exhibit high swelling (DFS>100%). Thus it is recommended to locate the foundation at a minimum depth of 3.0m from the lowest ground level. For the structure of stilt + 8 storeyed building it is recommended to support the structure on a raft foundation. The recommended bearing capacity of soil for the raft foundation of 23m x 46m (approximate size) is 250kN/m^2. Though the soil below the depth of foundation possesses higher bearing strength, it is

advised not to exceed the value of 250kN/m^2 because of non-homogenous nature of the deposit. Recommended level of foundation for the blocks M1 to M6 is as below:

Sl.No:	Block	Reduced level of Foundation,(m)
1	M1	-3.2
2	M2	-2.4
3	M3	-2.1
4	M4	-2.0
5	M5	-1.8
6	M6	-2.0

The level of foundation refers to base of a raft and the raft shall be laid on leveling course followed by sand cushion of adequate thickness each as per the practice in the board.

11. Precautions

1. The top soil to the depth of 2.2m is poor and highly swelling (expansive) hence does not use the soil for any construction or filling works.
2. The maximum depth of water table is -0.02m (RL) and the soil at this depth is clayey at most of the location hence excavation under this condition without dewatering will lead to collapse of cut and also reduction in strength of soil because of seepage through the bearing stratum.
3. Earth work excavation particularly below the water table to be allowed unless the water level is lowered to minimum depth of 0.5m from the recommended level of foundation. Adopt suitable scientific method for dewatering.
4. The minimum depth of foundation recommended is 3.0m. There may be a chance for variation in foundation depth because of uncertainty in the characteristics of highly weathered residual deposit in the area at depth around 3.0m. Improper dewatering and submergence of weathered soil may lead to significant reduction in strength, which may demand foundation at deeper depth to realize recommended bearing capacity. Do not reduce the foundation depth without obtaining proper approval from

the consultant in case of good bearing stratum met at higher level than the recommended level of foundation.

5. The water table in this area is at shallow depth. The seepage of water at the interface of weathered rock and soil cover will be critical hence conduct a pilot study to determine seepage parameters of deposits and design the dewatering system suitability. Technical support required for designing the dewatering system will be provided if required by the client. No case seepage is permitted directly through the foundation soil i.e. flow of ground water shall be away from the excavation area (i.e. foundation area) and not towards the excavation area.
6. The quality of ground water is not suitable for any construction work especially for foundation construction. Since the environment of both ground water and soil is aggressive, this will lead to sulphate attack on concrete and corrosion of reinforcement. The concrete and steel need to be protected from the aggressive action. Thus provide minimum cover of 75mm in addition to any other protective measures considered suitable. Obtain opinion from structural engineer for protecting foundation elements and part of columns and beams buried below the ground. Further the cement quality and the content shall satisfy the requirement of Table 4 of IS 456-2000.
7. Since the ground water is not satisfying the quality required for concreting work, use good water for all concrete related work. Minimum grade of concrete recommended for the foundation work is M25. Follow all the condition relevant to quality of water for concrete work as per IS 456-2000 including minimum cover thickness.
8. For filling works both inside the basement and outside around the building use good earth. The native soil particularly the high plastic clay is not at all suitable for any construction work including basement filling.
9. The basement filling will be more than 3.0m hence conventional flooring for the ground storey may lead to settlement problem on later days. It is suggested to provide RCC floor for ground floor base slab.

10. In case of any variation observed from the soil profile reported while execution of foundation work, it shall be brought to the notice of consultant for suitable advice. Do not change the recommended level of foundation without the knowledge of foundation consultant.

24/07/2014

Dr. K. ILAMPARUTHI
Project Co-Coordinator &
Professor and Chairman
Department of Civil Engineering
Anna University
Chennai - 600 025

Dr. K. ILAMPARUTHI, M.E., Ph.D.,
Professor & Chairman
Faculty of Civil Engineering
Anna University, Chennai-600 025.

Figure A1 Perumbakkam Project – Zones of Investigation

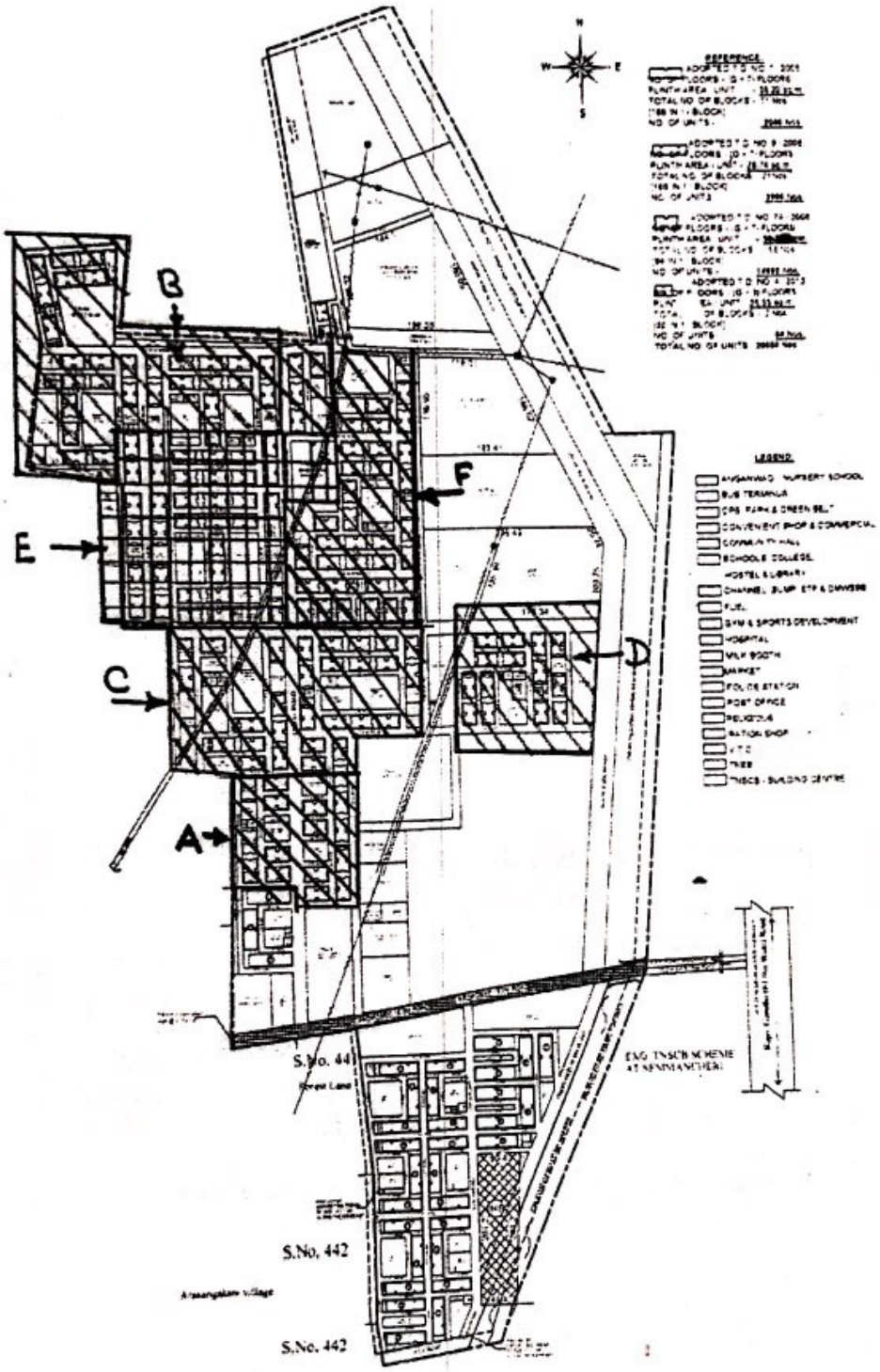
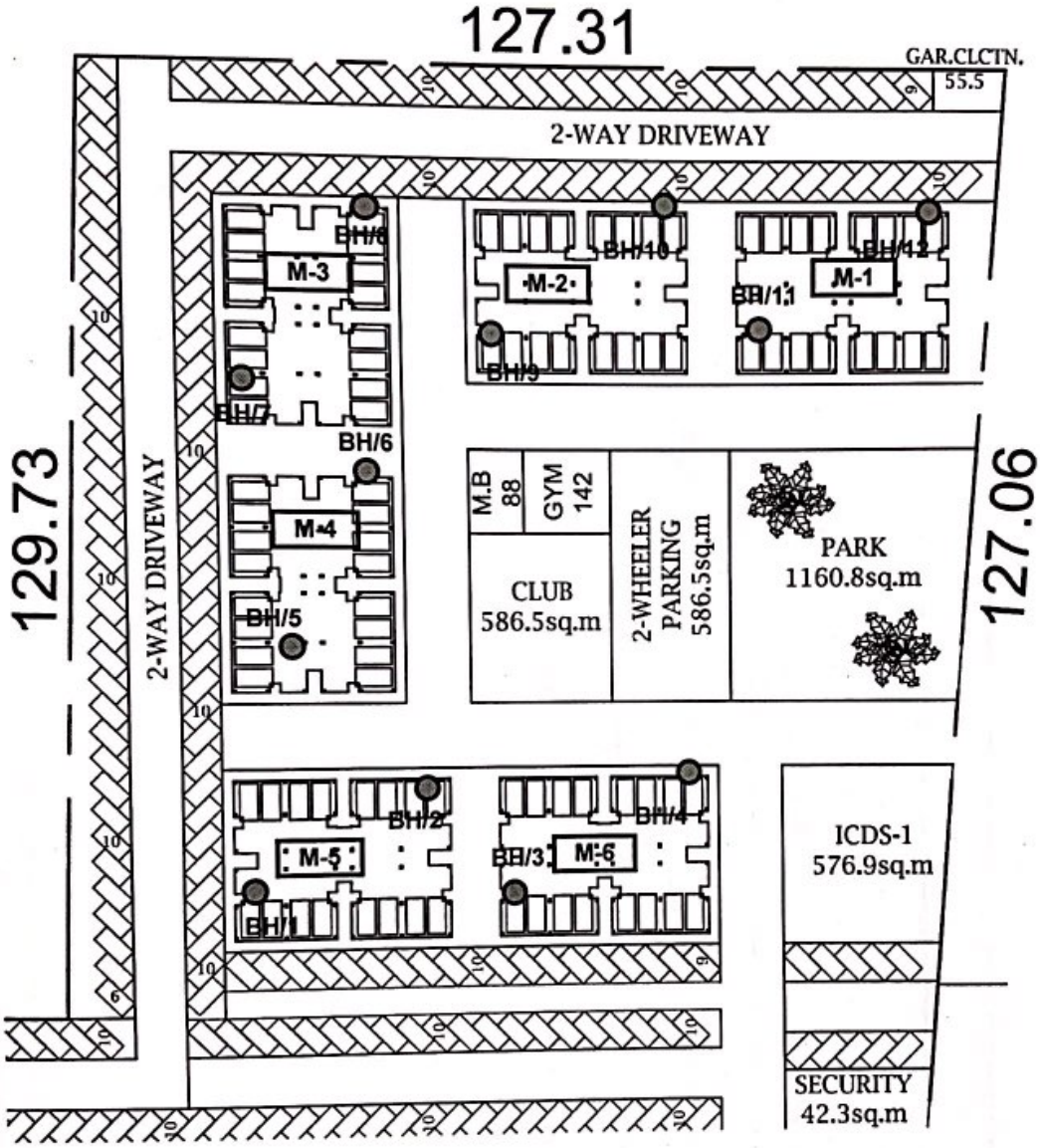


FIGURE 1B. LOCATION OF BORE HOLES (ZONE M1)

SOIL INVESTIGATION FOR
THE PROPOSED MIG BLOCKS
TNSCB, PERUMBAKKAM



Boreholes BH/1, BH/3, BH/4, BH/6, BH/7, BH/9, BH/10 and BH/12 are located 5.0m from the boundary on either side.
Boreholes BH/2, BH/5, BH/8 and BH/11 are located 5.0m from the boundary and mid length along the length of block.

FIGURE 2 SOIL PROFILE AND SPT N VALUES AT BH 1 - M1

PROJECT NO:	SF/KI-47/ZONE M1/PMPKM
BORE HOLE NO:	BH1

Project MIG Tenements, TNSCB, Chennai
Site Perumbakkam
Co-ordinates : Block M5
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 4-Mar-2013
Date of finish : 4-Mar-2013
GWL from GL : 0.90m
Ground level RL : 1.289m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
1.0		Yellowish grey silty clay with few stones		0.50							
				0.75	0.75	1	1	1	1	2	Soft
2.0				1.50	1.50	1	0	1	0	1	
2.2											
2.6		Greyish brown clayey silty fine to coarse sand									
3.0				2.25	2.25	7	11	40		51	Med dense
		Greyish brown dirty fine to coarse sand with weathered stones		3.00	3.00	50/10cm				>100	Very dense
3.8											
4.0					3.75	Rebound				RB	
		Yellowish grey completely weathered rock (calcareous sandstone)	3.75-4.55		TC core drilling 4.55	Rebound				RB	Very weak
5.0											
5.1			4.55-5.05		DC NX size, REC 10%, RQD nill						
5.8		Yellowish grey severely jointed weathered granitic gneiss									
6.0			5.05-6.05		Diamond core drilling NX size, recovery 15%, RQD nil						Weak
		Yellowish grey and grey weathered closely jointed granitic gneiss	6.05-7.05		Diamond core drilling NX size, recovery 21%, RQD nil						Moderate
7.0											
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 3.75m to 4.55m DC core drilling from 4.55m to 7.05m									

Borehole terminated at 7.05m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 3 SOIL PROFILE AND SPT N VALUES AT BH 2 - M1

PROJECT NO:	SF/KI-47/ZONE M1/PMPKM
BORE HOLE NO:	BH2

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam
Co-ordinates : Block M5
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 5-Mar-2013
Date of finish : 5-Mar-2013
GWL from GL : 1.00m
Ground level RL : 1.330m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
			UDS	DS	Test depth m	SPT blow counts 15	30	45	60	N**	
1.0		Yellowish grey silty clay with few stones		0.50							Soft
1.4				0.75	0.75	1	1	1	2	2	
2.0		Yell grey and brown silty clay with few stones		1.50	1.50	1	1	2	3	3	Soft
2.2											
2.9		Greyish brown clayey silty fine to coarse sand with gravel		2.25	2.25	20	20	23		43	Dense
3.0				3.00	3.00	50/10cm				>100	
4.0		Greyish dirty fine to coarse sand with weathered stones (weathered decomposed rock)		3.75	3.75	50/15cm				>100	Very dense
5.0				4.50	4.50	35	50/10cm			>100	
					5.00	Rebound				RB	
6.0		Greyish yellow completely weathered calcareous sandstone	5.00-6.30		TC core drilling						Very weak
6.3					6.30	Rebound				RB	
7.0		Brownish and grey completely weathered rock	6.30-7.30		Diamond core drilling NX size, recovery 13%, RQD nil						Weak
7.1		Greyish partly weathered closely jointed rock (granitic gneiss)	7.30-8.30		Diamond core drilling NX size, recovery 10%, RQD 10%						Moderate
8.0		Greyish jointed rock (granitic gneiss)									Strong
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.00m to 6.30m DC core drilling from 6.30m to 8.30m									

Borehole terminated at 8.30m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 4 SOIL PROFILE AND SPT N VALUES AT BH 3 - M1

PROJECT NO:	SF/KI-47/ZONE M1/PMPKM
BORE HOLE NO:	BH3

Project MIG Tenements, TNSCB, Chennai
Site Perumbakkam
Co-ordinates : Block M6
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 6-Mar-2013
Date of finish : 6-Mar-2013
GWL from GL : 1.40m
Ground level RL : 1.310m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
1.0		Yellowish grey silty clay with few stones		0.50							
1.8				0.75	0.75	1	1	2	2	3	Soft
2.0		Brownish grey and light grey silty clay		1.50	1.50	2	3	5	5	8	
2.3		Greyish brown clayey silty fine to coarse sand with weathered stones									Med stiff
3.0				2.25	2.25	11	15	25		40	Dense
3.9		Yellowish grey sandy clay with weathered stones		3.00	3.00	15	25	40		65	Very dense
4.0				3.75	3.75	30	50/15cm			>100	
5.0		Greyish brown clayey silty fine to coarse sand with weathered stones		4.50	4.50	50/10cm				>100	Very dense
5.3					5.30	Rebound				RB	
6.0		Greyish yellow completely weathered calcareous sandstone	5.30-6.10		TC core drilling 6.10	Rebound				RB	Very weak to weak
7.0			6.10-7.10		Diamond core drilling NX size, recovery 8%, RQD nil						
7.1		Greyish moderately jointed rock (Granitic gneiss)	7.10-8.10		Diamond core drilling NX size, recovery 18%, RQD 13%						Strong
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.30m to 6.10m DC core drilling from 6.10m to 8.10m									

Borehole terminated at 8.10m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 5 SOIL PROFILE AND SPT N VALUES AT BH 4 - M1

PROJECT NO:	SF/KI-47/ZONE M1/PMPKM
BORE HOLE NO:	BH4

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam
Co-ordinates : Block M6
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 7-Mar-2013
Date of finish : 8-Mar-2013
GWL from GL : 1.20m
Ground level RL : 1.314m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Yellowish grey silty clay with roots		0.50							Med stiff
1.0		Yellowish grey silty clay with black patches		0.75	0.75	1	1	2	2	3	Soft to medium stiff
2.0				1.50	1.50	2	3	5	6	8	
2.1		Greyish brown sandy clay with weathered stones and clayey sand pockets		2.25	2.25	17	39	47		86	Very stiff
3.0				3.00	3.00	35	50/10cm			>100	
3.2		Light greyish brown fine to coarse sand with weathered stones (wdr)		3.75	3.75	50/6cm				>100	Very dense
4.0											
4.5		Greyish brown dirty fine to coarse sand with weathered stones		4.50	4.50	50/10cm				>100	Very dense
5.0					5.50	Rebound				RB	
5.5		Brownish grey weathered fractured rock	5.50-6.10		6.10	Rebound				RB	Very weak
6.0		Brownish and grey highly weathered severely jointed rock	6.10-7.10		Diamond core drilling NX size, recovery 3%, RQD nil						Weak
6.1		Greyish closely jointed rock (Granitic gneiss)	7.10-8.10		Diamond core drilling NX size, recovery 27%, RQD 21%						Moderate
6.9		Yell grey highly weathered severely jointed rock									
7.0											
7.7											
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.50m to 6.10m DC core drilling from 6.10m to 8.10m									

Borehole terminated at 8.10m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 6 SOIL PROFILE AND SPT N VALUES AT BH 5 - M1

PROJECT NO:	SF/KI-47/ZONE M1/PMPKM
BORE HOLE NO:	BH5

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam
Co-ordinates : Block M4
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 20-Mar-2013
Date of finish : 20-Mar-2013
GWL from GL : 1.10m
Ground level RL : 1.349m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.3		Brownish dirty sand with brick pieces		0.50							Fill
1.0		Yellowish grey silty clay		0.75	0.75	2	3	4	4	7	Medium stiff
1.7				1.50	1.50	1	6	9	10	15	Stiff
2.0		Yell br & grey sandy silty clay with weath stones		2.25	2.25	25	30	41		71	Very stiff
2.3				3.00	3.00	Rebound				RB	Very weak
2.9		Lt gr grey sandy clay with gravel and stones		3.75	3.75	29	40	47		87	Very dense
3.0		Lt grey & yell brown highly weath fractured rock		4.50	4.50	50/10cm				>100	
3.5					5.20	Rebound				RB	Very weak
4.0		Yellowish brown dirty fine to coarse sand with weathered stones	5.20-6.10		TC core drilling 6.10	Rebound				RB	
4.6			6.10-7.10		Diamond core drilling NX size, recovery 8%, RQD nil						Weak
5.0		Yellowish brown highly weathered fractured rock	7.10-8.10		Diamond core drilling NX size, recovery 55%, RQD 55%						Strong
6.0											
6.1		Greyish and brownish weathered severely jointed rock									
7.0											
8.0		Greyish hard rock (Granitic gneiss)									
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.20m to 6.10m DC core drilling from 6.10m to 8.10m									

Borehole terminated at 8.10m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 7 SOIL PROFILE AND SPT N VALUES AT BH 6 - M1

PROJECT NO:	SF/KI-47/ZONE M1/PMPKM
BORE HOLE NO:	BH6

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam
Co-ordinates : Block M4
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 8-Mar-2013
Date of finish : 9-Mar-2013
GWL from GL : 1.30m
Ground level RL : 1.490m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
1.0		Yellowish grey silty clay with roots		0.50							Soft
1.4				0.75	0.75	1	1	1	1	2	
2.0		Light yellowish grey silty clay with brown patches	1.50								
2.8				1.80	1.80	5	6	9	15	15	Medium stiff
3.0		Yell grey & br grey clayey silty sand with weath stones & sandy clay		2.55	2.55	7	50/7cm			>100	Very dense
3.5				3.75	3.75	50/8cm				>100	
4.0		Greyish brown dirty fine to coarse sand with weathered stones (wdr)									Very dense
5.0				4.50	4.50	50/6cm				>100	
5.4					5.40	Rebound				RB	
6.0		Greyish brown highly weathered fractured rock	5.40-6.00		6.00	Rebound				RB	Very weak
7.0		Yellowish grey completely weathered severely jointed rock	6.00-7.00		Diamond core drilling NX size, recovery nil						Weak
8.0			7.00-8.00		Diamond core drilling NX size, recovery 15%, RQD nil						
9.0		Greyish closely jointed granitic gneiss with weathered patches	8.00-9.00		Diamond core drilling NX size, recovery 26%, RQD 10%						Moderate
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.40m to 6.00m DC core drilling from 6.00m to 9.00m									

Borehole terminated at 9.00m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 8 SOIL PROFILE AND SPT N VALUES AT BH 7 - M1

PROJECT NO:	SF/KI-47/ZONE M1/PMPKM
BORE HOLE NO:	BH7

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam
Co-ordinates : Block M3
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 19-Mar-2013
Date of finish : 19-Mar-2013
GWL from GL : 1.00m
Ground level RL : 1.532m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.7		Brownish grey silty clay with brown patches		0.50							Medium stiff
1.0		Yellowish grey silty clay		0.75	0.75	2	3	3	4	6	Medium stiff
1.4		Lt grey & yell brown silty clay with few gravel		1.50	1.50	1	1	5	9	6	Soft
2.0		Yell brown clayey silty sand with weathered stones and sandy clay lumps		2.25	2.25	11	22	25		47	Dense
3.0		Yellowish brown dirty fine to coarse sand with weathered stones		3.00	3.00	25	50/15cm			>100	Very dense
3.8		Dk gr grey clayey silty sand with weath stones		3.75	3.75	29	50/10cm			>100	Very dense
4.0		Dark greenish grey highly weathered disintegrated / fractured rock		4.50	4.50	50/11cm				>100	Very weak
4.5					5.20	Rebound				RB	
5.0			5.20-6.20		TC core drilling 6.20	Rebound				RB	
6.0											
6.2		Light brownish and grey completely weathered severely jointed rock	6.20-7.20		Diamond core drilling NX size, recovery 11%, RQD nil						Weak to moderate
7.0			7.20-8.20		Diamond core drilling NX size, recovery 26%, RQD 21%						Strong
7.7											
8.0		Greyish jointed hard rock (Granitic gneiss)									
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.20m to 6.20m DC core drilling from 6.20m to 8.20m									

Borehole terminated at 8.20m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 9 SOIL PROFILE AND SPT N VALUES AT BH 8 - M1

PROJECT NO:	SF/KI-47/ZONE M1/PMPKM
BORE HOLE NO:	BH8

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam
Co-ordinates : Block M3
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 12-Mar-2013
Date of finish : 12-Mar-2013
GWL from GL : 1.30m
Ground level RL : 1.280m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	SPT blow counts					
			UDS	DS	m	15	30	45	60	N**	
0.6		Yellowish grey silty clay with roots		0.50							Medium stiff
1.0		Light brownish grey silty clay with few stones		0.75	0.75	1	1	1	1	2	Soft
1.4		Yellowish grey and brownish grey sandy silty clay with gravel		1.50	1.50	3	6	9	10	15	Medium stiff
2.0		Brownish weathered fractured rock		2.25	2.25	Rebound				RB	Weak
2.3		Yellowish grey and light grey silty clay with fine sand and weathered stones		3.00	3.00	15	20	32		52	Stiff
2.6		Greyish brown dirty fine to coarse sand with weathered stones (wdr)		3.75	3.75	50/10cm				>100	Very dense
3.0				4.50	4.50	50/6cm				>100	
3.4					5.30	Rebound				RB	
4.0											
5.0											
5.3		Greyish brown highly weathered fractured rock	5.30-6.10		TC core drilling 6.10	Rebound				RB	Very weak
6.0		Yellowish grey highly weathered severely jointed rock	6.10-7.10		Diamond core drilling NX size, recovery nil						Weak to moderate
6.1											
7.0			7.10-8.10		Diamond core drilling NX size, recovery 12%, RQD nil						
7.8											
8.0		Yellowish grey and grey completely / highly weathered jointed rock									Weak
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.30m to 6.10m DC core drilling from 6.10m to 8.10m									

Borehole terminated at 8.10M

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 10 SOIL PROFILE AND SPT N VALUES AT BH 9 - M1

PROJECT NO:	SF/KI-47/ZONE M1/PMPKM
BORE HOLE NO:	BH9

Project MIG Tenements, TNSCB, Chennai
Site Perumbakkam
Co-ordinates : Block M2
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 13-Mar-2013
Date of finish : 14-Mar-2013
GWL from GL : 1.30m
Ground level RL : 1.405m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
1.0		Yellowish grey silty clay with few stones		0.50							
2.0				0.75	0.75	2	2	3	4	5	Medium stiff
2.1				1.50	1.50	3	6	8	10	14	
3.0		Brownish clayey silty sand with sandy clay lumps and light grey patches		2.25	2.25	7	12	16	20	28	Dense
3.7				3.00	3.00	10	15	15	20	30	
4.0		Brownish grey dirty fine to coarse sand with weathered stones		3.75	3.75	25	50/15cm			>100	Very dense
5.0				4.50	4.50	50/13cm				>100	
5.4					5.40	Rebound				RB	
6.0		Yellowish grey weathered fractured / severely jointed rock	5.40-6.60		TC core drilling 6.60	Rebound				RB	Very weak
7.0			6.60-7.60		Diamond core drilling NX size, recovery 16%, RQD nil						
7.3		Yellowish grey weathered severely / closely jointed rock (granitic gneiss)	7.60-8.60		Diamond core drilling NX size, recovery nil						Weak to moderate
8.0			8.60-9.60		Diamond core drilling NX size, recovery 20%, RQD nil						
9.0											
9.1		Greyish closely jointed rock with weathered patches (granitic gneiss)									Moderate
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.40m to 6.60m DC core drilling from 6.60m to 9.60m									

Borehole terminated at 9.60m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 11 SOIL PROFILE AND SPT N VALUES AT BH 10 - M1

PROJECT NO:	SF/KI-47/ZONE M1/PMPKM
BORE HOLE NO:	BH10

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam
Co-ordinates : Block M2
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 14-Mar-2013
Date of finish : 14-Mar-2013
GWL from GL : 1.20m
Ground level RL : 1.262m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	SPT blow counts					
			UDS	DS	m	15	30	45	60	N**	
0.5		Yellowish grey silty clay with roots		0.50							Medium stiff
1.0		Greyish silty clay		0.75	0.75	1	1	1	2	2	Soft
1.8				1.50	1.50	3	5	8	10	13	
2.0		Yellowish grey silty clay									Stiff
2.3		Brownish clayey silty fine to coarse sand with weathered stones		2.25	2.25	15	30	30		60	Dense
3.0				3.00	3.00	17	32	41		73	
3.1		Brownish grey dirty fine to coarse sand with weathered stones									Dense
3.9				3.75	3.75	50/10cm				>100	
4.0		Greyish brown dirty fine to coarse sand with weathered stones (wdr)		4.50	4.50	50/15cm				>100	Very dense
5.0					5.00	Rebound				RB	
5.8		Brownish grey highly weathered fractured rock	5.00-5.80		TC core drilling 5.80	Rebound				RB	Very weak
6.0		Brownish grey highly weathered severely jointed rock (granitic gneiss)	5.80-6.80		Diamond core drilling NX size, recovery 9%, RQD nil						Weak to moderate
7.0		Greyish partly weathered severely jointed rock (granitic gneiss)	6.80-7.80		Diamond core drilling NX size, recovery 7%, RQD nil						Weak to moderate
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.00m to 5.80m DC core drilling from 5.80m to 7.80m									

Borehole terminated at 7.80m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

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FIGURE 12 SOIL PROFILE AND SPT N VALUES AT BH 11 - M1

PROJECT NO:	SF/KI-47/ZONE M1/PMPKM
BORE HOLE NO:	BH11

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam
Co-ordinates : Block M1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 18-Mar-2013
Date of finish : 18-Mar-2013
GWL from GL : 1.30m
Ground level RL : 1.294m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Yellowish grey silty clay with roots		0.50							Medium stiff
1.0		Yellowish grey silty clay with black patches		0.75	0.75	1	2	2	2	4	Medium to stiff
2.0				1.50	1.50	3	4	6	7	10	
2.6				2.25	2.25	6	12	14	16	26	
3.0		Yellowish brown sandy silty clay with weathered stones and clayey sand patches		3.00	3.00	19	13	15	30	28	Stiff
3.7				3.75	3.75	50/10cm				>100	
4.0		Yellowish brown and grey clayey silty sand with weathered stones		4.50	4.50	50/15cm				>100	Very dense
4.6					5.00	Rebound				RB	
5.0		Brownish clayey silty sand with weathered stones									
5.9		Brownish grey highly weathered fractured rock	5.00-5.90		TC core drilling 5.90	Rebound				RB	Very weak
6.0		Brownish grey highly weathered severely jointed rock	5.90-6.90		Diamond core drilling NX size, recovery nil						Weak
7.0											
7.2		Brownish & grey weathered severely jointed rock	6.90-7.90		Diamond core drilling NX size, recovery 15%, RQD nil						Weak
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.00m to 5.90m DC core drilling from 5.90m to 7.90m									

Borehole terminated at 7.90m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 13 SOIL PROFILE AND SPT N VALUES AT BH 12 - M1

PROJECT NO:	SF/KI-47/ZONE M1/PMPKM
BORE HOLE NO:	BH12

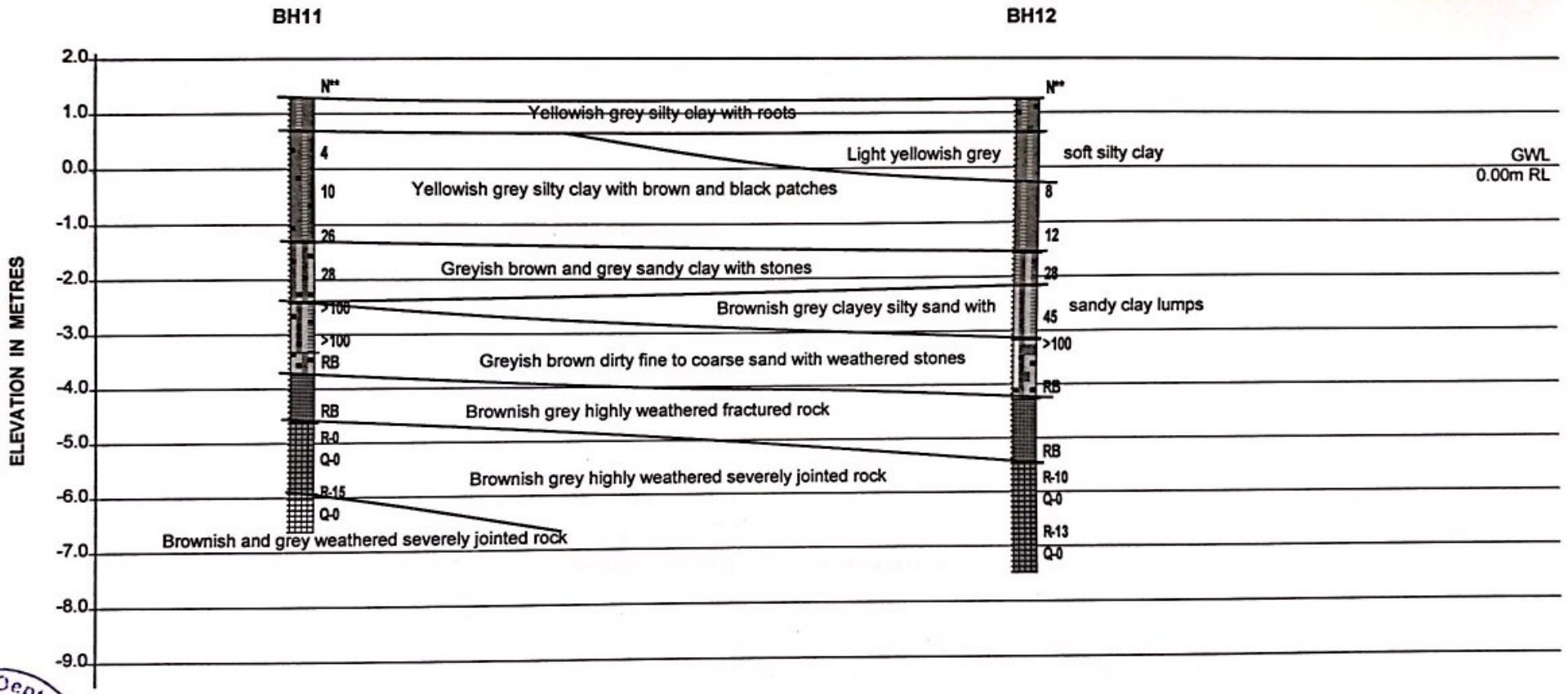
Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam
Co-ordinates : Block M1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 15-Mar-2013
Date of finish : 16-Mar-2013
GWL from GL : 1.20m
Ground level RL : 1.224m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Yell grey silty clay with roots and black patches		0.50							Medium stiff
1.0		Light yellowish grey soft silty clay		0.75	0.75	s_u=0.22 kg/cm^2					Soft
1.5		Yellowish grey silty clay with brown patches		1.50	1.50	2	3	5	5	8	Medium stiff
2.8				2.25	2.25	2	5	7	9	12	
3.0		Gr brown & grey sandy silty clay with dk br ptches		3.00	3.00	6	8	20	23	28	Stiff
3.4		Brownish grey clayey silty sand with sandy clay lumps		3.75	3.75	20	20	25		45	Dense
4.4		Gr brown dirty fine to coarse sand with weath stones & sandy clay lumps		4.50	4.50	25	50/15cm			>100	Very dense
5.0					5.50	Rebound				RB	
5.5											
6.0		Greyish brown highly weathered fractured rock	5.50-6.70		TC core drilling 6.70	Rebound				RB	Very weak
6.7											
7.0		Brownish grey highly weathered severely jointed rock	6.70-7.70		Diamond core drilling NX size, recovery 10%, RQD nil						Weak
8.0			7.70-8.70		Diamond core drilling NX size, recovery 13%, RQD nil						
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.50m to 6.70m DC core drilling from 6.70m to 8.70m									

Borehole terminated at 8.70m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}



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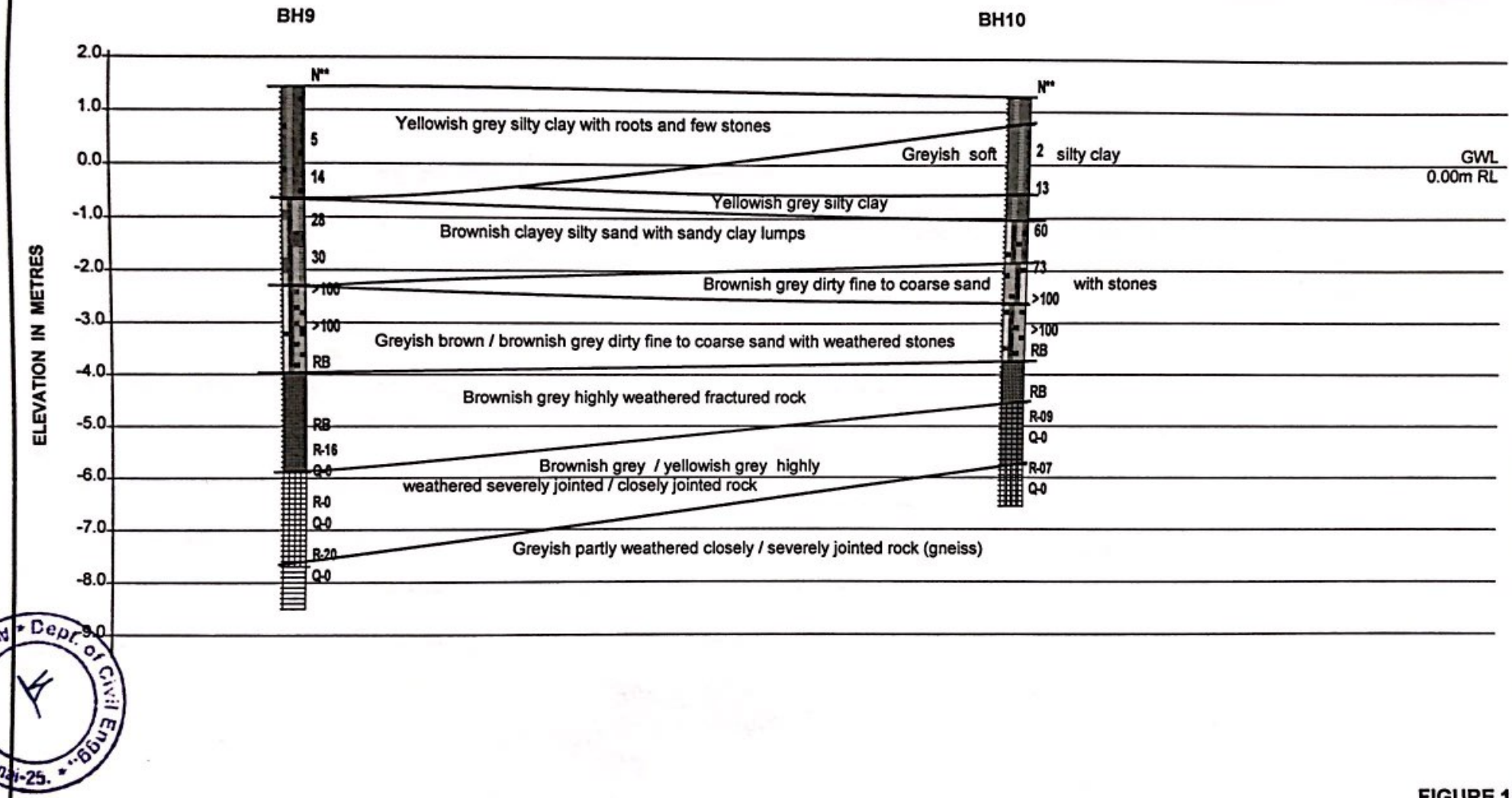
NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes

FIGURE 14

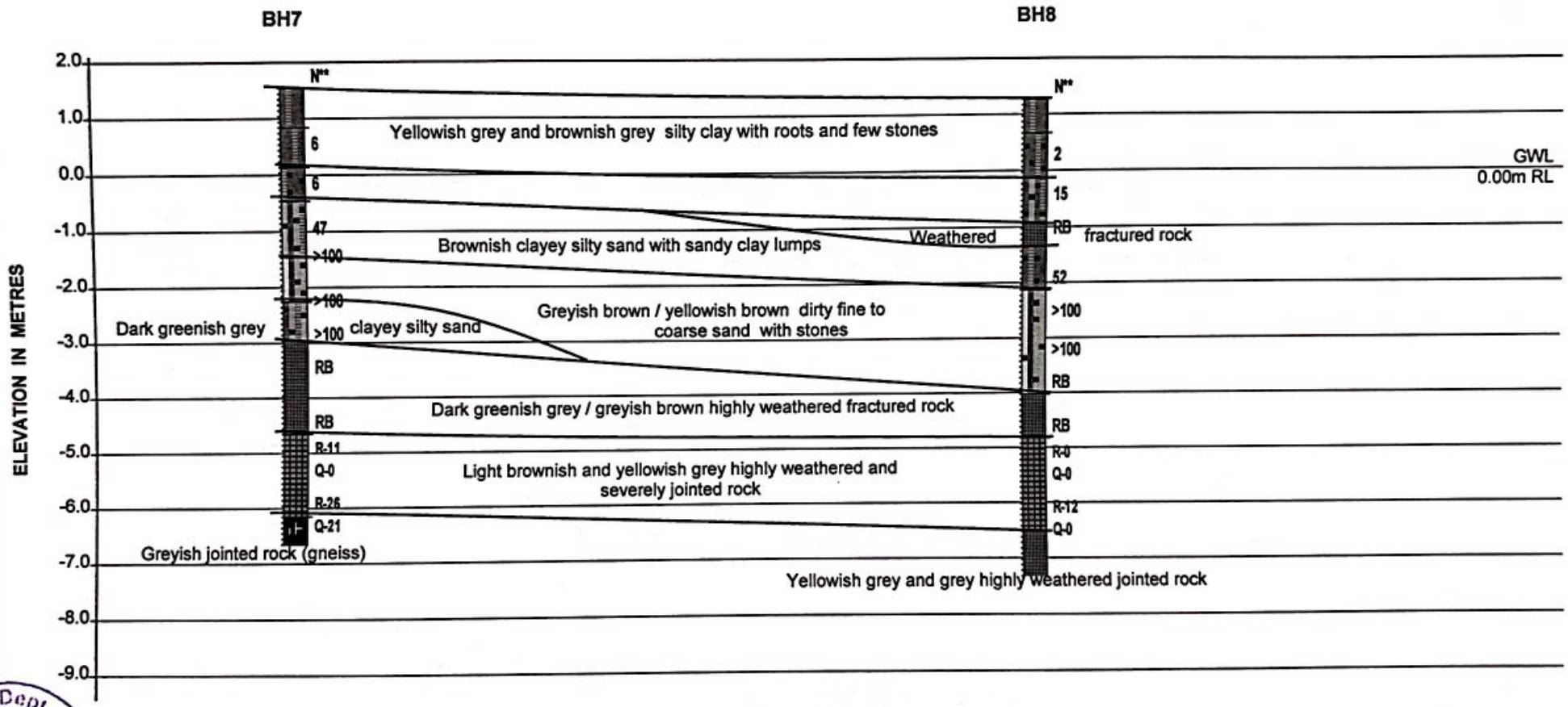
SUB-SOIL PROFILE BH/11 – BH/12 – BLOCK M-1
TNSCB TENEMENTS AT PERUMBAKKAM



NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes

FIGURE 15

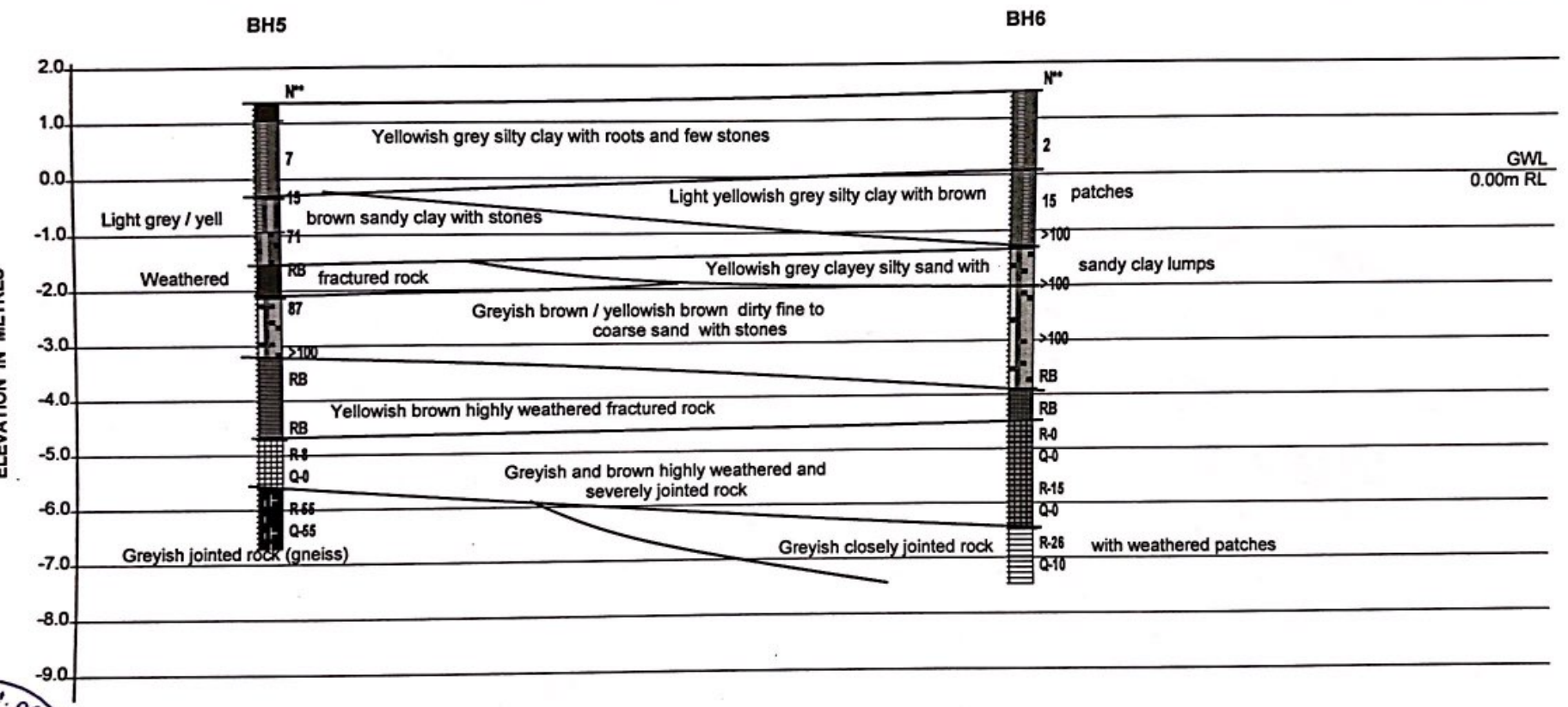
SUB-SOIL PROFILE BH/9 – BH/10 – BLOCK M-2
TNSCB TENEMENTS AT PERUMBAKKAM



NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes

FIGURE 16

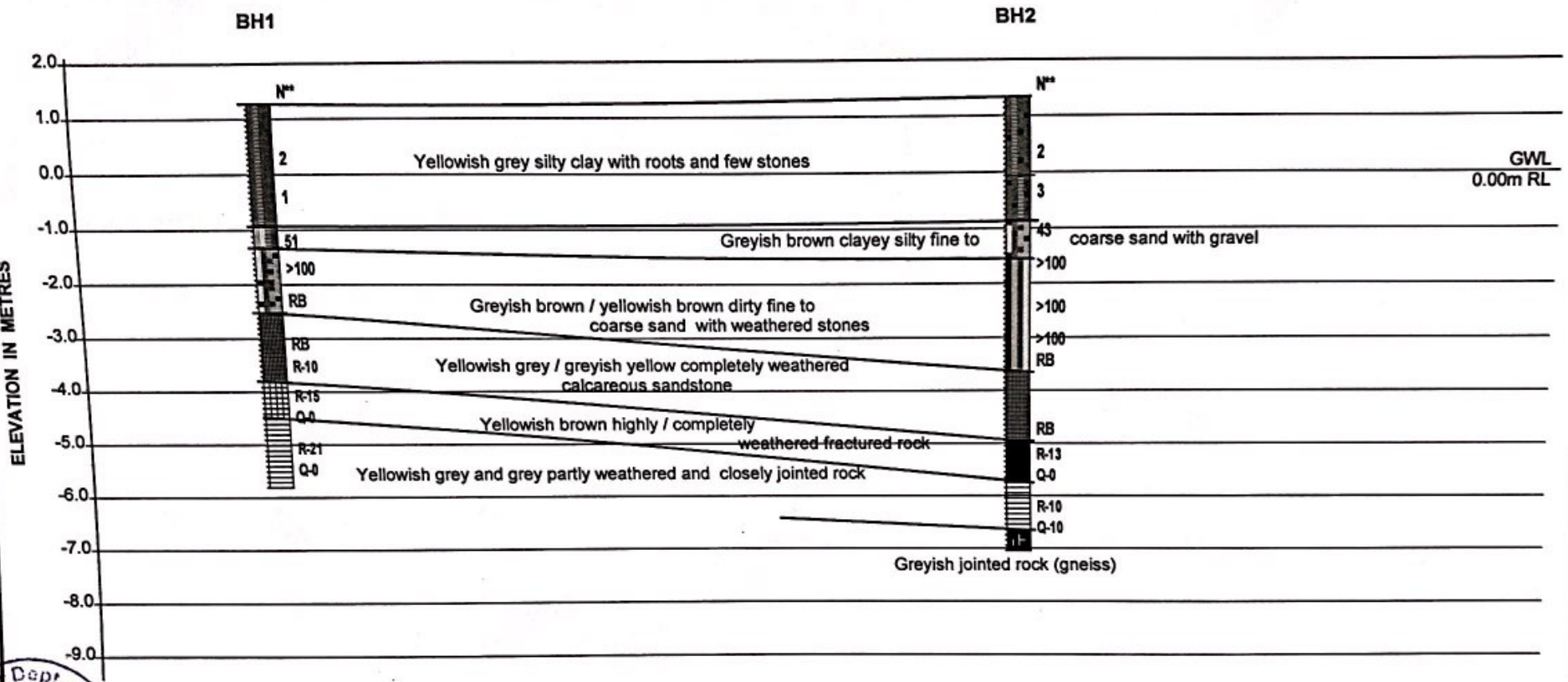
SUB-SOIL PROFILE BH/7 – BH/8 – BLOCK M-3
TNSCB TENEMENTS AT PERUMBAKKAM



NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes

FIGURE 17

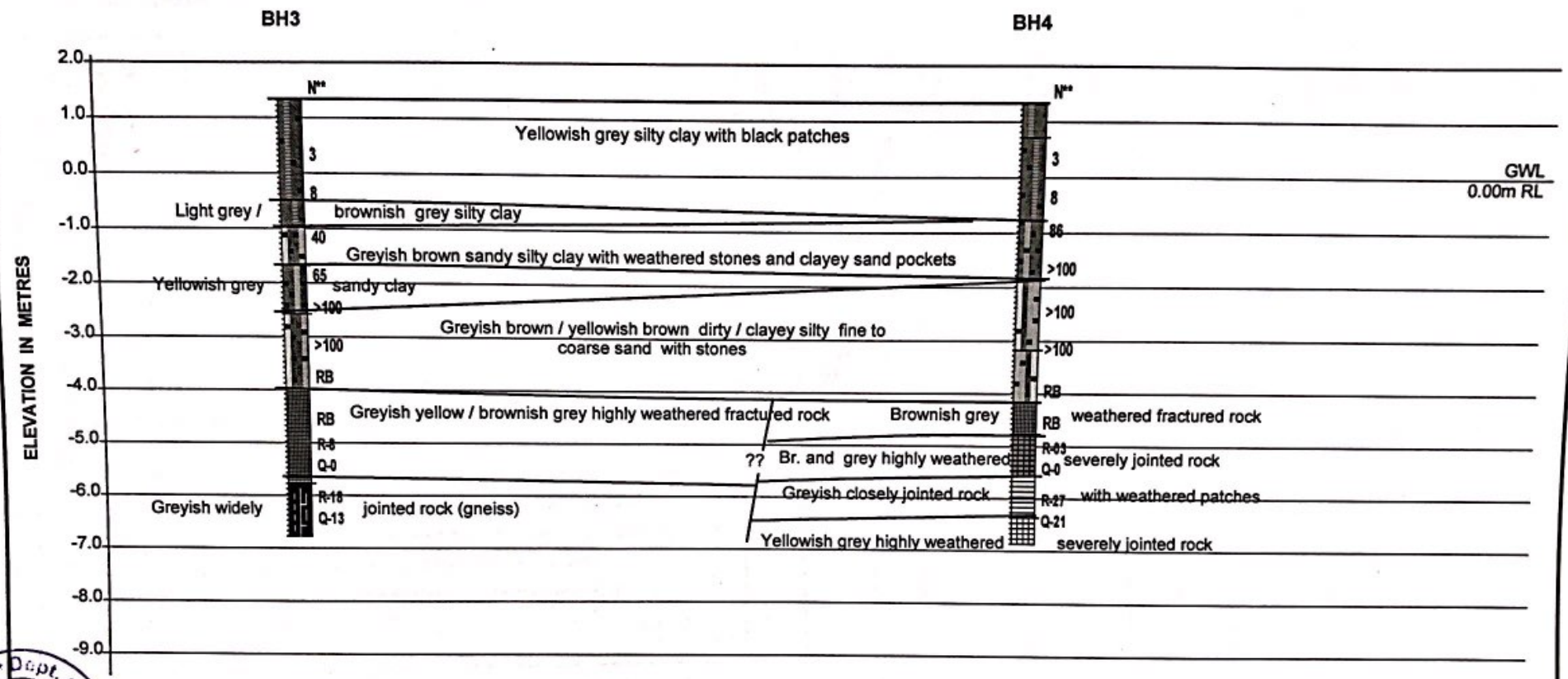
SUB-SOIL PROFILE BH/5 – BH/6 – BLOCK M-4
TNSCB TENEMENTS AT PERUMBAKKAM



NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes

FIGURE 18

SUB-SOIL PROFILE BH/1 – BH/2 – BLOCK M-5
TNSCB TENEMENTS AT PERUMBAKKAM



NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes

FIGURE 19

SUB-SOIL PROFILE BH/3 – BH/4 – BLOCK M-6
TNSCB TENEMENTS AT PERUMBAKKAM

TABLE 1 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 1 - M1

Project: **MIG Tenements, TNSCB Perumbakkam**
Borehole Nos: **BH1**
Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Sample Depth m	Sample Type	Visual Identification of Soil	SPT "N"	Classification	Natural Moisture content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Free Swell Index %	Specific Gravity	Gravel %	Coarse Sand %	Medium Sand %	Fine Sand %	Silt %	Clay %
Depth (1)	Type (2)	Description (3)	(4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH1															
GL-0.50	DS	Yellowish grey silty clay		CH	25.4	69.0	23.4	45.6	0.044	90.5							
0.75	SPT	Yellowish grey silty clay with few stones	2	CH	34.8	69.3	18.9	50.4	0.315	39.1							
1.50	SPT	Yellowish grey silty clay with few stones (soft)	1	CH	46.6	76.6	23.1	53.5	0.439	72.7							
2.25	SPT	TOP: Greyish brown clayey silty fine to coarse sand with weathered stones	51	SC	18.6							5.2	11.6	25.7	27.7	29.8	
		BOT: Greyish brown dirty fine to coarse sand with weathered stones		SC/SM	8.6							9.4	16.4	31.6	28.3	14.3	
3.00	SPT	Greyish brown dirty fine to coarse sand with weathered stones	>100		5.3												
4.55-5.05		Yellowish grey completely weathered rock (calcareous sandstone)															
5.05-6.05		Yellowish grey severely jointed weathered granitic gneiss															
6.05-7.05		Yellowish grey and grey weathered closely jointed granitic gneiss															

TABLE 2 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 2 - M1

Project: **MIG Tenements, TNSCB Perumbakkam**
Borehole Nos: **BH2**
Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Sample Depth m	Sample Type	Visual Identification of Soil	SPT "N"	Classification	Natural Moisture content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Free Swell Index %	Specific Gravity	Gravel %	Coarse Sand %	Medium Sand %	Fine Sand %	Silt %	Clay %
Depth (1)	Type (2)	Description (3)	(4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH2															
GL-0.50	DS	Yellowish grey silty clay		CH	28.0	69.8	23.0	46.8	0.107	72.7							
0.75	SPT	Yellowish grey silty clay with few stones	2	CH	32.4	62.4	18.5	43.9	0.317	39.1							
1.50	SPT	TOP: Yellowish grey and brown silty clay with few stones	3	CH	38.7	77.2	23.9	53.3	0.278	81.8							
		BOT: Yellowish grey and white sandy silty clay with stones			15.1												
2.25	SPT	Greyish brown clayey silty fine to coarse sand with gravel	43	SC/SM	12.5							17.1	20.3	23.8	17.1	21.7	
3.00	SPT	Greyish dirty fine to coarse sand with weathered stones	>100	SP/SM	7.9							12.8	24.0	34.7	20.4	8.1	
3.75	SPT	Greyish dirty fine to coarse sand with weathered stones	>100		12.8												
4.50	SPT	Greyish dirty fine to coarse sand with weathered stones	>100	SP/SM	11.1							19.7	17.5	29.2	22.2	11.4	
5.00-6.30		Greyish yellow completely weathered calcareous sandstone															
6.30-7.30		TOP: Brownish and grey completely weathered rock															
		TIP: Greyish partly weathered closely jointed rock (granitic gneiss)															
7.30-8.30		TIP: Greyish jointed rock (granitic gneiss)															

TABLE 3 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 3 - M1

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH3**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH3															
GL-0.50	DS	Yellowish grey silty clay		CH	27.7	69.9	23.3	46.6	0.094	58.3							
0.75	SPT	Yellowish grey silty clay with few stones	3	CH	37.4	72.3	25.2	47.1	0.259	41.7							
1.50	SPT	TOP: Yellowish grey silty clay with few stones	8	CH	34.6	72.3	22.5	49.8	0.243	66.6							
		BOT: Brownish grey and light grey silty clay		CH	34.4	71.2	21.6	49.6	0.258	100.0							
2.25	SPT	Greyish brown clayey silty fine to coarse sand with weathered stones	40	SC	19.8							14.2	16.9	30.4	18.6	19.9	
3.00	SPT	Yellowish grey sandy clay with weathered stones	65		19.1												
3.75	SPT	Greyish brown clayey silty fine to coarse sand with weathered stones	>100	SC	16.6							7.8	17.0	29.2	24.0	22.0	
4.50	SPT	Greyish brown clayey silty fine to coarse sand with weathered stones	>100		17.5												
6.10-7.10		Greyish yellow completely weathered calcareous sandstone															
7.10-8.10		Greyish moderately jointed rock (Granitic gneiss)															

TABLE 4 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 4 - M1

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH4**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH4															
GL-0.50	DS	Yellowish grey silty clay with roots			29.3					63.6							
0.75	SPT	Yellowish grey silty clay with black patches	3	CH	38.9	75.6	25.2	50.4	0.272	66.6							
1.50	SPT	Yellowish grey silty clay with black patches	8	CH	32.9	78.4	26.3	52.1	0.127	75.0							
2.25	SPT	Greyish brown sandy clay with weathered stones and clayey sand pockets	86	SC/SM	14.5							18.3	20.2	24.2	16.9	20.4	
3.00	SPT	Light greyish brown fine to coarse sand with weathered stones	>100	SW	5.4							3.3	39.3	35.1	17.7	4.6	
3.75	SPT	Light greyish brown fine to coarse sand with weathered stones (wdr)	>100		9.0												
4.50	SPT	Greyish brown dirty fine to coarse sand with weathered stones	>100	SC/SM	11.5							12.1	22.2	27.2	19.9	18.6	
6.10-7.10		Brownish and grey highly weathered severely jointed rock															
7.10-8.10		TOP: Greyish closely jointed rock (Granitic gneiss)															
		BOT: Yellowish grey highly weathered severely jointed rock															

TABLE 5 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 5 - M1

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH5**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH5															
GL	DS	Brownish dirty sand with brick pieces			5.9												
0.50	DS	Yellowish grey silty clay		CH	32.4	71.4	22.5	48.9	0.202	70.0							
0.75	SPT	Yellowish grey silty clay	7	CH	32.3	65.0	23.6	41.4	0.210	115.0							
1.50	SPT	TOP: Yellowish grey silty clay with yellowish brown patches and gravel			24.3												
		BOT: Yellowish brown & grey sandy silty clay with weathered stones		SC/CI	16.3	40.9	15.1	25.8	0.047	30.0							
2.25	SPT	Light greenish grey sandy clay with gravel and stones	71	SC	17.0							26.5	16.6	15.9	14.6	26.4	
3.00	SPT	Light grey and yellowish brown highly weathered fractured rock															
3.75	SPT	Yellowish brown dirty fine to coarse sand with weathered stones	87	SC/SM	10.1							2.3	11.6	31.8	36.4	17.9	
4.50	SPT	Yellowish brown highly weathered fractured rock	>100		4.4												
6.10-7.10		Greyish and brownish weathered severely jointed rock															
7.10-8.10		Greyish hard rock (Granitic gneiss)															

TABLE 6 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 6 - M1

Project: **MIG Tenements, TNSCB Perumbakkam**
Borehole Nos: **BH6**
Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH6															
GL-0.50	DS	Yellowish grey silty clay with roots		CH	32.1	72.6	25.1	47.5	0.147	63.6							
0.75	SPT	Yellowish grey silty clay with roots	2	CH	39.9	72.5	24.6	47.9	0.319	66.6							
1.50	UDS	Light yellowish grey silty clay with brown patches		CH	33.7	75.7	24.1	51.6	0.186	72.3							
1.80	SPT	TOP: Yellowish grey and brown silty clay with weathered stones	15	CH	18.8	63.3	19.3	44.0	<0.00	66.6							
		TIP: Brownish dirty fine to coarse sand			15.9												
2.55	SPT	TOP: Yell grey & br grey clayey silty sand with weath stones & sandy clay	>100	SC	19.6							10.7	12.1	16.9	26.2	34.1	
		BOT: Yellowish grey dirty fine to coarse sand with weathered stones (wdr)		SW/SM	11.0							24.7	23.4	22.6	18.6	10.7	
3.50	SPT	Greyish brown dirty fine to coarse sand with weathered stones (wdr)	>100	SW	4.8							29.3	25.9	19.8	19.8	5.2	
4.50	SPT	Greyish brown dirty fine to coarse sand with weathered stones (wdr)	>100		7.3												
7.00-8.00		Yellowish grey completely weathered severely jointed rock															
8.00-9.00		Greyish closely jointed granitic gneiss															

TABLE 7 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 7 - M1

Project: **MIG Tenements, TNSCB Perumbakkam**
Borehole Nos: **BH7**
Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH7															
GL-0.50	DS	Brownish grey silty clay with brown patches		CH	28.7	71.1	24.3	46.8	0.094	63.6							
0.75	SPT	Yellowish grey silty clay	6	CH	36.3	74.0	23.3	50.7	0.256	73.9							
1.50	SPT	TOP: Light grey and yellowish brown silty clay with few gravel	6	CH	28.7	51.4	14.3	37.1	0.388	50.0							
		BOT: Yellowish brown and yellowish grey silty clay with gravel			22.1												
2.25	SPT	Yell brown clayey silty sand with weathered stones and sandy clay lumps	47	SC	17.7							6.6	12.7	27.5	27.1	26.1	
3.00	SPT	Yellowish brown dirty fine to coarse sand with weathered stones	>100	SW/SM	11.4							6.6	30.4	32.3	20.0	10.7	
3.75	SPT	Dark greenish grey clayey silty sand with weathered stones	>100	SC	16.3							7.5	12.3	23.5	28.8	27.9	
4.50	SPT	Dark greenish grey highly weathered disintegrated / fractured rock	>100		7.4												
6.20-7.20		Light brownish and grey completely weathered severely jointed rock															
7.20-8.20		Greyish jointed hard rock (Granitic gneiss)															

TABLE 8 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 8 - M1

Project: ***MIG Tenements, TNSCB Perumbakkam***

Borehole Nos: ***BH8***

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH8															
GL-0.50	DS	Yellowish grey silty clay with roots		CH	30.8	71.0	24.9	46.1	0.128	66.6							
0.75	SPT	Light brownish grey silty clay with few stones	2	CH	41.5	76.1	25.7	50.4	0.313	64.3							
1.50	SPT	Yellowish grey and brownish grey sandy silty clay with gravel	15	SC/CI	23.0	46.1	15.0	31.1	0.257	77.3							
3.00	SPT	TOP: Yellowish grey and light grey silty clay with fine sand and weathered st	52		21.9												
		BOT: Yellowish grey clayey silty fine to coarse sand		SC	11.7							7.5	9.5	25.2	33.5	24.3	
3.75	SPT	Greyish brown dirty fine to coarse sand with weathered stones (wdr)	>100	SW	6.6							29.4	31.0	23.1	13.0	3.5	
4.50	SPT	Greyish brown dirty fine to coarse sand with weathered stones (wdr)	>100		5.7												
7.10-8.10		Yellowish grey and grey completely / highly weathered jointed rock															

TABLE 9 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 9 - M1

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH9**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH9															
				CH	27.0	69.6	21.9	47.7	0.107	52.2							
GL-0.50	DS	Yellowish grey silty clay	5	CH	36.4	74.8	25.9	48.9	0.215	66.6							
0.75	SPT	Yellowish grey silty clay	14		28.6												
1.50	SPT	TOP: Yellowish grey silty clay		CH	19.2	67.4	19.3	48.1	<0.00	65.2							
		BOT: Yellowish grey silty clay with stones	28	SC/CH	22.3	55.9	19.5	36.4	0.077	47.8							
2.25	SPT	Brownish clayey silty sand with sandy clay lumps and light grey patches	30	SC	13.9							23.1	12.6	18.0	18.1	28.2	
3.00	SPT	Yellowish grey sandy silty clay with weathered stones	>100	SC/SM	12.3							9.2	17.7	28.8	26.6	17.7	
3.75	SPT	Brownish grey dirty fine to coarse sand with weathered stones	>100	SC/SM	15.2							18.2	20.5	18.7	18.6	24.0	
4.50	SPT	Greyish brown clayey silty fine to coarse sand with weathered stones															
6.60-7.60		TOP: Yellowish grey weathered severely jointed rock															
		TIP: Yellowish grey weathered jointed rock (granitic gneiss)															
8.60-9.60		Greyish closely jointed rock with weathered patches (granitic gneiss)															

TABLE 10 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 10 - M1

Project: ***MIG Tenements, TNSCB Perumbakkam***

Borehole Nos: BH10

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH10															
GL-0.50	DS	Yellowish grey silty clay with roots		CH	30.8	70.4	23.7	46.7	0.152	100.0							
0.75	SPT	Greyish silty clay	2	CH	40.2	79.9	26.8	53.1	0.252	118.0							
1.50	SPT	TOP: Greyish silty clay	13		29.7												
		BOT: Yellowish grey silty clay		CH	28.0	67.3	19.8	47.5	0.173	58.0							
2.25	SPT	Brownish clayey silty fine to coarse sand with weathered stones	60	SC/SM	15.3							13.1	19.7	30.0	19.3	17.9	
3.00	SPT	Brownish grey dirty fine to coarse sand with weathered stones	73	SC/SM	15.6							6.5	15.7	31.7	24.6	21.5	
3.75	SPT	Greyish brown weathered disintegrated rock	>100		10.2												
4.50	SPT	Greyish brown dirty fine to coarse sand with weathered stones (wdr)	>100	SW	7.1							0.9	33.4	38.2	21.4	6.1	
5.80-6.80		Brownish grey highly weathered severely jointed rock (granitic gneiss)															
6.80-7.80		Greyish partly weathered severely jointed rock (granitic gneiss)															

TABLE 11 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 11 - M1

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH11**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH11															
GL-05	DS	Yellowish grey silty clay with roots		CH	27.4	74.6	24.2	50.4	0.063	95.0							
0.75	SPT	Yellowish grey silty clay with black patches	4	CH	42.4	81.7	26.4	55.3	0.289	78.0							
1.50	SPT	Yellowish grey silty clay with black patches	10		29.0												
2.25	SPT	TOP: Yellowish brown and yellowish grey silty clay with black patches	26		22.7												
		BOT: Yellowish brown sandy silty clay with weathered stones		SC/CI	17.0	45.8	17.5	28.3	<0.00	70.0							
3.00	SPT	TOP & TIP: Yellowish grey and brown silty clay with few gravel	28		30.6												
		MID: Yellowish and clayey silty sand with weathered stones		SC/SM	16.1							10.3	15.9	26.1	22.7	25.0	
3.75	SPT	TOP: Yellowish brown and grey clayey silty sand with weathered stones	>100		27.0												
		TIP: Yellowish grey highly weathered fractured rock			10.6												
4.50	SPT	Brownish clayey silty sand with weathered stones	>100														
6.90-7.90		Brownish and grey weathered severely jointed rock															

TABLE 12 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 12 - M1

Project: ***MIG Tenements, TNSCB Perumbakkam***

Borehole Nos: **BH12**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH12															
GL-0.50	DS	Yellowish grey silty clay with roots and black patches		CH	29.9	77.5	24.3	53.2	0.105	71.4							
0.75	VST	Light yellowish grey soft silty clay			46.5												
1.50	SPT	Yellowish grey silty clay	8	CH	31.1	71.5	22.8	48.7	0.170	90-9							
2.25	SPT	Yellowish grey and brown silty clay	12		24.5												
3.00	SPT	TOP: Greyish brown and grey sandy silty clay with dark brown patches	28	SC/CH	23.1	58.0	22.1	35.9	0.028	59.0							
		BOT: Brownish grey clayey silty sand with weathered stones		SC	14.7							11.5	19.5	24.7	20.3	24.0	
3.75	SPT	Brownish grey clayey silty sand with sandy clay lumps	45	SC	15.5							6.0	18.8	30.8	20.2	24.2	
4.50	SPT	Gr brown dirty fine to coarse sand with weath stones & sandy clay lumps	>100	SC/SM	11.5							9.3	29.0	29.3	17.8	14.6	
6.70-7.70		Brownish grey highly weathered severely jointed rock															
7.70-8.70		Brownish grey highly weathered severey jointed rock															

TABLE 13 SHEAR STRENGTH PARAMETERS FOR DIFFERENT LAYERS

TNSCB, MIG, PERUMBAKKAM, Ground water table = 1.00m to 1.4m (March-April 2013)

Borehole BH1 (GL = 1.289m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 2.20m	Yellowish grey silty clay with few stones, LI = 0.315 to 0.439	2,1	2		1.5 t/m²	52%	m_v=1/(42N)m²/t
2.20m to 2.60m	Greyish brown clayey silty fine to coarse sand		18	ϕ = 32.5°			C using q_c= 22 N t/m²
2.60m to 3.80m	Greyish brown dirty fine to coarse sand with weathered stones	>50	50	ϕ = 38.5°			C using q_c= 26 N t/m²
3.80m to 5.10m	Yellowish grey completely weathered rock (calcareous sandstone)	RB	200		c_u = 100 t/m²		
5.10m to 5.80m	Yellowish grey severely jointed weathered granitic gneiss						
5.80m to 7.10m	Yellowish grey and grey weathered closely jointed granitic gneiss						

Borehole BH2 (GL = 1.330m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 1.40m	Yellowish grey silty clay with few stones, LI = 0.107	2	2		c_u = 1.5 t/m²	44-47	m_v=1/(42N)m²/t
1.40m to 2.20m	Yell grey and brown silty clay with few stones, LI = 0.317	3	3		c_u = 2.0 t/m²	53	m_v=1/(42N)m²/t
2.20m to 2.90m	Greyish brown clayey silty fine to coarse sand with gravel	43	45	ϕ = 36°			C using q_c= 26 N t/m²
2.90m to 5.00m	Greyish dirty fine to coarse sand with weath stones (weathered decomposed rock)	>100	100	ϕ = 42°			C using q_c= 28 N t/m²
5.00m to 6.30m	Greyish yellow completely weathered calcareous sandstone	RB	200		c_u = 100 t/m²		
6.30m to 7.10m	Brownish and grey completely weathered rock						
7.10m to 8.00m	Greyish partly weathered closely jointed rock (granitic gneiss)						
8.00m to 8.30m	Greyish jointed rock (granitic gneiss)						

Borehole BH3 (GL = 1.310m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 1.80m	Yellowish grey silty clay with few stones, LI = 0.094 to 0.259	3	4		c_u = 2.5 t/m²	47.0	m_v=1/(42N)m²/t
1.80m to 2.30m	Brownish grey and light grey silty clay, LI = 0.258	8	8		c_u = 4.0 t/m²	49.6	m_v=1/(42N)m²/t
2.30m to 3.00m	Greyish brown clayey silty fine to coarse sand with weathered stones	40	40	ϕ = 36°			C using q_c= 26 N t/m²
3.00m to 3.90m	Yellowish grey sandy clay with weathered stones	65	50		c_u = 25 t/m²		
3.90m to 5.30m	Greyish brown clayey silty fine to coarse sand with weathered stones	>100	100	ϕ = 42°			C using q_c= 28 N t/m²
5.30m to 7.10m	Greyish yellow completely weathered calcareous sandstone	RB	200		c_u = 100 t/m²		
7.10m to 8.10m	Greyish moderately jointed rock (Granitic gneiss)						

Borehole BH4 (GL =1.314m RL)

Depth Below GL	Soil	N	Design N"	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.60m	Yellowish grey silty clay with roots						m_v=1/(42N)m²/t
0.60m to 2.10m	Yellowish grey silty clay with black patches, LI = 0.127 to 0.272	3,8	5		c_u = 2.5 t/m²	51%	
2.10m to 3.20m	Greyish brown sandy clay with weathered stones and clayey sand pockets	86	50		c_u = 25 t/m²		
3.20m to 4.50m	Light greyish brown fine to coarse sand with weathered stones (wdr)	>100	100	ϕ = 42°			C using q_c= 28 N t/m²
4.50m to 5.50m	Greyish brown dirty fine to coarse sand with weathered stones	>100	100	ϕ = 42°			C using q_c= 28 N t/m²
5.50m to 6.10m	Brownish grey weathered fractured rock	RB	200		c_u = 100 t/m²		
6.10m to 6.90m	Brownish and grey highly weathered severely jointed rock						
6.90m to 7.70m	Greyish closely jointed rock (Granitic gneiss)						
7.70m to 8.20m	Yell grey highly weathered severely jointed rock						

Borehole BH5 (GL = 1.349m RL)

Depth Below GL	Soil	N	Design N"	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.30m	Brownish dirty sand with brick pieces						m_v=1/(42N)m²/t
0.30m to 1.70m	Yellowish grey silty clay, LI = 0.21	7	7		c_u = 3.5 t/m²	41-48	
1.70m to 2.30m	Yell br & grey sandy silty clay with weathered stones	15	15		c_u = 7.5 t/m²		
2.30m to 2.90m	Lt gr grey sandy clay with gravel and stones	71	50		c_u = 25 t/m²		
2.90m to 3.50m	Lt grey & yell brown highly weathered fractured rock	RB	100		c_u = 50 t/m²		
3.50m to 4.60m	Yellowish brown dirty fine to coarse sand with weathered stones	87	70	ϕ = 40°			C using q_c= 28 N t/m²
4.60m to 6.10m	Yellowish brown highly weathered fractured rock	>100, RB	200		c_u = 100 t/m²		
6.10m to 7.00m	Greyish and brownish weathered severely jointed rock						
7.00m to 8.10m	Greyish hard rock (Granitic gneiss)						

Borehole BH6 (GL = 1.490m RL)

Depth Below GL	Soil	N	Design N"	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 1.40m	Yellowish grey silty clay with roots, LI = 0.147 to 0.319	2	2		c_u = 1.5 t/m²	48	m_v=1/(42N)m²/t
1.40m to 2.80m	Light yellowish grey silty clay with brown patches, LI = 0.186	15	15		c_u = 7.5 t/m²	44-51	m_v=1/(42N)m²/t
2.80m to 3.50m	Yell grey & br grey clayey silty sand with weathered stones & sandy clay	>100	100	ϕ = 42°			C using q_c= 26 N t/m²
3.50m to 5.40m	Greyish brown dirty fine to coarse sand with weathered stones (wdr)	>100	100	ϕ = 42°			C using q_c= 28 N t/m²
5.40m to 6.00m	Greyish brown highly weathered fractured rock	RB	200		c_u = 100 t/m²		
6.00m to 8.00m	Yellowish grey completely weathered severely jointed rock						
8.00m to 9.00m	Greyish closely jointed granitic gneiss with weathered patches						

Borehole BH7 (GL = 1.532m RL)

Depth Below GL	Soil	N	Design N"	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.70m	Brownish grey silty clay with brown patches						m_v=1/(42N)m²/t
0.70m to 1.40m	Yellowish grey silty clay, LI = 0.256	6	6		c_u = 3.0 t/m²	51	
1.40m to 2.00m	Lt grey & yell brown silty clay with few gravel, LI = 0.388		4		c_u = 2.0 t/m²	37	
2.00m to 3.00m	Yell brown clayey silty sand with weathered stones and sandy clay lumps	47	45	ϕ = 36°			C using q_c= 24 N t/m²
3.00m to 3.80m	Yellowish brown dirty fine to coarse sand with weathered stones	>100	75	ϕ = 40°			C using q_c= 28 N t/m²
3.80m to 4.50m	Dark greenish grey clayey silty sand with weathered stones	>100	75	ϕ = 40°			C using q_c= 28 N t/m²
4.50m to 6.20m	Dark greenish grey highly weathered disintegrated / fractured rock	RB	200		c_u = 100 t/m²		
6.20m to 7.70m	Light brownish and grey completely weathered severely jointed rock						
7.70m to 8.20m	Greyish jointed hard rock (Granitic gneiss)						

Borehole BH8 (GL = 1.280m RL)

Depth Below GL	Soil	N	Design N"	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.60m	Yellowish grey silty clay with roots						m_v=1/(42N)m²/t
0.60m to 1.40m	Light brownish grey silty clay with few stones, LI = 0.313	2	2		c_u = 1.5 t/m²	50.4	m_v=1/(42N)m²/t
1.40m to 2.30m	Yellowish grey and brownish grey sandy silty clay with gravel, LI = 0.257	15	15		c_u = 7.5 t/m²	31.1	
2.30m to 2.60m	Brownish weathered fractured rock	RB	-				
2.60m to 3.40m	Yellowish grey and light grey silty clay with fine sand and weathered stones		30		c_u = 15 t/m²		
3.40m to 5.30m	Greyish brown dirty fine to coarse sand with weathered stones (wdr)	>50	75	ϕ = 40 °			C using q_c= 28 N t/m²
5.30m to 6.10m	Greyish brown highly weathered fractured rock	RB	200		c_u = 100 t/m²		
6.10m to 7.80m	Yellowish grey highly weathered severely jointed rock						
7.80m to 8.60m	Yellowish grey and grey completely / highly weathered jointed rock						

Borehole BH9 (GL = 1.405m RL)

Depth Below GL	Soil	N	Design N"	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 2.10m	Yellowish grey silty clay with few stones, LI = 0.107 to 0.215	5, 14	8		c_u = 4.0 t/m²	48	m_v=1/(42N)m²/t
2.10m to 3.70m	Brownish clayey silty sand with sandy clay lumps and light grey patches	28, 30	30	ϕ = 35°			C using q_c= 26 N t/m²
3.70m to 5.40m	Brownish grey dirty fine to coarse sand with weathered stones	>100	75	ϕ = 40°			C using q_c= 28 N t/m²
5.40m to 7.30m	Yellowish grey weathered fractured / severely jointed rock	RB	200		c_u = 100 t/m²		
7.30m to 9.10m	Yellowish grey weathered severely / closely jointed rock (granitic gneiss)						
9.10m to 9.90m	Greyish closely jointed rock with weathered patches (granitic gneiss)						

Borehole BH10 (GL = 1.262m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.50m	Yellowish grey silty clay with roots						
0.50m to 1.80m	Greyish silty clay, LI = 0.252	2	2		c_u = 1.5 t/m²	46.7	m_v=1/(42N)m²/t
1.80m to 2.30m	Yellowish grey silty clay, LI = 0.173	13	12		c_u = 6 t/m²	53.1	m_v=1/(42N)m²/t
2.30m to 3.10m	Brownish clayey silty fine to coarse sand with weathered stones	60	50	ϕ = 38°		47.5	
3.10m to 3.90m	Brownish grey dirty fine to coarse sand with weathered stones	73	70	ϕ = 40°			C using q_c= 26 N t/m²
3.90m to 5.00m	Greyish brown dirty fine to coarse sand with weathered stones (wdr)	>100	75	ϕ = 42°			C using q_c= 28 N t/m²
5.00m to 5.80m	Brownish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 28 N t/m²
5.80m to 7.00m	Brownish grey highly weathered severely jointed rock (granitic gneiss)						
7.00m to 7.80m	Greyish partly weathered severely jointed rock (granitic gneiss)						

Borehole BH11 (GL = 1.294m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.60m	Yellowish grey silty clay with roots						
0.60m to 2.60m	Yellowish grey silty clay with black patches, LI = 0.289	4,10	6		c_u = 3.0 t/m²	55.3	m_v=1/(42N)m²/t
2.60m to 3.70m	Yellowish brown sandy silty clay with weathered stones and clayey sand patches	26,28	25		c_u = 12.5 t/m²		
3.70m to 4.60m	Yellowish brown and grey clayey silty sand with weathered stones	>100	50	ϕ = 38°			C using q_c= 26 N t/m²
4.60m to 5.00m	Brownish clayey silty sand with weathered stones	>100	75	ϕ = 42°			C using q_c= 28 N t/m²
5.00m to 5.90m	Brownish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		
5.90m to 7.20m	Brownish grey highly weathered severely jointed rock						
7.20m to 7.90m	Brownish & grey weathered severely jointed rock						

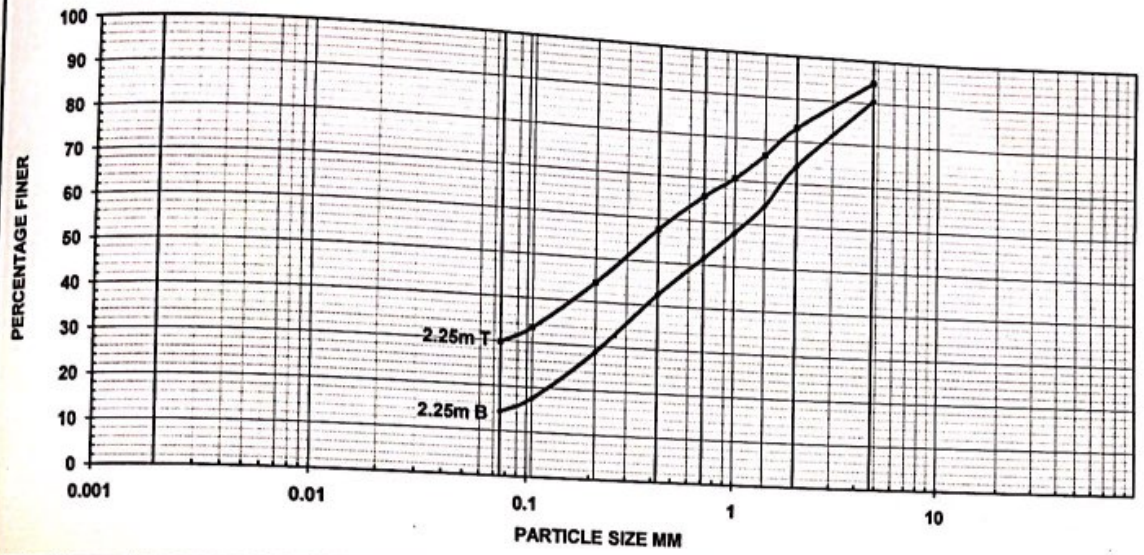
Borehole BH12 (GL = 1.224m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.60m	Yell grey silty clay with roots and black patches, LI = 0.105					53.2	
0.60m to 1.50m	Light yellowish grey soft silty clay, s_u=0.22kg/cm²				c_u = 2.2 t/m²		
1.50m to 2.80m	Yellowish grey silty clay with brown patches, LI = 0.17	8,12	8		c_u = 4.0 t/m²	48.7	m_v=1/(46N)m²/t
2.80m to 3.40m	Gr brown & grey sandy silty clay with dark brown patches	28	16		c_u = 8.0 t/m²		
3.40m to 4.40m	Brownish grey clayey silty sand with sandy clay lumps	45	45	ϕ = 36°			C using q_c= 26 N t/m²
4.40m to 5.50m	Gr brown dirty fine to coarse sand with weathered stones & sandy clay lumps	>100	75	ϕ = 42°			C using q_c= 30 N t/m²
5.50m to 6.70m	Greyish brown highly weathered fractured rock	RB	200		c_u = 100 t/m²		
6.70m to 8.70m	Brownish grey highly weathered severely jointed rock						

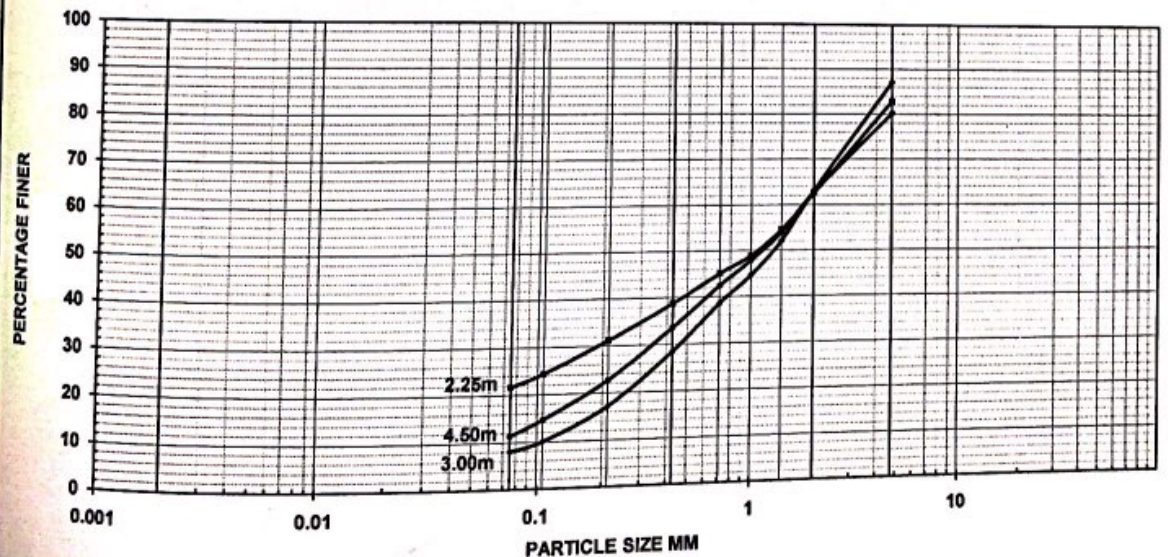
ANNEXURE G1

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: MIG, Perambakkam



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/1	2.25m T		100.0	94.8	83.2	57.5	29.8		5.2	11.6	25.7	27.7	29.8		SC-SP	0.285	8.258	0.625
BH/1	2.25m B		100.0	90.6	74.2	42.6	14.3		9.4	16.4	31.6	28.3	14.3		GC-SP	0.648	9.907	0.644

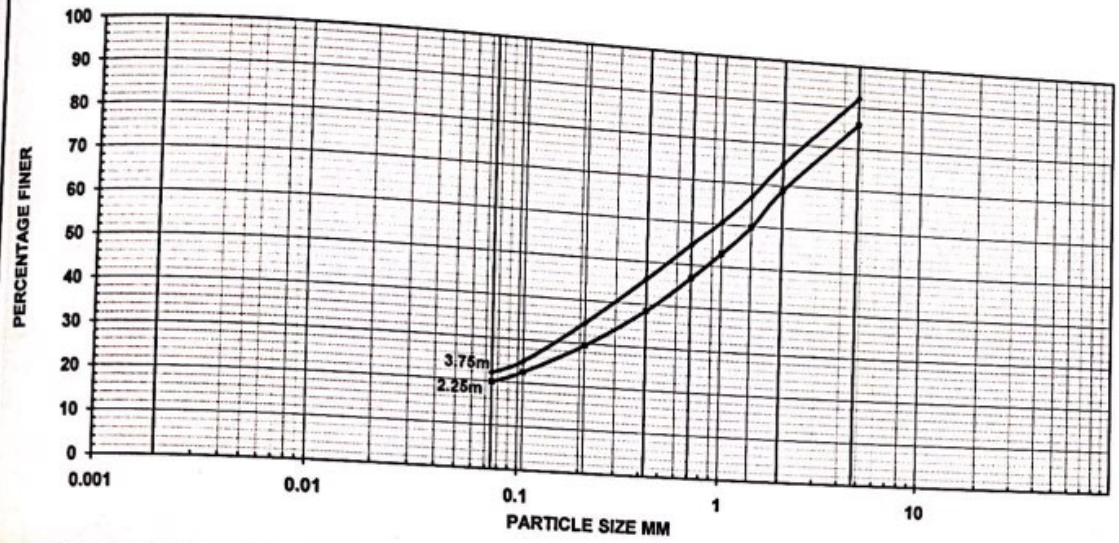


BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/2	2.25m		100.0	82.9	62.6	38.8	21.7		17.1	20.3	23.8	17.1	21.7		GC-SW	1.067	12.875	1.245
BH/2	3.00m		100.0	87.2	63.2	28.5	8.1		12.8	24.0	34.7	20.4	8.1		GSP	1.268	9.390	0.871
BH/2	4.50m		100.0	80.3	62.8	33.6	11.4		19.7	17.5	29.2	22.2	11.4		GC-SP	1.123	12.142	0.837

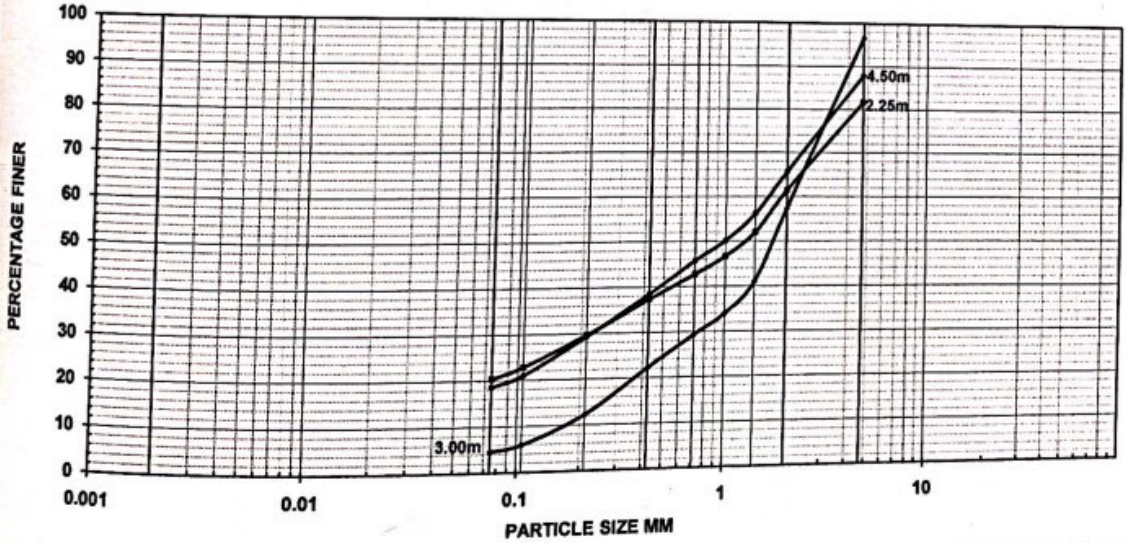
ANNEXURE G2

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: MIG, Perambakkam



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/3	2.25m		100.0	85.8	68.9	38.5	19.9		14.2	16.9	30.4	18.6	19.9		GC-SW	0.845	10.725	1.011
BH/3	3.75m		100.0	92.2	75.2	46.0	22.0		7.8	17.0	29.2	24.0	22.0		SC-SP	0.537	10.168	0.744

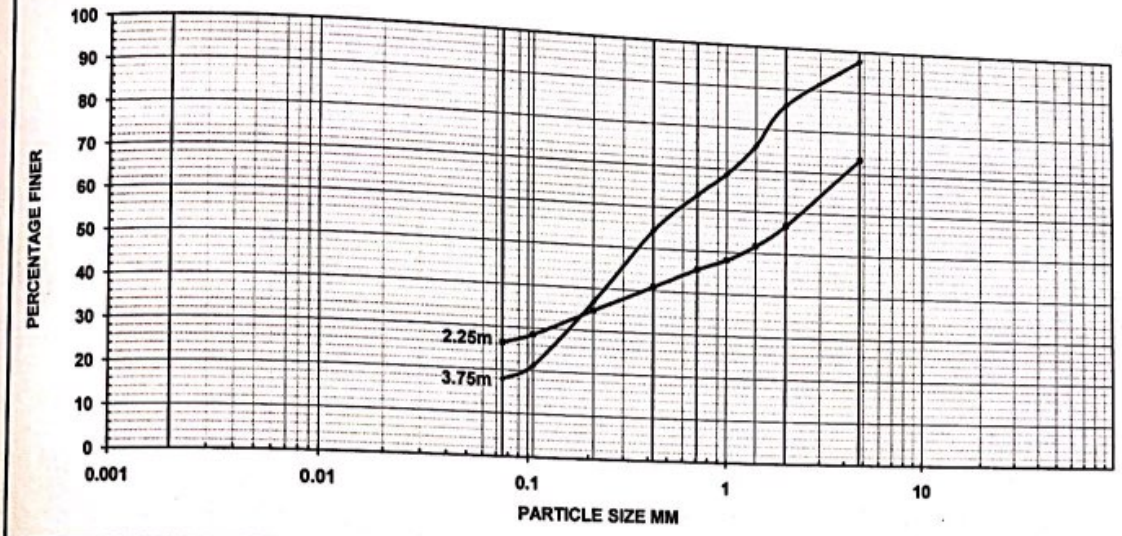


BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/4	2.25m		100.0	81.7	61.5	37.3	20.4		18.3	20.2	24.2	16.9	20.4		GC-SW	1.228	12.562	1.522
BH/4	3.00m		100.0	96.7	57.4	22.3	4.6		3.3	39.3	35.1	17.7	4.6		SW	1.701	9.086	1.689
BH/4	4.50m		100.0	87.9	65.7	38.5	18.6		12.1	22.2	27.2	19.9	18.6		GC-SW	0.985	12.242	0.956

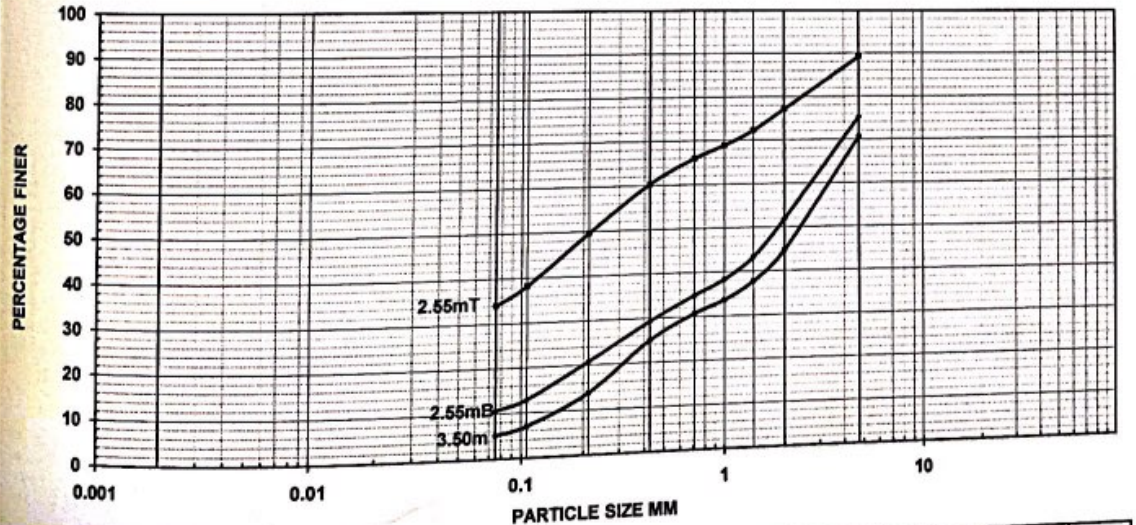
ANNEXURE G3

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: MIG, Perambakkam



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/5	2.25m		100.0	73.5	56.9	41.0	26.4		26.5	16.6	15.9	14.6	26.4		GCS	1.194	13.912	2.158
BH/5	3.75m		100.0	97.7	86.1	54.3	17.9		2.3	11.6	31.8	36.4	17.9		SC-SP	0.358	6.858	0.598



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/6	2.55mT		100.0	89.3	77.2	60.3	34.1		10.7	12.1	16.9	26.2	34.1		GCS	0.218	12.579	0.413
BH/6	2.55mB		100.0	75.3	51.9	29.3	10.7		24.7	23.4	22.6	18.6	10.7		GC-SW	1.847	13.062	1.751
BH/6	3.50m		100.0	70.7	44.8	25.0	5.2		29.3	25.9	19.8	19.8	5.2		GSW	2.379	11.711	31.679

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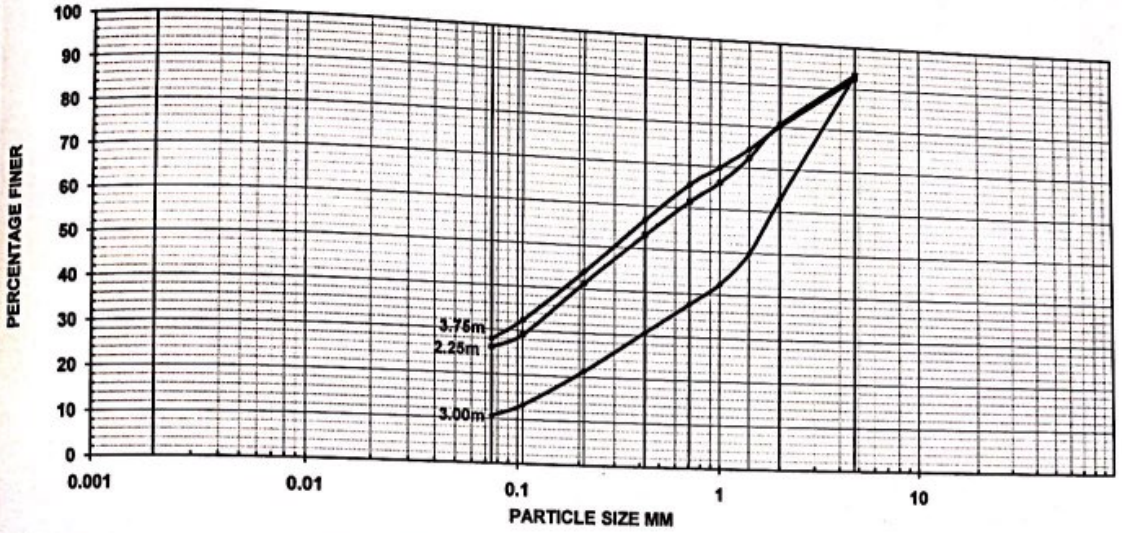
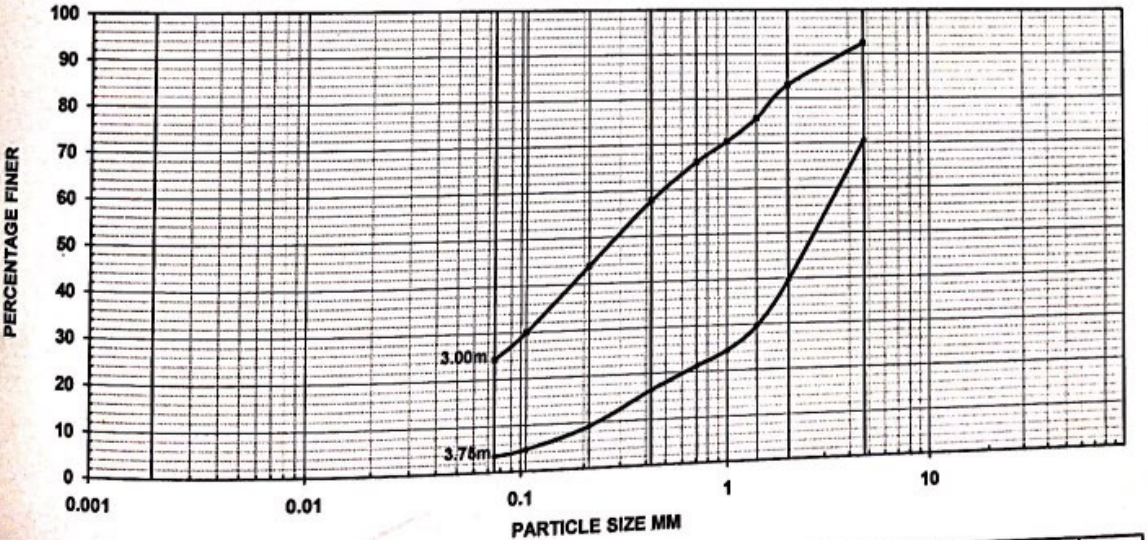
ANNEXURE G4

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: MIG, Perambakkam



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/7	2.25m		100.0	93.4	80.7	53.2	26.1		6.6	12.7	27.5	27.1	26.1		SC-SP	0.352	9.269	0.591
BH/7	3.00m		100.0	93.4	63.0	30.7	10.7		6.6	30.4	32.3	20.0	10.7		SW	1.404	11.311	1.302
BH/7	3.75m		100.0	92.5	80.2	56.7	27.9		7.5	12.3	23.5	28.8	27.9		SC-SP	0.295	8.865	0.598



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/8	3.00m		100.0	92.5	83.0	57.8	24.3		7.5	9.5	25.2	33.5	24.3		SC-SP	0.288	8.085	0.560
BH/8	3.75m		100.0	70.6	39.6	16.5	3.5		29.4	31.0	23.1	13.0	3.5		GSW	2.673	8.847	2.931

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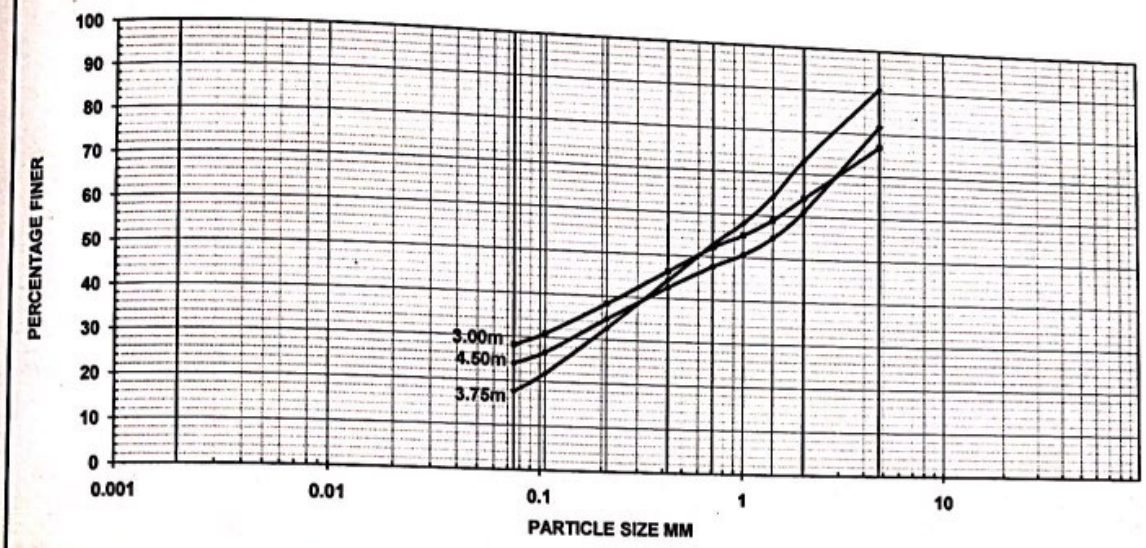
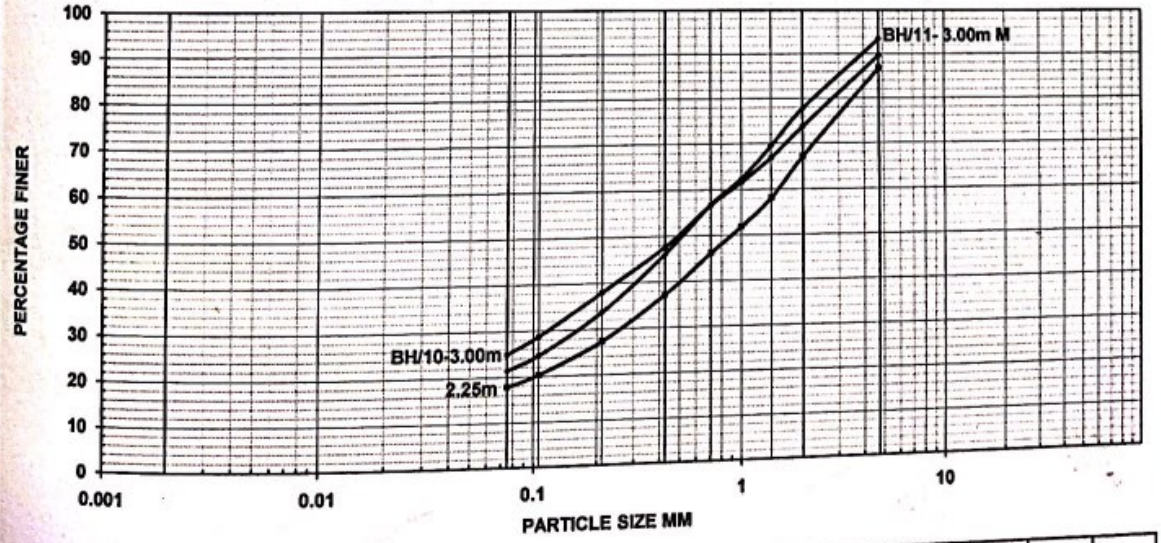
ANNEXURE G5

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: Residential Building, Mogapair



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/9	3.00m		100.0	76.9	64.3	46.3	28.2		23.1	12.6	18.0	18.1	28.2		GCS	0.586	14.684	0.860
BH/9	3.75m		100.0	90.8	73.1	44.3	17.7		9.2	17.7	28.8	26.6	17.7		GC-SP	0.597	11.381	0.670
BH/9	4.50m		100.0	81.8	61.3	42.6	24.0		18.2	20.5	18.7	18.6	24.0		GC-SW	0.921	14.936	1.066



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/10	2.25m		100.0	86.9	67.2	37.2	17.9		13.1	19.7	30.0	19.3	17.9		GC-SP	0.892	10.701	0.890
BH/10	3.00m		100.0	93.5	77.8	46.1	21.5		6.5	15.7	31.7	24.6	21.5		SC-SP	0.512	8.842	0.795
BH/11	3.00mM		100.0	89.7	73.8	47.7	25.0		10.3	15.9	26.1	22.7	25.0		GCS	0.485	11.728	0.797

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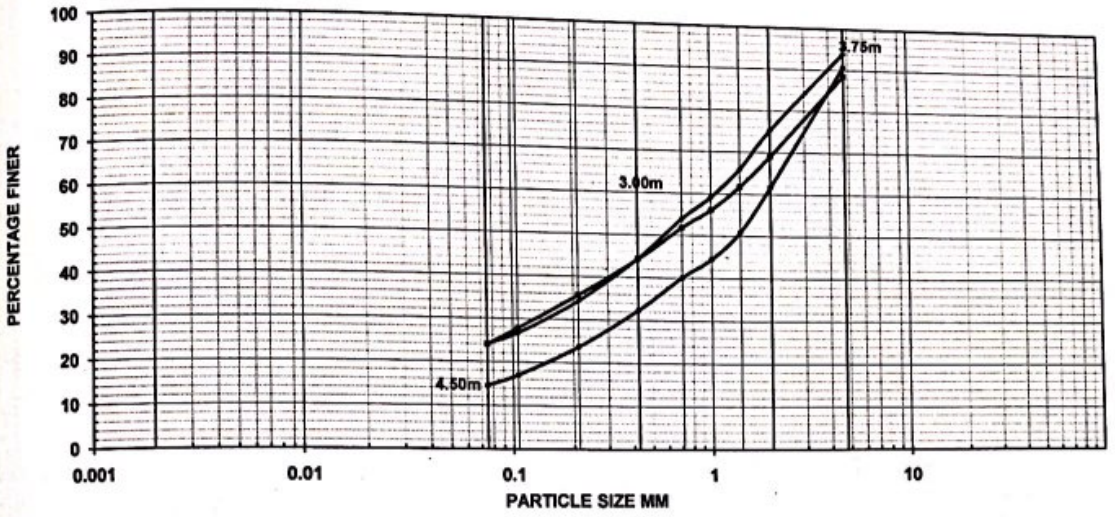
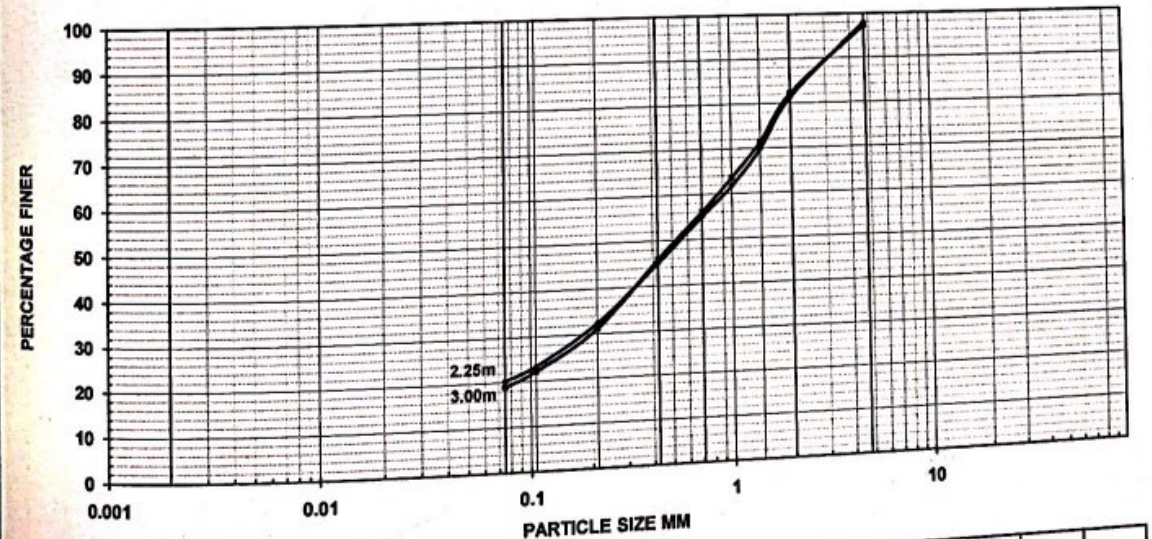
ANNEXURE G6

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: Residential Building, Mogapair



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/12	3.00m		100.0	88.5	69.0	44.3	24.0		11.5	19.5	24.7	20.3	24.0		GCS	0.628	13.751	0.845
BH/12	3.75m		100.0	94.0	75.2	44.4	24.2		6.0	18.8	30.8	20.2	24.2		SC-SP	0.575	9.605	0.871
BH/12	4.50m		100.0	90.7	61.7	32.4	14.6		9.3	29.0	29.3	17.8	14.6		GC-SW	1.335	10.975	1.169



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/13	2.25m		100.0	97.3	82.2	45.9	19.0		2.7	15.1	36.3	26.9	19.0		SC-SP	0.521	7.669	0.770
BH/13	3.00m		100.0	98.0	81.4	45.1	20.4		2.0	16.6	36.3	24.7	20.4		SC-SP	0.545	8.359	0.819

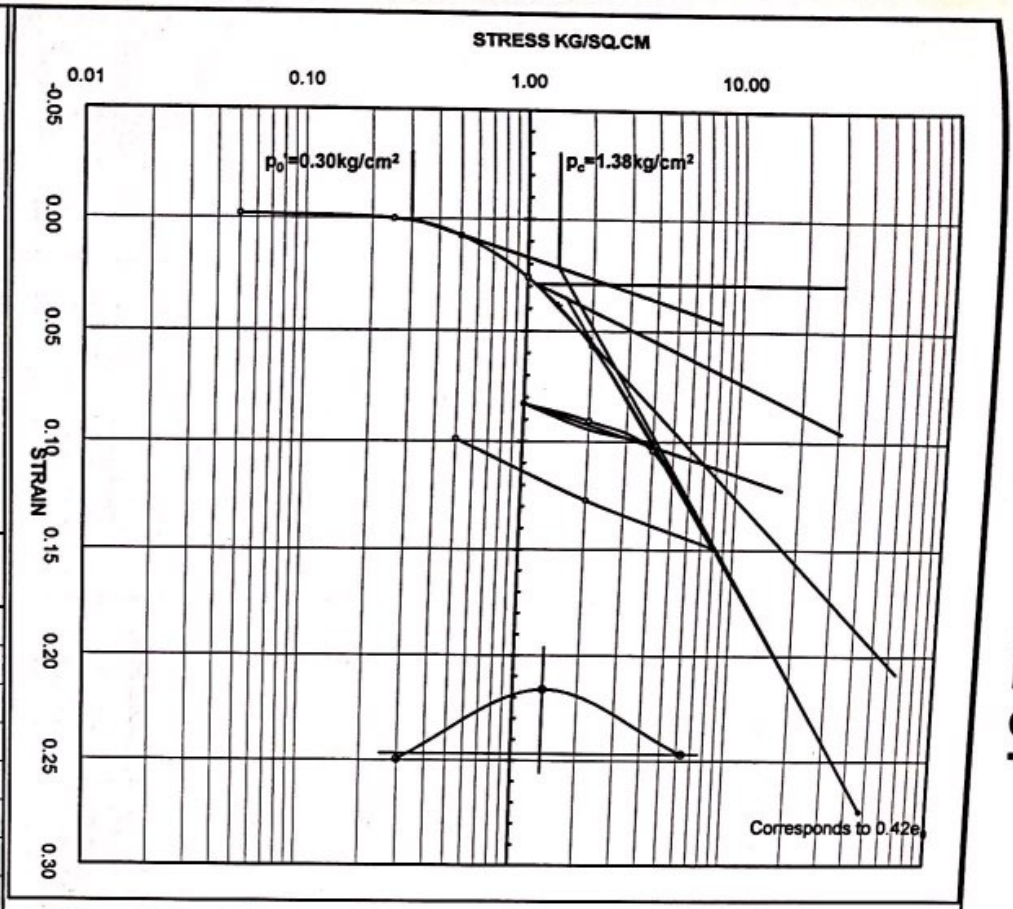
GEOTECHNICAL Solutions, Chennai

ANNEXURE C1

Wt of Consolidation Ring gm :	190.05	Diameter of ring mm :	59.90
Wt of Ring + wet Soil gm :	295.88	Height of ring mm :	19.71
Wt of Wet Soil gm :	105.83	Volume of Ring :	55.57
Wet Density gm/cc :	1.905	Specific Gravity :	2.690
Wt of Wet Soil after test gm :	102.73	Initial Void Ratio :	0.897
Wt of ring + Dry Soil gm :	268.86	Moisture Content % :	34.28
Wt of Dry soil gm :	78.81	Moisture after Test :	30.35
Dry Density gm/cc :	1.418	Height of Solids mm :	10.39
Liquid Limit %	75.70	Saturated Moisture %:	33.33
Plastic Limit %	24.10	Per cent Saturation :	102.86
Plasticity Index	51.60		
Liquidity Index	0.197		

Range of m_v cm^2/kg	from	to
	0.011	0.037

Stress kg/cm^2	Dial div	Incr div	Comp mm	Strain	Height mm	Void ratio	T_{90} min	C_v m^2/yr	Δ_p kg/cm^2	m_v cm^2/kg	E_c kg/cm^2
0.00	4450	0	0.000	0.000	19.71	0.897	–	–	–		
0.05	4470	-20	-0.040	-0.002	19.75	0.900	–	–	0.05	-0.041	-24.6
0.25	4449	1	0.002	0.000	19.71	0.896	–	–	0.20	0.011	93.9
0.50	4376	74	0.148	0.008	19.56	0.882	–		0.25	0.030	33.8
1.00	4194	256	0.512	0.026	19.20	0.847	67.4	0.62	0.50	0.037	27.1
2.00	3895	555	1.110	0.056	18.60	0.790	100.6	0.40	1.00	0.030	33.0
4.00	3461	989	1.978	0.100	17.73	0.706	148.1	0.25	2.00	0.022	45.4
1.00	3635	815	1.630	0.083	18.08	0.740	–	–	–	–	–
4.00	3424	1026	2.052	0.104	17.66	0.699	83.5	0.43	3.00	0.007	140.1
8.00	2982	1468	2.936	0.149	16.77	0.614	158.5	0.21	4.00	0.011	89.2
2.00	3199	1251	2.502	0.127	17.21	0.656	–	–	–		
0.50	3476	974	1.948	0.099	17.76	0.709	–	–	–		
0.00	3757	693	1.386	0.070	18.32	0.763	–	–	–		



Compression Ratio CR =	0.1642	ONE DIMENSIONAL CONSOLIDATION TEST RESULTS		
Re-compression ratio RR =	0.0324	PROJECT MIG Perambakkam, M Block		
Effective overburden presure	0.30 kg/cm²	BH NO BH/6	DEPTH 1.50m	strain - log p curve
Pre-consolidation Pressure p_c	1.38 kg/cm²	SOIL	Light yellowish grey silty clay with brown patches	
from Casagrande method	1.50 kg/cm²			

ANNEXURE U1

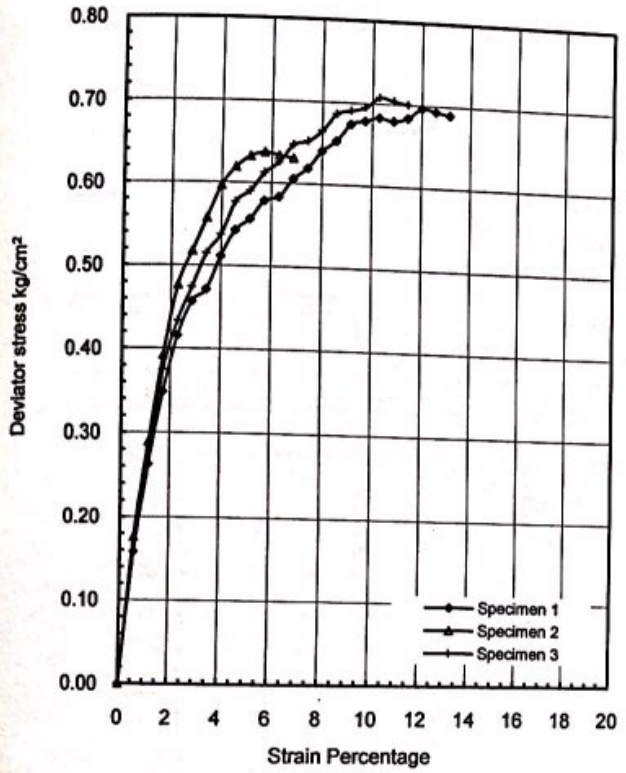
Unconfined Compression Strength Test UCC on soil sample

Project:
MIG Perambakkam, M Block

Date of Test	9-Mar-13
Borehole	BH/6
Depth	1.50m

Soil
Light yellowish grey silty clay with brown patches

Insitu bulk density	1.888 gm/cc
Insitu Dry Density	1.413 gm/cc
Water Content	33.66 %
Liquid Limit %	75.70
Plastic Limit %	24.10
Plasticity Index %	51.60
Liquidity Index	0.19

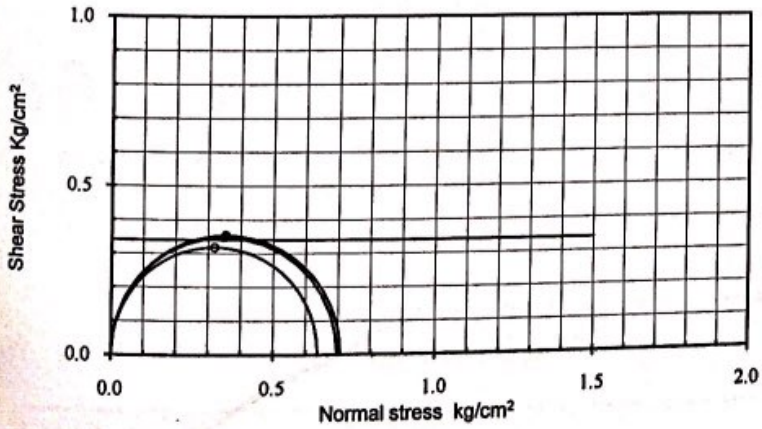


Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm²
Specimen 1	0.696	0.348
Specimen 2	0.637	0.319
Specimen 3	0.707	0.354

Results

Unconfined compression strength q_u	0.680 kg/cm²
Undrained Cohesion c_u	0.340 kg/cm²
Secant Modulus (undrained)	23.77 kg/cm²



ANNEXURE CS1

Unconfined Compressive Strength Test on Rock Core Sample

Project:
TNSCB, MIG, Perambakkam

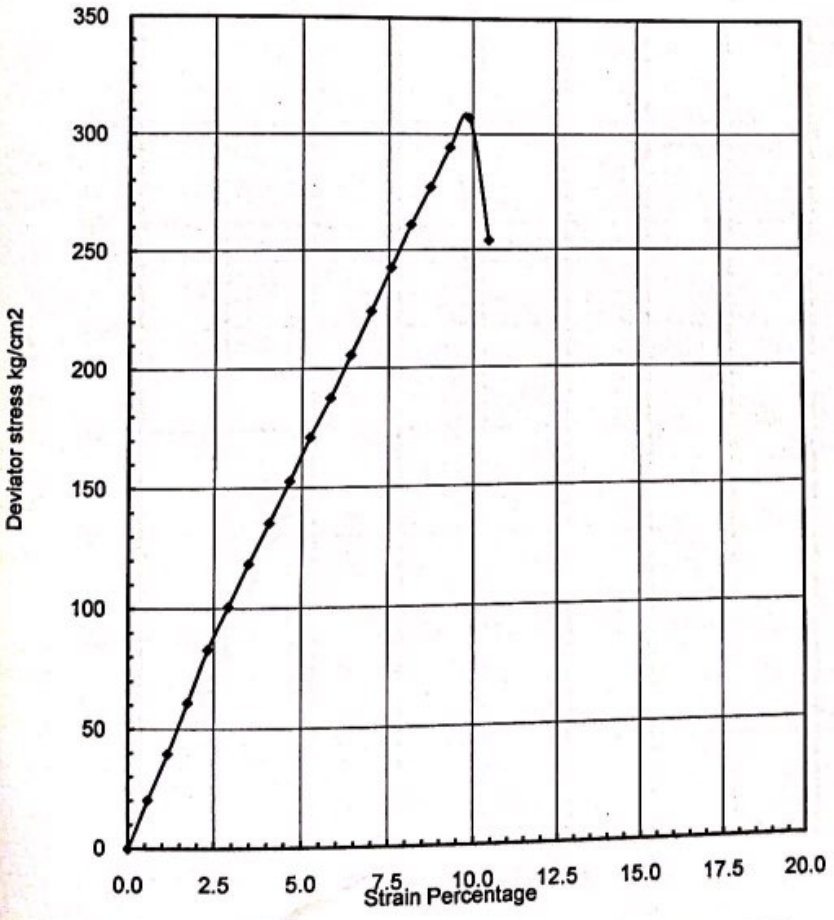
Date of Test	**12-Apr-13**
Borehole	**BH/2**
Depth	**7.30m to 8.30m (S1)**

Description
Greyish jointed rock

Insitu bulk density	2.656 gm/cc
Insitu Dry Density	2.641 gm/cc
Water Content	0.60 %

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm^2
Specimen 1	0.0	307.0



Results	
Unconfined compression strength q_u	307.0 kg/cm^2
Young's Modulus (secant)	3504 kg/cm^2

ANNEXURE CS2

Unconfined Compressive Strength Test on Rock Core Sample

Project:
TNSCB, MIG, Perambakkam

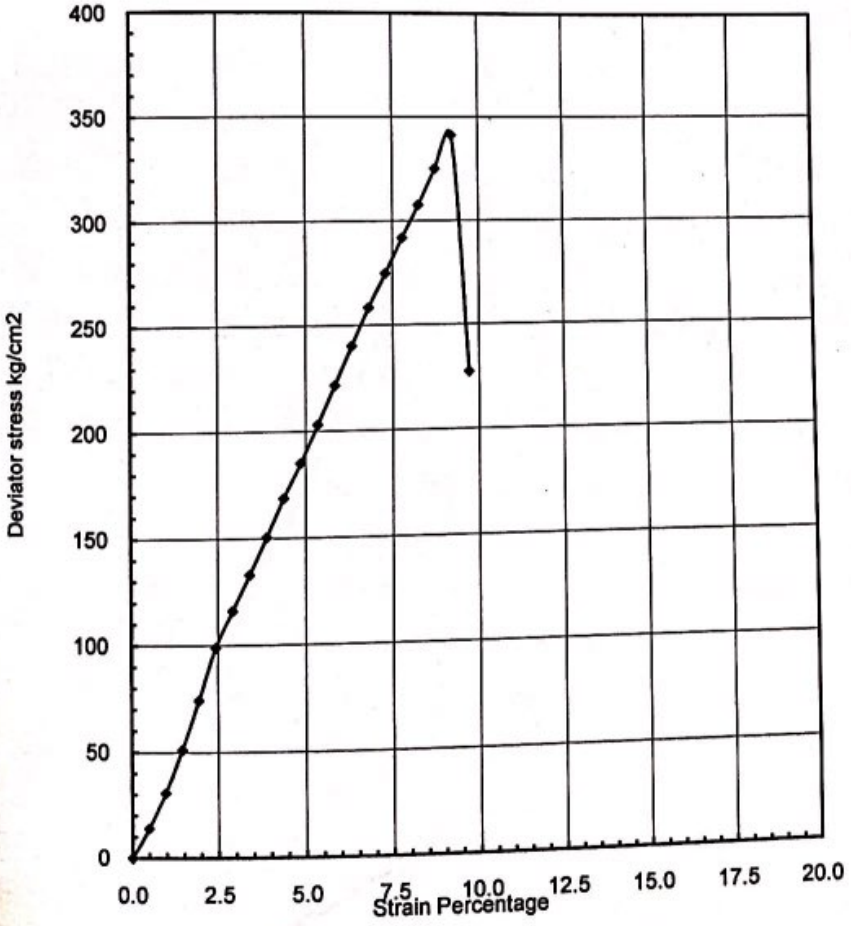
Date of Test	**12-Apr-13**
Borehole	**BH/3**
Depth	**7.10m to 8.10m (S2)**

Description
Greyish moderately jointed rock

Insitu bulk density	2.676 gm/cc
Insitu Dry Density	2.640 gm/cc
Water Content	1.33 %

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm^2
Specimen 1	0.0	341.0



Results	
Unconfined compression strength q_u	341.0 kg/cm^2
Young's Modulus (secant)	3517 kg/cm^2

ANNEXURE CS3

Unconfined Compressive Strength Test on Rock Core Sample

Project:
TNSCB, MIG, Perambakkam

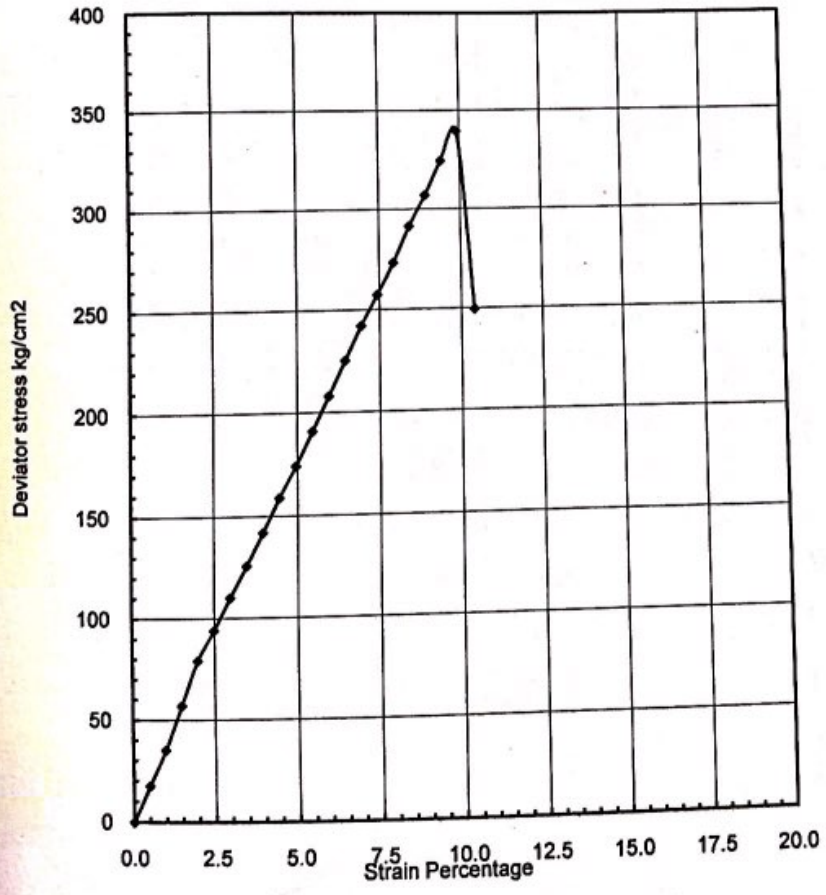
Date of Test	**12-Apr-13**
Borehole	**BH/4**
Depth	**7.10m to 8.10m (S3)**

Description
Greyish jointed rock

Insitu bulk density	2.680 gm/cc
Insitu Dry Density	2.630 gm/cc
Water Content	1.90 %

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm^2
Specimen 1	0.0	339.0



Results	
Unconfined compression strength q_u	339.0 kg/cm^2
Young's Modulus (secant)	3829 kg/cm^2

ANNEXURE CS4

Unconfined Compressive Strength Test on Rock Core Sample

Project:
TNSCB, MIG, Perambakkam

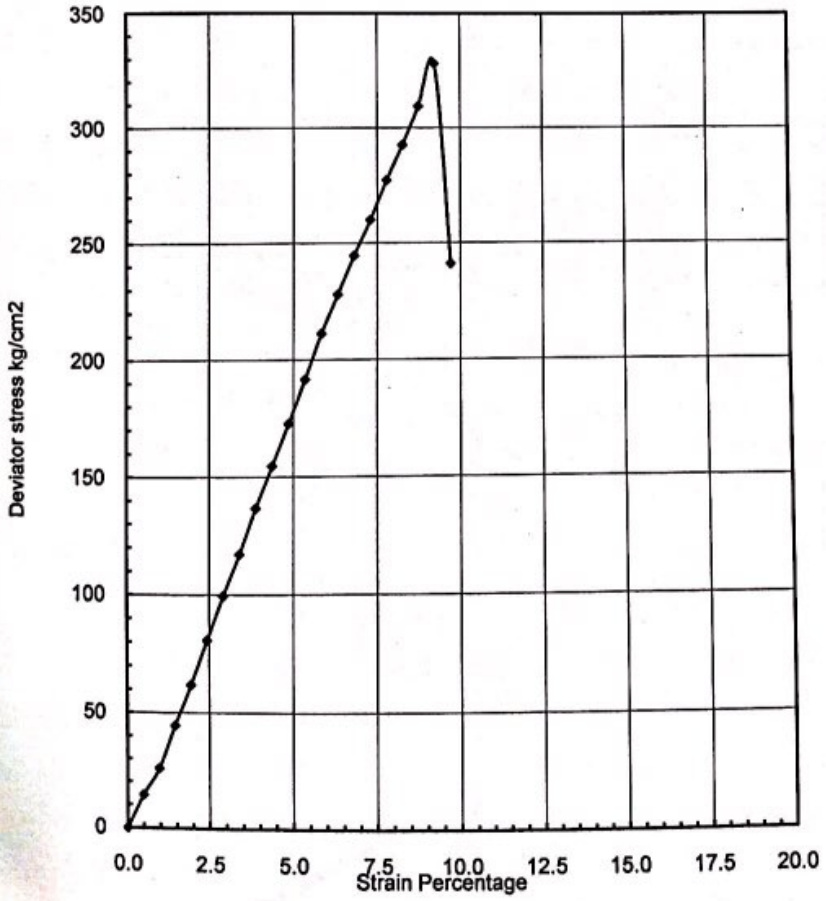
Date of Test	**12-Apr-13**
Borehole	**BH/5**
Depth	**7.10m to 8.10m (S2)**

Description
Greyish jointed rock

Insitu bulk density	2.881 gm/cc
Insitu Dry Density	2.848 gm/cc
Water Content	1.15 %

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm^2
Specimen 1	0.0	328.0



Results		
Unconfined compression strength q_u	328.0	kg/cm^2
Young's Modulus (secant)	3052	kg/cm^2

ANNEXURE CS5

Unconfined Compressive Strength Test on Rock Core Sample

Project:
TNSCB, MIG, Perambakkam

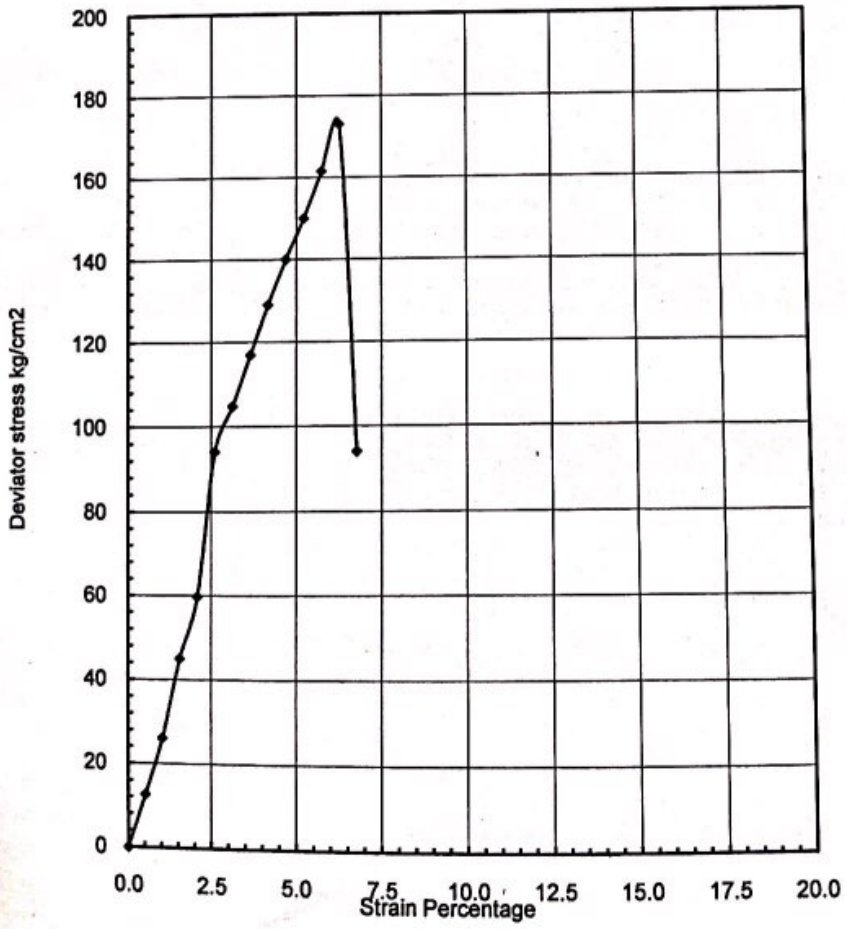
Date of Test	12-Apr-13
Borehole	BH/7
Depth	7.20m to 8.20m (S1)

Description
Greyish jointed rock

Insitu bulk density	2.802 gm/cc
Insitu Dry Density	2.736 gm/cc
Water Content	2.40 %

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm^2
Specimen 1	0.0	173.0



Results

Unconfined compression strength q_u	173.0 kg/cm^2
Young's Modulus (secant)	2877 kg/cm^2

Dept. of Civil Engg. Anna Univ.

PLATE 1 CORE SAMPLES FROM BH1 to BH14

CORE SAMPLES FROM BH/1 to BH/14
MIG TENEMENTS, TNSCB, PERUMBAKKAM