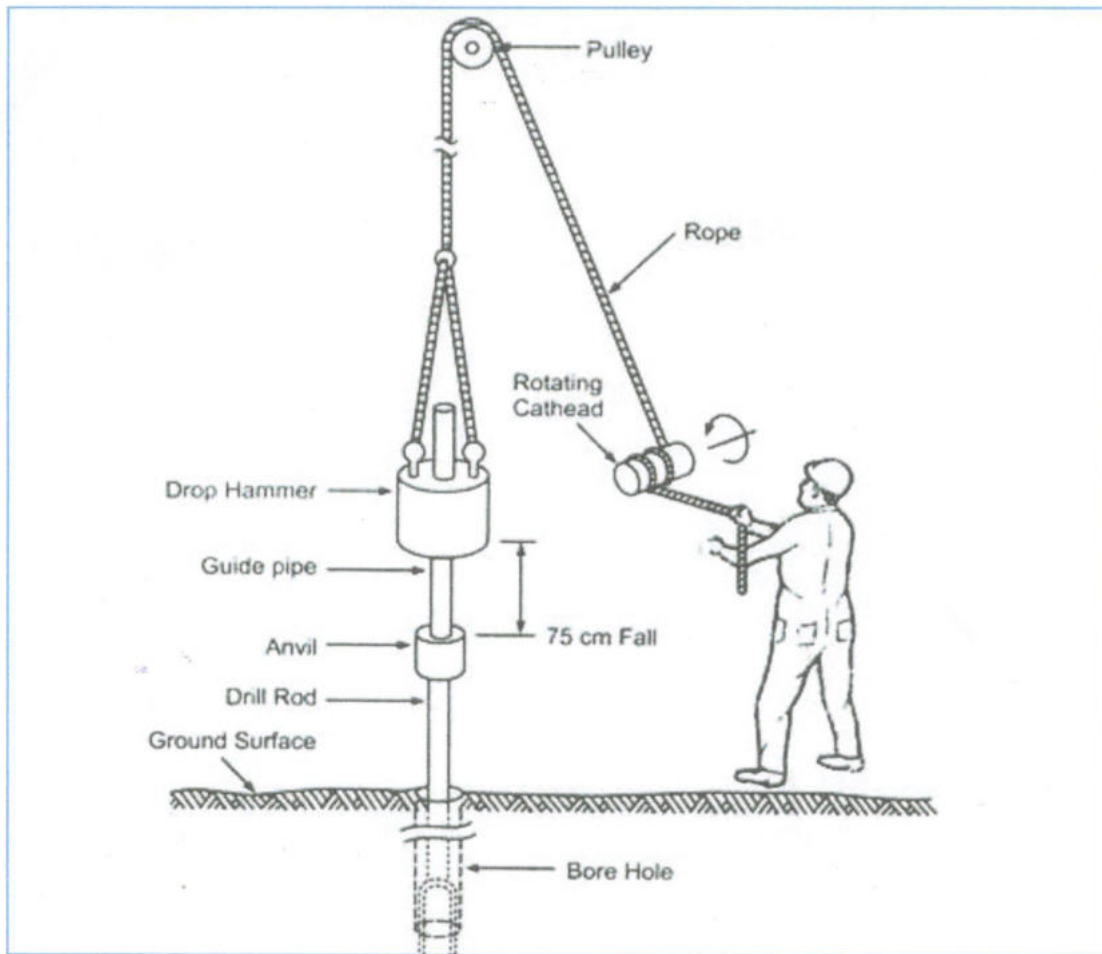


GEO-TECHNICAL INVESTIGATION REPORT



NAME OF THE WORK:

Proposed 220/132 KV GIS at Khumtai

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Team Leader
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LOCATION
Khumtai

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C	=	Cohesion
ϕ	=	Angle of internal friction of soil
DS	=	Disturbed sample
UDS	=	Undisturbed sample
NP	=	Non plastic soil
G	=	Specific Gravity
M	=	Silt content
C	=	Clay content
LL	=	Liquid Limit
PL	=	Plastic Limit
PI	=	Plasticity Index
CC	=	Compression index
K	=	Co-efficient of permeability
UCS	=	Unconfined compression
N	=	SPT value
BH	=	Borehole
GP	=	Poorly Graded Gravel
GW	=	Well Graded Gravel
SC	=	Clayey sand
SM	=	Silty sand
SW	=	Well Graded sand
SP	=	Poorly Graded sand
CH	=	Clay with high plasticity
CI	=	Clay with intermeadiate plasticity
CL	=	Clay of low Plasticity

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1. INTRODUCTION:

Sub-soil investigation was carried out at the site of investigation for Proposed 220/132 KV GIS at Khumtai

Field work including drilling of boreholes and sample collection was carried out in the presence of representative of Client. Laboratory tests were conducted on selected soil samples to determine the design parameters, confirming to relevant IS specifications and the guidelines received from time to time from representative of Client. This report includes the details of Methodology of Investigation, collection of samples (soil/rock), field test results, laboratory test results, analysis of results and recommendations for results for proposed structures based on soil sample collected from the locations of boreholes.

Twelve (12) numbers of boreholes were drilled at the site of investigation from existing ground level for BH-1, BH-2, BH-3, BH-4, BH-5, BH-6, BH-7, BH-8, BH-9, BH-10, BH-11, BH-12

2. OBJECTIVE:

The objective of this geotechnical investigation were to explore and evaluate subsurface condition of the site and develop geotechnical recommendation for design and construction of the proposed structure.

3.00. SCOPE OF INVESTIGATIONS:

The scope of work provided to us for this project was limited to the following:

- i) Mobilizing necessary equipments and personnel to the project site, setting up the equipment, shifting of the equipment from one test location to another location, carrying out the field investigations on land and demobilization on completion of work.
- ii) Making 150 mm nominal diameter bore holes at various locations in all types of soil using suitable approved method of boring at the specified locations to be given at site by the Engineer-in-Charge up to max **15.00** m depth or refusal whichever occurs earlier. Refusal shall mean when SPT field 'N' value reaches 100 for 30 cm or less penetration of SPT sampler.
- iii) Conducting standard penetration tests in the bore holes at 1.50 m interval in depth & at every change of strata, whichever is earlier as per specifications / instructions of Engineer-in-Charge.
- iv) Collecting undisturbed soil samples
- v) Collecting disturbed soil samples from bore holes at regular interval and at every identifiable change of strata to supplement the boring records.
- vi) Recording the depth of ground water table in all the bore holes if observed up to the depth of exploration during boring work as per specifications & withdrawing the casing pipe.

3.01-A Conducting the following laboratory tests on selected disturbed / undisturbed soil samples collected from various bore holes / test locations :-

- a) Liquid Limit & Plastic Limit
- b) Sieve analysis
- c) Natural moisture content
- d) Specific Gravity
- e) Direct shear Test
- f) Bulk and dry density
- g) Unconfined compression Test
- h) Free Swell Index
- i) Chemical analysis



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3.01-B Details of Fieldwork:

Total ~~Twenty~~ Twelve nos Boreholes (BH-01 to BH-12) were completed.

The boreholes were conducted by employing a mechanically operated soil boring equipment using rotary drilling method at this site as per IS: 1892-1979. Summary of boreholes drilled at site and buidling configurations are given in Table 1.

Table 1: Summary of Field Work Executed:

Borehole No	Corresponding structure description/configuration	Borehole termination depth (below E.G.L) m	Depth of Water Table below EGL	Date of commencement	Date of completion
BH-01	220/132 KV GIS	15.00	6.00	30-11-2022	30-11-2022
BH-02		15.00	1.50	27-11-2022	27-11-2022
BH-03		15.00	1.40	28-11-2022	28-11-2022
BH-04		15.00	3.20	24-11-2022	24-11-2022
BH-05		15.00	3.20	29-11-2022	29-11-2022
BH-06		15.00	4.60	19-11-2022	19-11-2022
BH-07		15.00	4.20	21-11-2022	21-11-2022
BH-08		15.00	5.00	20-11-2022	20-11-2022
BH-09		15.00	1.50	22-11-2022	22/11/202
BH-10		15.00	4.00	23-10-2022	23-10-2022
BH-11		15.00	1.00	26-11-2022	26-11-2022
BH-12		15.00	1.00	26/11/202	26-11-2022

4.00 METHODOLOGY OF FIELD INVESTIGATION:**I) SAMPLING:**

Representative soil samples collected from boreholes were confirming to IS 2132 in categories of Disturbed Sample& undisturbed sample.

I.A) DISTURBED SOIL SAMPLE:

Disturbed soil samples were taken at every 1.5m interval and at significant change of stratum and labelled depth wise and placed in polythene bags for conducting necessary laboratory tests.

I.B) UNDISTURBED SOIL SAMPLES:

Undisturbed soil samples were recovered by using thin walled metal sampling tubes as per IS 1932-1963 specification. The Sampling tubes were lubricated before use so as to minimize the wall friction. The samples so recovered were sealed with molten paraffin at the both ends so that the in situ properties were retained.



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II. STANDARD PENETRATION TEST :

As per IS: 2131:1981, Standard Penetration Test requires one drop hammer of 63.5Kg weight, a string of drill rods (A-type rods of 41.27mm OD and 28.57mm ID) of suitable length, casing, one split spoon sampler, one guide to transfer the impulse load from drop hammer to the drill rods and a mechanism to elevate the load and to release the same on the drill rods.

First the sampler is driven into the borehole with the drill rods to the required depth, at which we are going to take the S.P.T. value. The sampler is first driven in to the soil by light blows of hammer to a seating penetration of 15cm. Then the sampler is driven under full blows of the 63.5Kg hammer falling from a height of 75cm, to an additional penetration of 30cm and the no. of blows are recorded as the 'Standard Penetration Resistance' N -value.

The observed value of N has to be corrected for (i) submergence correction and ii) Overburden pressure correction.

CORRECTION OF N VALUES: In case of sandy /cohesionless soil the observed SPT values designated as "N" are to be corrected to account for the following two effect:-

I. OVERBURDEN PRESSURE CORRECTION :

For a constant density index the N-value increase with increasing effective overburden pressure for which correction have been proposed by Gibbs and Holtz, peck, Thornburn, Whitman Peck (1974) proposed that N-values be reported at a reference overburden pressure of 100 kN/m², and the normalized value of N (corrected for overburden as pressure) be expressed as

$$N_0 = C_n \cdot N$$

Where, N_0 = Corrected value for overburden effect,

N = Observed N-Value

C_n = Normalizing factor = $0.77 \times \log_{10} (2000/\sigma')$

Where, σ' = Effective overburden pressure (KN/m²)

II. SUBMERGENCE CORRECTION :

In very fine or silty sand, situated bellow the water table, an apparent increase in penetration resistance occurs. Tarzaghi and Peck have recommended the use and equivalent penetration resistance N_e in place of actually observed N, when N is greater than 15. N_e is given by the following relation.

$$N_e = 15 + 0.5 (N - 15) \dots\dots\dots(i)$$

SPT 'N' values were correlated with relative density of non-cohesive stratum and with consistency of cohesive stratum as given below:

Soil compactness as per SPT N values (table 15.8 & 15.9, page 496 & 497_text book of Gopal Ranjan

Correlatin with N values for cohesive soil		Correlatin with N values for cohesionless soil	
Consistency	SPT N value	Compactness	SPT N value
Very soft	0-2	Very loose	0-4
Soft	2-4	Loose	5-10
Medium	4-8	Medium	10-30
Stiff	8-16	Dense	30-50
Very stiff	16-32	Very Dense	>50
Hard	>32		

S P T Refusal :Refusal means when the sampler penetrates less than 2.5 cm under 50 blows



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5.00 LABORATORY INVESTIGATIONS:

The following laboratory tests were conducted on selected soil samples:

Table:1 Description of Tests

Description of Tests	Reference
Grain Size Analysis / Hydrometer	IS: 2720 (Part - 4)
Natural Moisture Content / Bulk / Dry density	IS : 2720 (Part – 2)
Atterberg Limits i) Liquid Limit ii) Plastic Limit	IS: 2720 (Part - 5)/IS: 2720 (Part - 5)
Specific Gravity	IS : 2720 (Part – 3)
Direct Shear Test	IS : 2720 (Part – 13)
Triaxial compressive shear test	IS : 2720 (Part – 11 & 12)
Chemical Analysis of Soil Samples	IS : 2720 (Part – 26, 27)

Note:- The detailed procedure adopted for conducting various laboratory tests is described in the following paragraphs:

I) GRAIN SIZE ANALYSIS AS PER IS: 2720, part-IV :**A) SIEVE ANALYSIS**

The complete sieve analysis can be divided into two parts, i.e., the coarse analysis and fine analysis. An oven dried samples of soil is separated into two fractions by sieving it through a 4.75 mm IS sieve. The portion retained of it (+4.75mm size) is termed as the gravel fraction and is kept for the coarse analysis, while the portion passing through it (-4.75mm size) is subjected to fine sieve analysis. Grain size distribution was determined by dry sieving process. Sieve analysis was carried out by sieving a soil sample through sieves of known aperture size (e.g., 4.75mm, 2mm, 1.18mm, 425, 300, 150 and 75 microns) by keeping one over the other, the largest size being kept at the top and the smallest size at the bottom. The soil is placed on the top sieve and shake for 10 minutes using a mechanical shaker. The soil retained on each sieve was weighed and expressed as a percentage of the weight of sample.

B) HYDROMETER ANALYSIS

In the wet method of mechanical analysis or sedimentation analysis, the soil fraction, finer than 75 micron size is kept in suspension in a liquid (usually water) medium. The analysis is based on stoke's law, according to which the velocity at which grains settle out of suspension, all other factor being equal, is depended upon the shape, weight and size of the particles/grains.



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II ATTERBERG'S LIMIT TEST AS PER IS: 2720, part-V

The physical properties of fine-grained soils (clay and silt) get affected with water content. Depending upon the amount of water present in a fine-grained soil, it can be in liquid, plastic or solid consistency states. The Atterberg Test was used for determining the consistency of a cohesive (fine) soil. The Liquid Limit is the water content at which a soil has a small shear strength that it flows to close a groove of standard width when jarred in a specified manner. The Plastic Limit is the water content at which a soil begins to crumble when rolled into threads of specified size i.e., 3mm. The water content determined at a stage when the rolled thread of soil just starts crumbling. Three such tests and the average value of water content

were taken as Plastic Limit. The Plasticity Index is the numerical difference between the Liquid Limit and the Plastic Limit. The liquid limit of the fine-grained soils was determined using the Casagrande liquid limit device. A Plastic limit was determined using the standard 'rolling the soil into a thread of 3mm' method. Casagrande plasticity chart was employed to determine the classification of fine-grained soil according to the Unified Soil Classification System. However, in this study, the Atterberg limit tests are not applicable as the soil found in the site was sand and gravel.

III. MOISTURE CONTENT AS PER IS: 2720, part-IX

A moisture cup is loosely filled with soil and weighed with lid. It is then kept in oven with lid removed and maintained at temperature of the oven at 1100 C for 24 hours. The lid of the container is replaced and the dry weight found out. The percentage of water content shall be calculated using the formula.

$$W = (W_2 - W_3 / W_3 - W_1) * 100$$

Where

W₂ = weight of container with wet soil, in g.

W₃ = weight of container with dry soil, in g

W₁ = weight of container with lid, in g, W = moisture content (%)

IV DRY DENSITY AND BULK DENSITY AS PER IS: 2720, part-IX :

The unit weight of soil in g/cc is its weight per unit volume. Soil is filled in container and its weight determined. Knowing the volume of container, the ratio of weight to volume represents bulk density. The soil is then oven dried and weighed and dry density γ_d (g/cc) is computed using formula

$$\gamma_d = \gamma_b / (1 + W), \text{Where, } \gamma_b = \text{bulk density in g/cc}$$

W = natural moisture content in %

V. SPECIFIC GRAVITY AS PER IS: 2720, part-II :

The specific gravity of soil solids can be defined as the weight of given volume of soil particles to the weight of equal volume of distilled water. This term is used in relating weight of soil to its volume. Specific gravity is found out using standard specific gravity bottle of 50 ml capacity by weighing empty bottle (w₁), bottle + dry soil (w₂), bottle + dry soil + water (w₃), bottle + water (w₄)

$$\text{Specific gravity of soil} = (w_2 - w_1) / ((w_2 - w_1) - (w_3 - w_4))$$



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VI. DIRECT SHEAR TEST AS PER IS: 2720, part-XIII :

The shear strength of a soil mass is its property against sliding along internal planes within itself and is determined in this case to compute the safe bearing capacity of the foundation soil. Direct shear tests were conducted on disturbed samples collected from the three boreholes. The samples were carefully extruded from the sampling tubes and molded using standard moulds of 6.0 x 6.0 cm² cross-sectional areas and trimmed to 2.5 cm high. Solid metal plates were placed on both surfaces of the samples to prevent the dissipation of pore water during shearing. The direct shear equipment is mechanically operated, and shearing is applied at more or less constant strain rate. If the samples are cohesive, they will be sheared at a relatively fast rate (duration of tests less than 10 minutes) to maintain un-drained condition. The samples were sheared at three different normal stresses (i.e., 50 kPa, 100 kPa, 200 kPa). The direct shear test results are presented in terms of the failure envelopes to give the angle of internal frictions (ϕ) and the cohesion intercepts (C).

VII TRI-AXIAL SHEAR TEST AS PER IS: 2720, part-XII :

The shear strength properties of soil play an important role in the determination of the bearing of soil. The values of "C" and " ϕ " are obtained from Mohr's circle drawn as required in IS: 2720 (part-XII) for the soil samples tested in unconsolidated un-drained triaxial compression without measurement of pore pressure.

VIII CONSOLIDATION TEST AS PER IS: 2720, part-XV :

To obtain specimens for consolidation test, the odometer ring was placed on the trimmed horizontal faces of the soil within the 10 cm diameter sampling tube and the soil around the cutting edge was gradually removed with a spatula as the ring was gently pushed into the soil. The ring with the soil was then removed by cutting across the soil core with the help of a piano wire saw. Consolidation tests were run in floating ring type odometers, in single & four unit consolidation frames under standard load increment ratio starting from 0.25 kg/sq.cm and going up to 16 kg/sq.cm in general. The pressure vs void ratio curves are given in this report.

IX UNCONFINED COMPRESSIVE STRENGTH TEST AS PER IS : 2720, part-XI

The primary purpose of this test is to determine the Unconfined Compressive Strength of the soil sample and which is then used to determine unconsolidated and un-drained shear strength of the soil sample. As per ASTM, unconfined compressive strength is defined as the compressive strength at which an unconfined cylindrical specimen of the soil will fail in a simple compressive test. In this test, maximum unconfined compressive stress is equal to the stress at failure or stress corresponding to 15% axial strain, whichever occurs first. An undisturbed soil sample is used to determine the strength of the soil. It is subjected to loading at a constant rate and loading and deformation is measured simultaneously. Area is corrected for various deformation values by applying corresponding formulae and stress corresponding to various strains is measured and plotted. The result is a stress-strain curve. Allowable bearing capacity of soil is found by applying requisite formulae on the results of this test. Shear strength of soil can also be determined from the unconfined strength of the soil and is equal to one half of the unconfined strength of the soil.

XII Collection of Ground Water Samples from bore holes:

As the water table was met at the location of boreholes carried out for proposed structures. All the samples were properly sealed, lebeled and carefully transported to the laboratory for chemical analysis

6. GROUND WATER TABLE:

Determination of Ground water table & water depth from existing Ground level was done using steel tap with weigh. The depth of Ground water table was determined as per procedure laid in IS 6935-1973 . The Ground Water Table at the locations of boreholes **BH-1 to BH-12** was encountered at depths varying from **1.00 m to 6.00 m** below the existing ground level, it may rise up during heavy rains / rainy season. However, for the analysis of various foundations, the water table has been considered at existing ground level. At the time of soil investigation at site ground water table was encountered at the following depth from existing ground level.

7.00 ANALYSIS OF TEST RESULTS AND INTERPRETATION**7.01 STRATIFICATION**

Table : 2 From the study of the borehole Twelve (12) it is revealed that the sub strata

Borehole No	Corresponding structure description/config uration	Depth below Ground (m)			Subsoil condition
BH-01	220/132 KV GIS	0.00	-	8.70	Silty clay
		8.70	-	15.00	Silty sand
BH-02		0.00	-	4.20	Silty clay
		4.20	-	15.00	Silty sand
BH-03		0.00	-	2.30	Silty clay
		2.30	-	15.00	Silty sand
BH-04		0.00	-	4.00	Silty clay
		4.00	-	15.00	Silty sand
BH-05		0.00	-	8.00	Silty clay
		8.00	-	15.00	Silty sand
BH-06		0.00	-	7.00	Silty clay
		7.00	-	15.00	Silty sand
BH-07		0.00	-	2.50	Silty clay
		2.50	-	15.00	Silty sand
BH-08		0.00	-	5.50	Silty clay
		5.50	-	15.00	Silty sand
BH-09		0.00	-	4.40	Silty clay
		4.40	-	15.00	Silty sand
BH-10		0.00	-	8.90	Silty clay
		8.90	-	15.00	Silty sand
BH-11		0.00	-	7.40	Silty clay
		7.40	-	15.00	Silty sand
BH-12		0.00	-	4.40	Silty clay
		4.40	-	15.00	Silty sand



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7.02 RESULTS OF CHEMICAL ANALYSIS

Results of chemical analysis of soil samples (as per Annexure-I) indicates that the soil sample falls under Class I for sulphates and chlorides concentration (As per IS 456-2000 and CIRIA Sp Publication No. 31). The results are summarized here in below :-

Table 3: Summary of chemical analysis of soil samples

Chemical property	Results (min to max)	Remarks (Required limits as per IS 456-2000)
pH	7.33-8.50	> 6.0
Sulphate as SO ₄ (%)	0.00398-0.0085	< 0.2% (Class I)
Chlorides as Cl (%)	0.0019-0.0028	No limit specified in IS 456. However, a limit of 0.10% specified for class I in CIRIA Sp. Publication No. 31)

As the various chemical contents are within the permissible limit hence no special precautions are required due to this.

8. TYPE AND DEPTH OF FOUNDATION WITH ANALYSIS:**8.01 TYPE & DEPTH OF FOUNDATION**

Based on the nature & strength characteristics of the substrata and requirement of the project, the following type of foundation have been analyzed as given below:

BH No.	Type of Foundation	Length of Pile/ Depth of foundation below E.G.L. (m)	Dia. of Pile /Size of foundation (m)
BH-1 to BH-12	Pile Foundation	9.00,10.00	0.450,0.500
	shalow Foundation	1.50,2.00,2.50,3.00,3.50	1.50x1.50 1.80x1.80 2.00x2.00



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8.02 ANALYSIS OF FOUNDATION**A. Shallow Foundation****From Shear Failure Criteria**

Net Safe Bearing capacity from Shear Failure consideration has been computed in accordance with IS: 6403-1981, which is based on, modified Terzaghi's classical approach. A factor of safety of 2.5 has been taken to estimate the net safe bearing capacity from ultimate net bearing capacity. For soils, containing both coarse grained (gravels & sands) and fine grained (clays), c and Φ are used to determine the soil strength. In case of predominantly fine grained soils, c and Φ are determined by the Triaxial Compression test as per IS: 2720 pt XI. For predominantly coarse grained soils, c and Φ are determined by Direct Shear test as per IS: 2720 pt XIII. These c and Φ values were used for determining the SBC of soil as per shear failure criteria

The safe bearing capacity in case of general shear failure is given by following expression,

$$q_a = \frac{1}{F} [c N_c s_c d_c i_c + \gamma D (N_q - 1) s_q d_q i_q + 0.5 \gamma B N_\gamma s_\gamma d_\gamma i_\gamma w']$$

The safe bearing capacity in case of local shear failure is given by following expression,

$$Q_a = \left[\frac{1}{F} (2/3) c N'_c s'_c d'_c i'_c + \gamma D (N'_q - 1) s'_q d'_q i'_q + 0.5 \gamma B N'_\gamma s'_\gamma d'_\gamma i'_\gamma w' \right]$$

Where,

F = factor of safety

C = Cohesion

γ = Submerged density

D = Depth of footing

B = Width of footing

L = Length of the footing

w' = Water table correction

N_c, N_q, N_γ & N'_c, N'_q, N'_γ are the bearing capacity factors depending upon the Φ & Φ' values respectively

s_c, s_q, s_γ are the shape factors :

Shape of the footing	s_c	s_q	s_γ
Square	1.3	1.2	0.8
Circular	1.3	1.2	0.6
Rectangular	$1 + 0.2 (B/L)$	$1 + 0.2 (B/L)$	$1 + 0.4 (B/L)$

d_c, d_q, d_γ are the depth factors :

$$d_c = 1 + 0.2 \frac{D}{B} \tan(45^\circ + \frac{\Phi}{2})$$

$$d_q = d_\gamma = 1 \text{ when } \Phi < 10^\circ$$

$$d_q = d_\gamma = 1 + 0.1 \frac{D}{B} \tan(45^\circ + \frac{\Phi}{2}) \text{ when } \Phi > 10^\circ$$

i_c, i_q, i_γ are the inclination factors for inclined loads

$$\emptyset \text{ for local shear failure} = \tan^{-1} (0.67 \tan \emptyset)$$



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From Settlement Failure Criteria

Allowable Bearing Pressure from Settlement Failure consideration has been computed in accordance with IS: 8009 (Part-I). The magnitude of settlement, when foundation loads are applied, depends upon the compressibility of the underlying strata and rigidity of the substructure. The total permissible settlement in cohesion-less soil is estimated using SPT value as per IS: 8009 (Part-I). While using this approach, the N value was corrected, wherever applicable, below the footing base to at least 1.5B (where 'B' is the width of foundation) for the effects of energy ratio, dilation for submerged silty fine sands / fine sands as well as that due to the overburden pressure. Further the immediate settlements in cohesive soil are estimated using the elastic theory considering the effect of a rigid stratum underlying the foundation soils (Reference: "Foundation Analysis and Design" by J.E.Bowles) and for consolidation settlement in cohesive soil the following equation has been used

The following expression is used to compute the consolidation settlement of fine grained soil

$$S = \frac{C_c H}{1 + e_0} \log_{10} \frac{\rho_0 + d\rho}{\rho_0}$$

Here,

C_c = Compression Index

H = Height of Consolidating layer

e_0 = In-situ void ratio

ρ_0 = Effective overburden pressure at middle of consolidating layer

$d\rho$ = Increase in vertical stress due to applied loading at center of layer

The settlement obtained from above expression is corrected for rigidity and 3 Dimensional consolidation effect as per IS 8009- Part I: 2009. The permissible settlement for fine grained and coarse grained soil is adopted 75 mm as per Codal provision.

Lower of the two values obtained from settlement and shear criteria is used in arriving at allowable bearing capacity of the soil. Sample calculation for computation of allowable bearing capacity of sub-strata for **shallow** foundation resting on soil are attached Annexure II.

(B) PILE FOUNDATION

The safe Load Carrying Capacity of normal bored cast in-situ RCC pile is determined in compression, uplift and lateral as per IS: 2911 (Part-1/Sec-2): 2010. The axial capacity of a pile depends upon the soil skin friction along the shaft and end bearing at it's tip.

Thus Axial load = Skin Friction + End-bearing

The following expression is used to determine the capacity of single pile in Compression :

i) **Piles in cohesion less soil,**

$$Q_u = A_p(0.5D_f N_f + P_D N_q) + \sum K P_{Di} \tan \delta A_{si}$$

ii) **Piles in cohesive soil,**

$$Q_u = A_p N_c C_p + \alpha C A_s$$

Here,

A_p = Cross-sectional area of pile tip in m^2

N_c = Bearing capacity factor = 9

N_q = Bearing Capacity factor

N_f = Bearing capacity factor depending upon internal friction angle

C_p = Average cohesion at pile tip in t/m^2

K_i = Coefficient of earth pressure in i th layer

P_{Di} = Effective overburden pressure for i th layer



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ρ_D = Effective overburden pressure at the pile tip

$\bar{\delta}_i$ = Angle of wall friction between pile and soil for ith layer

A_{si} = Surface area of pile shaft in the ith layer in m²

α_i = Adhesion factor for the ith layer depending on the consistency of soil

D = Diameter of the pile shaft

For Accurate Analysis the full length of pile which is responsible for developing skin friction is divided into several segments based on type and nature of soil stratum encountered. For fine grained strata total stress analysis and for coarse grained strata effective stress analysis is used. A factor of safety 2.5 is used to obtain safe load carrying capacity over ultimate load carrying capacity of piles.

C) **For computation of safe load carrying capacity of pile in lateral, the following equation has been used:**

Fixed Head Condition

$$Q = (12 * E * I * Y) / (L1 + Lf)^3$$

Where,

Q = Lateral Load (in kg)

Y = Permissible lateral deflection taken as 5mm

E = Modulus of Elasticity of concrete

I = Moment of Inertia of the pile cross-section

L1 = Length of pile above cut-off level

Lf = Length of fixity

The sample calculation for computation of safe load carrying capacity of normal bored cast-in situ RCC pile in compression & uplift are attached vide Annexure-V

The sample calculation for computation of safe load carrying capacity of normal bored cast-in-situ RCC pile in lateral are attached vide Annexure-VI

9. FOUNDATION RECOMMENDATIONS

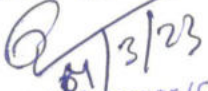
9.01 FOUNDATION RECOMMENDATIONS

* Based on the nature & strength characteristics of the substrata and requirement of the project, shallow foundation have been analysed at the location of boreholes.

*Based on the method of analysis & design parameters given under Para 3.02, table 4, the recommended net allowable bearing capacity values have been tabulated below vide table no. 5:



Table 6: Recommended Net Allowable Bearing Capacity for Shallow Foundation For the purpose of design based on weakest subsoil profile

BH	structure description and relevant boreholes	Depth of foundation below EGL (m)	Foundation size (m)	Net safe bearing capacity from shear criteria (kN/m ²)	Allowable Bearing pressure from settlement failure (KN/m ²)	Recommended Allowable Bearing capacity (Kn/m ²)
 Team Leader PT Feedback Infra Indonesia  Deputy General Manager (C) EGCL, Bijulee Bhawan, Katanbazar, Guwahati-1	220/132 KV GIS	1.50	1.50x1.50	117.20	338.60	117.20
			1.80x1.80	114.30	266.80	114.30
			2.00x2.00	112.30	232.90	112.30
		2.00	1.50x1.50	127.90	328.00	127.90
			1.80x1.80	122.90	260.10	122.90
			2.00x2.00	120.90	227.20	120.90
		2.50	1.50x1.50	139.50	318.20	139.50
			1.80x1.80	134.20	252.50	134.20
			2.00x2.00	131.10	221.10	131.10
		3.00	1.50x1.50	152.60	308.60	152.60
			1.80x1.80	144.90	246.20	144.90
			2.00x2.00	141.70	215.70	141.70
		3.50	1.50x1.50	166.20	282.70	166.20
			1.80x1.80	157.20	239.80	157.20
			2.00x2.00	152.70	210.70	152.70

Note: SBC calculated weakest soil profile among the 12 Boreholes

*Based on the method of analysis given under Para 8.02 table 4, The values of Safe Load Carrying Capacity of pile in soil in compression, uplift and lateral under static conditions have been tabulated below:-

Table 7: Safe Load Carrying Capacity of normal bored cast in-situ RCC Pile in Soil

Dia of pile (mm)	Pile cut off Length (m)	Pile length below NGL (m)	Safe compression capacity (KN)	Safe uplift capacity (KN)	Safe Horizontal capacity (KN) (Fixed head)
450	1.00	9	376.32	195.68	47.00
	1.00	10	418.63	217.69	
500	1.00	9	449.81	233.90	62.06
	1.00	10	500.00	260.00	

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7. OBSERVED AND CORRECTED N VALUE :

Observed and Corrected N value details are shown in the table given below -

TABLE NO 3 : OBSERVED AND CORRECTED N VALUE

BH No	DEPTH (m)	OBSERVED N VALUE	CORRECTED N VALUE
1	1.50	17	17
	3.00	28	28
	4.50	20	20
	6.00	13	13
	7.50	19	19
	9.00	22	19
	10.50	24	20
	12.00	26	20
	13.50	28	21
	15.00	30	21
2	1.50	14	14
	3.00	9	9
	4.50	13	16
	6.00	17	18
	7.50	19	18
	9.00	22	19
	10.50	24	20
	12.00	27	21
	13.50	44	28
	15.00	30	21



TABLE NO 2 : OBSERVED AND CORRECTED N VALUE

BH No	DEPTH (m)	OBSERVED N VALUE	CORRECTED N VALUE
3	1.50	24	24
	3.00	21	23
	4.50	23	22
	6.00	25	23
	7.50	27	23
	9.00	30	24
	10.50	32	24
	12.00	34	24
	13.50	31	22
	15.00	34	23
4	1.50	23	23
	3.00	16	16
	4.50	20	20
	6.00	22	21
	7.50	24	21
	9.00	26	21
	10.50	28	22
	12.00	30	22
	13.50	32	23
	15.00	34	23



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TABLE NO 2 : OBSERVED AND CORRECTED N VALUE

BH No	DEPTH (m)	OBSERVED N VALUE	CORRECTED N VALUE
5	1.50	14	14
	3.00	16	16
	4.50	23	23
	6.00	22	22
	7.50	24	24
	9.00	26	21
	10.50	29	22
	12.00	32	23
	13.50	34	24
	15.00	37	24
6	1.50	23	23
	3.00	44	44
	4.50	51	51
	6.00	44	44
	7.50	52	37
	9.00	61	41
	10.50	63	40
	12.00	65	40
	13.50	67	40
	15.00	69	39



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TABLE NO 2 : OBSERVED AND CORRECTED N VALUE

BH No	DEPTH (m)	OBSERVED N VALUE	CORRECTED N VALUE
7	1.50	17	17
	3.00	63	54
	4.50	65	51
	6.00	67	49
	7.50	69	47
	9.00	71	46
	10.50	73	46
	12.00	75	45
	13.50	77	45
	15.00	79	44
8	1.50	20	20
	3.00	41	41
	4.50	31	31
	6.00	49	38
	7.50	51	37
	9.00	52	36
	10.50	54	36
	12.00	56	35
	13.50	16	15
	15.00	46	29



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TABLE NO 2 : OBSERVED AND CORRECTED N VALUE

BH No	DEPTH (m)	OBSERVED N VALUE	CORRECTED N VALUE
9	1.50	12	12
	3.00	27	27
	4.50	62	49
	6.00	64	47
	7.50	65	45
	9.00	68	45
	10.50	70	44
	12.00	72	44
	13.50	74	43
	15.00	76	43
10	1.50	21	21
	3.00	16	16
	4.50	40	40
	6.00	16	16
	7.50	35	35
	9.00	37	28
	10.50	39	28
	12.00	41	28
	13.50	43	28
	15.00	45	28



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TABLE NO 2 : OBSERVED AND CORRECTED N VALUE

BH No	DEPTH (m)	OBSERVED N VALUE	CORRECTED N VALUE
11	1.50	17	17
	3.00	32	32
	4.50	16	16
	6.00	18	18
	7.50	12	12
	9.00	25	21
	10.50	28	22
	12.00	30	22
	13.50	32	23
	15.00	36	24
12	1.50	13	13
	3.00	17	17
	4.50	24	23
	6.00	26	23
	7.50	29	24
	9.00	32	25
	10.50	34	25
	12.00	37	26
	13.50	40	27
	15.00	44	28



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Table-8 SOIL CHARACTERISTICS

BH No.	Sample type	Depth (m)	Observed SPT N value	Corrected SPT N value	Soil description	IS symbol	Grain size distribution %				Atterberg limit %			Index properties				Consolidation parameter		Shear strength parameter			
							Clay (%) < 0.002 mm	Silt (%) 0.002 - 0.075 mm	sand (%) 0.075 - 4.75 mm	Gravel (%) > 4.75 mm	Liquid Limit	Plastic Limit	Plasticity Index	Bulk density Kn/m3	Natural moisture content %	Dry density (Kn/m3	Specific gravity	Void ratio	Compression index Cc	Type of test	Cu (Kn/m2)	Ø (%)	Free swell index (%)
1	SPT-1	1.50	17	17	Silty clay	CI	68.00	29.60	2.40	0.00	42.6	29.6	13	19.28	33.23	14.47	2.69	0.894	0.29	UCS	-	-	-
	UDS-1	2.00	-	-		CI	67.10	29.20	3.70	0.00	43.2	26	17.2	19.3	31	14.73	2.69	0.834	0.3		65.0	0	-
	SPT-2	3.00	28	28		CI	67.60	29.50	2.90	0.00	42.1	28.6	13.5	19.38	27.22	15.23	2.69	0.732	0.29		-	-	-
	SPT-4	4.50	20	20		CI	66.90	26.00	7.10	0.00	41.6	27.3	14.3	19.49	26.22	15.44	2.72	0.713	0.28		-	-	-
	UDS-2	5.00	-	-		CI	66.50	25.00	8.50	0.00	41.2	27	14.2	19.5	36.28	14.31	2.73	0.99	0.28		97.00	0	-
	SPT-5	6.00	13	13		CI	65.80	25.00	9.20	0.00	40.8	26	14.8	19.66	36.28	14.43	2.73	0.99	0.28		-	-	-
	SPT-6	7.50	19	19	Silty sand	CI	64.30	24.60	11.10	0.00	39.9	25.8	14.1	19.75	22.17	16.17	2.7	0.599	0.27	DST	-	-	-
	SPT-7	9.00	22	19		SP	0.00	4.80	95.20	0.00	-	NP	-	18.25	23.29	14.8	2.65	0.617	-		0	32.99	-
	SPT-8	10.50	24	20		SP	0.00	4.30	95.70	0.00	-	NP	-	18.31	13.45	16.14	2.65	0.356	-		0	32.96	-
	SPT-9	12.00	26	20		SP	0.00	4.10	95.90	0.00	-	NP	-	18.39	18.61	15.5	2.65	0.493	-		0	32.81	-
	SPT-10	13.50	28	21		SP	0.00	3.60	96.40	0.00	-	NP	-	18.46	13.64	16.24	2.65	0.361	-		0	33.10	-
SPT-11	15.00	30	21	SP	0.00	2.10	97.90	0.00	-	NP	-	18.65	18.83	15.69	2.65	0.499	-	0	33.07	-			



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Table:8 SOIL CHARACTERISTICS

BH No.	Sample type	Depth (m)	Below EGSL	Observed SPT N value	Corrected SPT N value	Soil description	IS symbol	Grain size distribution %				Atterberg limit %			Index properties					Consolidation parameter		Shear strength parameter		
								Clay (%) < 0.002 mm	Silt (%) 0.002 - 0.075 mm	sand (%) 0.075 - 4.75 mm	Gravel (%) > 4.75 mm	Liquid Limit	Plastic Limit	Plasticity index	Bulk density Kn/m3	Natural moisture content %	Dry density (Kn/m3	Specific gravity	Void ratio	Compression index Cc	Type of test	Cu (Kn/m2)	Ø (°)	Free swell index (%)
2	SPT-1	1.50	14	14	Silty clay	CI	67.00	28.60	4.40	0.00	45	29.8	15.2	19.33	30.7	14.79	2.7	0.829	0.32	UCS	-	-	-	
	UDS-1	2.00	-	-			CI	66.90	27.00	6.10	0.00	44.9	29.7	15.2	19.38	31	14.79	2.7	0.837		0.31	51.00	0	-
	SPT-2	3.00	9	9			CI	67.00	27.30	5.70	0.00	44.3	29.1	15.2	19.65	35.2	14.53	2.7	0.95		0.31	-	-	-
	SPT-4	4.50	13	16	Silty sand	SC	0.00	18.00	82.00	0.00	33	24	9	18.67	17.89	15.84	2.72	0.487	-	DST	0	32.32	-	
	SPT-5	6.00	17	18			0.00	16.60	83.40	0.00	32.8	23.6	9.2	18.69	20.63	15.49	2.73	0.563	-		0	32.62	-	
	SPT-6	7.50	19	18			0.00	15.30	84.70	0.00	32.6	23.5	9.1	18.72	18.21	15.84	2.7	0.492	-		0	32.71	-	
	SPT-7	9.00	22	19			0.00	13.00	87.00	0.00	31.9	22.9	9	18.77	24	15.14	2.65	0.636	-		0	33.71	-	
	SPT-8	10.50	24	20			0.00	4.90	95.10	0.00	-	NP	-	18.88	22.18	15.45	2.65	0.588	-		0	33.07	-	
	SPT-9	12.00	27	21			0.00	4.30	95.70	0.00	-	NP	-	18.88	7.72	17.53	2.65	0.205	-		0	33.36	-	
	SPT-10	13.50	44	28			0.00	2.90	97.10	0.00	-	NP	-	18.91	17.15	16.14	2.65	0.454	-		0	35.04	-	
	SPT-11	15.00	30	21			0.00	1.60	98.40	0.00	-	NP	-	18.93	19.94	15.78	2.65	0.528	-		0	33.40	-	



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Table:8 SOIL CHARACTERISTICS

BH No.	Sample type	Depth (m)	Below EGSL	Observed SPT N value	Corrected SPT N value	Soil description	IS symbol	Grain size distribution %				Atterberg limit %			Index properties				Consolidation parameter		Shear strength parameter			
								Clay (%) < 0.002 mm	Silt (%) 0.002 - 0.075 mm	sand (%) 0.075 - 4.75 mm	Gravel (%) > 4.75 mm	Liquid Limit	Plastic Limit	Plasticity Index	Bulk density Kn/m3	Natural moisture content %	Dry density (Kn/m3	Specific gravity	Void ratio	Compression index Cc	Type of test	Cu (Kn/m2)	Ø (°)	Free swell index (%)
3	SPT-1	1.50		24	24	Silty clay	CI	65.00	28.60	6.40	0.00	42.6	28.6	14	19.1	23.02	15.53	2.7	0.622	0.29	UCS	-	-	-
	SPT-2	3.00		21	23			SC	0.00	18.10	81.90	0.00	34.5	24	10.5	18.69	20.96	15.45	2.7	0.566	-	0	33.66	-
	SPT-4	4.50		23	22	Silty sand	SC	0.00	16.60	83.40	0.00	33.6	24	9.6	18.61	22.35	15.21	2.72	0.608	-	0	33.14	-	
	SPT-5	6.00		25	23			0.00	15.40	84.60	0.00	32.8	23.6	9.2	18.68	18.91	15.71	2.73	0.516	-	0	33.07	-	
	SPT-6	7.50		27	23			0.00	14.00	86.00	0.00	32.1	23.1	9	18.29	14.74	15.94	2.7	0.398	-	0	33.74	-	
	SPT-7	9.00		30	24			0.00	12.80	87.20	0.00	32.1	22	10.1	18.67	11.53	16.74	2.65	0.306	-	0	34.07	-	
	SPT-8	10.50		32	24	SP	0.00	4.60	95.40	0.00	-	NP	-	18.2	12.81	16.13	2.65	0.339	-	0	34.18	-		
	SPT-9	12.00		34	24	SP	0.00	4.20	95.80	0.00	-	NP	-	18.26	6.33	17.17	2.65	0.168	-	0	34.21	-		
	SPT-10	13.50		31	22	SP	0.00	3.30	96.70	0.00	-	NP	-	18.35	21	15.17	2.65	0.557	-	0	34.03	-		
	SPT-11	15.00		34	23	SP	0.00	1.90	98.10	0.00	-	NP	-	18.39	20.44	15.27	2.65	0.542	-	0	34.00	-		



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Table:8 SOIL CHARACTERISTICS

BH No.	Sample type	Depth (m)	Below EGSL	Observed SPT N value	Corrected SPT N value	Soil description	IS symbol	Grain size distribution %				Atterberg limit %			Index properties				Consolidation parameter		Shear strength parameter			
								Clay (%) < 0.002 mm	Silt (%) 0.002 - 0.075 mm	sand (%) 0.075 - 4.75 mm	Gravel (%) > 4.75 mm	Liquid Limit	Plastic Limit	Plasticity Index	Bulk density Kn/m3	Natural moisture content %	Dry density (Kn/m3	Specific gravity	Void ratio	Compression index Cc	Type of test	Cu (Kn/m2)	Ø (°)	Free swell index (%)
4	SPT-1	1.50		23	23	Silty clay	CI	67.80	28.00	4.20	0.00	43.1	29.6	13.5	19.6	30.79	14.99	2.7	0.831	0.3	-	-	-	
	UDS-1	2.00	-	-			CI	66.90	27.30	5.80	0.00	43	29.2	13.8	19.62	30	15.09	2.7	0.81	0.3	80	0.00	-	
	SPT-2	3.00	16	16			CI	66.30	26.00	7.70	0.00	42.6	29.1	13.5	19.67	31.45	14.96	2.7	0.849	0.29	-	-	-	
	SPT-4	4.50		20	20	Silty sand	SC	0.00	15.60	84.40	0.00	33.8	24	9.8	18.1	17.34	15.43	2.72	0.472	-	0	33.56	-	
	SPT-5	6.00		22	21		SC	0.00	15.10	84.90	0.00	33.1	24	9.1	18.55	15.83	16.01	2.73	0.432	-	0	33.16	-	
	SPT-6	7.50		24	21		SC	0.00	15.00	85.00	0.00	32.00	23.6	8.4	18.81	17.59	16	2.7	0.475	-	0	33.07	-	
	SPT-7	9.00		26	21		SC	0.00	14.60	85.40	0.00	32.00	22.6	9.4	18.91	23.04	15.37	2.65	0.611	-	0	33.74	-	
	SPT-8	10.50		28	22		SC	0.00	12.10	87.90	0.00	32.00	22.1	-	-	18.93	25.84	15.04	2.65	0.685	-	0	33.64	-
	SPT-9	12.00		30	22		SP	0.00	3.10	96.90	0.00	-	NP	-	18.95	7.28	17.66	2.65	0.193	-	0	34.07	-	
	SPT-10	13.50		32	23		SP	0.00	2.80	97.20	0.00	-	NP	-	-	18.97	9.73	17.29	2.65	0.258	-	0	34.17	-
	SPT-11	15.00		34	23		SP	0.00	2.60	97.40	0.00	-	NP	-	-	18.97	12.8	16.82	2.65	0.339	-	0	34.35	-



Table:8 SOIL CHARACTERISTICS

BH No.	Sample type	Depth (m)	Below EGSL	Observed SPT N value	Corrected SPT N value	Soil description	IS symbol	Grain size distribution %				Atterberg limit %			Index properties						Consolidation n parameter		Shear strength parameter		
								Clay (%) < 0.002 mm	Silt (%) 0.002 - 0.075 mm	sand (%) 0.075 - 4.75 mm	Gravel (%) > 4.75 mm	Liquid Limit	Plastic Limit	Plasticity index	Bulk density Kn/m ³	Natural moiture content %	Dry density (Kn/m ³)	Specific gravity	Void ratio	Compressio n index Cc	Type of test	Cu (Kn/m ²)	Ø (°)	Free swell index (%)	
5	SPT-1	1.50		14	14	Silty clay	CI	66.00	28.00	6.00	0.00	43	28.1	14.9	19.1	22.09	15.64	2.7	0.596	0.3	UCS	-	-	-	
	SPT-2	3.00		16	16		CI	65.40	25.00	9.60	0.00	42.1	27.2	14.9	19.27	28.04	15.05	2.7	0.757	0.29		-	-	-	
	UDS-1	4.00	-	-	-		CI	64.90	25.00	10.10	0.00	42	27	15	19.33	27	15.22	2.72	0.734	0.29		55	0	-	
	SPT-4	4.50		23	23		CI	64.90	24.00	11.10	0.00	42.1	26.1	16	19.35	22.11	15.85	2.72	0.601	0.29		-	-	-	
	SPT-5	6.00		22	22		CI	63.80	23.30	12.90	0.00	41.9	25.0	16.9	19.46	24.73	15.6	2.73	0.675	0.29		-	-	-	
	UDS-2	7.00	-	-	-		CI	63.80	23.15	13.05	0.00	40.80	24.6	16.2	19.4	30	14.92	2.7	0.81	0.28		105	0	-	
	SPT-6	7.50		24	24	CI	62.20	22.00	15.80	0.00	41.20	25.0	16.2	19.67	33.53	14.73	2.7	0.905	0.28	-	-	-			
	SPT-7	9.00		26	21	Silty sand	SC	0.00	15.00	85.00	0.00	34.00	23.0	11.00	18.19	41.36	12.87	2.65	1.096	-	0	33.33	-		
	SPT-8	10.50		29	22		SC	0.00	13.00	87.00	0.00	33.90	23.0	10.90	18.68	10.3	16.94	2.65	0.273	-	0	34.18	-		
	SPT-9	12.00		32	23		SP	0.00	4.20	95.80	0.00	-	NP	-	18.33	25.64	14.59	2.65	0.679	-	0	34.57	-		
	SPT-10	13.50		34	24		SP	0.00	4.10	95.90	0.00	-	NP	-	18.61	7.01	17.39	2.65	0.186	-	0	34.44	-		
SPT-11	15.00		37	24	SP		0.00	2.10	97.90	0.00	-	NP	-	18.72	14.28	16.38	2.65	0.378	-	0	34.64	-			



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Table:8 SOIL CHARACTERISTICS

BH No.	Sample type	Depth (m)	Observed SPT N value	Corrected SPT N value	Soil description	IS symbol	Grain size distribution %				Atterberg limit %			Index properties				Consolidation parameter		Shear strength parameter		
							Clay (%) < 0.002 mm	Silt (%) 0.002 - 0.075 mm	sand (%) 0.075 - 4.75 mm	Gravel (%) > 4.75 mm	Liquid Limit	Plastic Limit	Plasticity Index	Bulk density Kn/m3	Natural moisture content %	Dry density (Kn/m3	Specific gravity	Void ratio	Compression index Cc	Type of test	Cu (Kn/m2)	Ø (°)
6	SPT-1	1.50	23	23	Silty clay	CI	62.00	28.10	9.90	0.00	42	28.1	13.9	19.15	22.09	15.69	2.7	0.596	0.29	-	-	-
	SPT-2	3.00	44	44		CI	62.00	26.00	12.00	0.00	42	26.6	15.4	19.25	28.04	15.03	2.7	0.757	0.29	-	-	-
	UDS-1	4.00	-	-		CI	61.80	25.80	12.40	0.00	41.9	26.5	15.4	19.45	29	15.08	2.72	0.789	0.29	150	0	-
	SPT-4	4.50	51	51		CI	61.10	25.40	13.50	0.00	41.9	25.2	16.7	19.36	22.11	15.85	2.72	0.601	0.29	-	-	-
	SPT-5	6.00	44	44		CI	59.00	23.10	17.90	0.00	40.3	25.6	14.7	19.46	24.73	15.6	2.73	0.675	0.27	-	-	-
	SPT-6	7.50	52	37	Silty sand	SC	0.00	15.80	84.20	0.00	34.10	23.6	10.5	18.16	33.53	13.6	2.7	0.905	-	0	37.8	-
	SPT-7	9.00	61	41		SC	0.00	15.20	84.80	0.00	33.60	22.1	11.50	18.29	41.36	12.94	2.65	1.096	-	0	37.4	-
	SPT-8	10.50	63	40		SC	0.00	14.30	85.70	0.00	32.90	22.1	10.80	18.36	10.3	16.65	2.65	0.273	-	0	37.9	-
	SPT-9	12.00	65	40		SP	0.00	4.30	95.70	0.00	-	NP	-	18.81	25.64	14.97	2.65	0.679	-	0	37.2	-
	SPT-10	13.50	67	40		SP	0.00	2.80	97.20	0.00	-	NP	-	18.87	7.01	17.63	2.65	0.186	-	0	37.5	-
	SPT-11	15.00	69	39		SP	0.00	1.20	98.80	0.00	-	NP	-	18.91	14.28	16.55	2.65	0.378	-	0	37.8	-



Table:8 SOIL CHARACTERISTICS

BH No.	Sample type	Depth (m)	Below EGSL	Observed SPT N value	Corrected SPT N value	Soil description	IS symbol	Grain size distribution %				Atterberg limit %			Index properties				Consolidation parameter		Shear strength parameter			
								Clay (%) < 0.002 mm	Silt (%) 0.002 - 0.075 mm	sand (%) 0.075 - 4.75 mm	Gravel (%) > 4.75 mm	Liquid Limit	Plastic Limit	Plasticity Index	Bulk density Kn/m3	Natural moisture content %	Dry density (Kn/m3	Specific gravity	Void ratio	Compression index Cc	Type of test	Cu (Kn/m2)	Ø (%)	Free swell index (%)
7	SPT-1	1.50		17	17	Silty clay	CI	65.00	25.00	10.00	0.00	42	28.6	13.4	19.1	22.45	15.6	2.7	0.606	0.29	UCS	-	-	-
	SPT-2	3.00		63	54	Silty sand	SC	0.00	17.60	82.40	0.00	34.1	23	11.1	19.22	27.03	15.13	2.7	0.73	-	0	40.04	-	
	SPT-4	4.50		65	51		SC	0.00	17.10	82.90	0.00	33.6	23	10.6	19.26	19.7	16.09	2.72	0.536	-	0	40.84	-	
	SPT-5	6.00		67	49		SC	0.00	16.60	83.00	0.40	32.3	22.8	9.5	19.1	13.57	16.82	2.73	0.37	-	0	40.72	-	
	SPT-6	7.50		69	47		SC	0.00	15.40	84.60	0.00	32.10	21.9	10.2	18.93	18.79	15.94	2.7	0.507	-	0	40.81	-	
	SPT-7	9.00		71	46		SC	0.00	15.10	84.90	0.00	32.00	21.2	10.80	18.29	19.11	15.36	2.65	0.506	-	DST	0	40.82	-
	SPT-8	10.50		73	46		SC	0.00	14.30	85.70	0.00	31.90	20.6	11.30	18.16	22.82	14.79	2.65	0.605	-	0	40.82	-	
	SPT-9	12.00		75	45		SP	0.00	2.60	97.40	0.00	-	NP	-	18.33	27.6	14.37	2.65	0.731	-	0	40.88	-	
	SPT-10	13.50		77	45		SP	0.00	2.20	97.80	0.00	-	NP	-	18.1	13.55	15.94	2.65	0.359	-	0	41.38	-	
	SPT-11	15.00		79	44	SP	0.00	1.60	94.40	4.00	-	NP	-	18.26	24.38	14.68	2.65	0.646	-	0	41.12	-		



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Table:8 SOIL CHARACTERISTICS

BH No.	Sample type	Depth (m)	Observed SPT N value	Corrected SPT N value	Soil description	IS symbol	Grain size distribution %				Atterberg limit %			Index properties				Consolidation parameter		Shear strength parameter			
							Clay (%) < 0.002 mm	Silt (%) 0.002 - 0.075 mm	sand (%) 0.075 - 4.75 mm	Gravel (%) > 4.75 mm	Liquid Limit	Plastic Limit	Plasticity index	Bulk density Knm/3	Natural moiture content %	Dry density (Knm/3	Specific gravity	Void ratio	Compressio n index Cc	Type of test	Cu (Kn/m2)	Ø (°)	Free swell index (%)
9	SPT-1	1.50	12	12	Silty clay	Cl	66.10	28.10	5.80	0.00	43	28.1	14.9	19.22	32	14.56	2.7	0.864	0.3	UCS	-	-	-
	UDS-1	2.00	-	-		Cl	65.90	26.00	8.10	0.00	42.9	27.6	15.3	19.36	31.45	14.73	2.7	0.849	0.3		91	0	-
	SPT-2	3.00	27	27		Cl	65.80	27.60	6.60	0.00	42.1	27.6	14.5	19.35	31.6	14.7	2.7	0.853	0.29		-	-	-
	SPT-4	4.50	62	49	Silty sand	SC	0.00	18.10	81.90	0.00	34	24	10	18.56	28	14.5	2.72	0.762	-	DST	0	39.2	-
	SPT-5	6.00	64	47		SC	0.00	16.60	83.40	0.00	33.3	23.3	10	18.18	27.3	14.28	2.73	0.745	-		0	39.2	-
	SPT-6	7.50	65	45		SC	0.00	15.50	84.50	0.00	32.60	22.8	9.8	18.31	26.6	14.46	2.7	0.718	-		0	39.8	-
	SPT-7	9.00	68	45		SC	0.00	14.30	85.70	0.00	32.10	22.1	10.00	18.26	25.4	14.56	2.65	0.673	-		0	39.96	-
	SPT-8	10.50	70	44		SC	0.00	13.10	86.90	0.00	32.00	21.3	10.70	18.61	23.6	15.06	2.65	0.625	-		0	39.7	-
	SPT-9	12.00	72	44		SP	0.00	3.00	97.00	0.00	-	NP	-	18.62	22.9	15.15	2.65	0.607	-		0	40.9	-
	SPT-10	13.50	74	43		SP	0.00	3.00	97.00	0.00	-	NP	-	18.22	21.6	14.98	2.65	0.572	-		0	41.1	-
	SPT-11	15.00	76	43		SP	0.00	2.11	97.89	0.00	-	NP	-	18.3	20.3	15.21	2.65	0.538	-		0	41.2	-



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Table:8 SOIL CHARACTERISTICS

BH No.	Sample type	Depth (m) Below EGSL	Observed SPT N value	Corrected SPT N value	Soil description	IS symbol	Grain size distribution %				Atterberg limit %			Index properties						Consolidation n parameter		Shear strength parameter		
							Clay (%) < 0.002 mm	Silt (%) 0.002 - 0.075 mm	sand (%) 0.075 - 4.75 mm	Gravel (%) > 4.75 mm	Liquid Limit	Plastic Limit	Plasticity index	Bulk density Kn/m3	Natural moiture content %	Dry density (Kn/m3)	Specific gravity	Void ratio	Compressio n index Cc	Type of test	Cu (Kn/m2)	Ø (°)	Free swell index (%)	
10	SPT-1	1.50	21	21	Silty clay	CI	64.10	25.00	10.90	0.00	43	29	14	19.1	27.21	15.01	2.42	0.658	0.3	UCS	-	-	-	
	SPT-2	3.00	16	16		CI	63.60	24.10	12.30	0.00	42.5	29	13.5	19.22	14.96	16.72	2.7	0.404	0.29		-	-	-	
	UDS-1	4.00	-	-		CI	62.80	24.00	13.20	0.00	42.45	28.6	13.85	19.49	28.65	15.15	2.72	0.779	0.29		88	0	-	
	SPT-4	4.50	40	40		CI	62.10	23.00	14.90	0.00	42.1	28.4	13.7	19.36	29.07	15	2.72	0.791	0.29		-	-	-	
	UDS-2	5.00	-	-		CI	62.00	22.90	15.10	0.00	40.3	28.2	12.1	19.42	15.47	16.82	2.73	0.422	0.27		91.5	0	-	
	SPT-5	6.00	16	16		CI	62.00	22.10	15.90	0.00	40.3	28.2	12.1	19.42	15.47	16.82	2.73	0.422	0.27		-	-	-	
	SPT-6	7.50	35	35	CI	59.00	21.90	19.10	0.00	40.10	28.0	12.1	19.51	22.83	15.88	2.7	0.616	0.27	-	-	-			
	SPT-7	9.00	37	28	Silty sand	SP	0.00	4.10	95.90	0.00	-	NP	-	18.22	20.22	15.16	2.65	0.536	-	0	34.3	-		
	SPT-8	10.50	39	28		SP	0.00	3.60	96.40	0.00	-	NP	-	18.26	33.25	13.7	2.65	0.881	-	0	34.9	-		
	SPT-9	12.00	41	28		SP	0.00	3.20	96.80	0.00	-	NP	-	18.3	24.53	14.7	2.65	0.65	-	0	34.3	-		
	SPT-10	13.50	43	28		SP	0.00	2.00	98.00	0.00	-	NP	-	18.33	29.98	14.1	2.65	0.794	-	0	35.4	-		
SPT-11	15.00	45	28	SP		0.00	1.30	98.70	0.00	-	NP	-	18.39	20.99	15.2	2.65	0.556	-	0	35.1	-			



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Table:8 SOIL CHARACTERISTICS

BH No.	Sample type	Depth (m)	Below EGSL	Observed SPT N value	Corrected SPT N value	Soil description	IS symbol	Grain size distribution %				Atterberg limit %			Index properties						Consolidation parameter		Shear strength parameter		
								Clay (%) < 0.002 mm	Silt (%) 0.002 - 0.075 mm	sand (%) 0.075 - 4.75 mm	Gravel (%) > 4.75 mm	Liquid Limit	Plastic Limit	Plasticity index	Bulk density Kn/m3	Natural moisture content %	Dry density (Kn/m3)	Specific gravity	Void ratio	Compression index Cc	Type of test	Cu (Kn/m2)	Ø (°)	Free swell index (%)	
11	SPT-1	1.50		17	17	Silty clay	CI	66.10	29.10	4.80	0.00	42.8	29	13.8	19.66	31.14	14.99	2.42	0.754	0.16	UCS	-	-	-	
	SPT-2	3.00		32	32		CI	65.30	28.60	6.10	0.00	42.1	28.1	14	19.67	24.16	15.84	2.7	0.652	0.16		-	-	-	
	UDS-1	4.00		-	-		CI	64.30	28.40	7.30	0.00	42	27.9	14.1	19.69	23	16.01	2.7	0.621	0.16		88	0	-	
	SPT-4	4.50		16	16		CI	64.10	27.30	8.60	0.00	42	28	14	19.35	42.77	13.55	2.72	1.163	0.16		-	-	-	
	SPT-5	6.00		18	18		CI	62.00	26.60	11.40	0.00	41.9	27.0	14.9	19.33	24.53	15.52	2.73	0.67	0.16		-	-	-	
	SPT-6	7.50		12	12	Silty sand	SP	0.00	4.80	95.20	0.00	-	NP	-	18.1	41.19	12.82	2.7	1.112	-	DST	0	30.2	-	
	SPT-7	9.00		25	21		SP	0.00	4.10	95.90	0.00	-	NP	-	18.22	24.24	14.67	2.65	0.642	-		0	33.6	-	
	SPT-8	10.50		28	22		SP	0.00	4.10	95.90	0.00	-	NP	-	18.65	24.09	15.03	2.65	0.638	-		0	34.8	-	
	SPT-9	12.00		30	22		SP	0.00	2.60	97.40	0.00	-	NP	-	18.38	25.29	14.67	2.65	0.67	-		0	34.4	-	
	SPT-10	13.50		32	23		SP	0.00	1.80	98.20	0.00	-	NP	-	18.74	24.31	15.08	2.65	0.644	-		0	35.1	-	
	SPT-11	15.00		36	24		SP	0.00	1.22	98.78	0.00	-	NP	-	18.65	22.5	15.22	2.65	0.596	-		0	35.4	-	



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BH No.	Sample type	Depth (m) Below EGSL	Observed SPT N value	Corrected SPT N value	Soil description	IS symbol	Grain size distribution %				Atterberg limit %			Index properties					Consolidation n parameter		Shear strength parameter			
							Clay (%) < 0.002 mm	Silt (%) 0.002 - 0.075 mm	sand (%) 0.075 - 4.75 mm	Gravel (%) > 4.75 mm	Liquid Limit	Plastic Limit	Plasticity index	Bulk density Kn/m3	Natural moiture content %	Dry density (Kn/m3)	Specific gravity	Void ratio	Compressio n index Cc	Type of test	Cu (Kn/m2)	Ø (°)	Free swell index (%)	
12	SPT-1	1.50	13	13	Silty clay	CI	65.00	28.00	7.00	0.00	42	28.6	13.4	19.1	36.35	14.01	2.42	0.88	0.16	UCS	-	-	-	
	UDS-1	2.00	-	-		CI	64.90	27.20	7.90	0.00	41.6	27.3	14.3	19.26	33	14.48	2.7	0.891	0.16		75	0	-	
	SPT-2	3.00	17	17		CI	65.00	27.10	7.90	0.00	41.9	28.1	13.8	19.15	35.26	14.16	2.7	0.952	0.16		-	-	-	
	SPT-4	4.50	24	23	Silty sand	SC	0.00	19.00	81.00	0.00	34	24.3	9.7	18.65	25.93	14.81	2.72	0.705	-	DST	0	33.3	-	
	SPT-5	6.00	26	23		SC	0.00	18.60	81.40	0.00	33.6	23.1	10.5	18.67	23.38	15.13	2.73	0.638	-		0	34.6	-	
	SPT-6	7.50	29	24		SC	0.00	17.30	82.70	0.00	32.10	22.8	9.3	18.71	21.15	15.44	2.7	0.571	-		0	34.5	-	
	SPT-7	9.00	32	25		SC	0.00	16.20	83.80	0.00	32.00	21.2	10.8	18.77	15.12	16.3	2.65	0.401	-		0	34.7	-	
	SPT-8	10.50	34	25		SC	0.00	12.20	87.80	0.00	31.80	21.1	10.7	18.81	12.51	16.72	2.65	0.332	-		0	34.8	-	
	SPT-9	12.00	37	26		SP	0.00	4.90	95.10	0.00	-	NP	-	-	18.88	26.08	14.97	2.65	0.691		-	0	35.9	-
	SPT-10	13.50	40	27		SP	0.00	4.20	95.80	0.00	-	NP	-	-	18.92	31.91	14.34	2.65	0.846		-	0	34.9	-
	SPT-11	15.00	44	28		SP	0.00	1.60	98.40	0.00	-	NP	-	-	18.93	24.83	15.16	2.65	0.658		-	0	35	-



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LOAD CARRYING CAPACITY OF PILE (Sample calculation)

Material	RCC
Diameter (m)	0.450
Length (m)	10.00
Cutoff Length (m)	1.00
Embedded Length (m)	9.00

End bearing resistance of pile can be calculated as per table below:

BH No.	Pile Dia (m)	Pile Length (m)	A_p	ϕ	N_v	N_q (from Graph)	N_c	γ	C_p	P_D
2	0.45	9.00	0.1589625	35	—	41	9	19.5	—	98.445
Point resistance= (KN/m ²)		$(0.5D\gamma N_v + PDN_q) + A_p N_c C_p$				= 4036.245				

##

End bearing (KN)= $q_u \times A_p = 641.6115958$



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Frictional resistance along the stem of pile:

Pile Dia (m)	0.450	
Layer (m)	1 - 7.5	7.5 - 10
Length (m)	6.50	2.5
Cumulative Length (m)	6.50	9.00
Asi	9.1845	3.5325
ϕ	0	36
δ	0	27
K	—	1
$\tan\delta$	—	0.509
Pdi (Kn/m ²)	40.235	58.21
$\sum PDi(\text{avg})$		69.34
γ	16	17
α	0.5	—
C	38	0
Skin friction (KN)= $\sum KPDi \tan\delta Asi + \alpha CAs$	174.5055	124.676267
Total skin friction (KN)=	299.18	

Ultimate pile Load capacity (KN)=	940.79
Allowable pile Load capacity (KN)=	376.3173451



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Conclusion:

From the careful study it is concluded that sub-soil horizon is investigated area may be suitable for design and construction. The bearing capacity estimation and settlement calculation of the foundation soil is carried out using standard penetration resistance values and undisturbed soil samples collected from the site. The safe bearing capacity and safe bearing pressure based on shear and settlement behavior of the soil along with the Allowable bearing pressure values are shown in tabular form. It has been seen that the allowable bearing pressure values ranges between ~~117.20~~ ^{152.70} KN/m² to ~~117.20~~ ^{152.70} KN/m² at depths 1.50 m, 2.00 m, 2.50 m, 3.00 m and 3.50 m. A plate load test at the proposed depth of foundation may be carried out for better bearing capacity estimates.

Further for the higher load on foundation bearing pile shall be used. Further safe load capacity of pile is calculated based on field and laboratory test result and shown in tabular form above. The safe load carrying capacity of single pile falls in the range of 376.31 KN to 500.00 KN with ~~400~~ ⁴⁵⁰ to 500 mm diameter pile with length 9.00 m, 10.00 m below cut off level.

An initial load test as per IS: 1888 shall be conducted for authentication of theoretical values. Two nos. minimum random routine load test shall preferably be carried out to ascertain the actual soil-pile behavior under vertical and horizontal loadings.

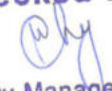
However, the type of foundation and depth, length and diameter of pile may be decided by the design engineer based on various data furnished in the report for safety and economy.

* SBC considered for design shall not be more than 120 KN/m².


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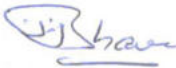



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GMC Market, Chandernagor, Ghy-03

Checked by

Deputy Manager (C)
Design & Project
AEGCL, Kahilipara, Ghy-19

APPROVED

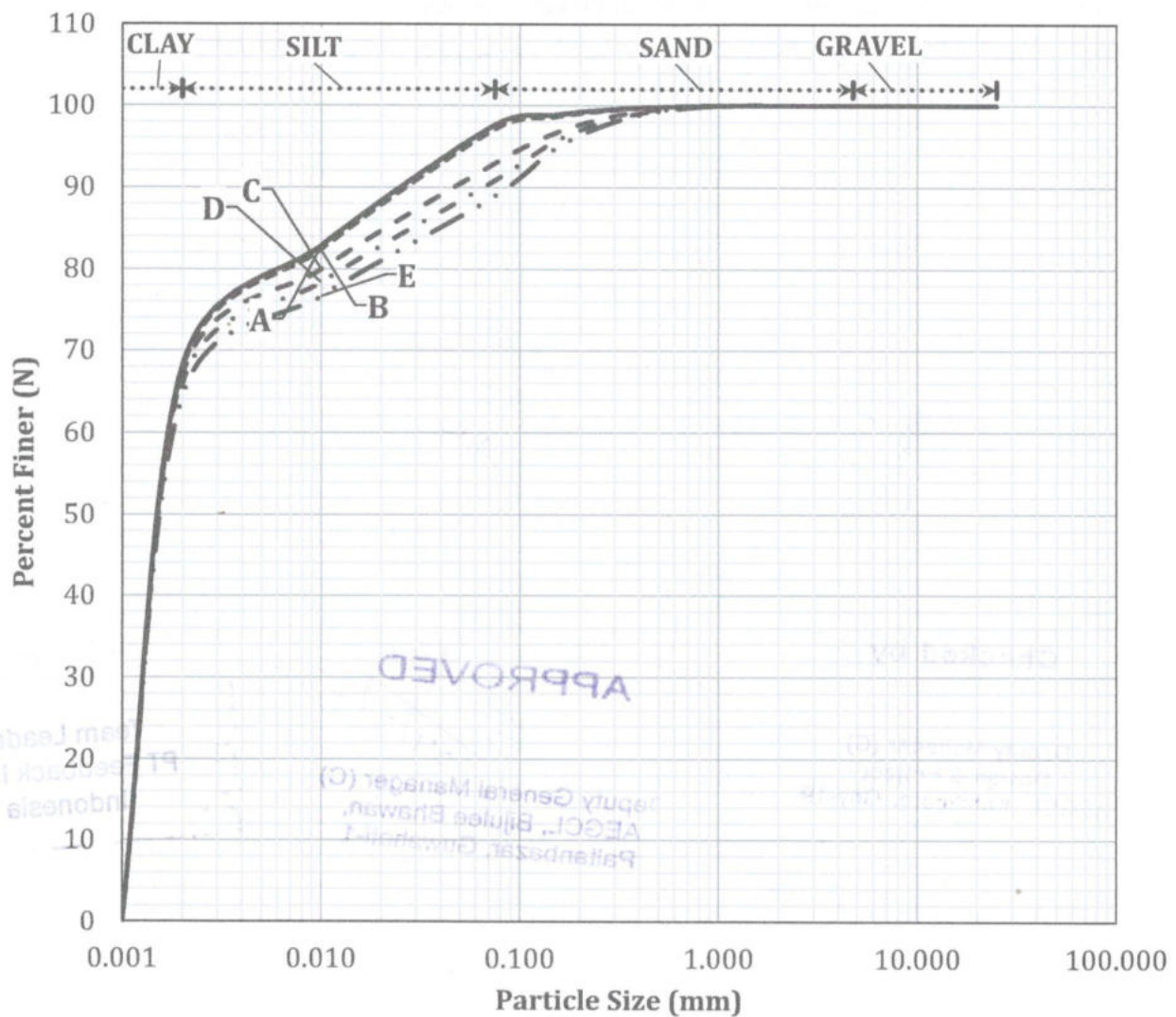
Deputy General Manager (C)
AEGCL, Bijulee Bhawan,
Paltanbazar, Guwahati-1

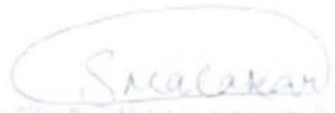

Team Leader
PT Feedback Infra
Indonesia

GRAIN SIZE DISTRIBUTION GRAPH

TABLE 3 : GRAIN SIZE DISTRIBUTION SUMMARY

BH No	DEPTH (m) Below EGSL	INDEX	CLAY (%) < 0.002 mm	SILT (%) 0.002-0.075 mm	SAND (%) 0.075-4.75 mm	GRAVEL (%) > 4.75 mm
1	1.50	A	68.00	29.60	2.40	0.00
	3.00	B	67.60	29.50	2.90	0.00
	4.50	C	66.90	26.00	7.10	0.00
	6.00	D	65.80	25.00	9.20	0.00
	7.50	E	64.30	24.60	11.10	0.00

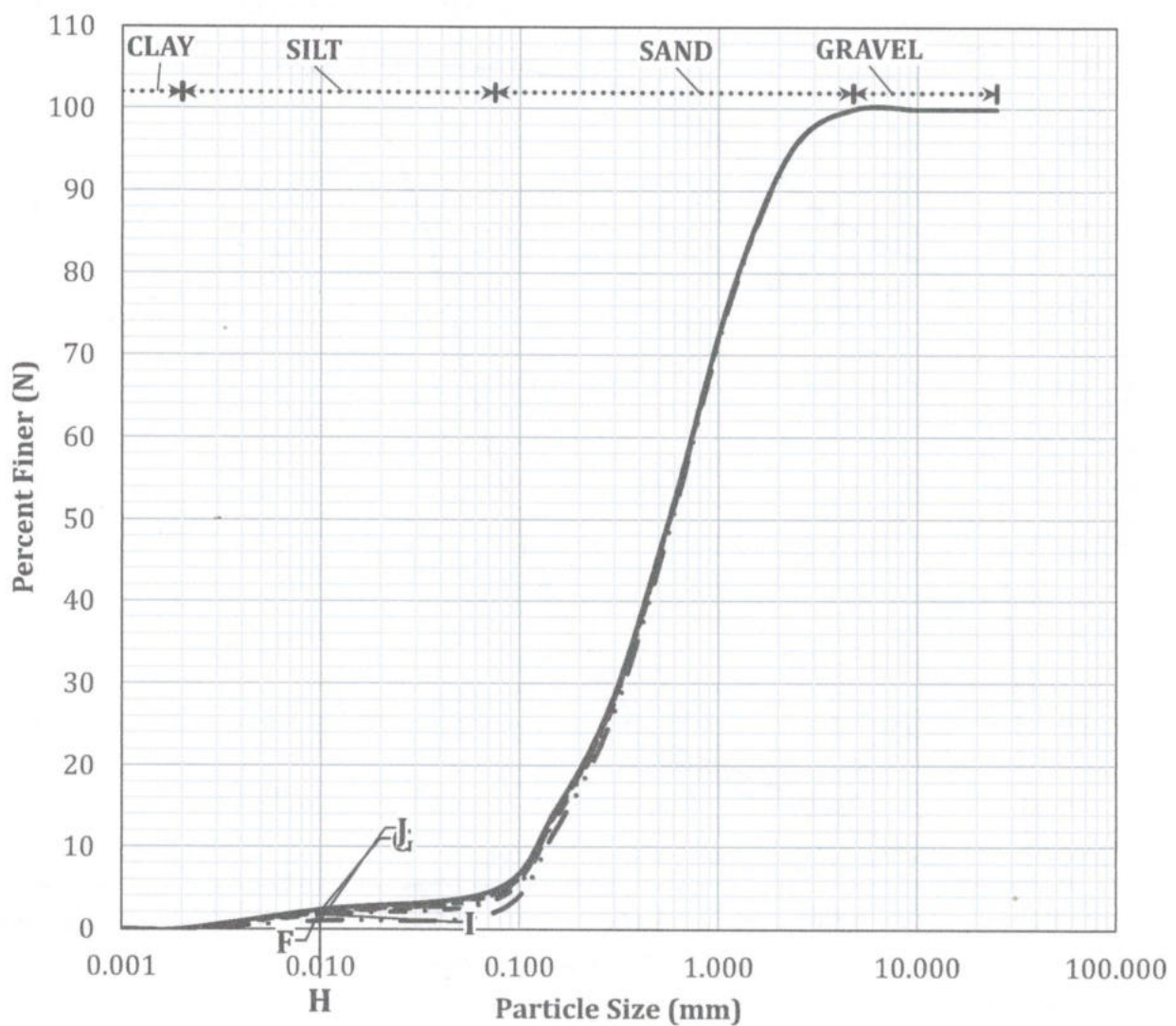



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GRAIN SIZE DISTRIBUTION GRAPH

TABLE 3 : GRAIN SIZE DISTRIBUTION SUMMARY

BH No	DEPTH (m) Below EGSL	INDEX	CLAY (%) < 0.002 mm	SILT (%) 0.002-0.075 mm	SAND (%) 0.075-4.75 mm	GRAVEL (%) > 4.75 mm
1	9.00	F	0.00	4.80	95.20	0.00
	10.50	G	0.00	4.30	95.70	0.00
	12.00	H	0.00	4.10	95.90	0.00
	13.50	I	0.00	3.60	96.40	0.00
	15.00	J	0.00	2.10	97.90	0.00

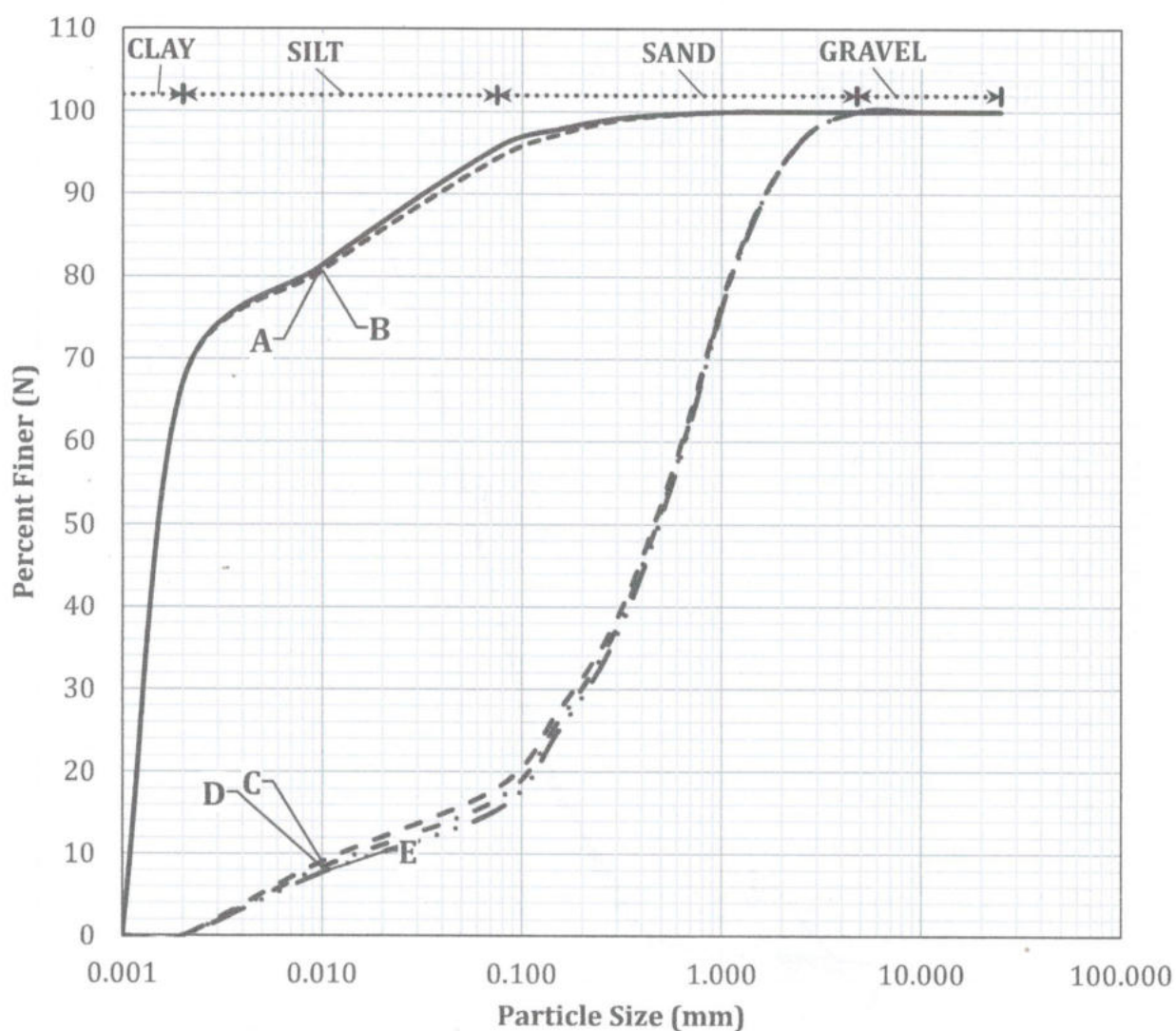


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GRAIN SIZE DISTRIBUTION GRAPH

TABLE 3 : GRAIN SIZE DISTRIBUTION SUMMARY

BH No	DEPTH (m) Below EGSL	INDEX	CLAY (%) < 0.002 mm	SILT (%) 0.002-0.075 mm	SAND (%) 0.075-4.75 mm	GRAVEL (%) > 4.75 mm
2	1.50	A	67.00	28.60	4.40	0.00
	3.00	B	67.00	27.30	5.70	0.00
	4.50	C	0.00	18.00	82.00	0.00
	6.00	D	0.00	16.60	83.40	0.00
	7.50	E	0.00	15.30	84.70	0.00

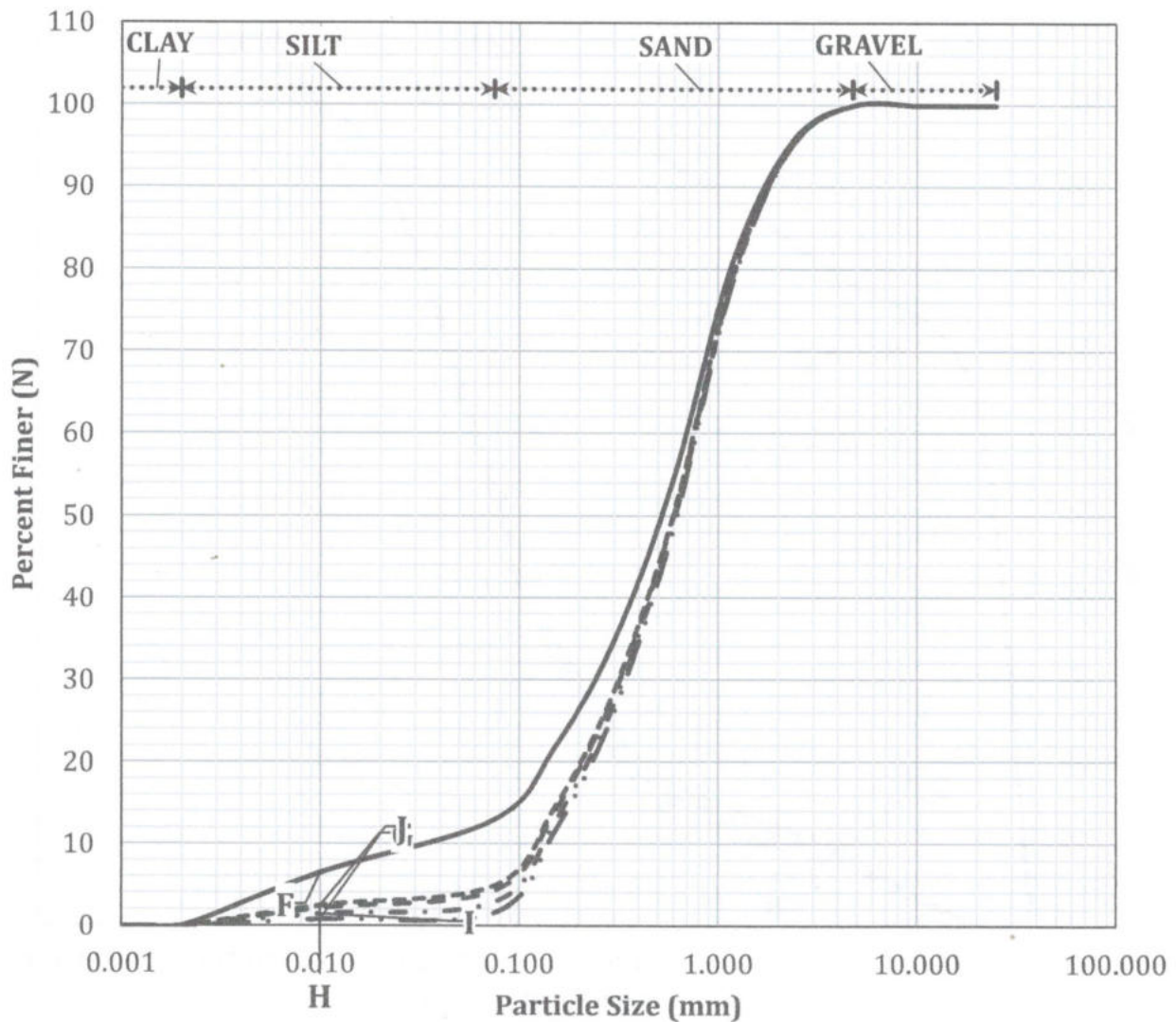


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GRAIN SIZE DISTRIBUTION GRAPH

TABLE 3 : GRAIN SIZE DISTRIBUTION SUMMARY

BH No	DEPTH (m) Below EGSL	INDEX	CLAY (%) < 0.002 mm	SILT (%) 0.002-0.075 mm	SAND (%) 0.075-4.75 mm	GRAVEL (%) > 4.75 mm
2	9.00	F	0.00	13.00	87.00	0.00
	10.50	G	0.00	4.90	95.10	0.00
	12.00	H	0.00	4.30	95.70	0.00
	13.50	I	0.00	2.90	97.10	0.00
	15.00	J	0.00	1.60	98.40	0.00

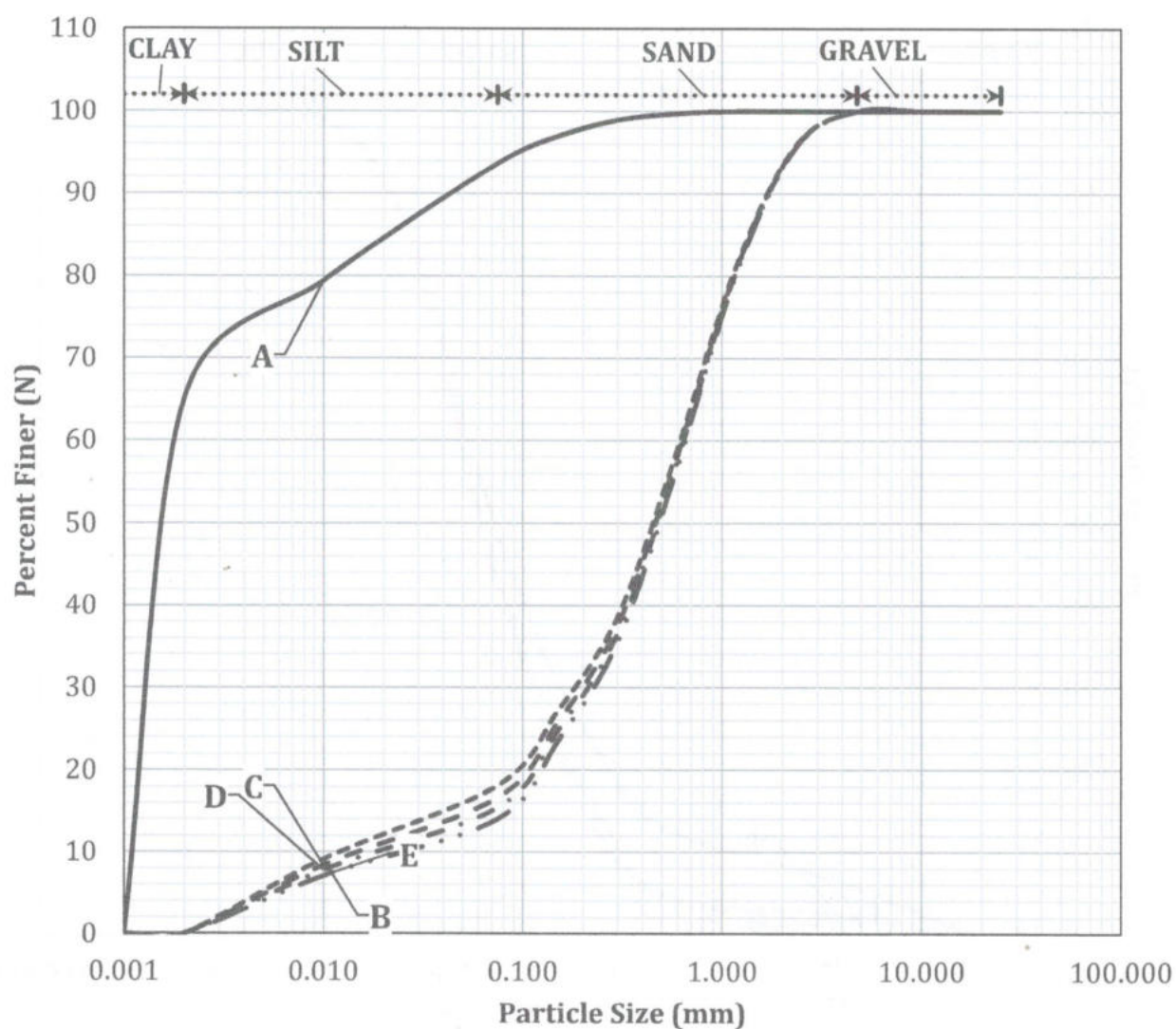


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GRAIN SIZE DISTRIBUTION GRAPH

TABLE 3 : GRAIN SIZE DISTRIBUTION SUMMARY

BH No	DEPTH (m) Below EGSL	INDEX	CLAY (%) < 0.002 mm	SILT (%) 0.002-0.075 mm	SAND (%) 0.075-4.75 mm	GRAVEL (%) > 4.75 mm
3	1.50	A	65.00	28.60	6.40	0.00
	3.00	B	0.00	18.10	81.90	0.00
	4.50	C	0.00	16.60	83.40	0.00
	6.00	D	0.00	15.40	84.60	0.00
	7.50	E	0.00	14.00	86.00	0.00

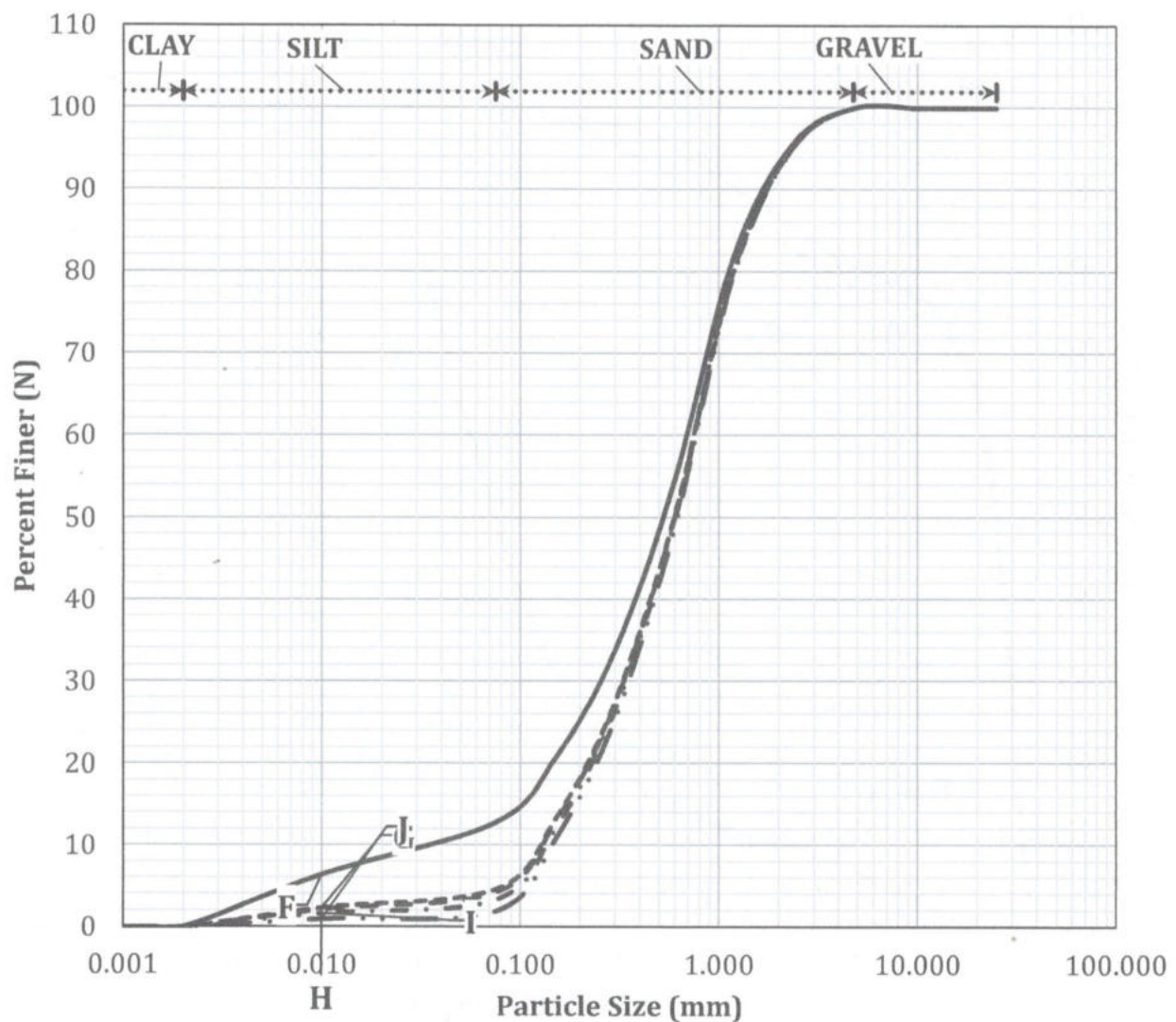


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GRAIN SIZE DISTRIBUTION GRAPH

TABLE 3 : GRAIN SIZE DISTRIBUTION SUMMARY

BH No	DEPTH (m) Below EGSL	INDEX	CLAY (%) < 0.002 mm	SILT (%) 0.002-0.075 mm	SAND (%) 0.075-4.75 mm	GRAVEL (%) > 4.75 mm
3	9.00	F	0.00	12.80	87.20	0.00
	10.50	G	0.00	4.60	95.40	0.00
	12.00	H	0.00	4.20	95.80	0.00
	13.50	I	0.00	3.30	96.70	0.00
	15.00	J	0.00	1.90	98.10	0.00

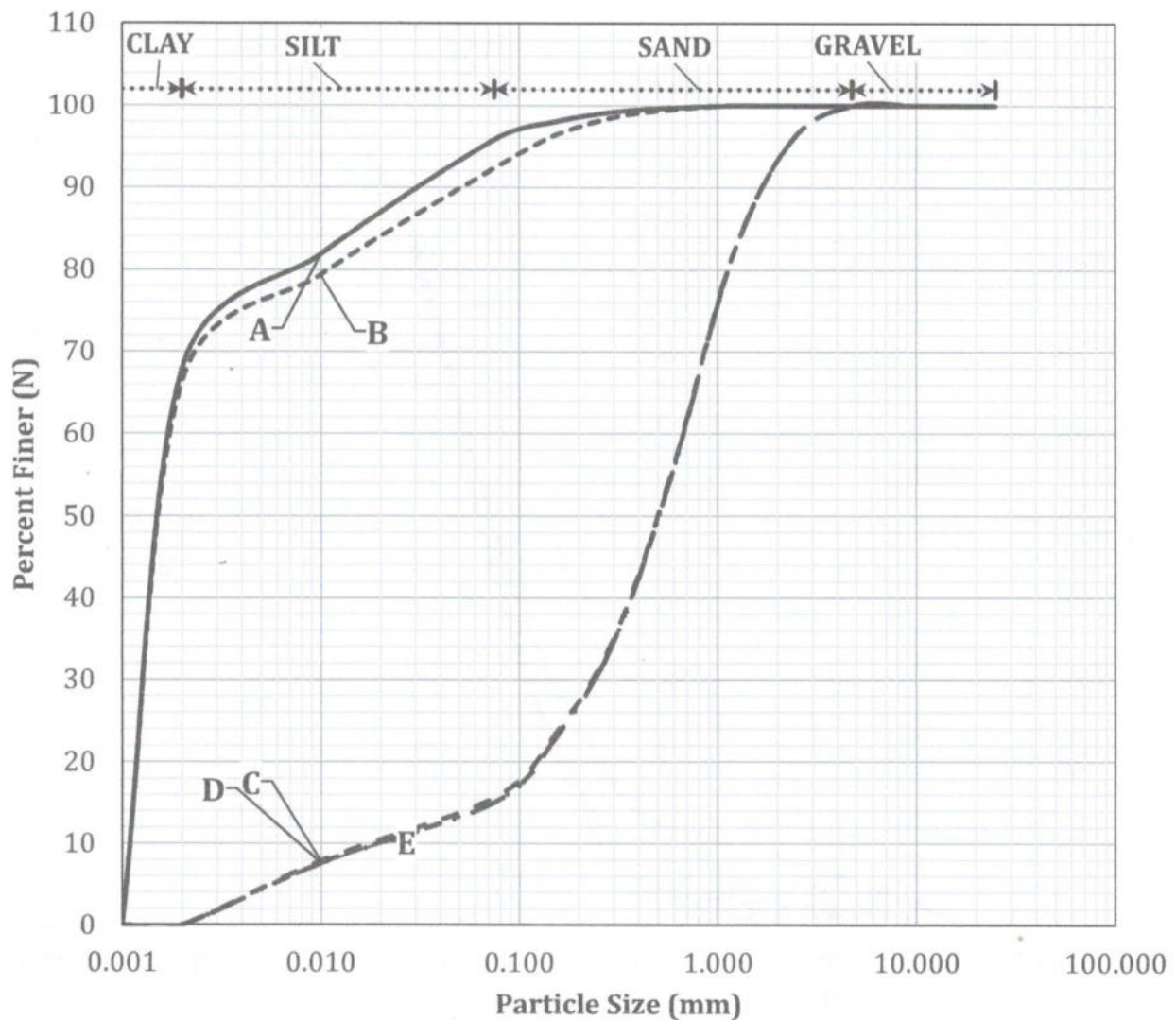


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GRAIN SIZE DISTRIBUTION GRAPH

TABLE 3 : GRAIN SIZE DISTRIBUTION SUMMARY

BH No	DEPTH (m) Below EGSL	INDEX	CLAY (%) < 0.002 mm	SILT (%) 0.002-0.075 mm	SAND (%) 0.075-4.75 mm	GRAVEL (%) > 4.75 mm
4	1.50	A	67.80	28.00	4.20	0.00
	3.00	B	66.30	26.00	7.70	0.00
	4.50	C	0.00	15.60	84.40	0.00
	6.00	D	0.00	15.10	84.90	0.00
	7.50	E	0.00	15.00	85.00	0.00

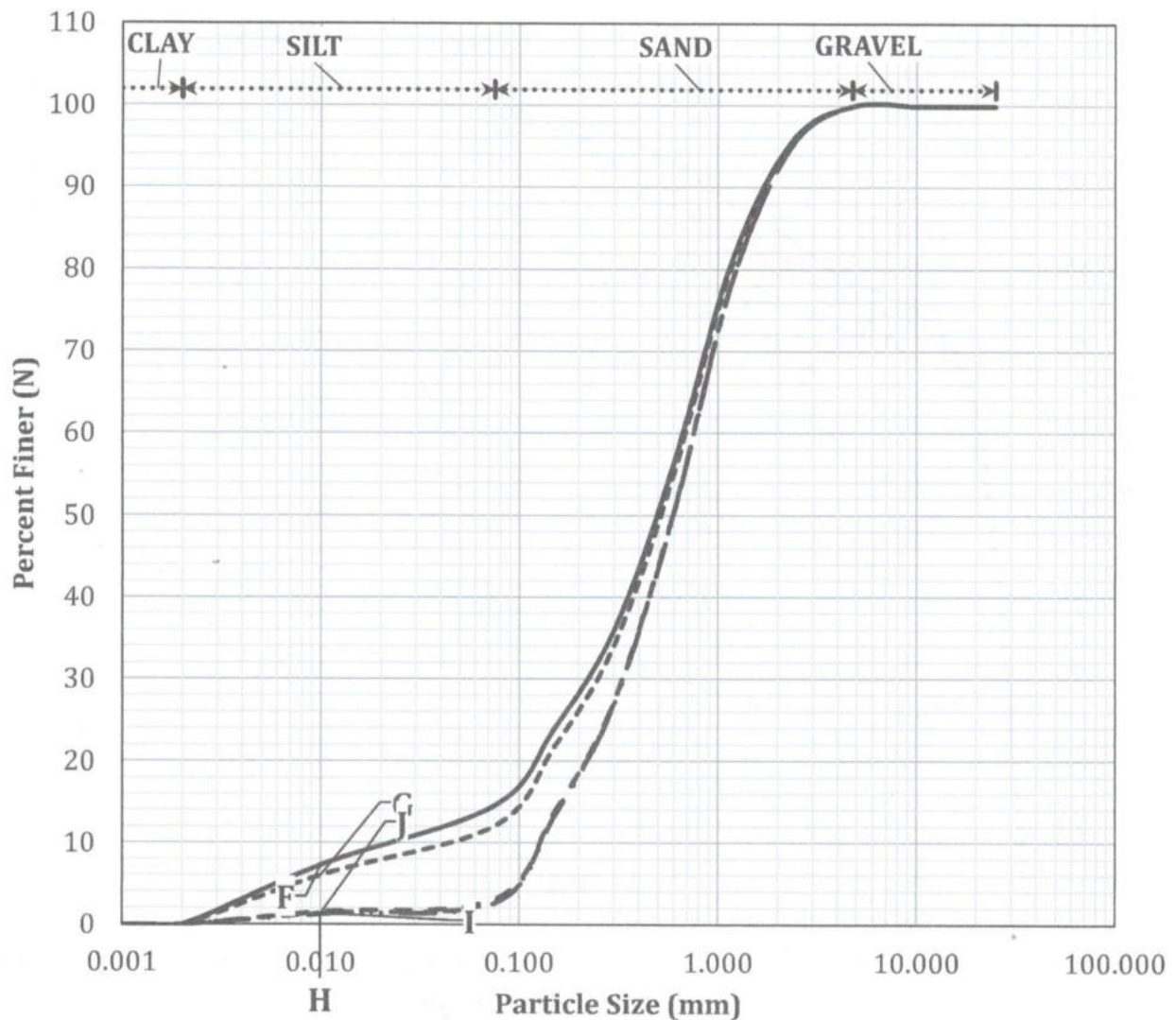



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GRAIN SIZE DISTRIBUTION GRAPH

TABLE 3 : GRAIN SIZE DISTRIBUTION SUMMARY

BH No	DEPTH (m) Below EGSL	INDEX	CLAY (%) < 0.002 mm	SILT (%) 0.002-0.075 mm	SAND (%) 0.075-4.75 mm	GRAVEL (%) > 4.75 mm
4	9.00	F	0.00	14.60	85.40	0.00
	10.50	G	0.00	12.10	87.90	0.00
	12.00	H	0.00	3.10	96.90	0.00
	13.50	I	0.00	2.80	97.20	0.00
	15.00	J	0.00	2.60	97.40	0.00

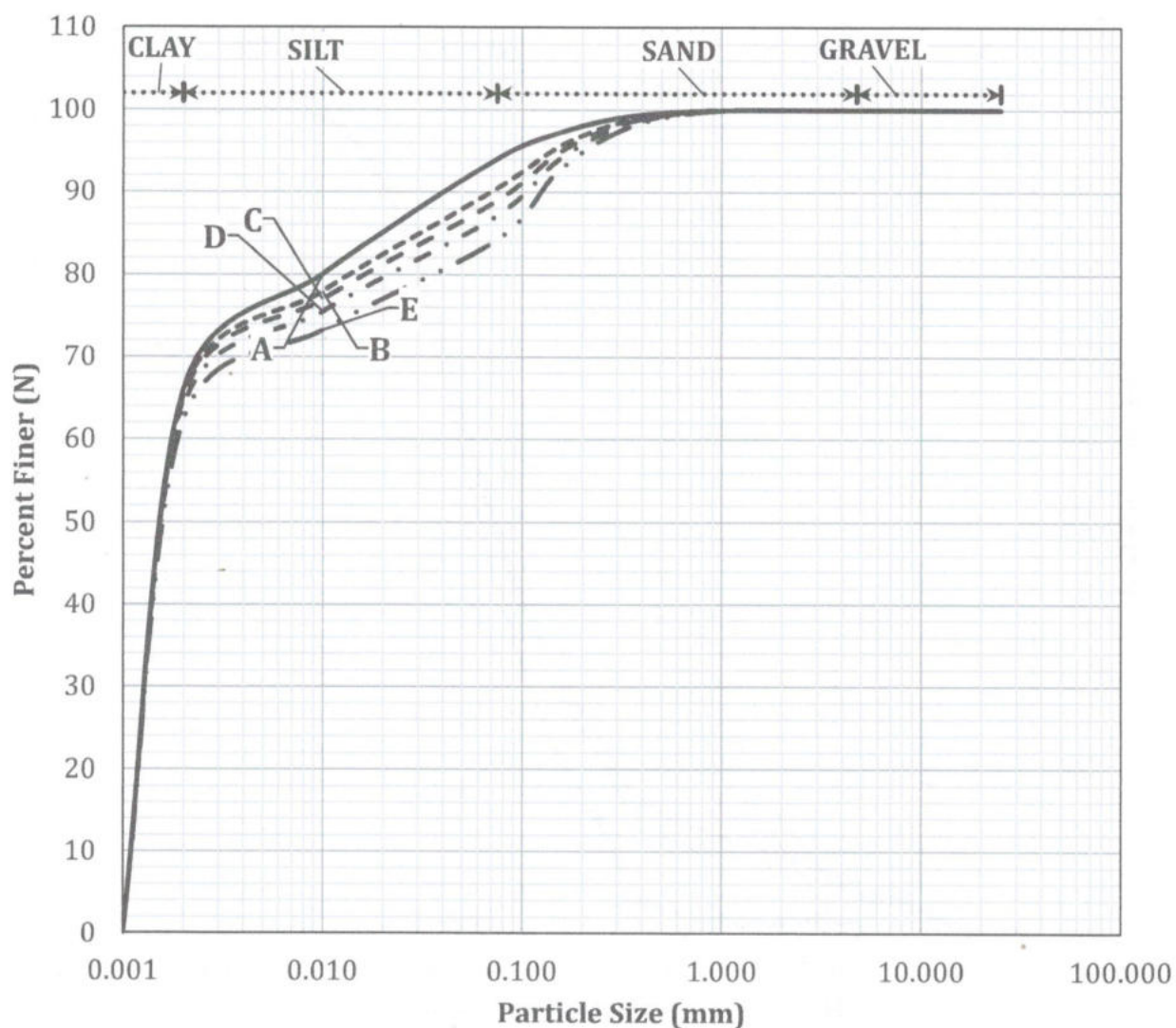


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GRAIN SIZE DISTRIBUTION GRAPH

TABLE 3 : GRAIN SIZE DISTRIBUTION SUMMARY

BH No	DEPTH (m) Below EGSL	INDEX	CLAY (%) < 0.002 mm	SILT (%) 0.002-0.075 mm	SAND (%) 0.075-4.75 mm	GRAVEL (%) > 4.75 mm
5	1.50	A	66.00	28.00	6.00	0.00
	3.00	B	65.40	25.00	9.60	0.00
	4.50	C	64.90	24.00	11.10	0.00
	6.00	D	63.80	23.30	12.90	0.00
	7.50	E	62.20	22.00	15.80	0.00

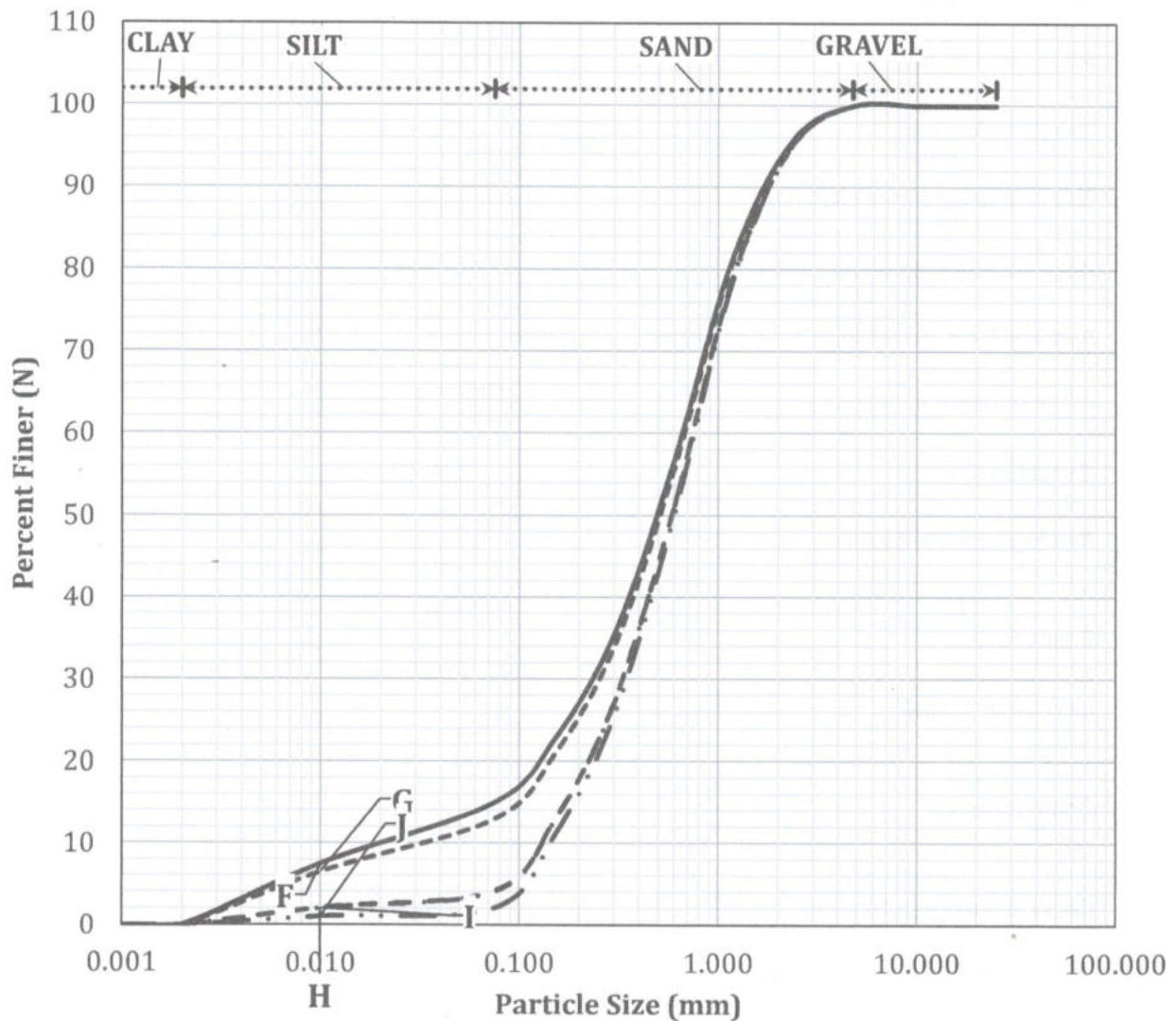


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GRAIN SIZE DISTRIBUTION GRAPH

TABLE 3 : GRAIN SIZE DISTRIBUTION SUMMARY

BH No	DEPTH (m) Below EGSL	INDEX	CLAY (%) < 0.002 mm	SILT (%) 0.002-0.075 mm	SAND (%) 0.075-4.75 mm	GRAVEL (%) > 4.75 mm
5	9.00	F	0.00	15.00	85.00	0.00
	10.50	G	0.00	13.00	87.00	0.00
	12.00	H	0.00	4.20	95.80	0.00
	13.50	I	0.00	4.10	95.90	0.00
	15.00	J	0.00	2.10	97.90	0.00



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ANNEXURE-I

SAMPLE CALCULATION BEARING CAPACITY BASED ON SHEAR CRITERIA

(Based on IS: 6403-1981)

Bore hole No.	=	1
Type of footing :	Square footing	
Type of soil at founding level	=	clay
Ground water table location (Dw)	=	0.0 m below NGL (assumed)
Unit weight of soil (γ)	=	1.9 t/m ³
Submerged unit of soil (γ')	=	0.9 t/m ³
Width of footing (B)	=	1.5 m
Length of footing(L)	=	1.5 m
Depth of footing from NGL (D_f)	=	1.5 m
Depth of pressure bulb ($1.50*B$)	=	3 m
Average Corr. 'N' value at base of footing	=	17
Angle of internal friction (ϕ)	=	0 deg.
Cohesion (C)	=	6.00 t/m ²
Bearing capacity factors		
Nc	=	5.14
Shape factors :		
Sc	=	1.00
Inclination factors :		
ic = 1		
Depth factors :		
dc	=	1.20
Factor of safety (F.S)	=	2.5
Ultimate bearing capacity (UBC)		
UBC = C *Nc * Sc * dc *ic		
Ultimate bearing capacity	=	37.01 t/m ²
Safe bearing capacity as per shear criteria,		
(SBC) = UBC/F.S	=	14.8 t/m ²



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BEARING CAPACITY BASED ON SETTLEMENT CRITERIA

Type of foundation	=	Square foundation
Unit weight of soil (γ)	=	1.90 t/m ³
Width of foundation (B)	=	2.00 m
Length of foundation (L)	=	1.80 m
Depth of foundation from NGL (D_f)	=	3.50 m
Bearing pressure at founding level (q)	=	15.27 t/m ²
Depth of pressure bulb below fdn ($1.50 \times B$), H	=	3.00 m
Depth of pressure bulb below NGL	=	6.50 m
Depth of water table below NGL D_w	=	0.00 m

Bearing capacity Based on Settlement

$$\text{Settlement in clay layer} = \frac{H C_c}{1+e_0} \log \left\{ \frac{P_0 + \Delta P}{P_0} \right\}$$

H	=	Depth of clay layer
Δp	=	Incremental pressure at centre of layer
P_0	=	Overburden pressure at centre of layer
C_c	=	Coefficient of compressibility
e_0	=	Initial void ratio

Layer I

Type of soil	=	Silty Clay
Layer thickness from NGL	=	0.00 to 3.75
Depth of layer below foundation (H)	=	1.50 m
Overburden pressure at centre, P_0	=	2.90 t/m ²
Increase in pressure at centre layer (i.e dispersed pressure) Δp	=	$q \times B \times L / (B+z)(L+z)$
	=	51.82 t/m ²
Initial void ratio, e_0	=	2.00
Coefficient of compressibility, C_c	=	0.10
Settlement	=	$\frac{H C_c}{1+e_0} \log \left\{ \frac{P_0 + \Delta P}{P_0} \right\}$
	=	63.8 mm
Depth correction factor	=	0.90 (as per Fig.12 of IS:8009-pt1)



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Rigidity factor = 0.80 (as per clause 9.5.2 of IS 8009-pt1)

Corrected settlement = 46 mm

Total Settlement = 163.4 mm <75mm ok



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ANNEXURE-IV

SAMPLE CALCULATION FOR PILE LATERAL LOAD CAPACITY

Bored Cast In-situ Concrete Piles (BCIS) as per IS-2911 (part 1/sec 2) : 2010

Predominant soil layers offering lateral capacity = Silty Soil

BH-1

Case-I PILE LATERAL LOAD CAPACITY: (Fixed Head condition)

Bored Cast In-situ Concrete Piles (BCIS) - IS-2911 (part 1/sec 2) : 2010

Diameter of the pile,	Dia	=	0.45	m	
Grade of Concrete	f_{ck}	=	25	N/mm ²	
Concrete Elastic Modulus, E = 5000	$\sqrt{f_{ck}}$	=	25000	N/mm ²	(As per IS 456:2000)
		=	25000000	kN/m ²	
		=	25000	MN/m ²	
Moment of Inertia of Pile,	I	=	0.00201	m ⁴	$\pi \times (\text{Dia})^4 / 64$
Avg. SPT-N value with in 10*Dia depth		=	16	(below COL)	
Modulus of subgrade reaction,	η_h	=	3.00	MN/m ³	(Appendix-C, table-3)
Stiffness factor,	$T = (E \cdot I / \eta_h)^{1/5}$	=	1.758	m	
Free length of pile below COL,	e = L1	=	0.00	m	
	L1 / T	=	0.000		
	Lf / T	=	2.200		
For fixed head pile,	L _f	=	3.87	m	(Fig. 4 of Annex C)
Allowable deflection at COL	y	=	4.50	mm	
Lateral capacity of fixed head pile,	H	=	(12 E I y) / (e + Z _f) ³	$y = \frac{H (e + Z_f)^3}{12 E I} \times 10^3$	
		=	47.00	kN	
Recommended for Fixed head condition		=	47.00	kN	

PILE LATERAL LOAD CAPACITY

Bored Cast In-situ Concrete Piles (BCIS) as per IS-2911 (part 1/sec 2) : 2010

Predominant soil layers offering lateral capacity = Silty Soil

Case-I PILE LATERAL-LOAD CAPACITY: (Fixed Head condition)

Bored Cast In-situ Concrete Piles (BCIS) - IS-2911 (part 1/sec 2) : 2010

Diameter of the pile,	Dia	=	5.00	m	
Grade of Concrete	f_{ck}	=	25	N/mm ²	
Concrete Elastic Modulus, E = 5000	$\sqrt{f_{ck}}$	=	25000	N/mm ²	(As per IS 456:2000)
		=	25000000	kN/m ²	
		=	25000	MN/m ²	
Moment of Inertia of Pile,	I	=	0.00201	m ⁴	$\pi \times (\text{Dia})^4 / 64$
Avg. SPT-N value with in 10*Dia depth		=	17	(below COL)	
Modulus of subgrade reaction,	η_h	=	4.00	MN/m ³	(Appendix-C, table-3)
Stiffness factor,	$T = (E \cdot I / \eta_h)^{1/5}$	=	1.659	m	
Free length of pile below COL,	e = L1	=	0.00	m	
	L1 / T	=	0.000		
	Lf / T	=	2.200		
For fixed head pile,	L _f	=	3.65	m	(Fig. 4 of Annex C)
Allowable deflection at COL	y	=	5.00	mm	
Lateral capacity of fixed head pile,	H	=	(12 E I y) / (e + Z _f) ³	$y = \frac{H (e + Z_f)^3}{12 E I} \times 10^3$	
		=	62.06	kN	
Recommended for Fixed head condition		=	62.06	kN	



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Project:		220/132 KV GIS									
BOREHOLE RECORD											
Boring Method: Rotary Drilling						Borehole No : 1					
Boring Diameter: 150 mm						Location : Khumtai					
Depth of GWT: 6 m						Date commenced : 30-11-2022					
						Date completed : 30-11-2022					
Depth (m)	Sample/In-situ Tests		SPT N Value				GWT (m)	Description	Log		
	Depth	Type	15	30	45	N					
0								Silty clay (GL - 8.7 m)			
	1.5	DS	5	7	10	17					
1											
2	3.0	DS	10	13	15	28					
3											
	4.5	DS	8	9	11	20					
4											
5	6.0	DS	5	5	8	13					
6											
	7.5	DS	6	8	11	19					
7											
								Sand (8.7 m - 15.0 m)			
8	9.0	DS	7	10	12	22					
9											
	10.5	DS	8	11	13	24					
10											
11	12.0	DS	9	12	14	26					
12											
	13.5	DS	10	13	15	28					
13											
14	15.0	DS	12	14	16	30					
15											

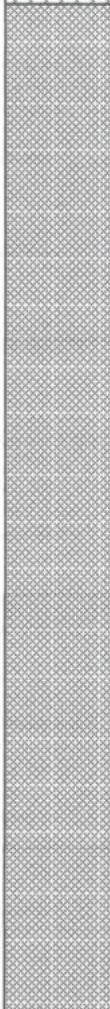
SPT: Standard Penetration Test

UDS: Undisturbed Sample

GWT: Ground water Table



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Project:		220/132 KV GIS									
BOREHOLE RECORD											
Boring Method: Rotary Drilling						Borehole No : 2					
Boring Diameter: 150 mm						Location : Khumtai					
Depth of GWT: 1.5 m						Date commenced : 27-11-2022					
						Date completed : 27-11-2022					
Depth (m)	Sample/In-situ Tests		SPT N Value				GWT (m)	Description	Log		
	Depth	Type	15	30	45	N					
0								Silty clay (GL - 4.2 m)			
1	1.5	DS	5	6	8	14					
2	3.0	DS	4	4	5	9		Sand (4.2 m - 15.0 m)			
3	4.5	DS	5	6	7	13					
4											
5	6.0	DS	6	8	9	17					
6											
7	7.5	DS	7	9	10	19					
8	9.0	DS	8	10	12	22					
9											
10	10.5	DS	9	11	13	24					
11	12.0	DS	11	12	15	27					
12											
13	13.5	DS	11	20	24	44					
14	15.0	DS	12	14	16	30					
15											

SPT: Standard Penetration Test

UDS: Undisturbed Sample

GWT: Ground water Table



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Project:		220/132 KV GIS									
BOREHOLE RECORD											
Boring Method: Rotary Drilling						Borehole No : 3					
Boring Diameter: 150 mm						Location : Khumtai					
Depth of GWT: 1.4 m						Date commenced : 28-11-2022					
						Date completed : 28-11-2022					
Depth (m)	Sample/In-situ Tests		SPT N Value				GWT (m)	Description	Log		
	Depth	Type	15	30	45	N					
0								Silty clay (GL - 2.3 m)			
	1.5	DS	7	11	13	24					
1											
2	3.0	DS	8	10	11	21					
3											
	4.5	DS	9	11	12	23					
4											
5	6.0	DS	10	12	13	25					
6											
	7.5	DS	11	13	14	27					
7											
8	9.0	DS	12	14	16	30					
9											
	10.5	DS	13	15	17	32					
10											
11	12.0	DS	14	16	18	34					
12											
	13.5	DS	12	14	17	31					
13											
14	15.0	DS	14	16	18	34					
15											

SPT: Standard Penetration Test

UDS: Undisturbed Sample

GWT: Ground water Table



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 GMC Market, Chandran, Ghy-03

Project:		220/132 KV GIS									
BOREHOLE RECORD											
Boring Method: Rotary Drilling						Borehole No : 4					
Boring Diameter: 150 mm						Location : Khumtai					
Depth of GWT: 3.2 m						Date commenced : 24-11-2022					
						Date completed : 24-11-2022					
Depth (m)	Sample/In-situ Tests		SPT N Value				GWT (m)	Description	Log		
	Depth	Type	15	30	45	N					
0							▼	Silty clay (GL - 4.0 m)			
1	1.5	DS	6	10	13	23					
2	3.0	DS	6	7	9	16					
3	4.5	DS	7	9	11	20					
4								Sand (4.0 m - 15.0 m)			
5	6.0	DS	8	10	12	22					
6											
7	7.5	DS	9	11	13	24					
8	9.0	DS	10	12	14	26					
9											
10	10.5	DS	11	13	15	28					
11	12.0	DS	12	14	16	30					
12											
13	13.5	DS	13	15	17	32					
14	15.0	DS	14	16	18	34					
15											

SPT: Standard Penetration Test

UDS: Undisturbed Sample

GWT: Ground water Table



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Project:		220/132 KV GIS									
BOREHOLE RECORD											
Boring Method: Rotary Drilling						Borehole No : 5					
Boring Diameter: 150 mm						Location : Khumtai					
Depth of GWT: 3.2 m						Date commenced : 29-11-2022					
						Date completed : 29-11-2022					
Depth (m)	Sample/In-situ Tests		SPT N Value				GWT (m)	Description	Log		
	Depth	Type	15	30	45	N					
0								Silty clay (GL - 8.0 m)			
1	1.5	DS	5	6	8	14					
2	3.0	DS	6	7	9	16					
3	4.5	DS	7	9	11	20					
4	6.0	DS	8	10	12	22					
5	7.5	DS	9	11	13	24					
6	9.0	DS	10	12	14	26					
7	10.5	DS	11	13	16	29					
8	12.0	DS	12	15	17	32					
9	13.5	DS	14	16	18	34					
10	15.0	DS	16	17	20	37					
11											
12											
13											
14											
15											

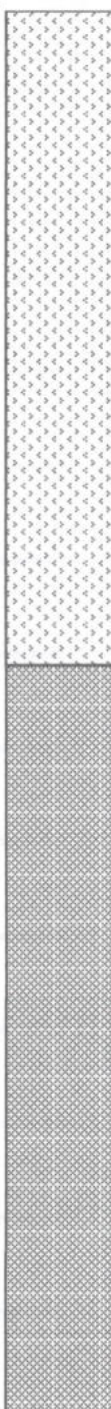
SPT: Standard Penetration Test

UDS: Undisturbed Sample

GWT: Ground water Table



S. Malakar
 Er. S. Ravi Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandwar, Ghy-03

Project:		220/132 KV GIS									
BOREHOLE RECORD											
Boring Method: Rotary Drilling						Borehole No : 6					
Boring Diameter: 150 mm						Location : Khumtai					
Depth of GWT: 4.6 m						Date commenced : 19-11-2022					
						Date completed : 19-11-2022					
Depth (m)	Sample/In-situ Tests		SPT N Value				GWT (m)	Description	Log		
	Depth	Type	15	30	45	N					
0								Silty clay (GL - 7.0 m)			
	1.5	DS	6	11	12	23					
1											
2	3.0	DS	20	20	24	44					
3											
	4.5	DS	22	24	27	51					
4											
5	6.0	DS	18	21	23	44					
6											
	7.5	DS	23	25	27	52					
7											
8	9.0	DS	24	28	33	61					
9											
	10.5	DS	25	29	34	63					
10											
11	12.0	DS	26	30	35	65					
12											
	13.5	DS	27	31	36	67					
13											
14	15.0	DS	28	32	37	69					
15											

SPT: Standard Penetration Test

UDS: Undisturbed Sample

GWT: Ground water Table



S. Kalakar
 Et. Gopi Rani Nelskar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandmani, Ghy-03

Project:		220/132 KV GIS									
BOREHOLE RECORD											
Boring Method: Rotary Drilling						Borehole No : 7					
Boring Diameter: 150 mm						Location : Khumtai					
Depth of GWT: 4.2 m						Date commenced : 21-11-2022					
						Date completed : 21-11-2022					
Depth (m)	Sample/In-situ Tests		SPT N Value				GWT (m)	Description	Log		
	Depth	Type	15	30	45	N					
0								Silty clay (GL - 2.5 m)			
1	1.5	DS	5	8	9	17					
2	3.0	DS	24	29	34	63					
3	4.5	DS	25	30	35	65					
4	6.0	DS	26	31	36	67					
5	7.5	DS	27	32	37	69					
6	9.0	DS	28	33	38	71					
7	10.5	DS	29	34	39	73					
8	12.0	DS	30	35	40	75					
9	13.5	DS	31	36	41	77					
10	15.0	DS	32	37	42	79					
11											
12											
13											
14											
15											

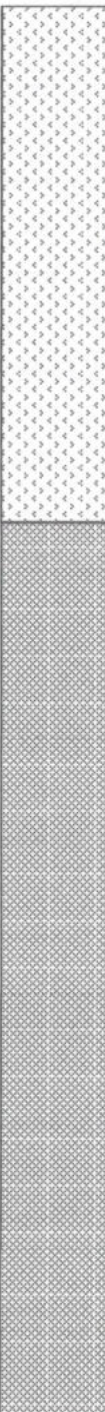
SPT: Standard Penetration Test

UDS: Undisturbed Sample

GWT: Ground water Table



S. K. S. S. S.
 Er. Gopi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chaudhary Ghy.03

Project:		220/132 KV GIS									
BOREHOLE RECORD											
Boring Method: Rotary Drilling						Borehole No : 8					
Boring Diameter: 150 mm						Location : Khumtai					
Depth of GWT: 5 m						Date commenced : 20-11-2022					
						Date completed : 20-11-2022					
Depth (m)	Sample/In-situ Tests		SPT N Value				GWT (m)	Description	Log		
	Depth	Type	15	30	45	N					
0								Silty clay (GL - 5.5 m)			
	1.5	DS	5	9	11	20					
1											
2	3.0	DS	12	18	23	41					
3											
	4.5	DS	10	14	17	31					
4											
5	6.0	DS	19	23	26	49					
6											
	7.5	DS	20	24	27	51					
7											
8	9.0	DS	21	25	27	52					
9											
	10.5	DS	22	26	28	54					
10											
11	12.0	DS	23	27	29	56					
12											
	13.5	DS	6	7	9	16					
13											
14	15.0	DS	20	22	26	48					
15											

SPT: Standard Penetration Test

UDS: Undisturbed Sample

GWT: Ground water Table



S. Malakar
 Er. Silpi Ram Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chanchan, Ghy-03

Project:		220/132 KV GIS									
BOREHOLE RECORD											
Boring Method: Rotary Drilling						Borehole No : 9					
Boring Diameter: 150 mm						Location : Khumtai					
Depth of GWT: 1.5 m						Date commenced : 22-11-2022					
						Date completed : 22-11-2022					
Depth (m)	Sample/In-situ Tests		SPT N Value				GWT (m)	Description	Log		
	Depth	Type	15	30	45	N					
0											
	1.5	DS	4	5	7	12		Silty clay (GL - 4.4 m)			
1											
	3.0	DS	8	12	15	27					
2											
	4.5	DS	24	28	34	62					
4											
	6.0	DS	25	29	35	64		Sand (4.4 m - 15.0 m)			
5											
	7.5	DS	26	30	36	66					
7											
	9.0	DS	27	31	37	68					
8											
	10.5	DS	28	32	38	70					
10											
	12.0	DS	29	33	39	72					
11											
	13.5	DS	30	34	40	74					
13											
	15.0	DS	31	35	41	76					
14											
15											

SPT: Standard Penetration Test

UDS: Undisturbed Sample

GWT: Ground water Table



S. Lalakar
 Sr. Civil Engr. Ravi Mohan, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandigarh-160003

Project:		220/132 KV GIS									
BOREHOLE RECORD											
Boring Method: Rotary Drilling						Borehole No : 10					
Boring Diameter: 150 mm						Location : Khumtai					
Depth of GWT: 4 m						Date commenced : 20-11-2022					
						Date completed : 20-11-2022					
Depth (m)	Sample/In-situ Tests		SPT N Value				GWT (m)	Description	Log		
	Depth	Type	15	30	45	N					
0								Silty clay (GL - 8.9 m)			
	1.5	DS	7	9	21	30					
1											
	3.0	DS	6	7	16	23					
2											
	4.5	DS	14	17	40	57					
3											
	6.0	DS	5	7	16	23					
4											
	7.5	DS	10	16	35	51					
5											
	9.0	DS	11	17	37	54					
6											
	10.5	DS	12	18	39	57					
7											
	12.0	DS	13	19	41	60					
8											
	13.5	DS	14	20	43	63					
9											
	15.0	DS	16	21	45	66					
10											
11											
12											
13											
14											
15											

SPT: Standard Penetration Test

UDS: Undisturbed Sample

GWT: Ground water Table



S. Lalakan
 Er. Gilpi Rani Mishra, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandigarh-160003

Project:		220/132 KV GIS									
BOREHOLE RECORD											
Boring Method: Rotary Drilling						Borehole No : 11					
Boring Diameter: 150 mm						Location : Khumtai					
Depth of GWT: 2 m						Date commenced : 25-11-2022					
						Date completed : 25-11-2022					
Depth (m)	Sample/In-situ Tests		SPT N Value				GWT (m)	Description	Log		
	Depth	Type	15	30	45	N					
0								Silty clay (GL - 7.4 m)			
	1.5	DS	5	7	10	17					
1											
2	3.0	DS	8	14	18	32					
3											
	4.5	DS	5	7	9	16					
4											
5	6.0	DS	7	7	11	18					
6											
	7.5	DS	5	5	7	12					
7											
8	9.0	DS	9	11	14	25					
9											
10	10.5	DS	10	12	16	28					
11	12.0	DS	11	13	17	30					
12											
	13.5	DS	12	14	18	32					
13											
14	15.0	DS	14	16	20	36					
15											

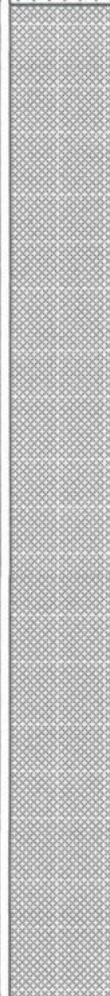
SPT: Standard Penetration Test

UDS: Undisturbed Sample

GWT: Ground water Table



S. Malakar
 Er. Silpi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandigarh-03

Project:		220/132 KV GIS									
BOREHOLE RECORD											
Boring Method: Rotary Drilling						Borehole No : 1					
Boring Diameter: 150 mm						Location : Khumtai					
Depth of GWT: 1 m						Date commenced : 26-11-2022					
						Date completed : 26-11-2022					
Depth (m)	Sample/In-situ Tests		SPT N Value				GWT (m)	Description	Log		
	Depth	Type	15	30	45	N					
0								Silty clay (GL - 4.4 m)			
	1.5	DS	3	5	8	13					
1											
2	3.0	DS	7	8	9	17			Sand (4.4 m - 15.0 m)		
3											
4	4.5	DS	9	11	13	24					
5	6.0	DS	10	12	14	26					
6											
7	7.5	DS	11	13	16	29					
8	9.0	DS	12	15	17	32					
9											
10	10.5	DS	14	16	18	34					
11	12.0	DS	16	17	20	37					
12											
13	13.5	DS	17	19	21	40					
14	15.0	DS	19	21	23	44					
15											

SPT: Standard Penetration Test

UDS: Undisturbed Sample

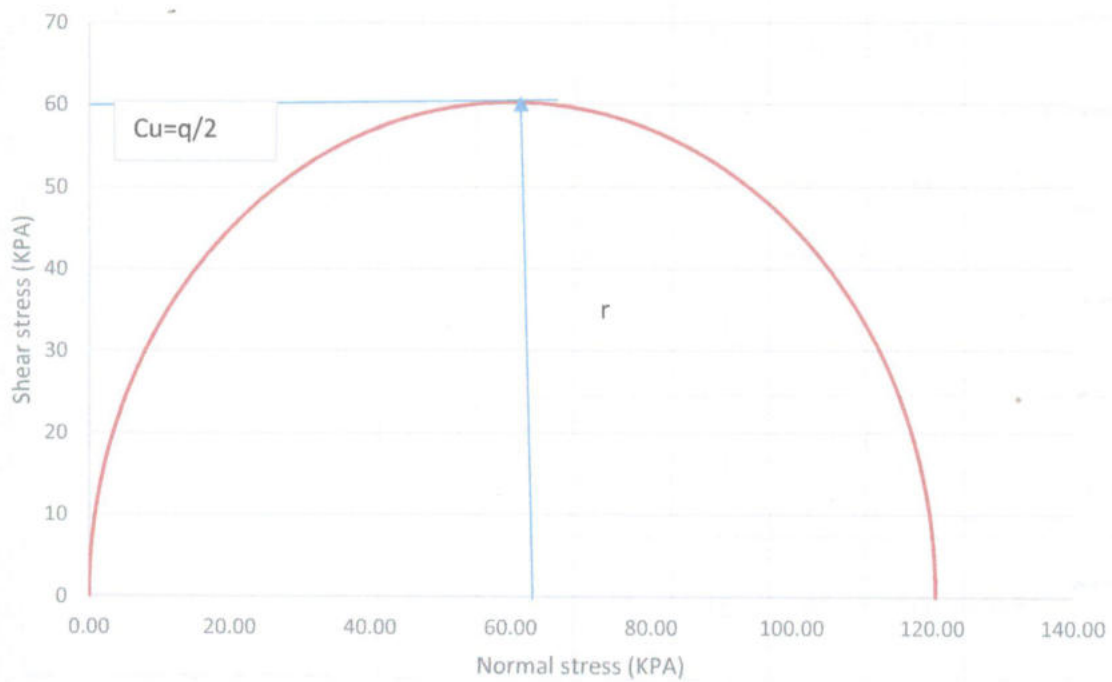
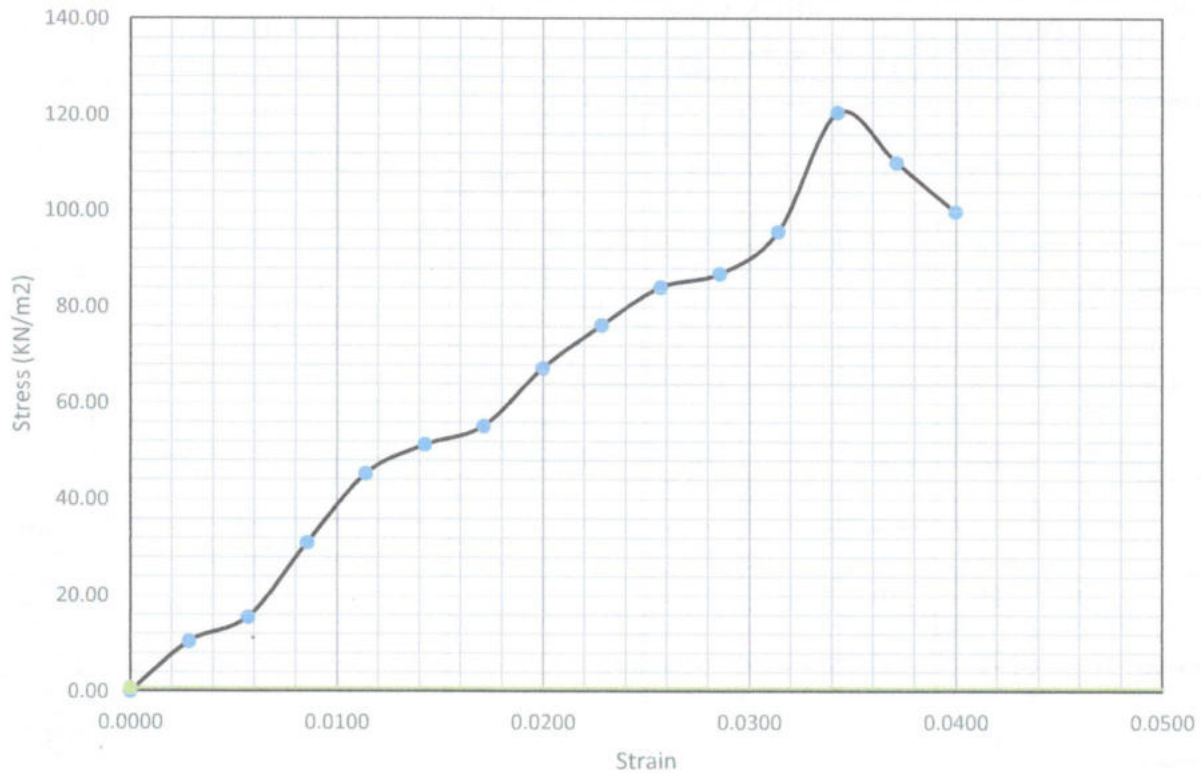
GWT: Ground water Table



S. Lalakan
 Er. Gopi Rani Molakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandanpur, Ghy-03

Type of Test: Unconfined Compression Test

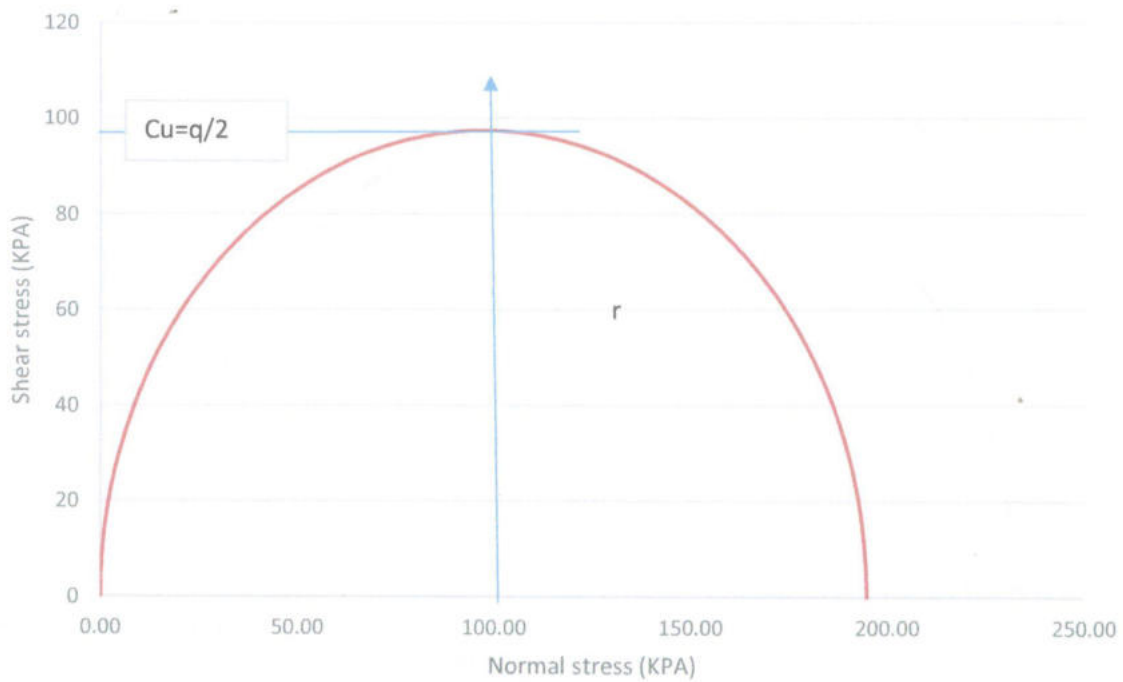
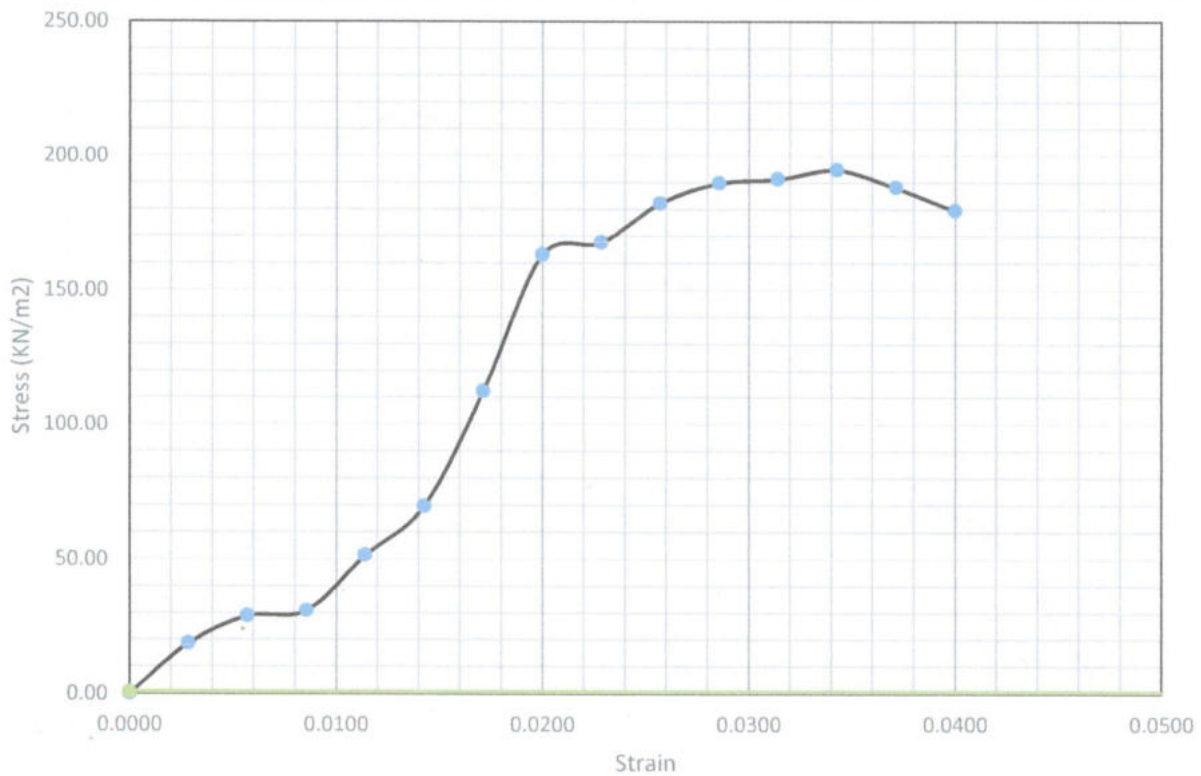
BH No.	1	Depth=	2
Results			
Qu=	120.510	KN/m2	
Cu=qu/2=	60.255	KN/m3	



S. Malakar
 Er. Silpi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandman, Ghy-03

Type of Test: Unconfined Compression Test

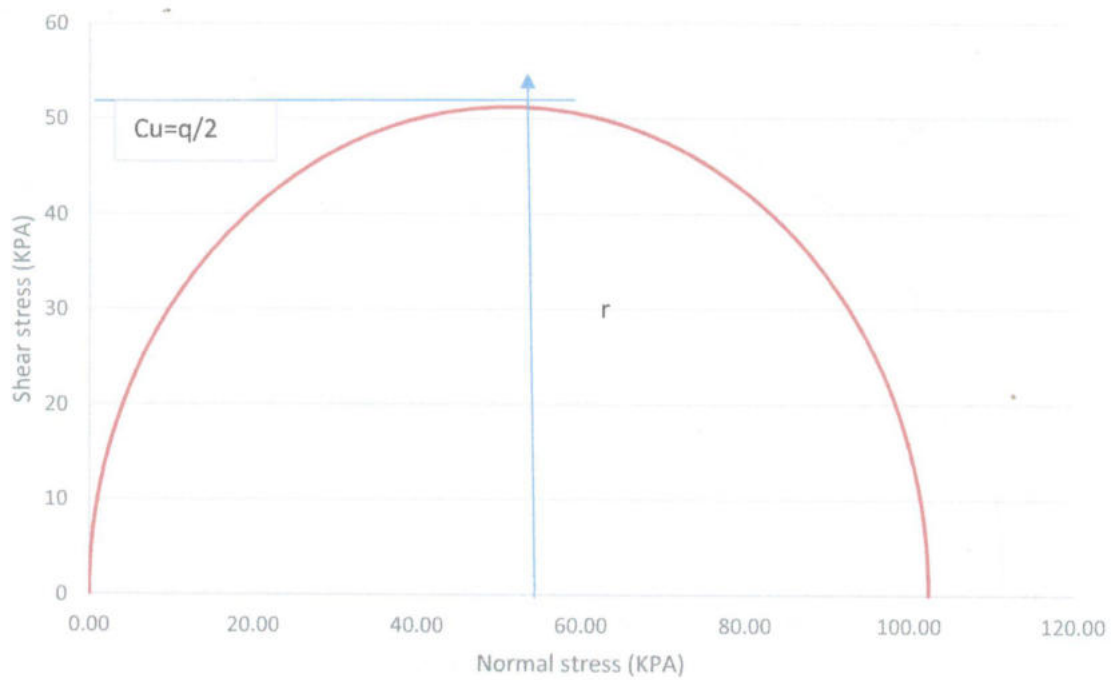
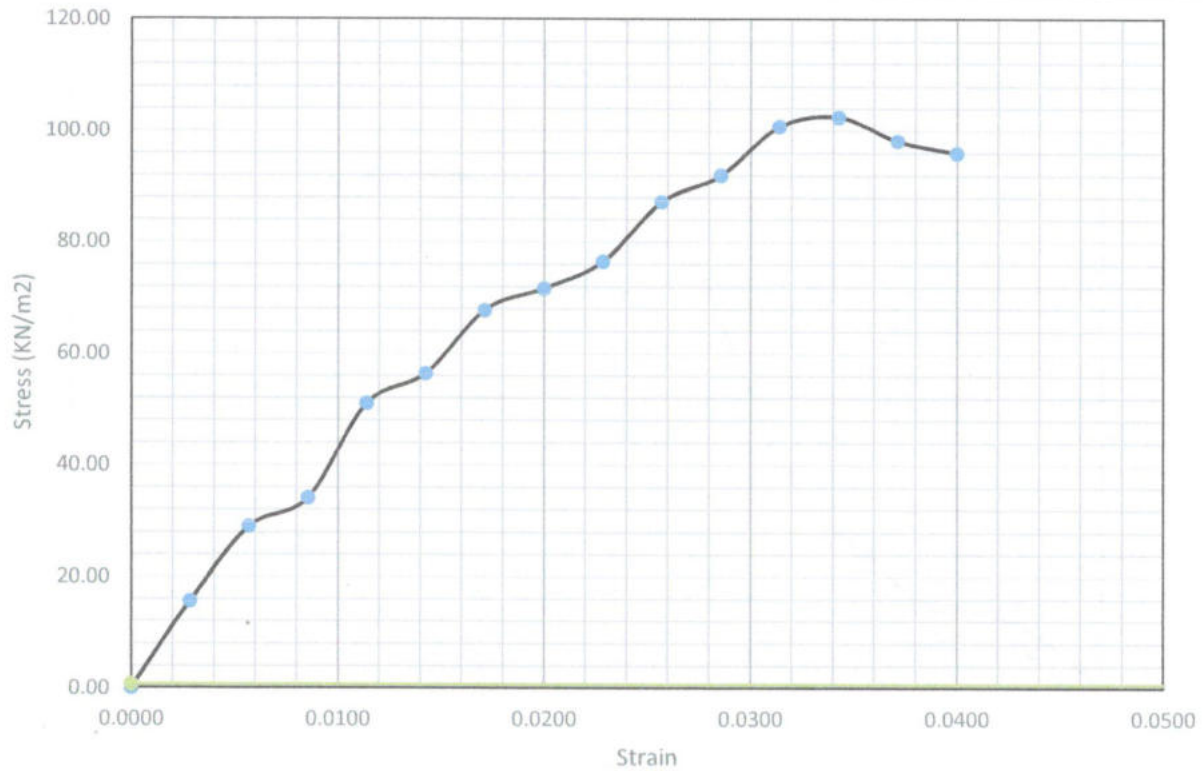
BH No.	1	Depth=	5
Results			
Qu=	194.825	KN/m2	
Cu=qu/2=	97.412	KN/m3	



S. Malakar
 Er. Gopal Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chanderpur, Ghy-03

Type of Test: Unconfined Compression Test

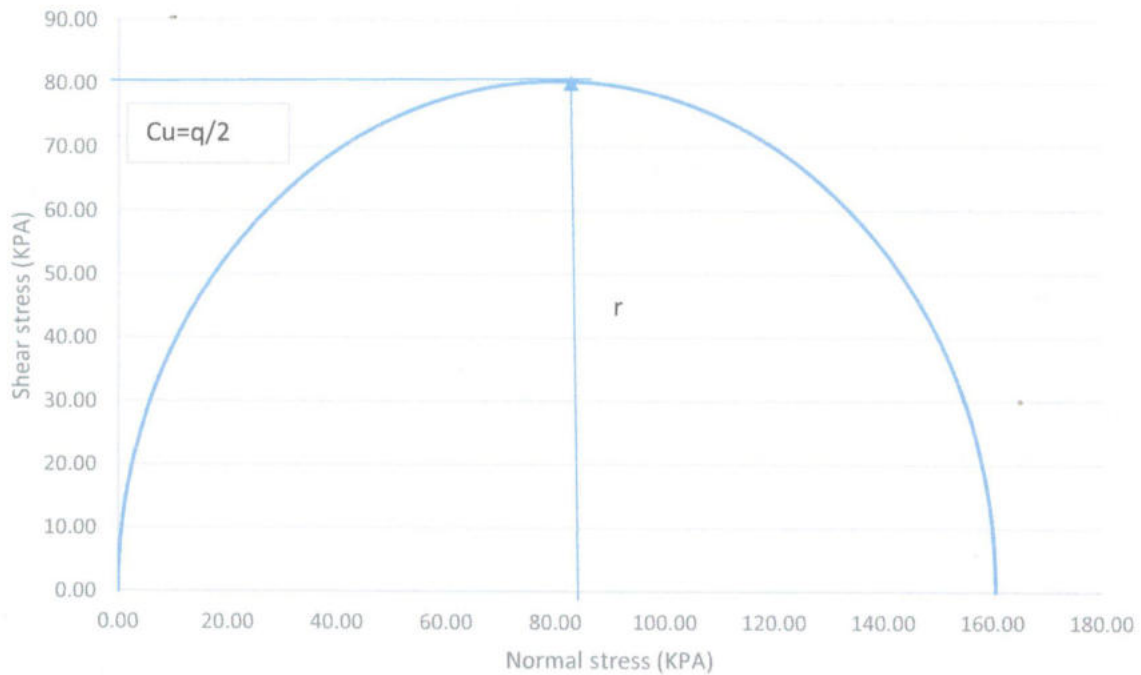
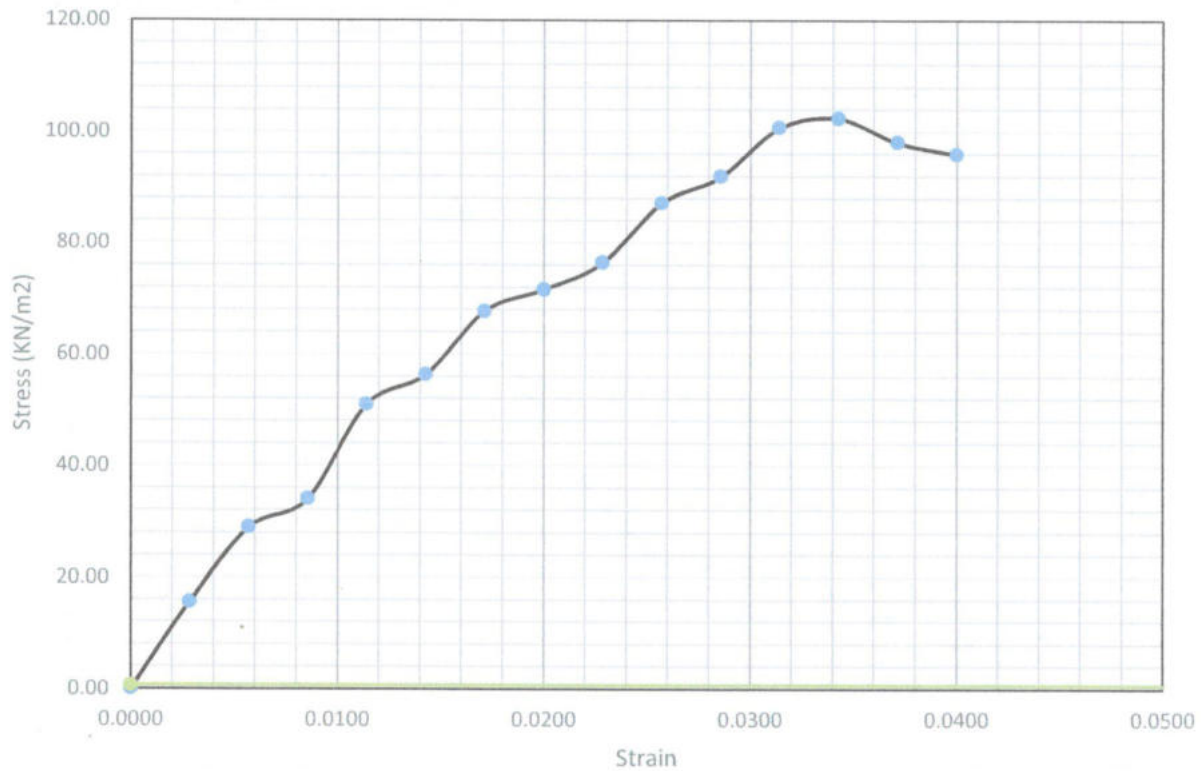
BH No.	2	Depth=	2
Results			
Qu=	102.434	KN/m2	
Cu=qu/2=	51.217	KN/m3	



S. Malakar
 Dr. Gopi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandigarh-03

Type of Test: Unconfined Compression Test

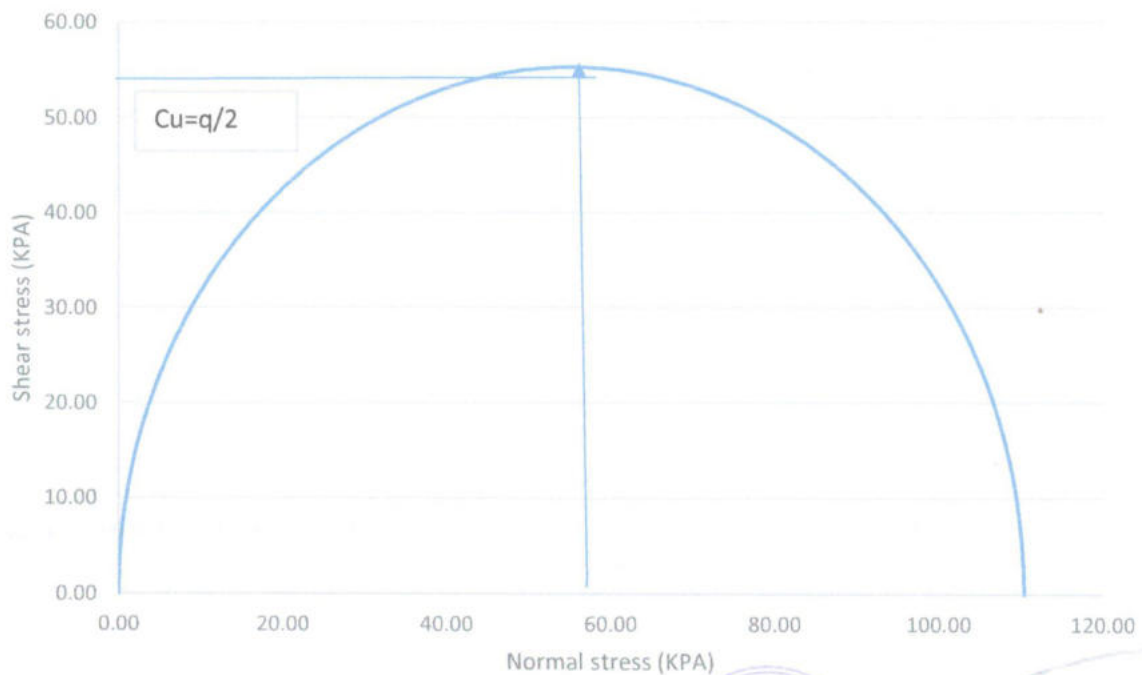
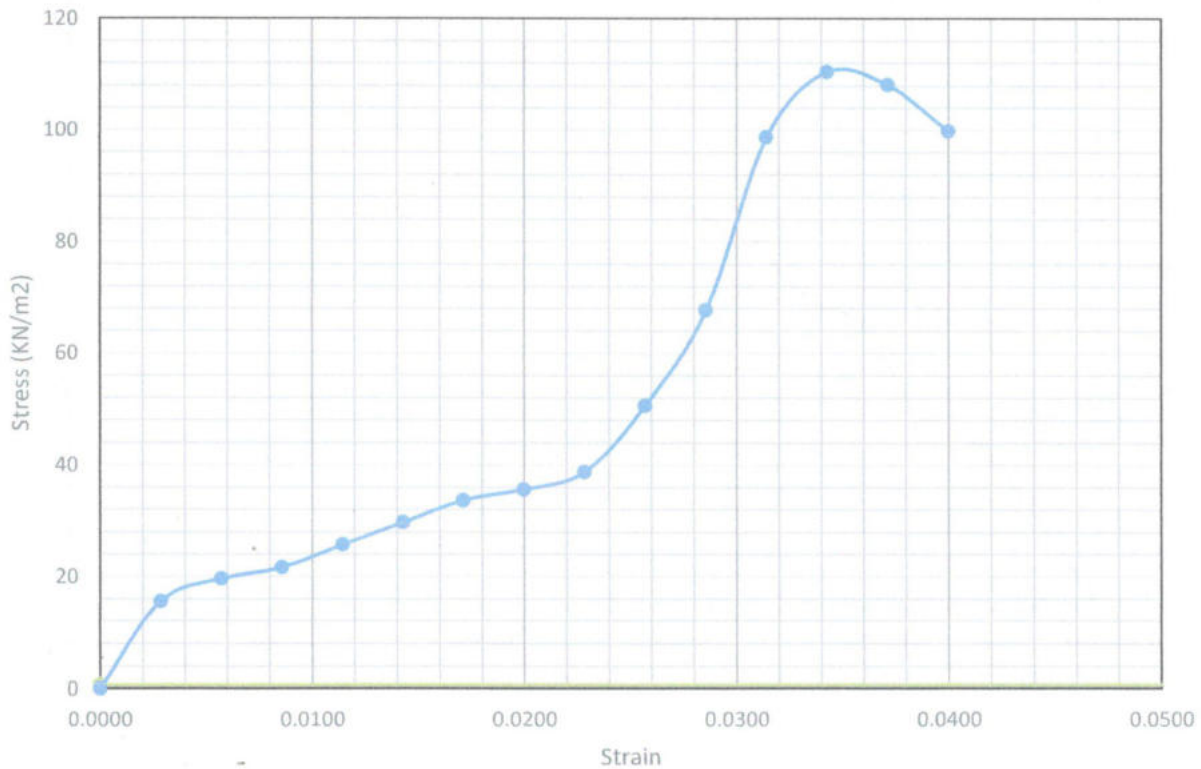
BH No.	4	Depth=	2
Results			
Qu=	160.680	KN/m ²	
Cu=qu/2=	80.340	KN/m ³	



S. Malakar
 Er. S. Ravi Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandran, Chy-03

Type of Test: Unconfined Compression Test

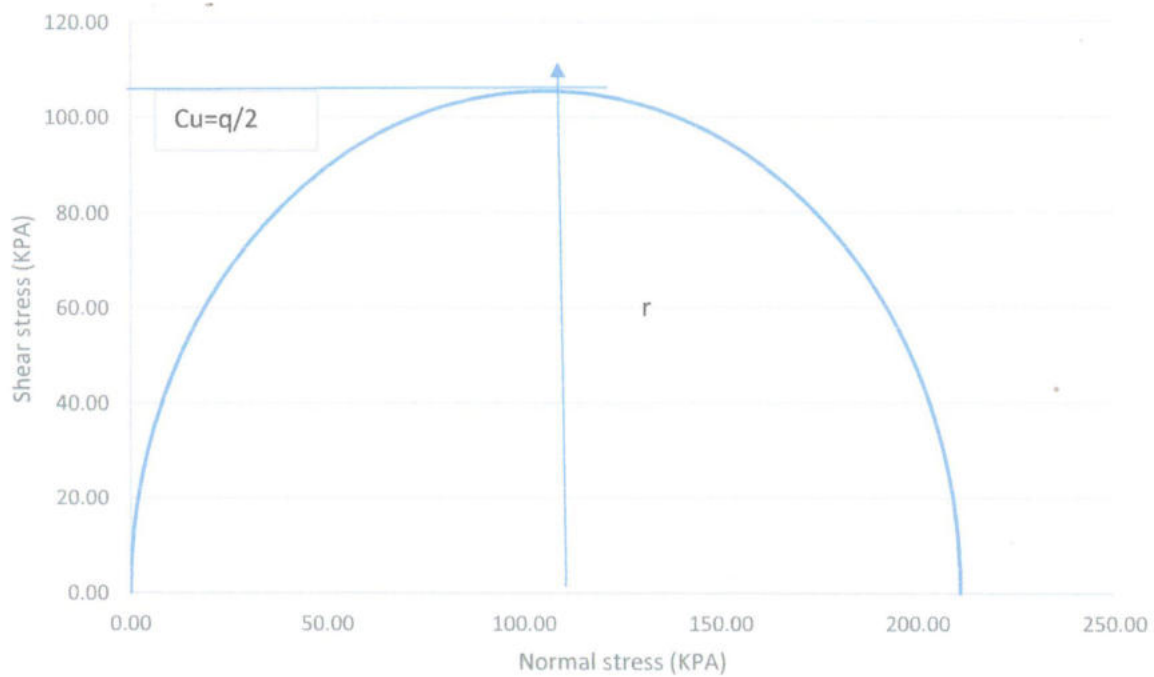
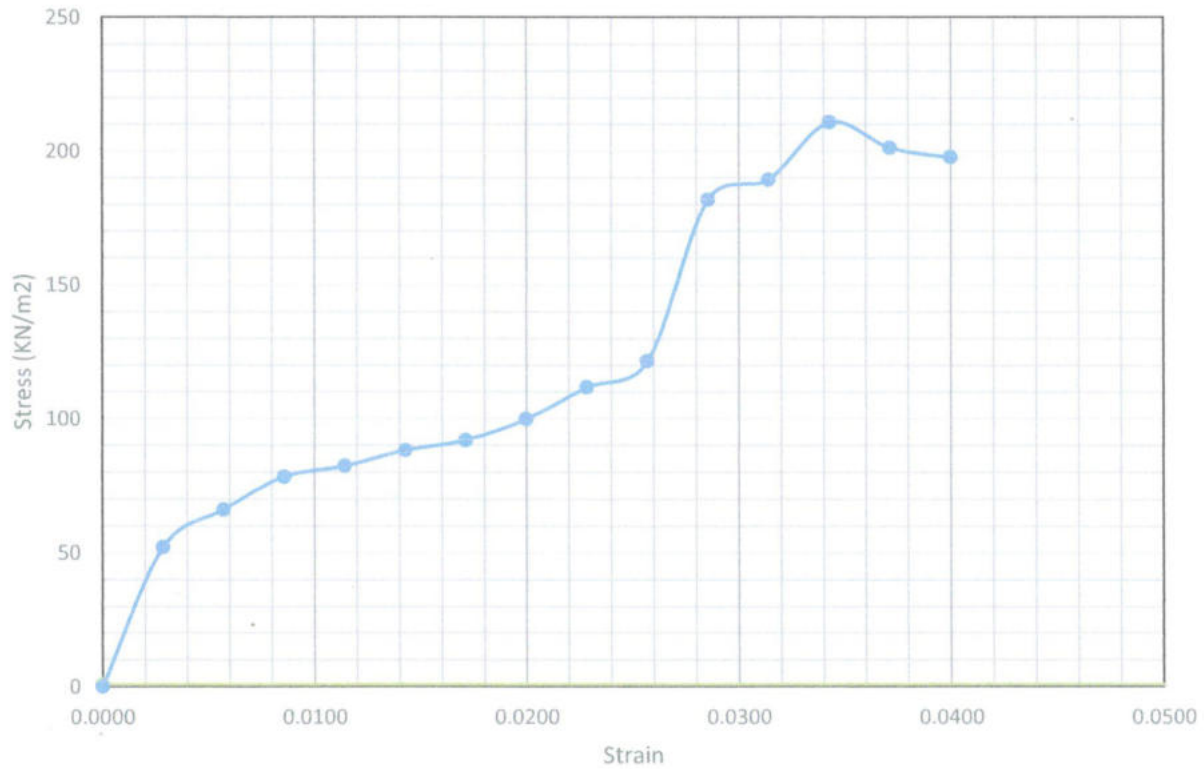
BH No.	5	Depth=	4
Results			
Qu=	110.468	KN/m2	
Cu=qu/2=	55.234	KN/m3	



S. Malakar
 En. Gulpi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandanpur, Ghy-03

Type of Test: Unconfined Compression Test

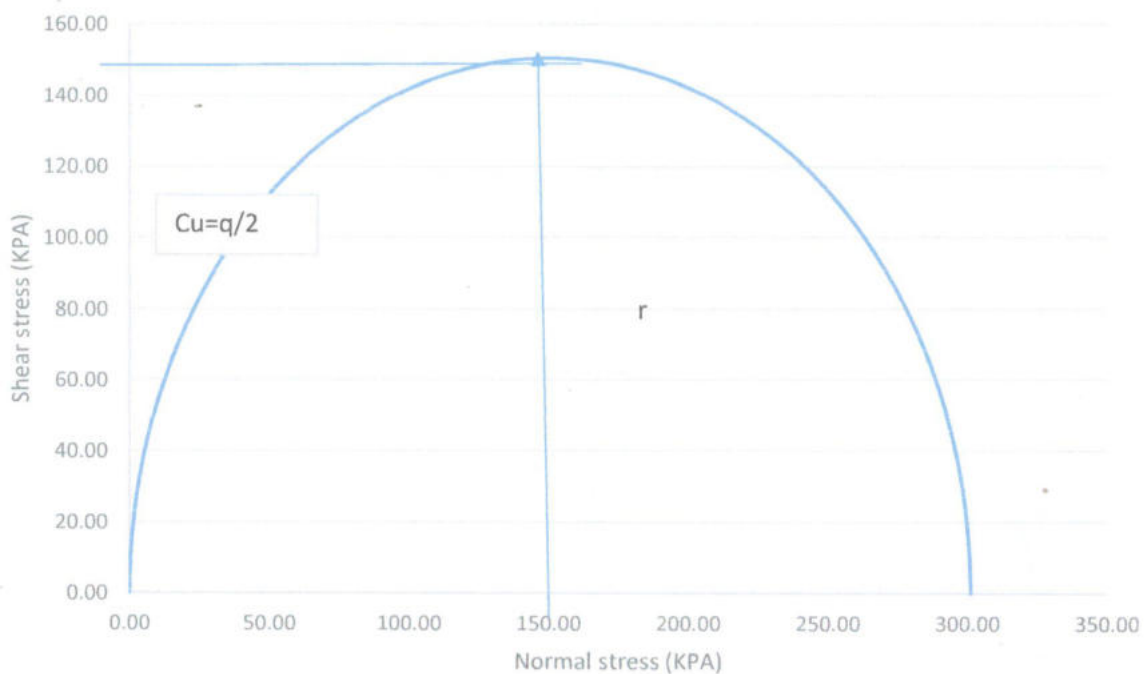
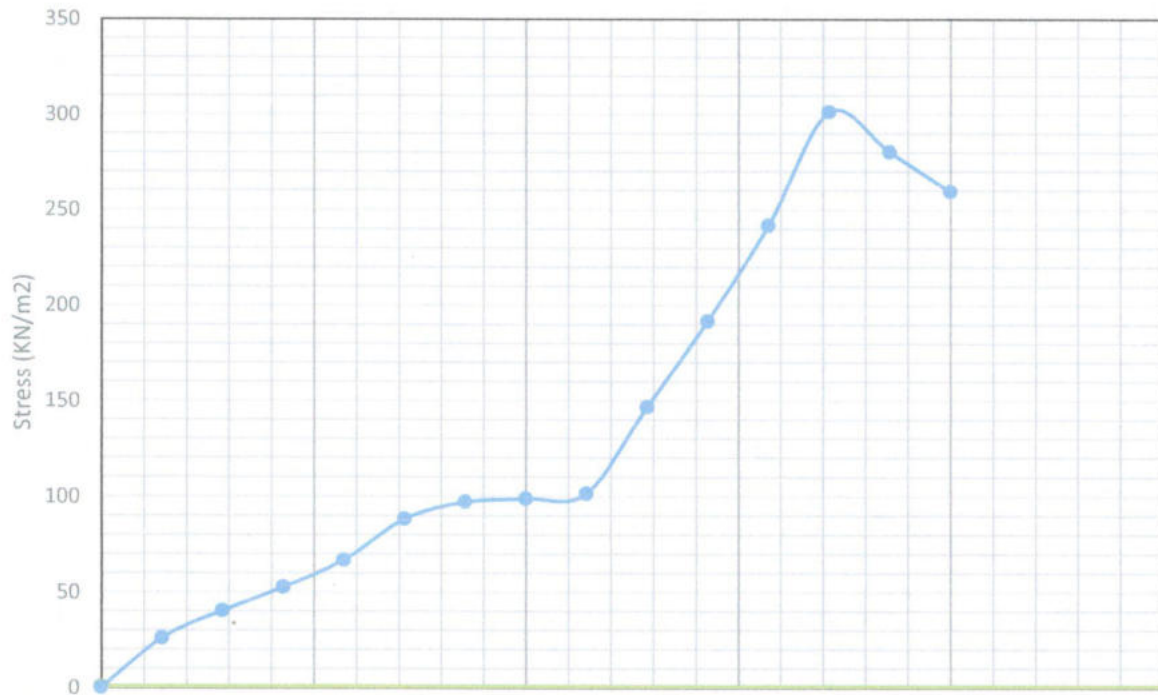
BH No.	5	Depth=	7
Results			
Qu=	210.893	KN/m2	
Cu=qu/2=	105.447	KN/m3	



S. Malakar
 Er. S. Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandrasekhar, Ghy-03

Type of Test: Unconfined Compression Test

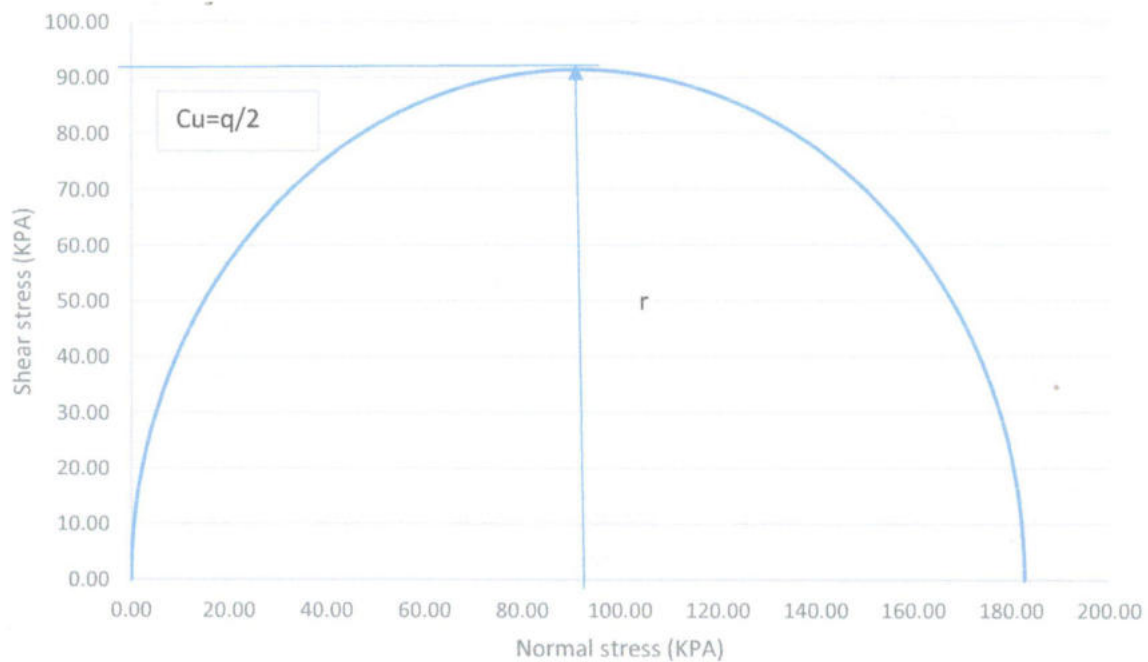
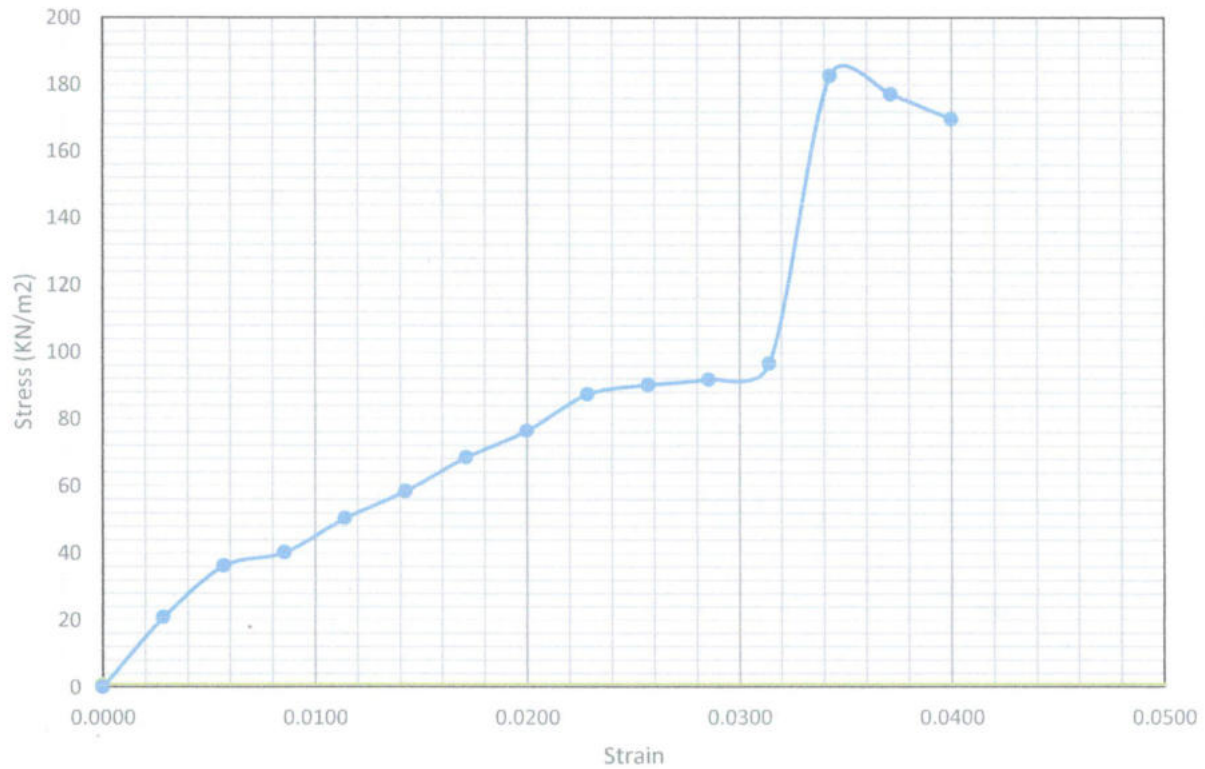
BH No.	6	Depth=	4
Results			
Qu=	301.276	KN/m2	
Cu=qu/2=	150.638	KN/m3	



S. Malakar
 Er. Gilpi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandernagor, Ghy-03

Type of Test: Unconfined Compression Test

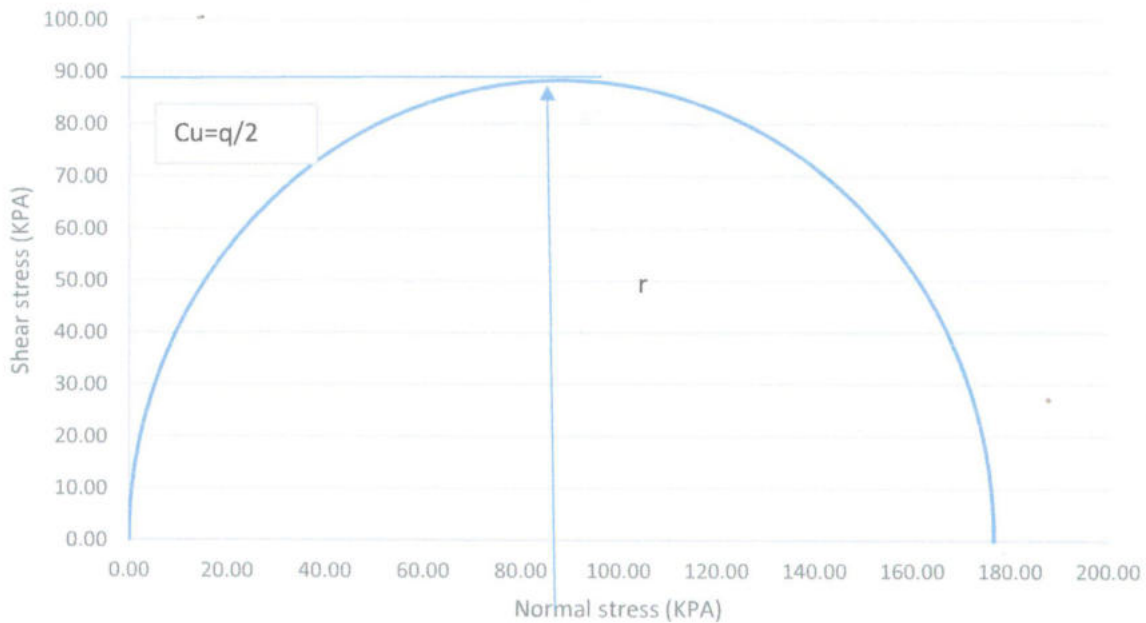
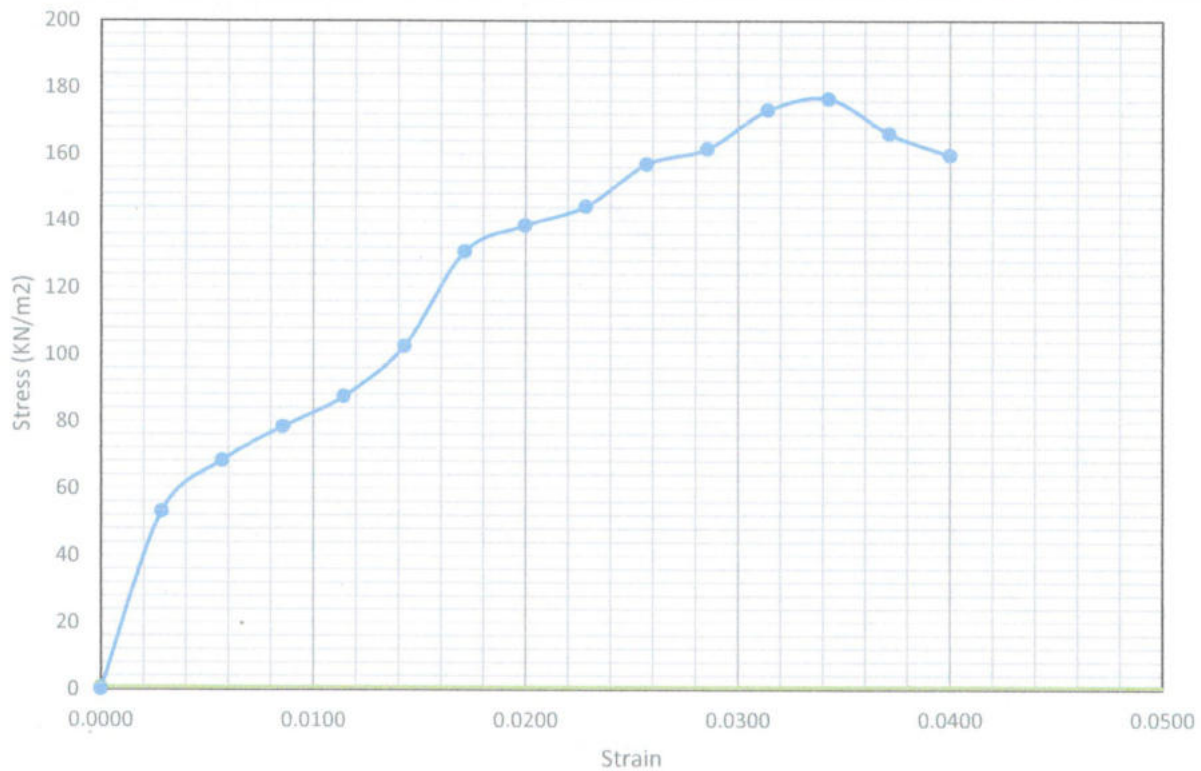
BH No.	9	Depth=	2
Results			
Qu=	182.774	KN/m ²	
Cu=qu/2=	91.387	KN/m ³	



S. Lalakar
 Er. Gopi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandmari, Ghy-03

Type of Test: Unconfined Compression Test

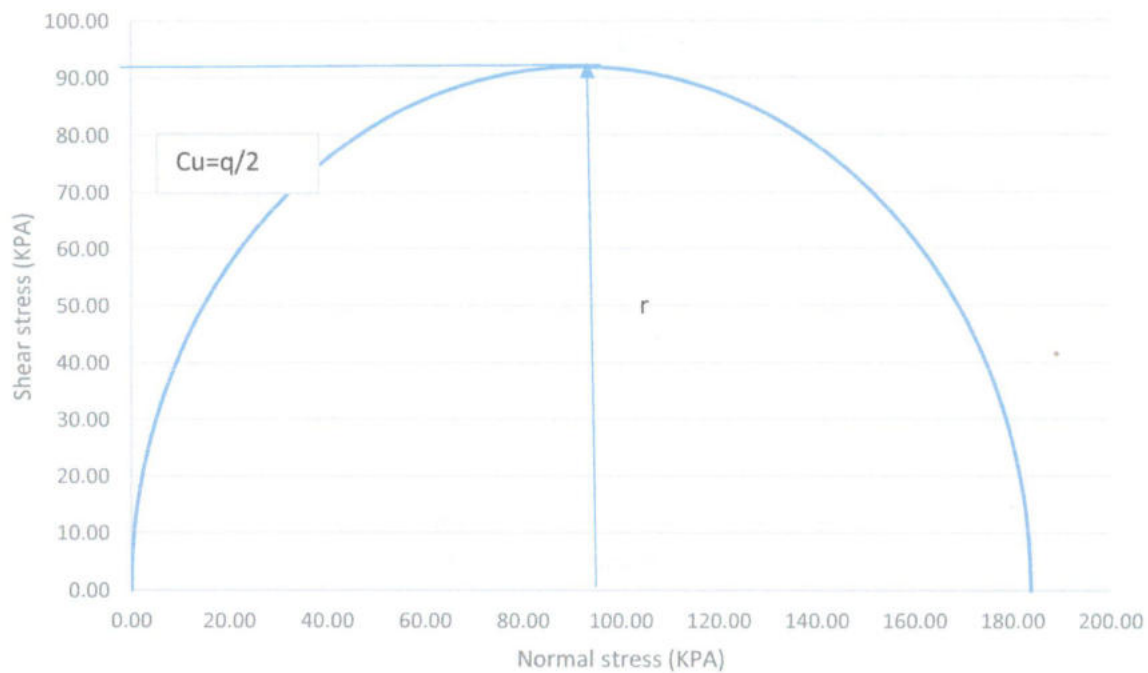
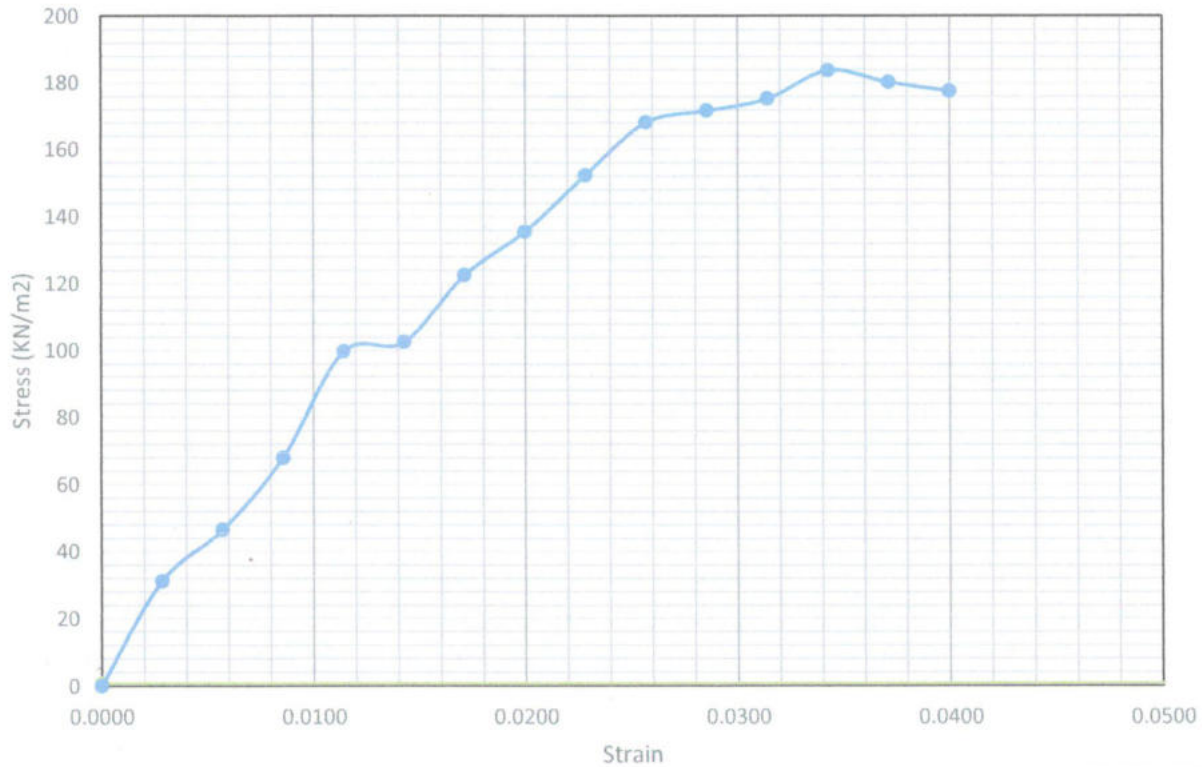
BH No.	10	Depth=	4
Results			
Qu=	176.748	KN/m ²	
Cu=qu/2=	88.374	KN/m ²	

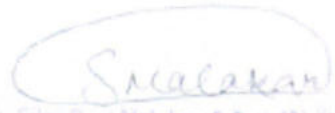


S. Malakar
 Sr. Civil Engineer, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandigarh, Chy-03

Type of Test: Unconfined Compression Test

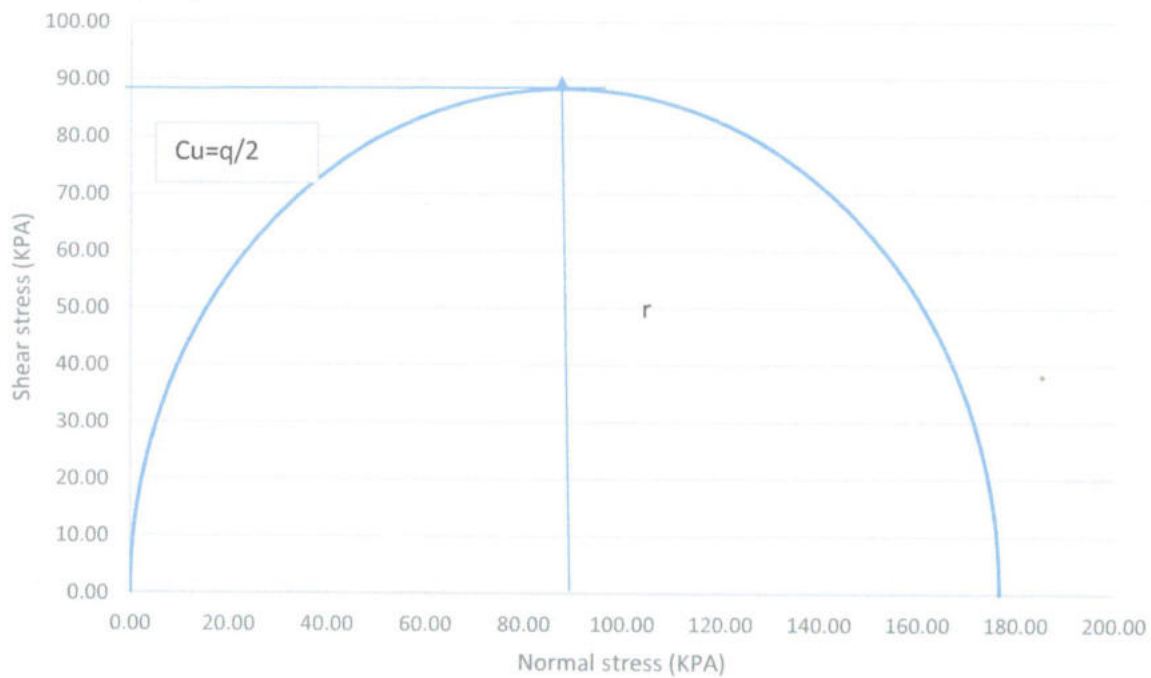
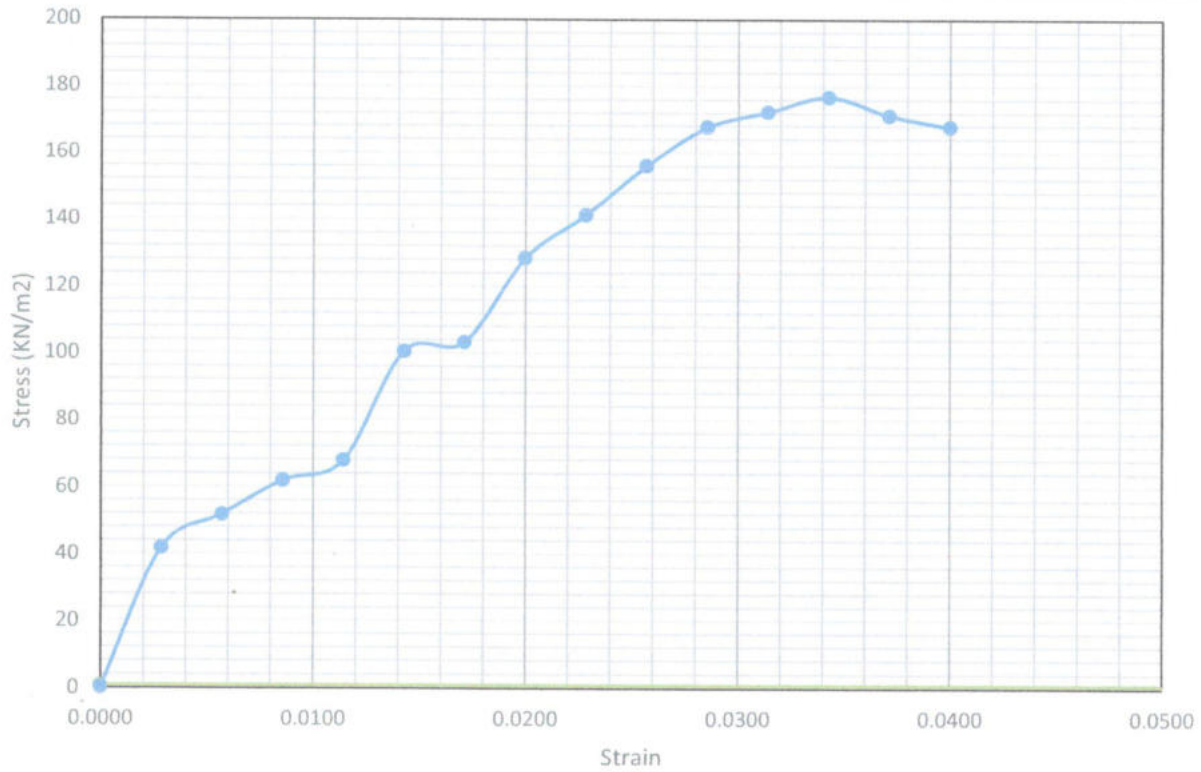
BH No.	10	Depth=	5
Results			
Qu=	183.778	KN/m ²	
Cu=q _u /2=	91.889	KN/m ³	




 Dr. Gilpi Rani Melakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandmari, Ghy-03

Type of Test: Unconfined Compression Test

BH No.	11	Depth=	4
Results			
Qu=	176.748	KN/m ²	
Cu=qu/2=	88.374	KN/m ³	



sigma

0

1

176.73

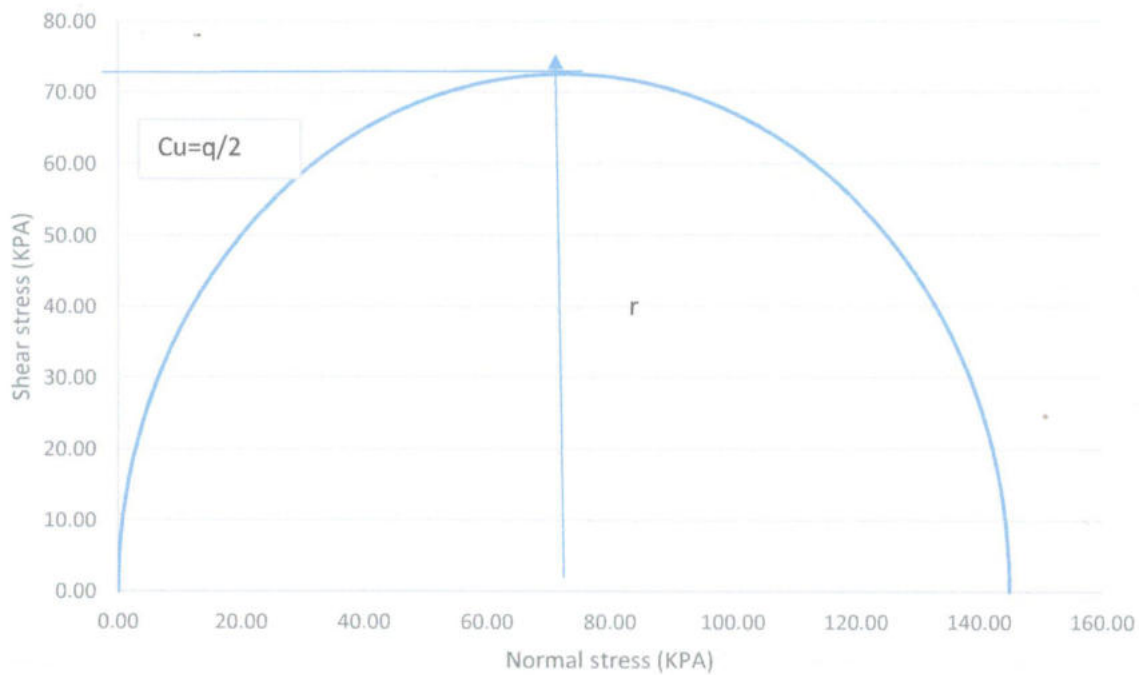
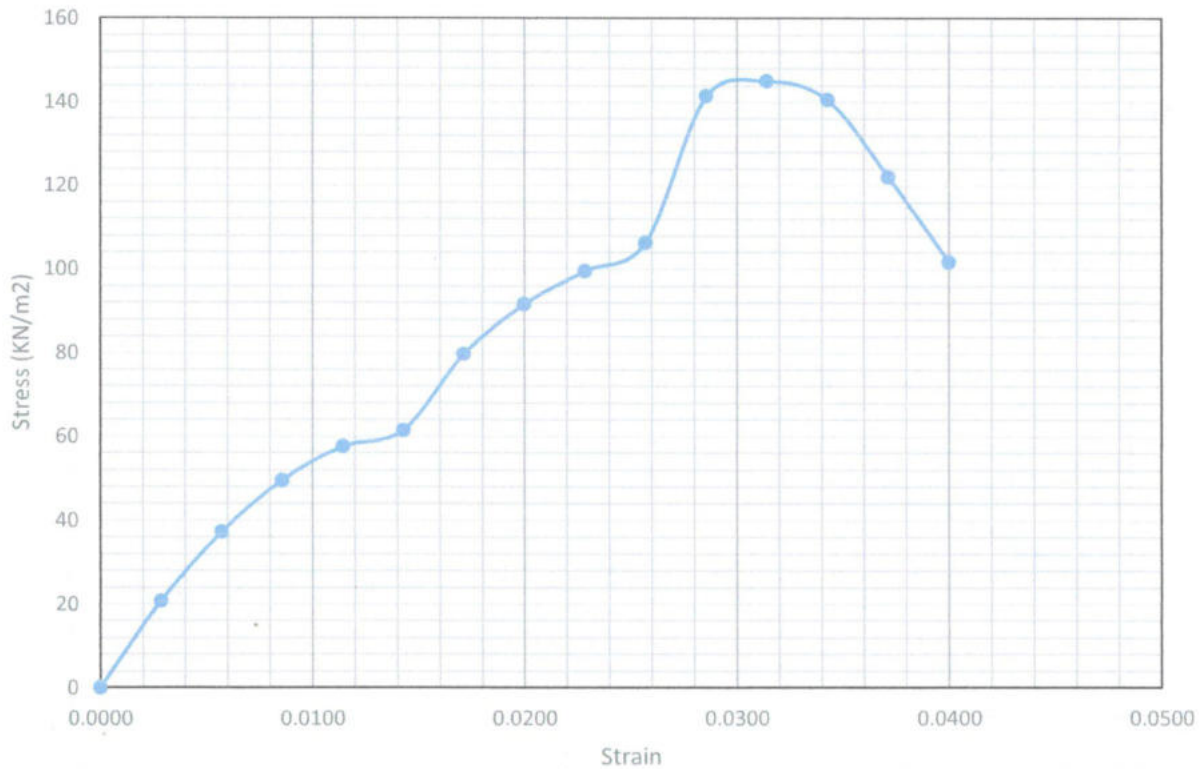
1.54



S. Malakar
 Sr. Civil Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandrasei, Ghy-03

Type of Test: Unconfined Compression Test

BH No.	12	Depth=	2
Results			
Qu=	145.040	KN/m2	
Cu=qu/2=	72.520	KN/m3	



S. Malakar
 En. Gilpi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandmari, Ghy-03

DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No.

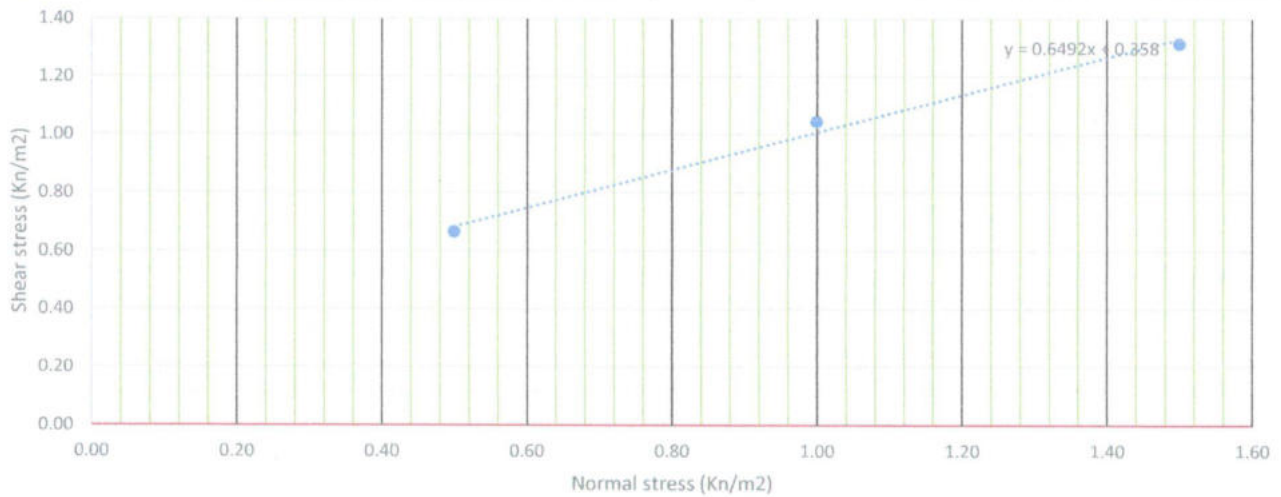
1

Depth=

9 m

Results From Graph

1	Angle of Internal Friction(°)	32.99
2	Cohesion C Kg/Cm2	0



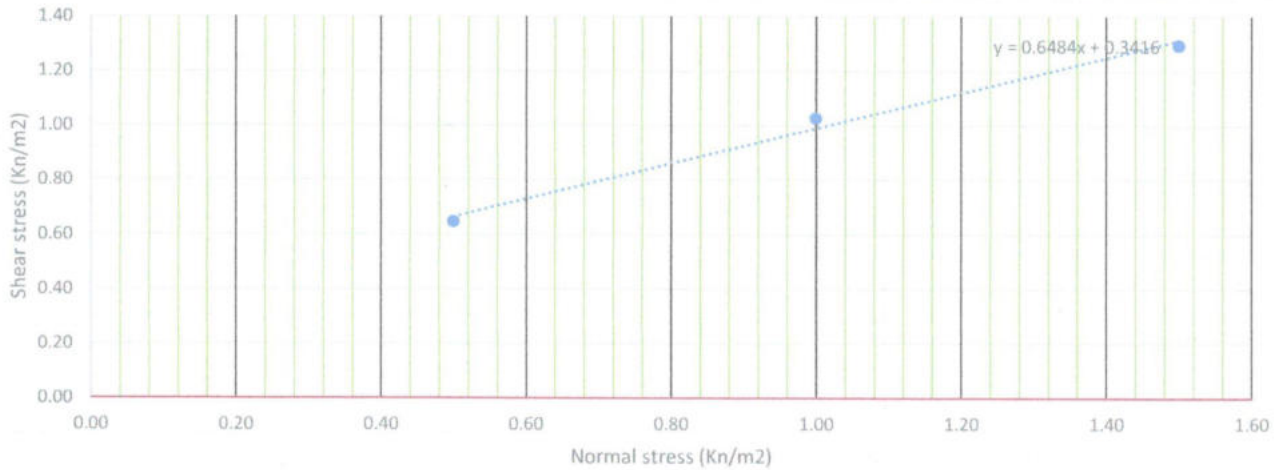
Sacalakar
Er. Gopi Rani Molakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandanpur, Ghy-03

DIRECT SHEAR TEST
(IS 2720 Part-13 : 2009)

BH No. 1 Depth= 10.5 m

Results From Graph

1	Angle of Internal Friction(°)	32.96
2	Cohesion C Kg/Cm2	0

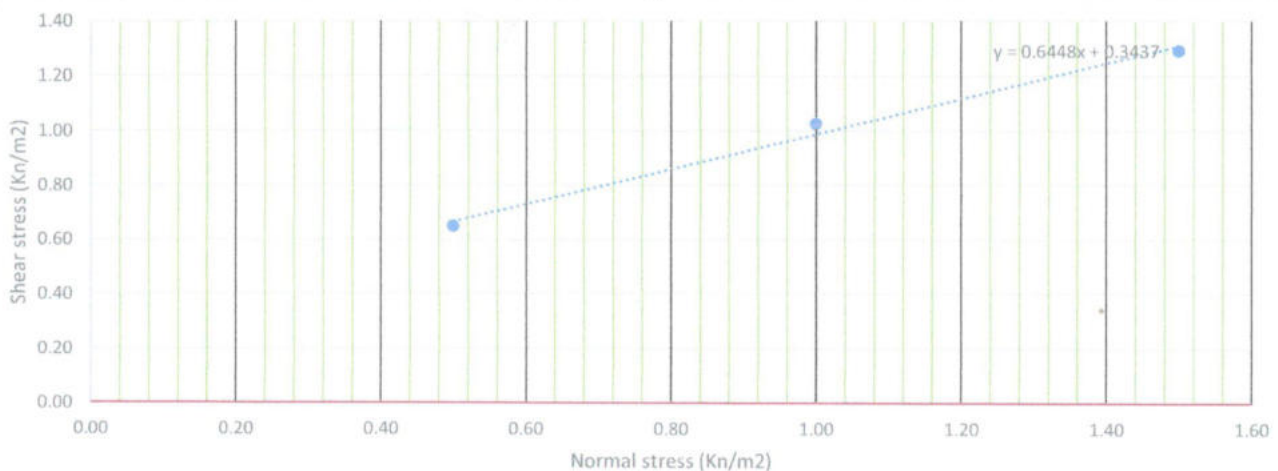


DIRECT SHEAR TEST
(IS 2720 Part-13 : 2009)

BH No. 1 Depth= 12 m

Results From Graph

1	Angle of Internal Friction(°)	32.81
2	Cohesion C Kg/Cm2	0



Sivalakan
Er. Gilpi Sasi Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chakdaha, Ghy-03

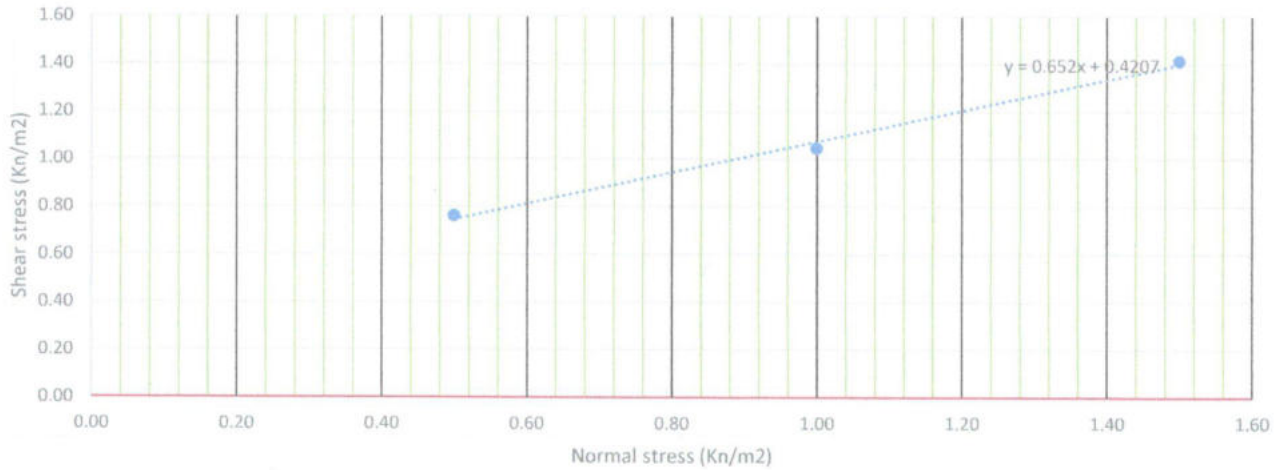
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 1 Depth= 13.5 m

Results From Graph

1	Angle of Internal Friction(°)	33.10
2	Cohession C Kg/Cm2	0



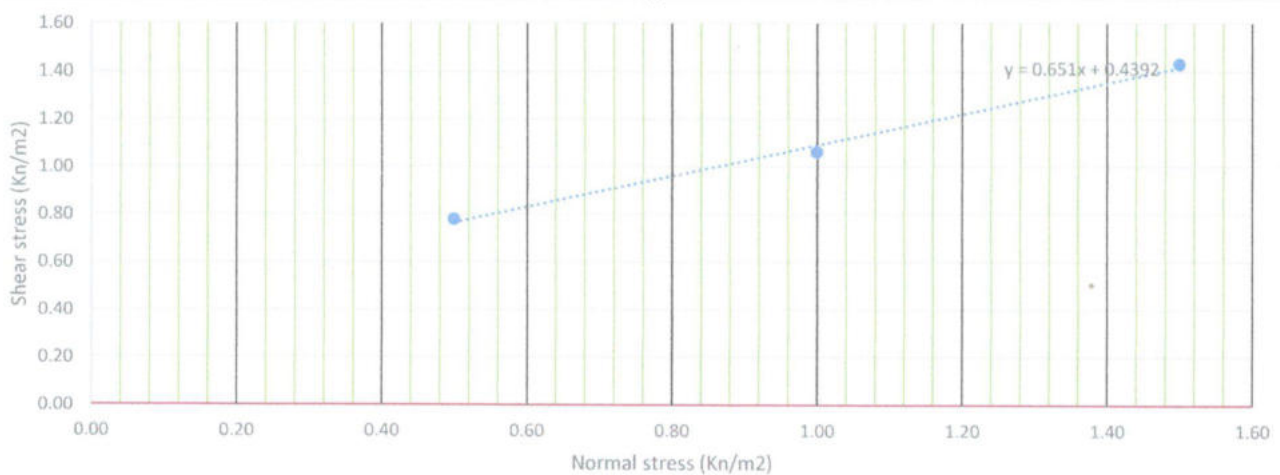
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 1 Depth= 15 m

Results From Graph

1	Angle of Internal Friction(°)	33.07
2	Cohession C Kg/Cm2	0



Snehalakar
Dr. Gopal Rani Metakur, B.Tech (Civil)
North East Engineer's
GMC Market, Chandmari, Ghy-03

DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No.

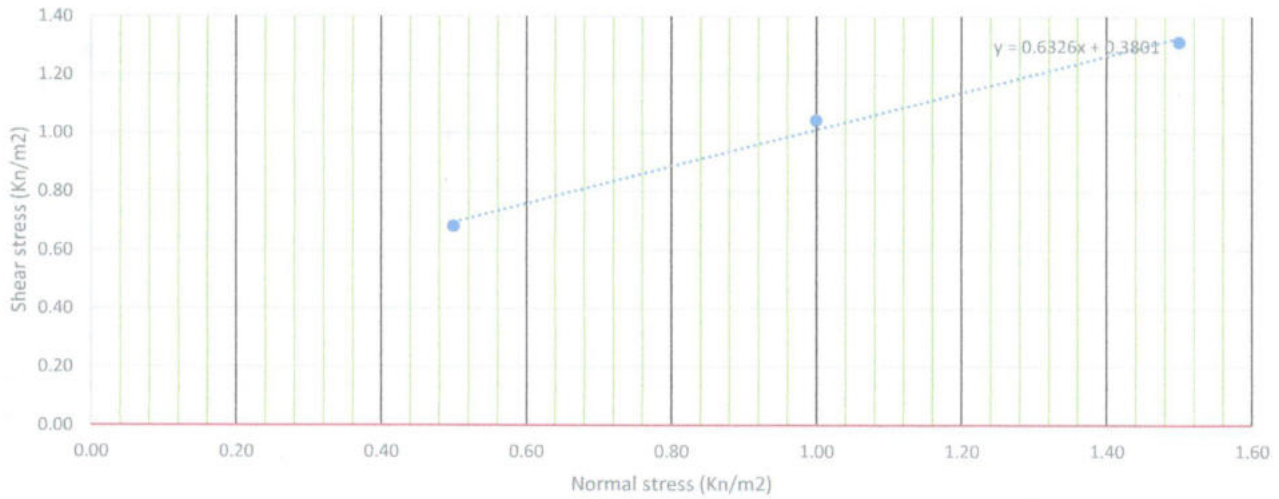
2

Depth=

4.5 m

Results From Graph

1	Angle of Internal Friction(°)	32.32
2	Cohesion C Kg/Cm2	0



S. Malakar
Er. Gopi Ravi Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-160003

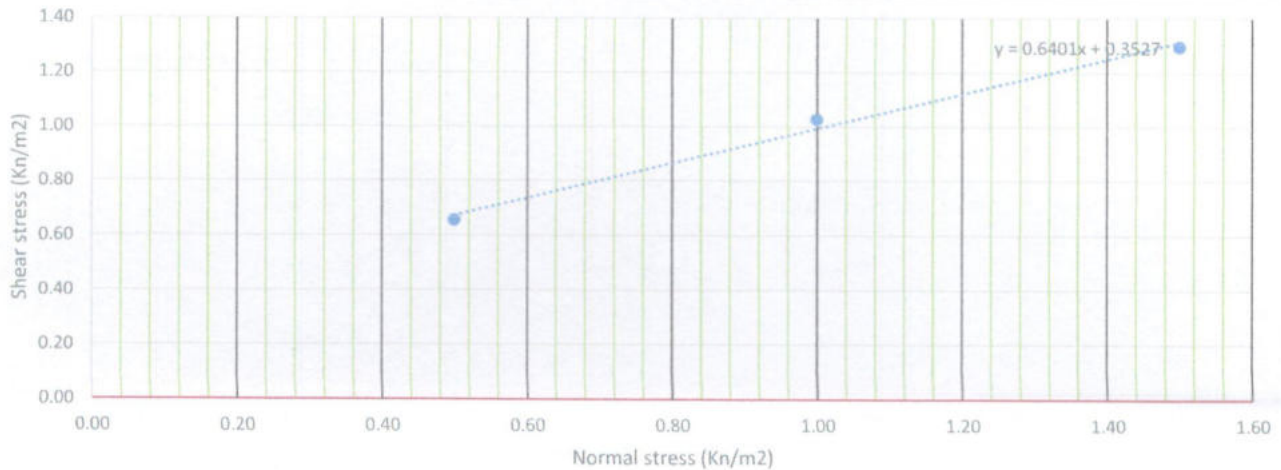
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 2 Depth= 6 m

Results From Graph

1	Angle of Internal Friction(°)	32.62
2	Cohession C Kg/Cm2	0



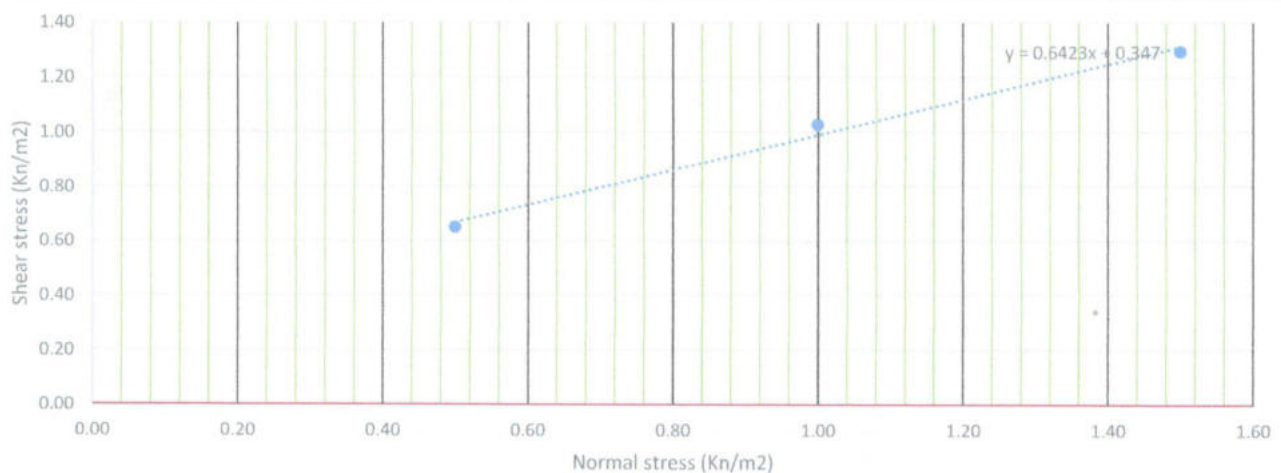
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 2 Depth= 7.5 m

Results From Graph

1	Angle of Internal Friction(°)	32.71
2	Cohession C Kg/Cm2	0



S. Kulkarni
En. Sili Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh, Ghy-03

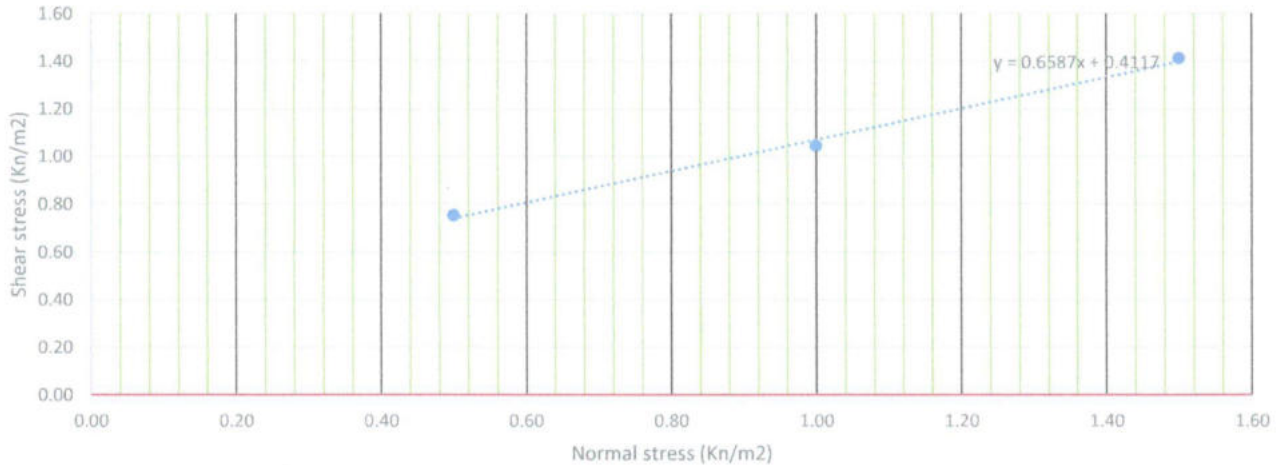
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 2 Depth= 9 m

Results From Graph

1	Angle of Internal Friction(°)	33.37
2	Cohesion C Kg/Cm2	0



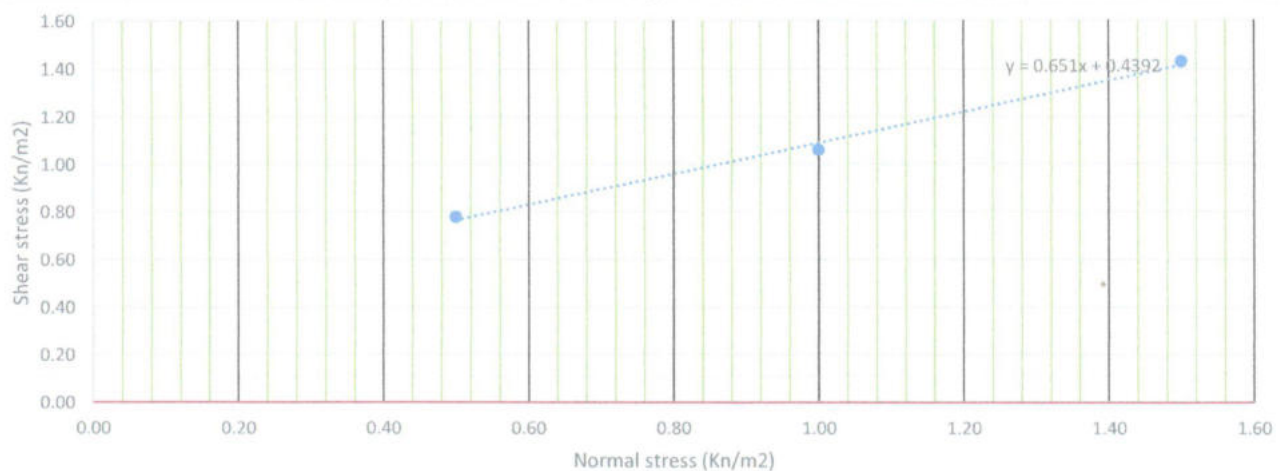
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 2 Depth= 10.5 m

Results From Graph

1	Angle of Internal Friction(°)	33.07
2	Cohesion C Kg/Cm2	0

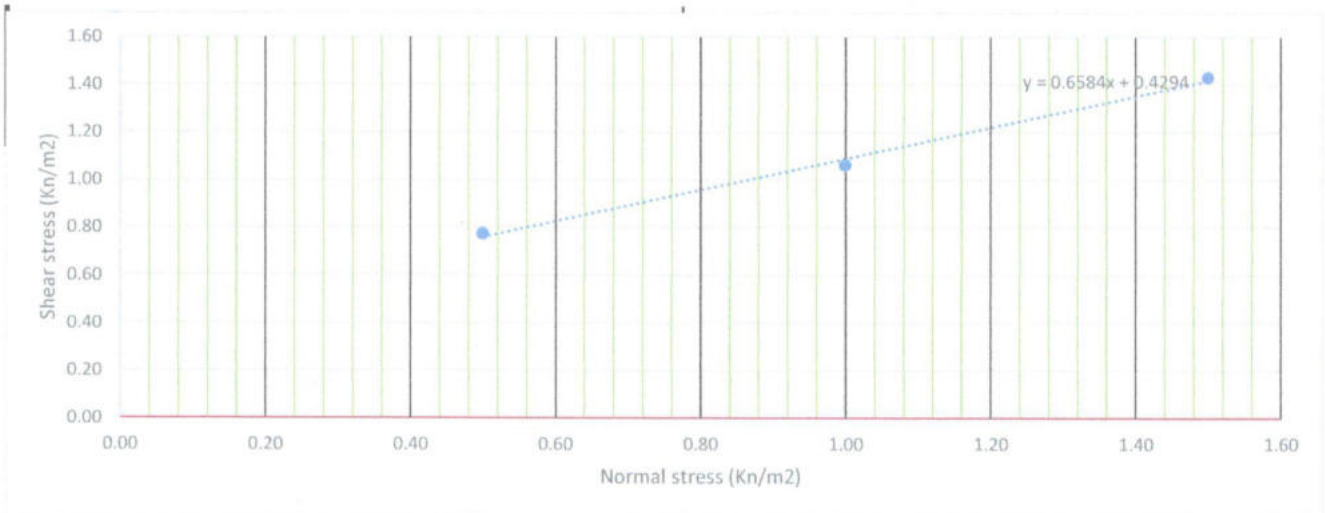


S. Malakar
Dr. Sibi Rami Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-03

BH No.	2	Depth=	12 m
Type of Material	sand		

Results From Graph

1	Angle of Internal Friction(°)	33.36
2	Cohesion C Kg/Cm2	0

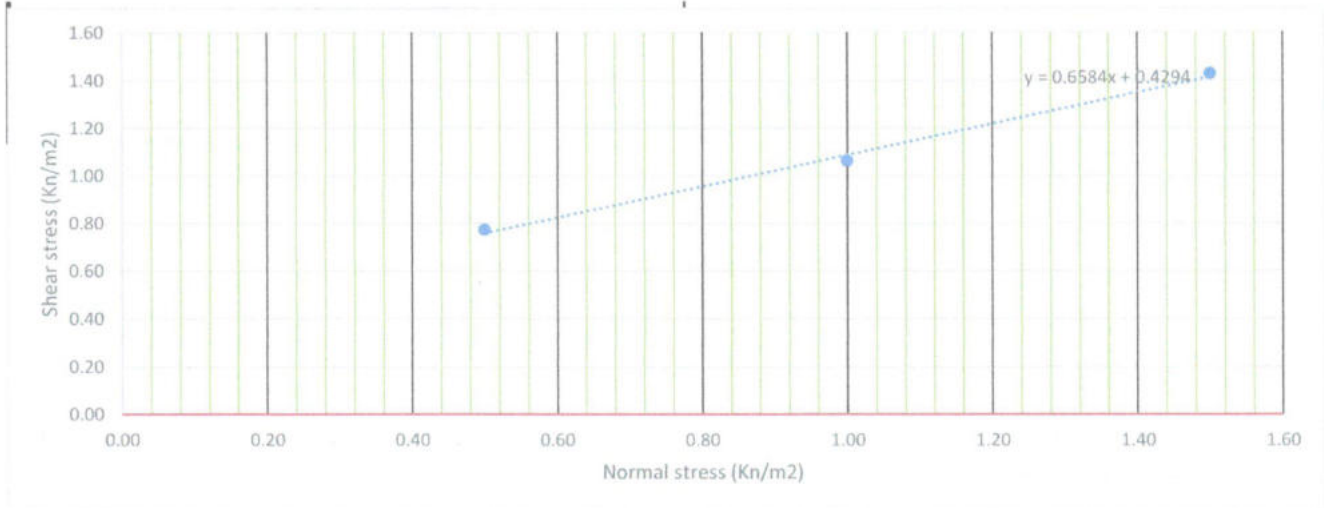


Sivalakan
 Er. Sibi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chanchal Gh-03

BH No.	2	Depth=	13.5 m
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Results From Graph

1	Angle of Internal Friction(°)	33.40
2	Cohesion C Kg/Cm2	0



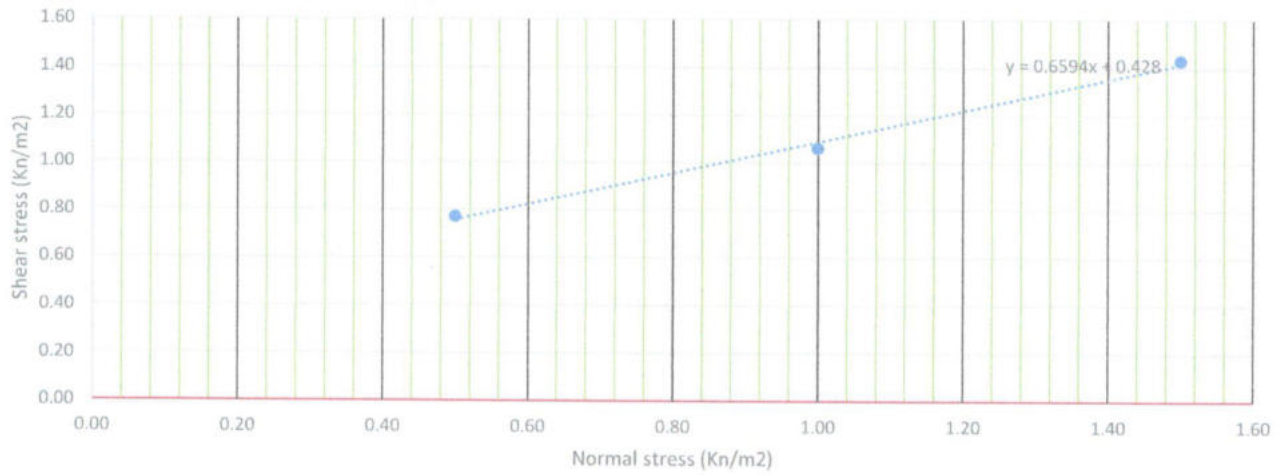
S. Malakar

Er. Sibi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-03

BH No.	2	Depth=	15 m
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Results From Graph

1	Angle of Internal Friction(°)	35.04
2	Cohesion C Kg/Cm2	0



S. Malakar
 Et. S. Rami Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandernagor Ghy-03

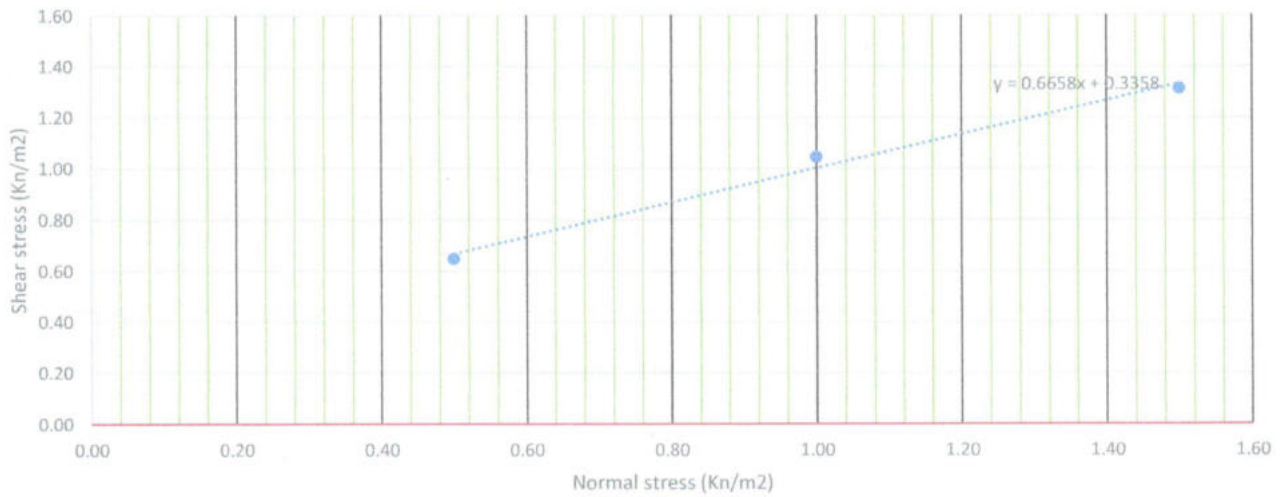
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 3 Depth= 3 m

Results From Graph

1	Angle of Internal Friction(°)	33.66
2	Cohesion C Kg/Cm2	0



S. Malakar
Er. Sibi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandrasekhar, Chy-03

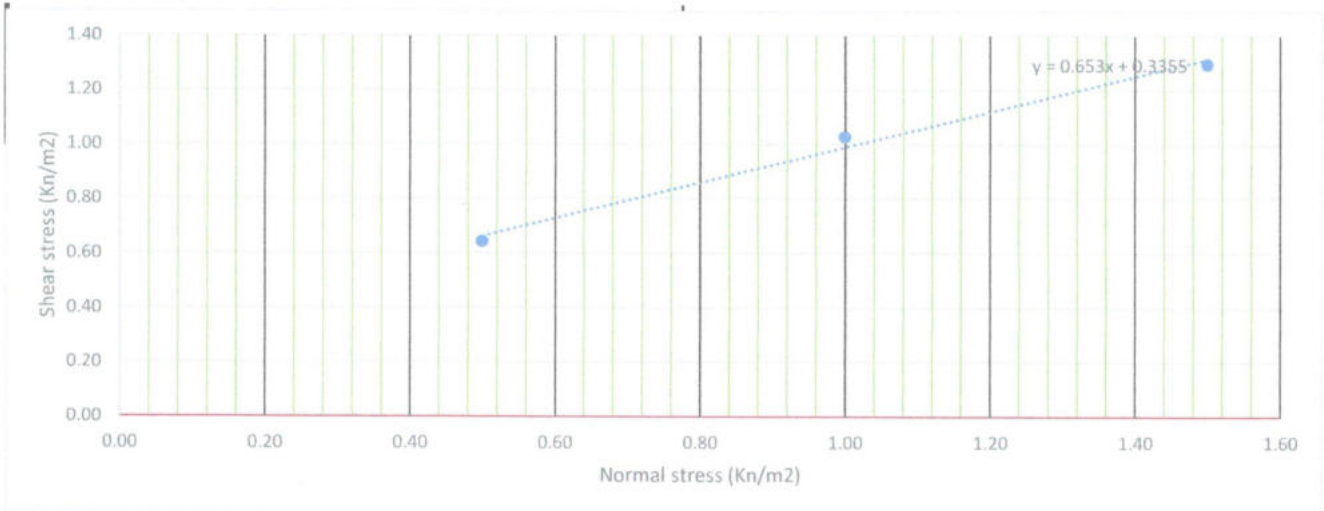
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 3 Depth= 4.5 m

Results From Graph

1	Angle of Internal Friction(°)	33.14
2	Cohesion C Kg/Cm2	0



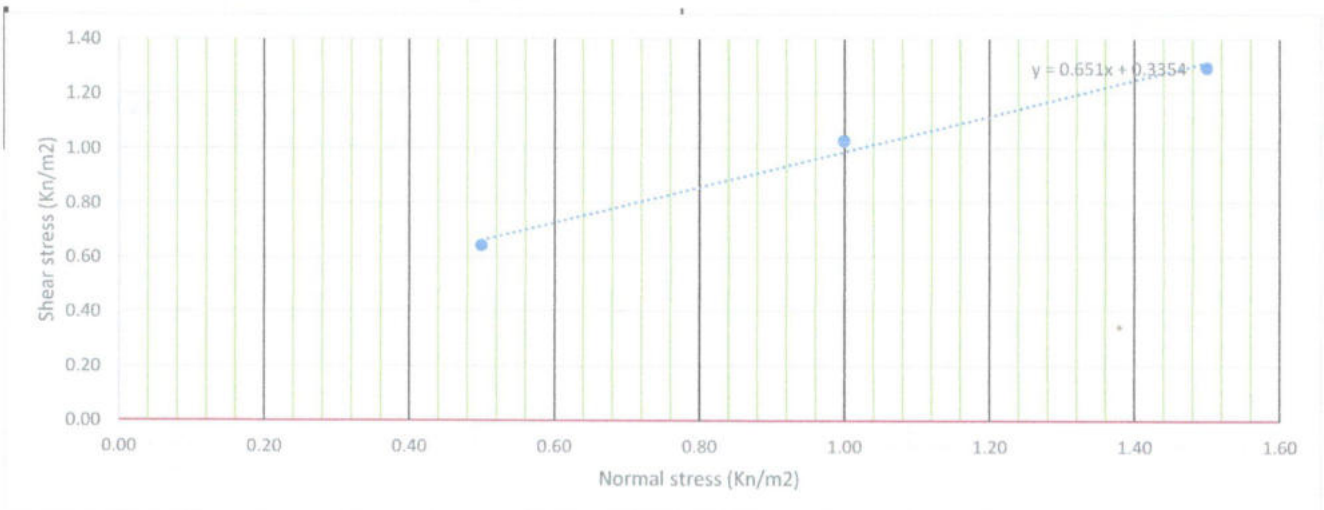
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 3 Depth= 6 m

Results From Graph

1	Angle of Internal Friction(°)	33.07
2	Cohesion C Kg/Cm2	0



S. Malakar
Er. S. Rami Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandan Gh. 03

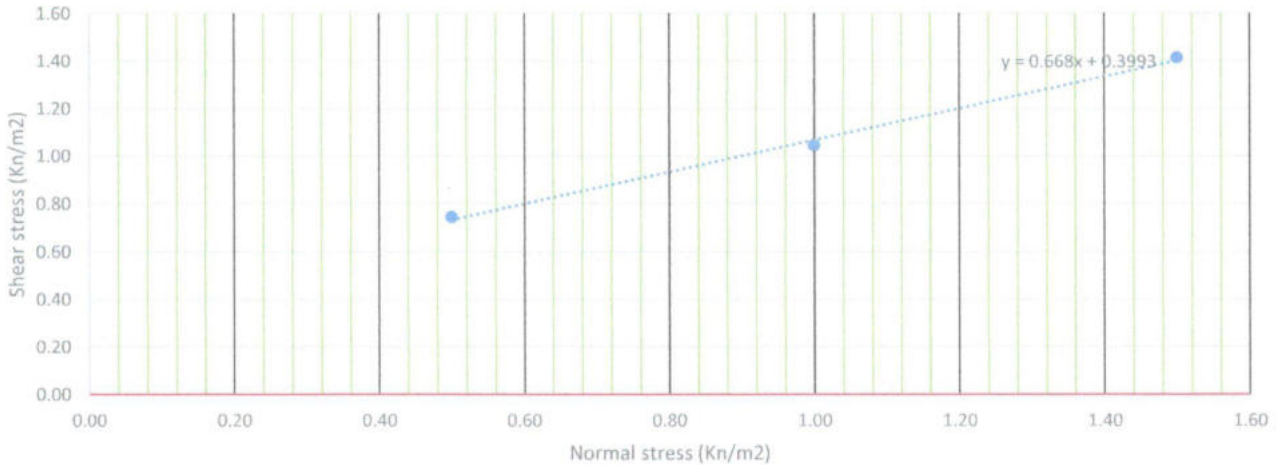
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 3 Depth= 7.5 m

Results From Graph

1	Angle of Internal Friction(°)	33.74
2	Cohesion C Kg/Cm2	0



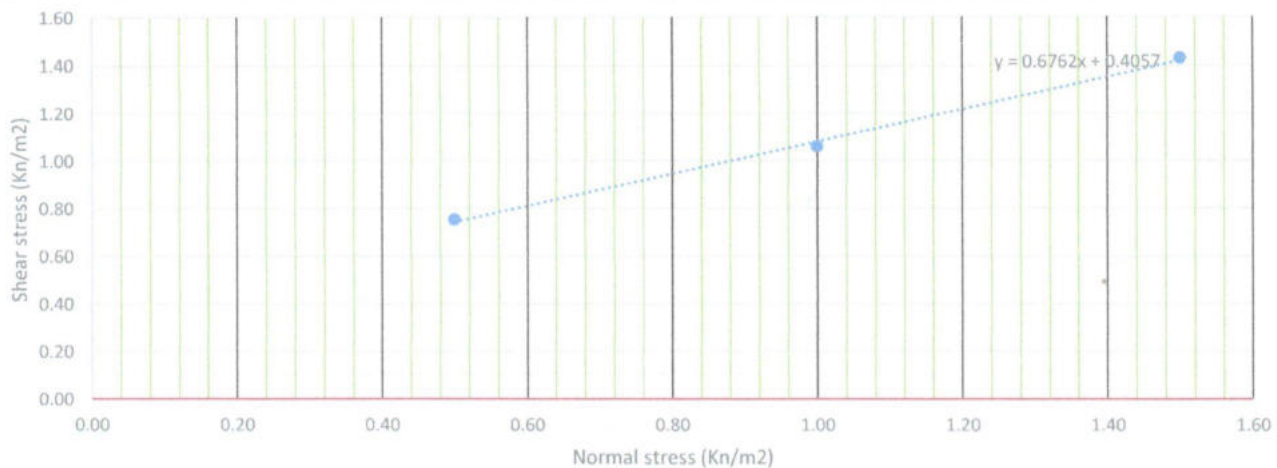
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 3 Depth= 9 m

Results From Graph

1	Angle of Internal Friction(°)	34.07
2	Cohesion C Kg/Cm2	0

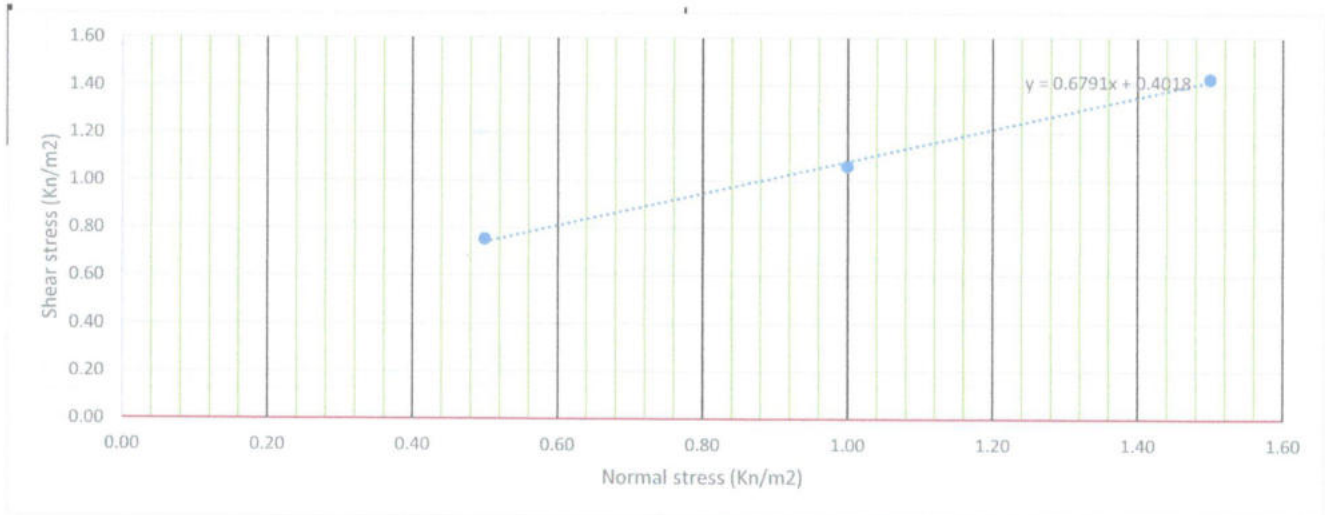


S. Malakar
Er. Sibi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandanani, Ghy-03

BH No.	3	Depth=	10.5 m
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Results From Graph

1	Angle of Internal Friction(°)	34.18
2	Cohesion C Kg/Cm2	0

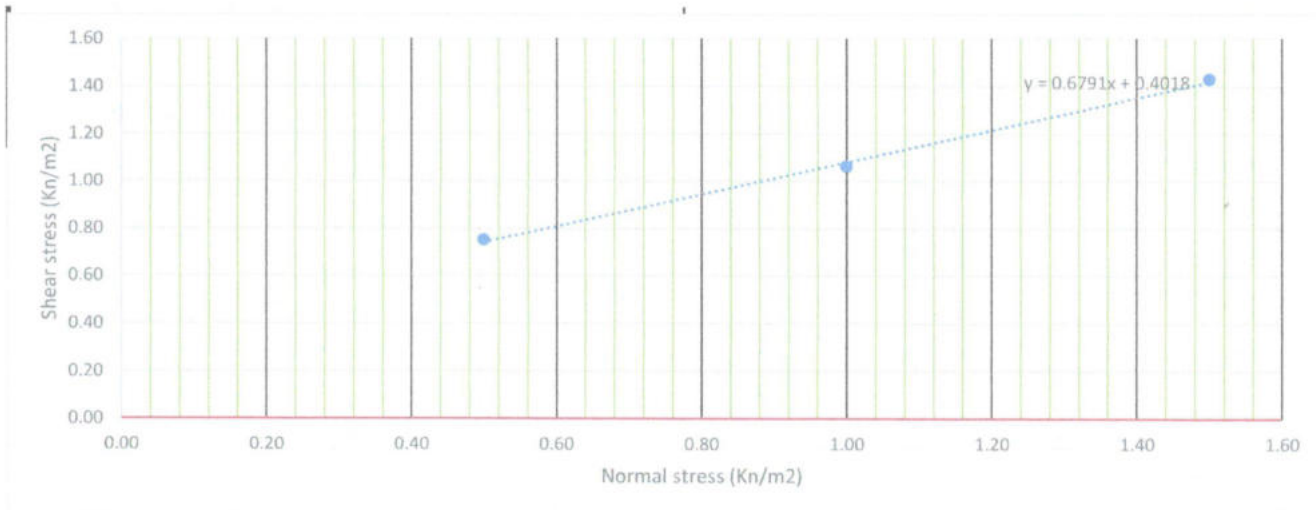


S. Malakar
 Cr. Sipli Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandanpur, Gh. 03

BH No. 3 Depth= 12 m

Results From Graph

1	Angle of Internal Friction(°)	34.21
2	Cohession C Kg/Cm2	0

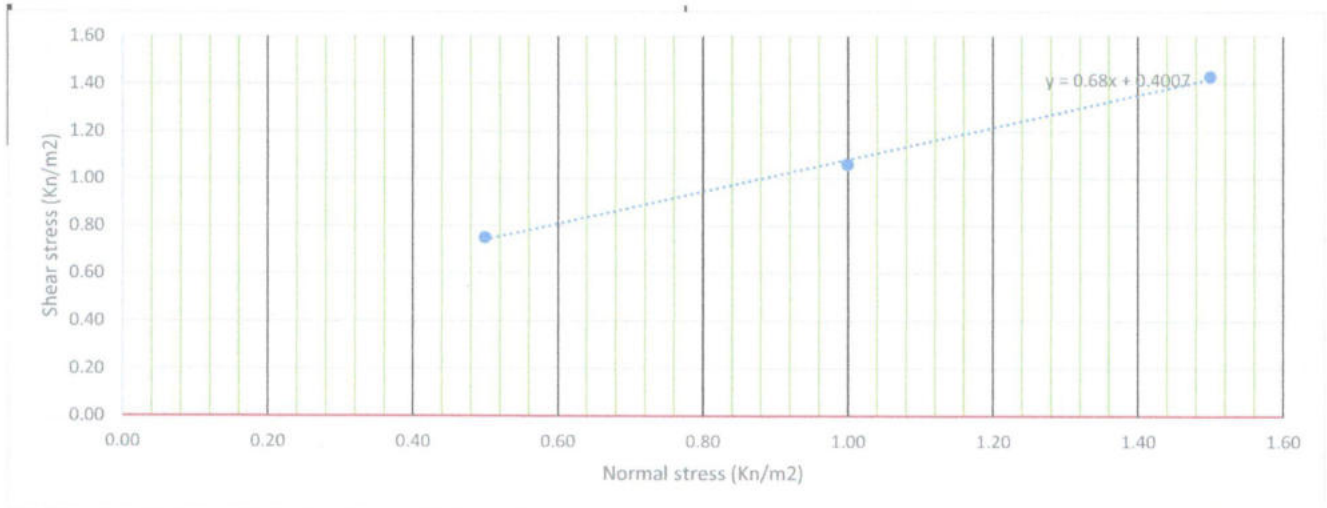


S. K. Lakshmi
Sr. Supt Rani Melakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chanderigarh, Chy-03

BH No. 3 Depth= 13.5 m

Results From Graph

1	Angle of Internal Friction(°)	34.03
2	Cohesion C Kg/Cm2	0

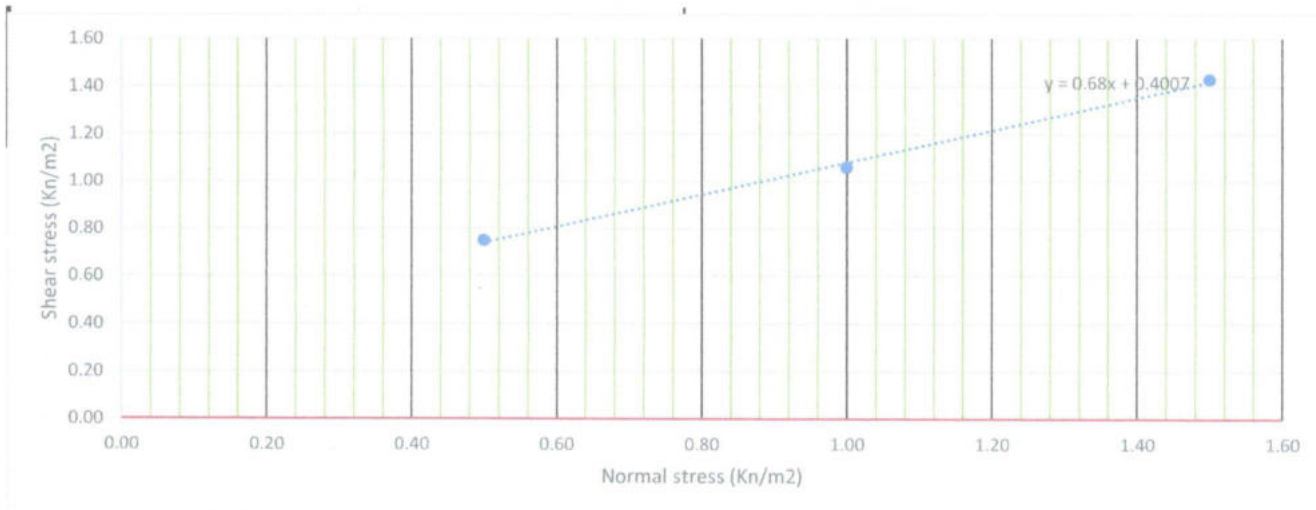


S. Malakar
Er. Silpi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandrasekhar, Ghy-03

BH No. 3 Depth= 15 m

Results From Graph

1	Angle of Internal Friction(°)	34.00
2	Cohession C Kg/Cm2	0



S. Lalakar
Er. Gipsi Rani Melakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandman Ghy-03

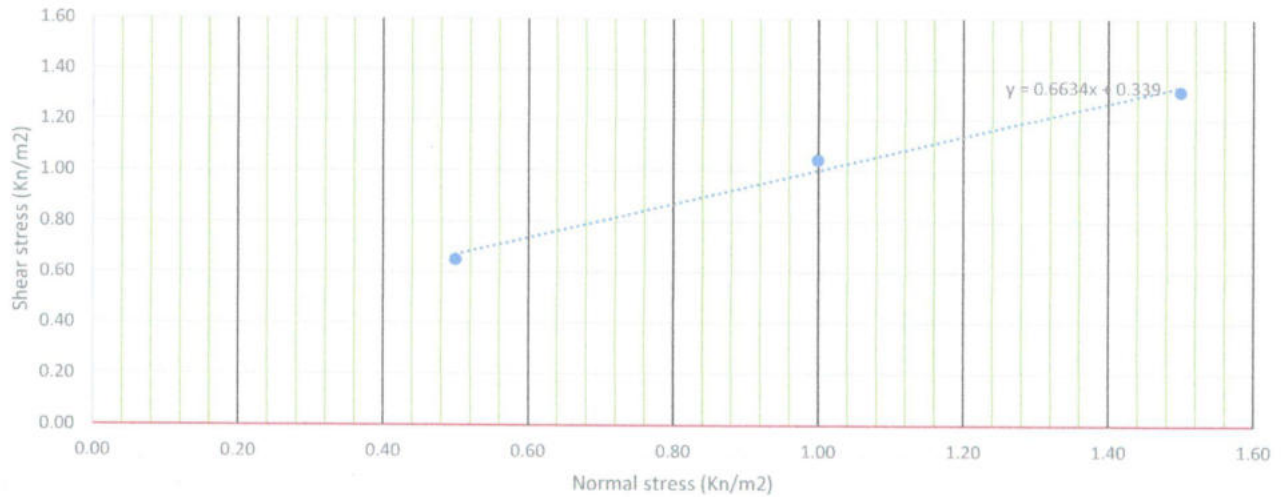
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 4 Depth= 4.5 m

Results From Graph

1	Angle of Internal Friction(°)	33.56
2	Cohesion C Kg/Cm2	0



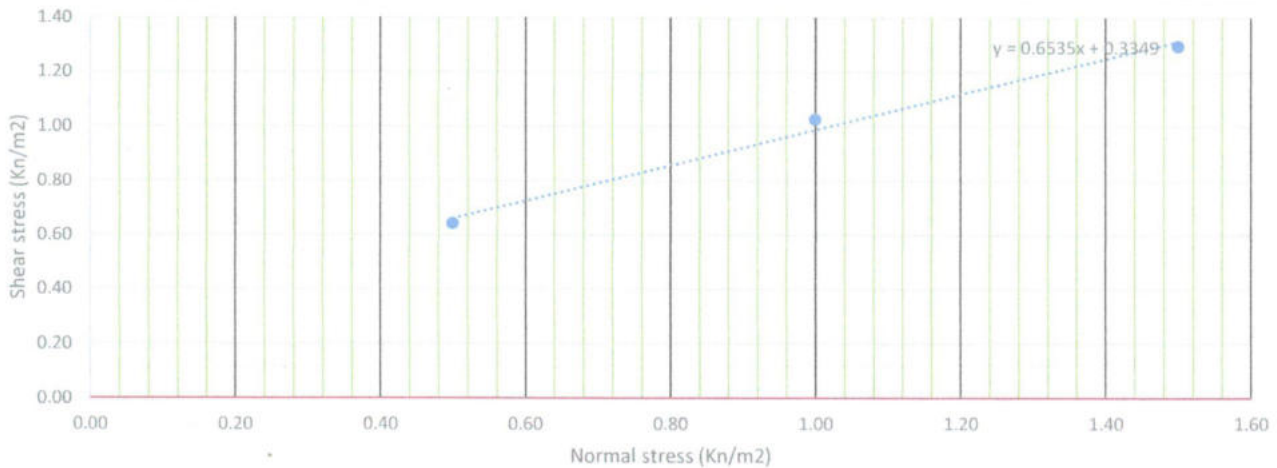
S. Lalakar
Sr. Civil Engr. Melakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-03

DIRECT SHEAR TEST (IS 2720 Part-13 : 2009)

BH No. 4 Depth= 6 m

Results From Graph

1	Angle of Internal Friction(°)	33.16
2	Cohession C Kg/Cm2	0

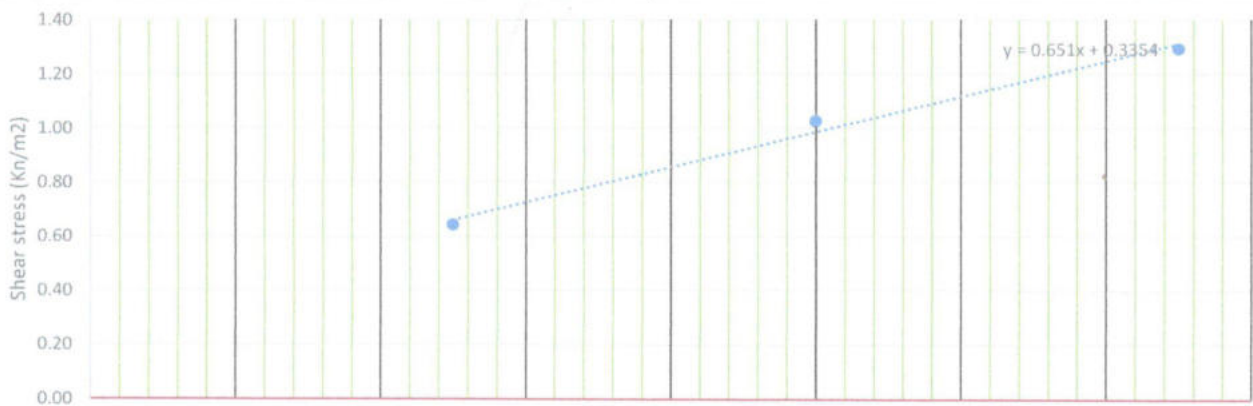


DIRECT SHEAR TEST (IS 2720 Part-13 : 2009)

BH No. 4 Depth= 7.5 m

Results From Graph

1	Angle of Internal Friction(°)	33.07
2	Cohession C Kg/Cm2	0



S. Malakar
Er. Silpi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandan Ghry-03

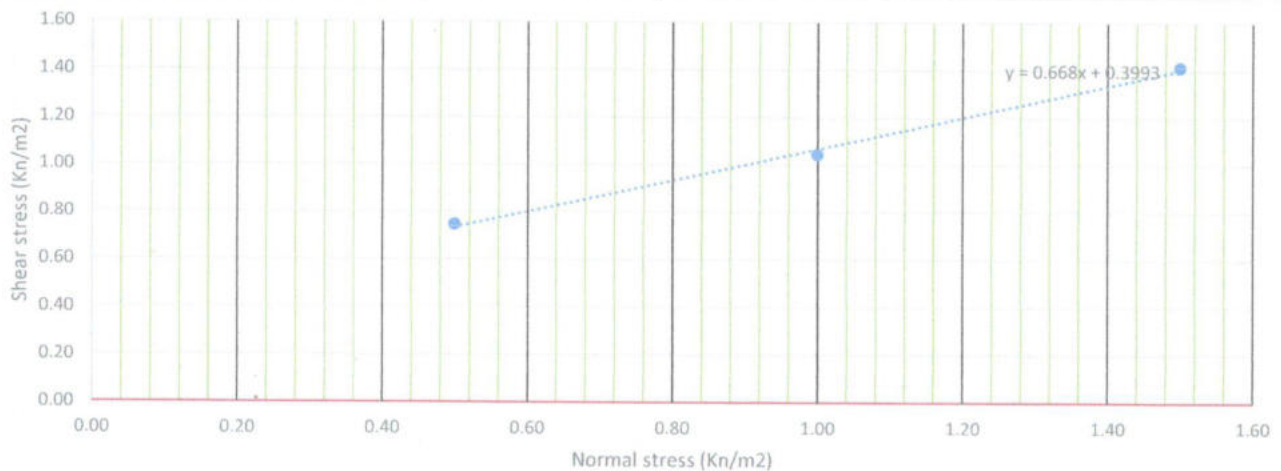
0.00 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
Normal stress (Kn/m²)

DIRECT SHEAR TEST
(IS 2720 Part-13 : 2009)

BH No. 4 Depth= 9 m

Results From Graph

1	Angle of Internal Friction(°)	33.74
2	Cohesion C Kg/Cm ²	0

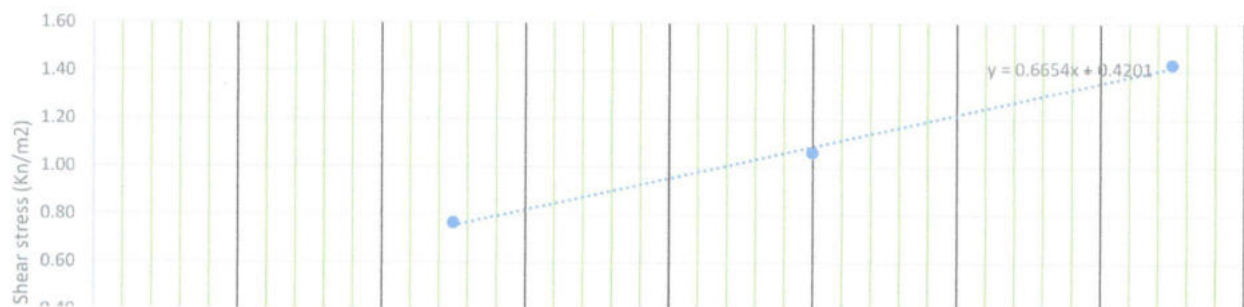


DIRECT SHEAR TEST
(IS 2720 Part-13 : 2009)

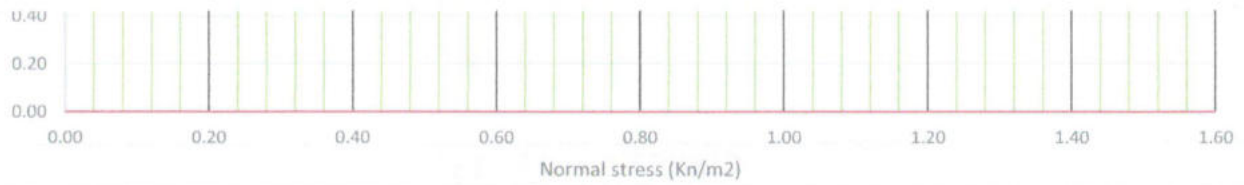
BH No. 4 Depth= 10.5 m

Results From Graph

1	Angle of Internal Friction(°)	33.64
2	Cohesion C Kg/Cm ²	0



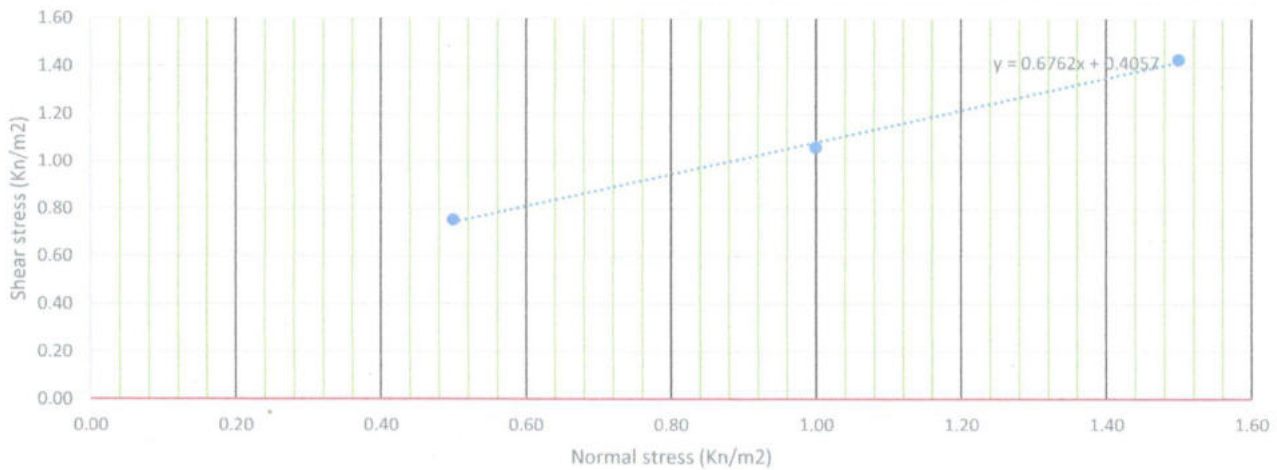
Sudhakar
Er. Gilpi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandeman, Ghy-03



BH No. 4 Depth= 12 m

Results From Graph

1	Angle of Internal Friction(°)	34.07
2	Cohession C Kg/Cm2	0

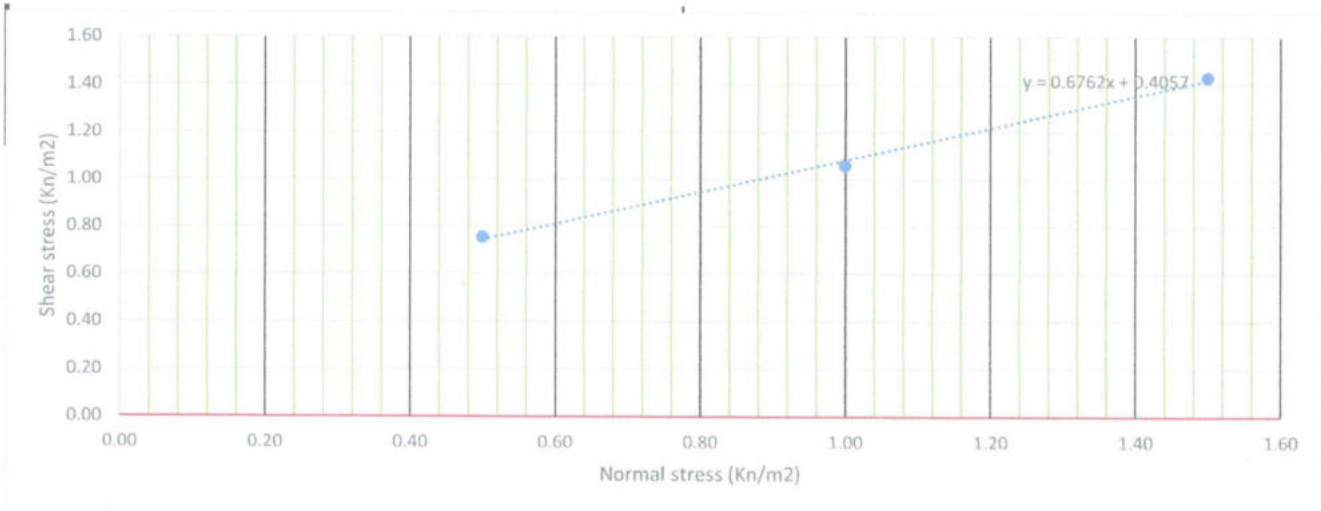


Sivalakan
 Er. Gopi Rani Molakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandigarh-03

BH No.	4	Depth=	13.5 m
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Results From Graph

1	Angle of Internal Friction(°)	34.17
2	Cohession C Kg/Cm2	0

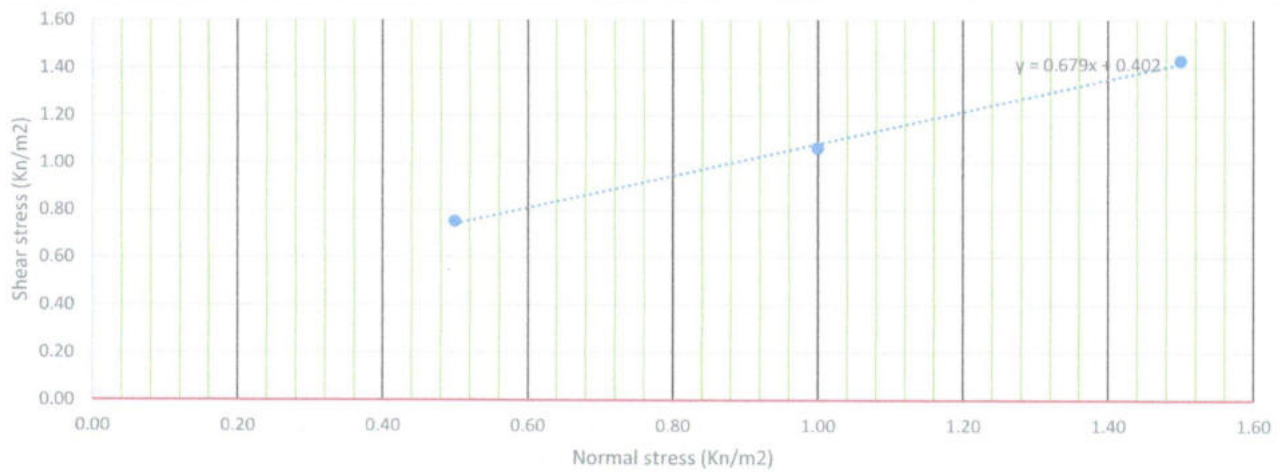


S. Malakar
 Et. Silpi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandigarh-03

BH No. 4 Depth= 15 m

Results From Graph

1	Angle of Internal Friction(°)	34.35
2	Cohesion C Kg/Cm2	0



S. Lalakar
Sr. Silpi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-03

DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No.

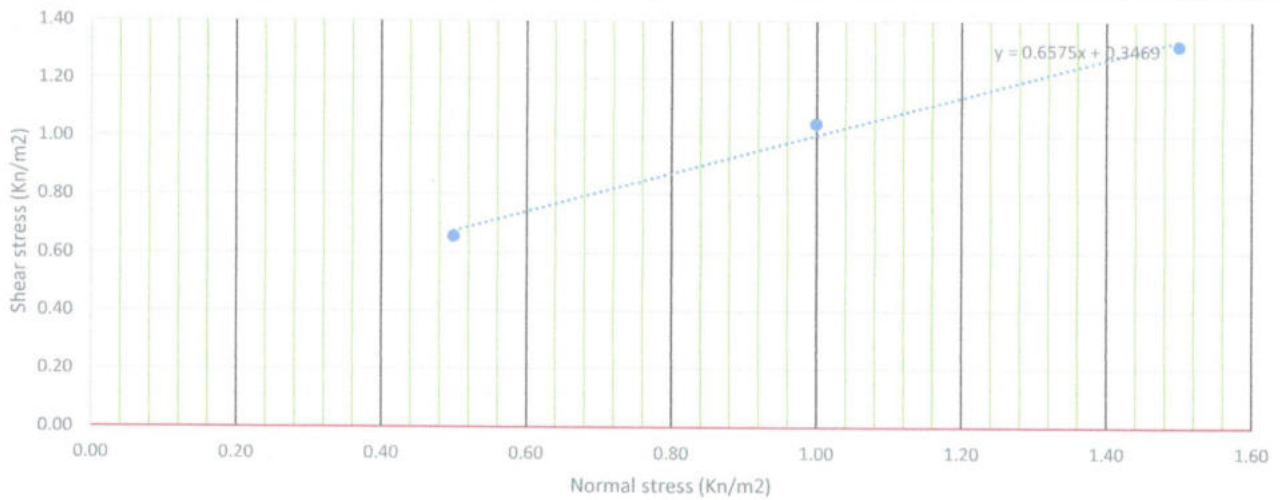
5

Depth=

9 m

Results From Graph

1	Angle of Internal Friction(°)	33.33
2	Cohesion C Kg/Cm2	0



S. Malakar
Er. Gilpi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandman, Ghy-03

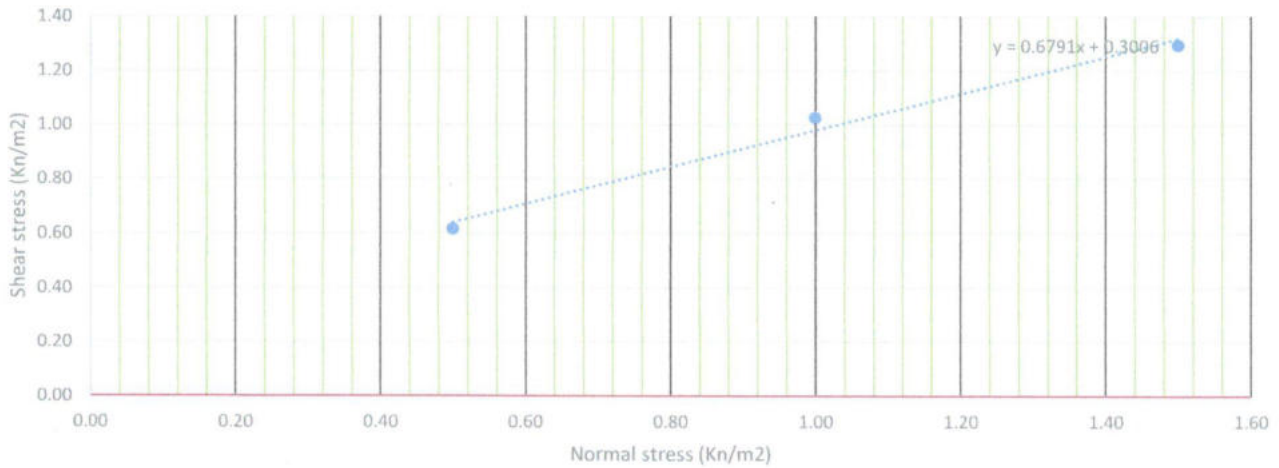
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 5 Depth= 10.5 m

Results From Graph

1	Angle of Internal Friction(°)	34.18
2	Cohesion C Kg/Cm2	0



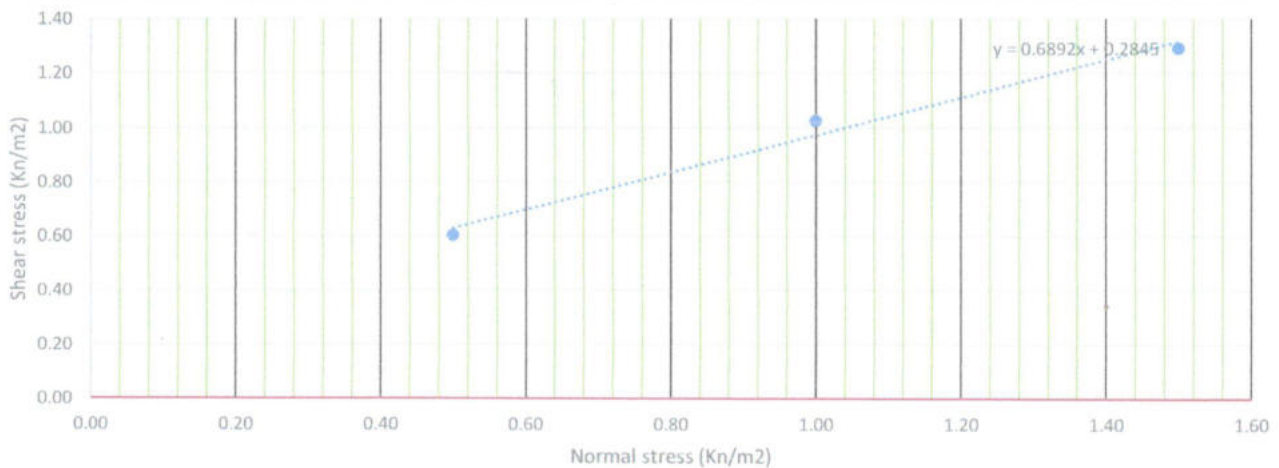
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 5 Depth= 12 m

Results From Graph

1	Angle of Internal Friction(°)	34.57
2	Cohesion C Kg/Cm2	0



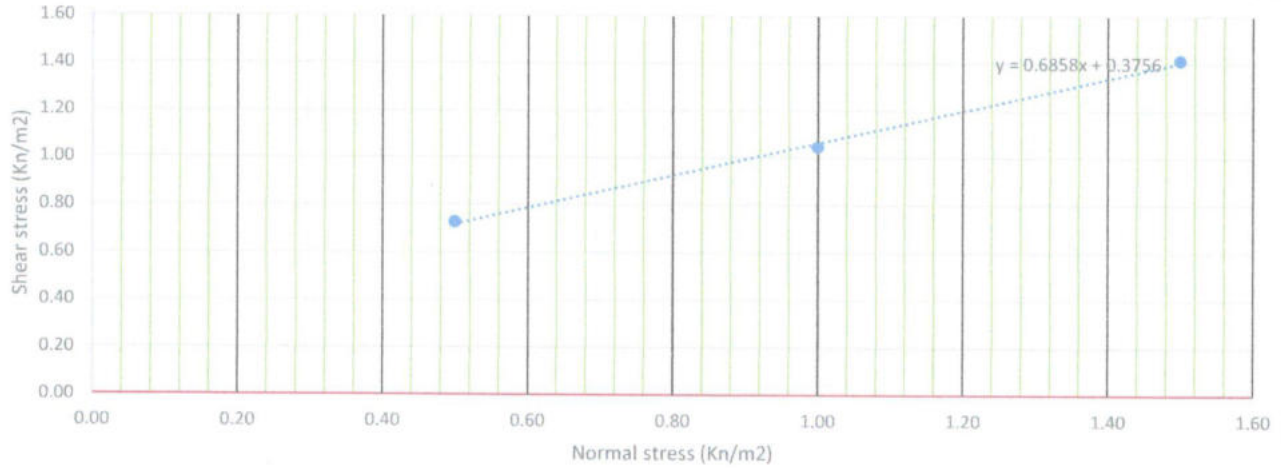
S. Malakar
Er. Sibi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandman Ghy-03

DIRECT SHEAR TEST
(IS 2720 Part-13 : 2009)

BH No. 5 Depth= 13.5 m

Results From Graph

1	Angle of Internal Friction(°)	34.44
2	Cohesion C Kg/Cm2	0

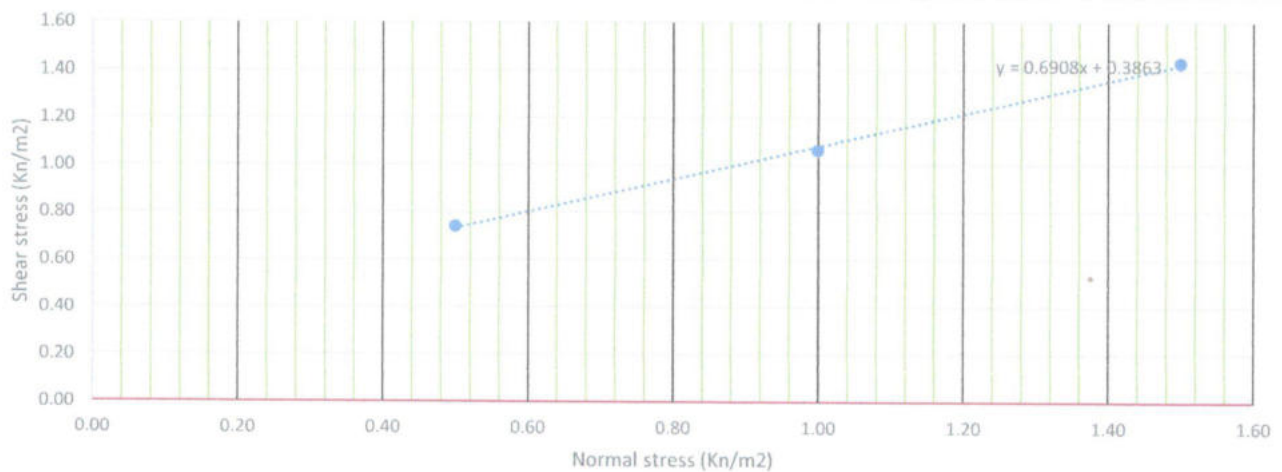


DIRECT SHEAR TEST
(IS 2720 Part-13 : 2009)

BH No. 5 Depth= 15 m

Results From Graph

1	Angle of Internal Friction(°)	34.64
2	Cohesion C Kg/Cm2	0

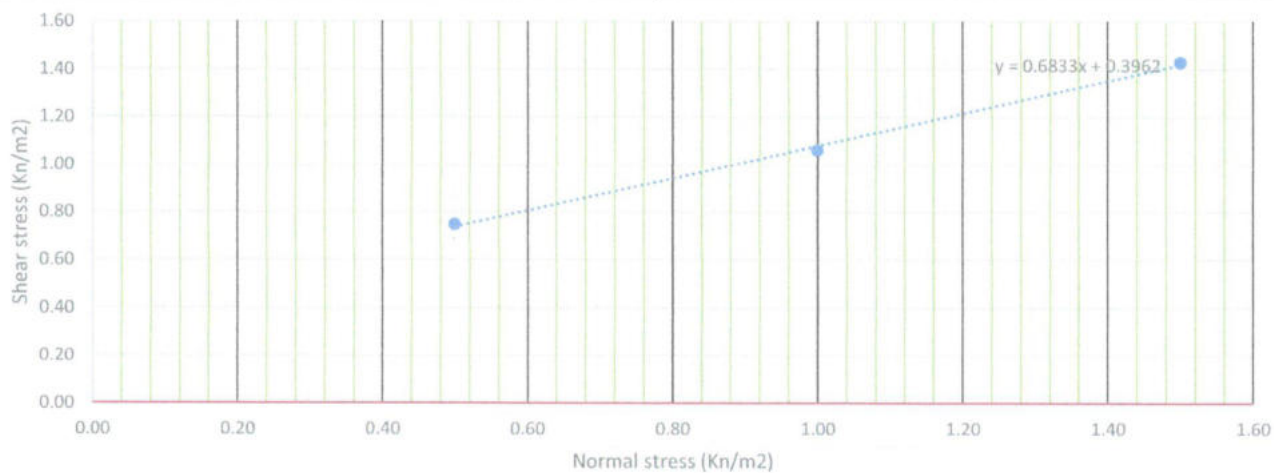


S. Malakar
Dr. Gulpr Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-03

BH No. 4 Depth= 12 m

Results From Graph

1	Angle of Internal Friction(°)	34.35
2	Cohesion C Kg/Cm2	0

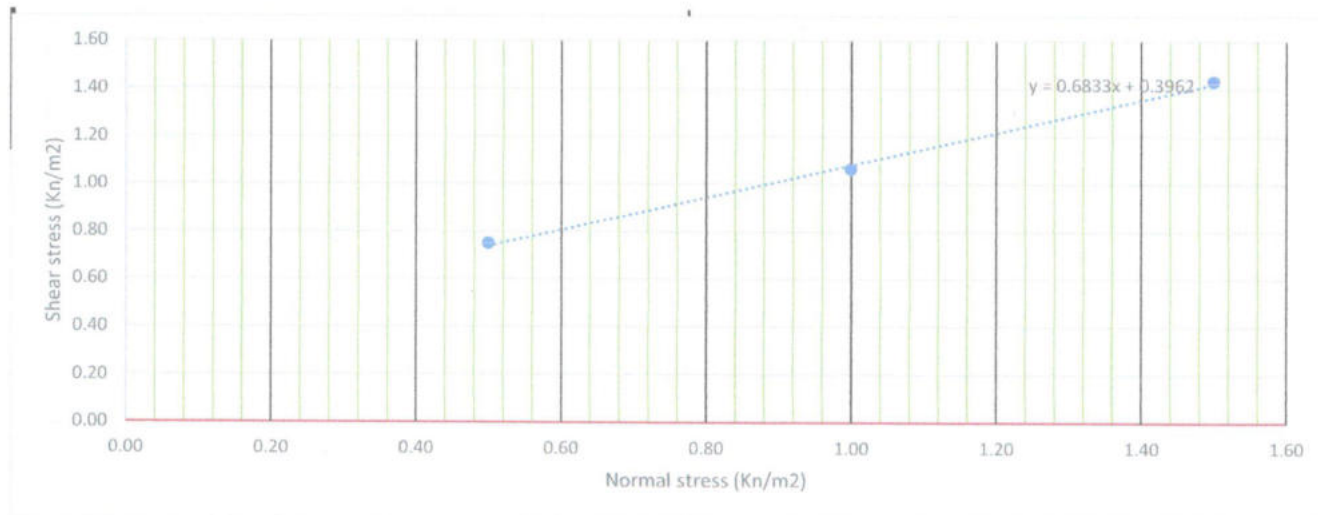


S. Malakar
Er. Sibi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandrasekhar, Chy. 03

BH No.	4	Depth=	13.5 m
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Results From Graph

1	Angle of Internal Friction(°)	34.38
2	Cohesion C Kg/Cm2	0

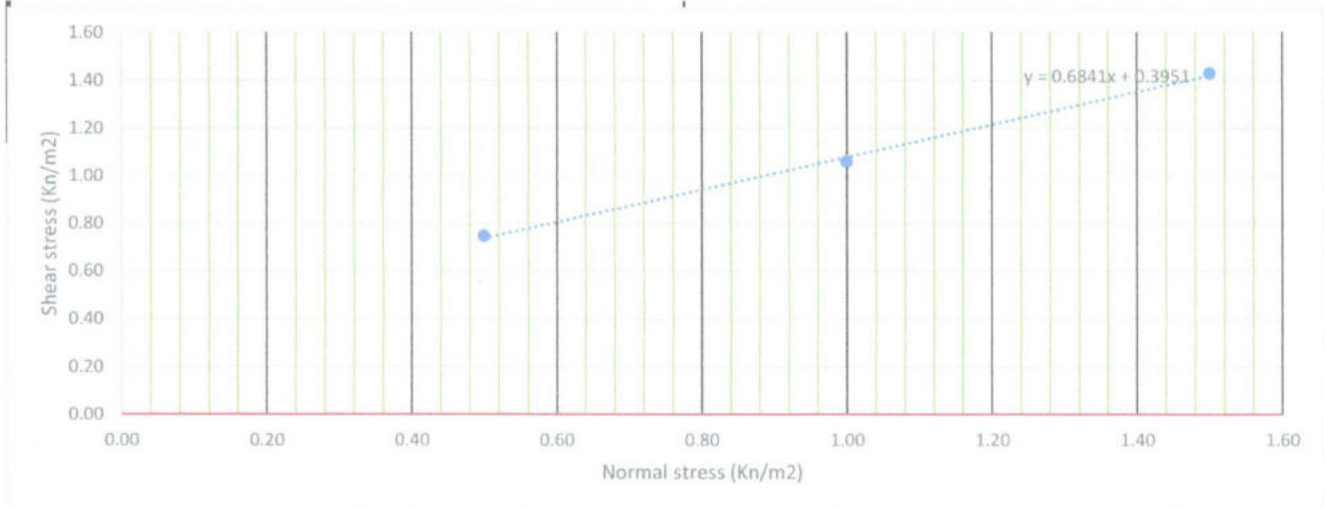


S. Malakar
 Er. Silpi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandman, Ghy-03

BH No.	4	Depth=	15 m
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Results From Graph

1	Angle of Internal Friction(°)	34.43
2	Cohession C Kg/Cm2	0



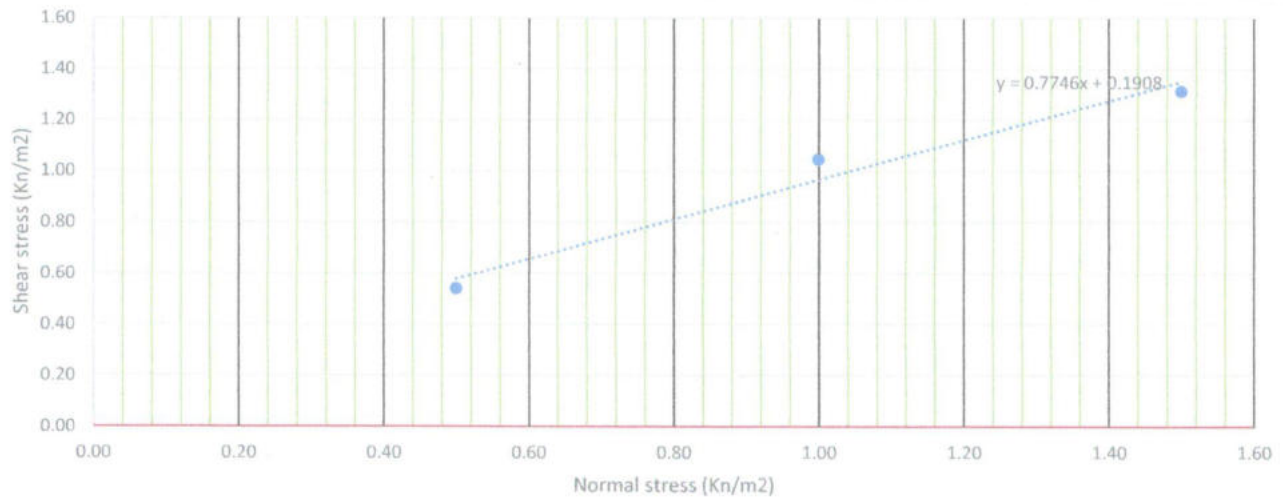
S. Malakar
 Er. Sipi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Channarayana, Ghy. 03

DIRECT SHEAR TEST
(IS 2720 Part-13 : 2009)

BH No. 6 Depth= 7.5 m

Results From Graph

1	Angle of Internal Friction(°)	37.76
2	Cohesion C Kg/Cm2	0



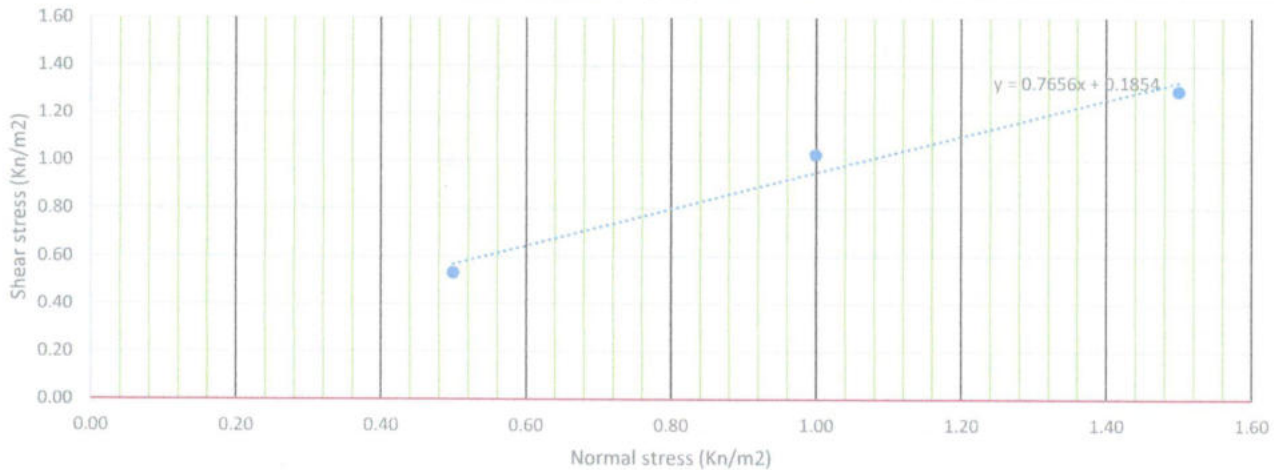
S. Melakar
Er. Silpi Rani Melakar, B.Tech (Civil)
North East Engineers
GME Market, Chandigarh-03

DIRECT SHEAR TEST
(IS 2720 Part-13 : 2009)

BH No. 6 Depth= 9 m

Results From Graph

1	Angle of Internal Friction(°)	37.44
2	Cohesion C Kg/Cm2	0

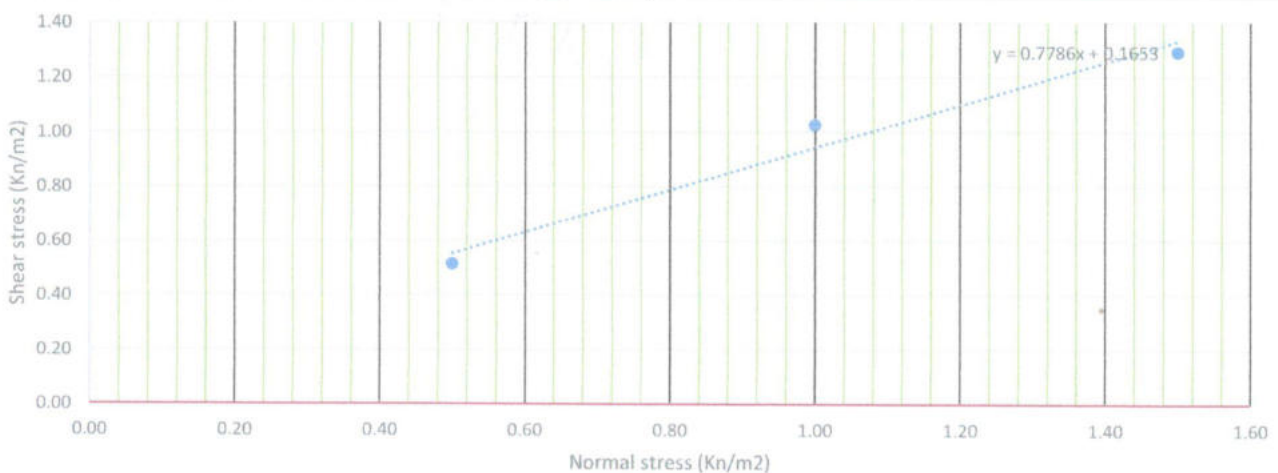


DIRECT SHEAR TEST
(IS 2720 Part-13 : 2009)

BH No. 6 Depth= 10.5 m

Results From Graph

1	Angle of Internal Friction(°)	37.90
2	Cohesion C Kg/Cm2	0



Sivalakan
En. Sipi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-160003

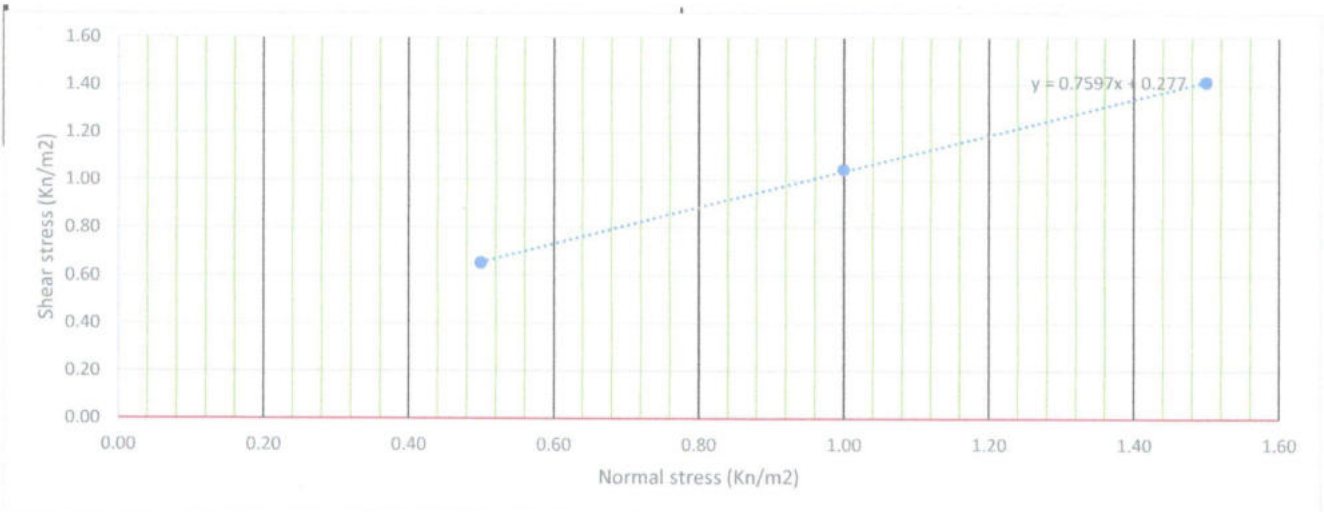
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 6 Depth= 12 m

Results From Graph

1	Angle of Internal Friction(°)	37.22
2	Cohession C Kg/Cm2	0



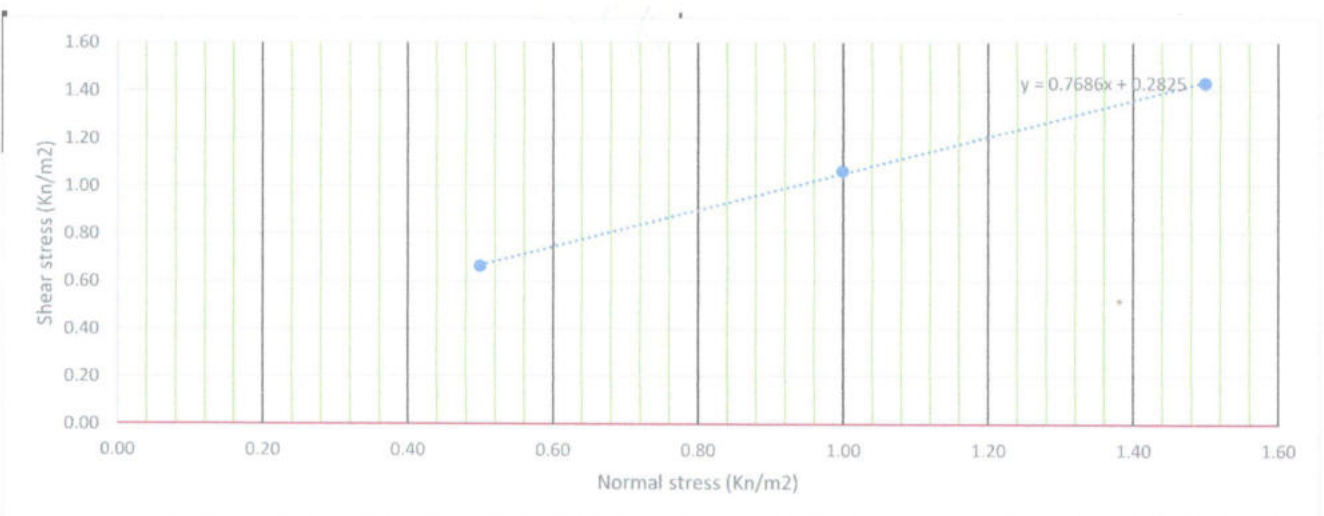
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 6 Depth= 13.5 m

Results From Graph

1	Angle of Internal Friction(°)	37.54
2	Cohession C Kg/Cm2	0

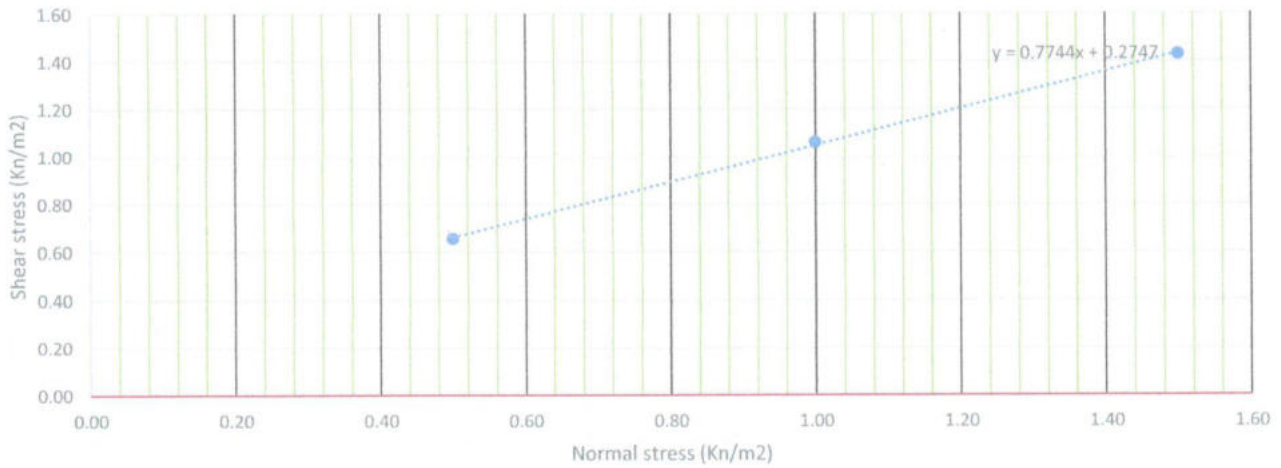


Sivalakan
Er. Gilpi Rani Molakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chaudhary Ghy.03

BH No. 6 Depth= 15 m

Results From Graph

1	Angle of Internal Friction(°)	37.75
2	Cohesion C Kg/Cm2	0

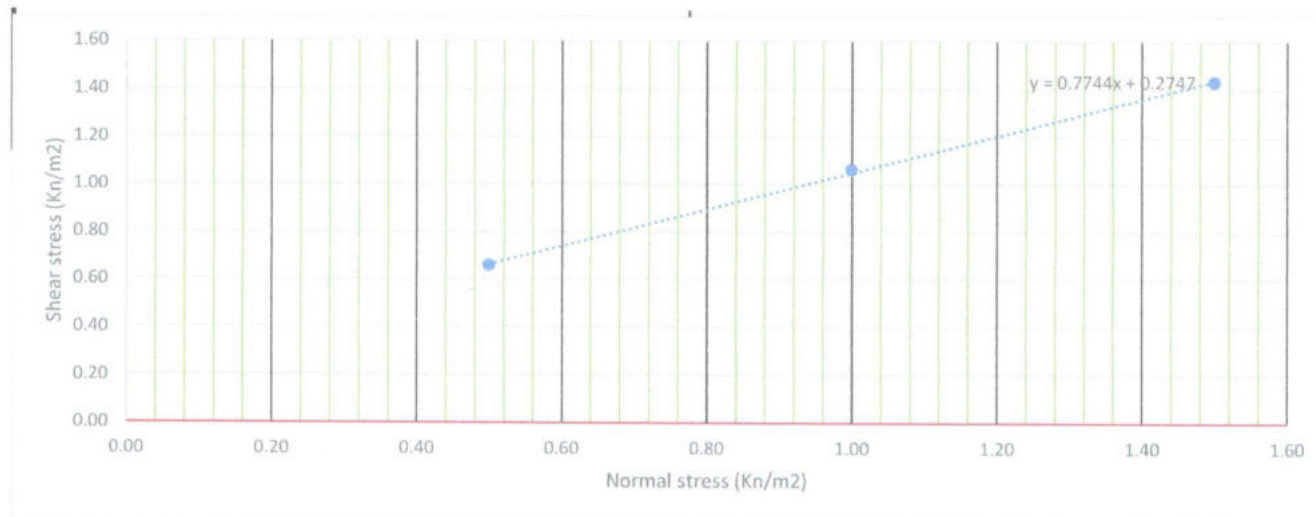


S. Lalakar
Et. Gupri Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-03

BH No.	4	Depth=	13.5 m
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Results From Graph

1	Angle of Internal Friction(°)	34.38
2	Cohession C Kg/Cm2	0

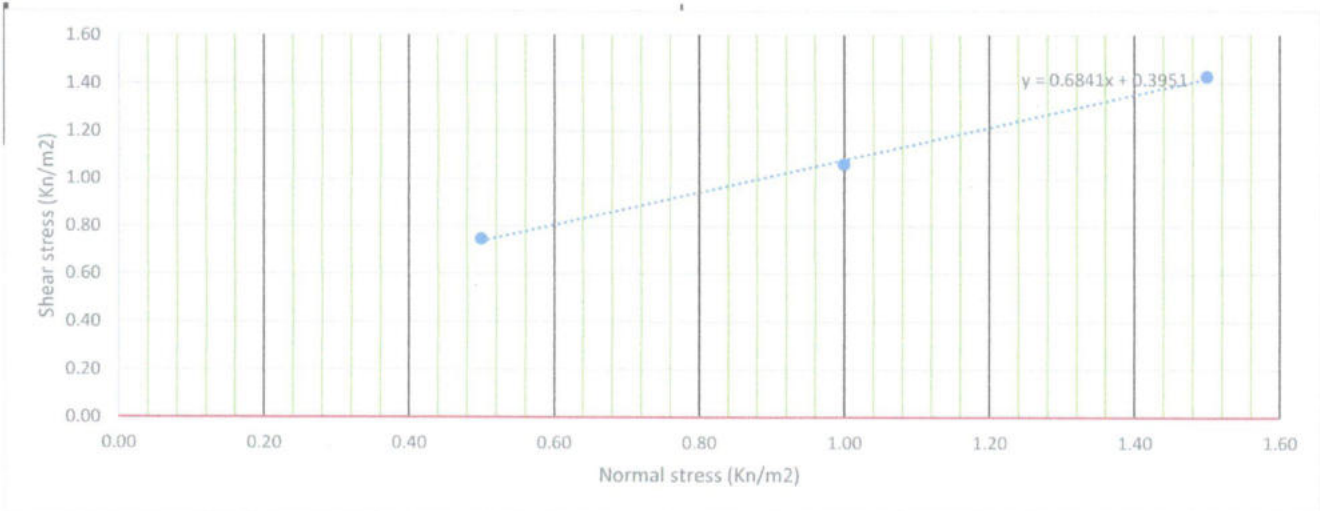


Sachin
 Er. Gopi Ram Nalaskar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandigarh-160003

BH No. 4 Depth= 15 m

Results From Graph

1	Angle of Internal Friction(°)	34.43
2	Cohesion C Kg/Cm2	0



Sivalakan
Er. Sibi Rasi Melakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandmani Ghy-03

DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No.

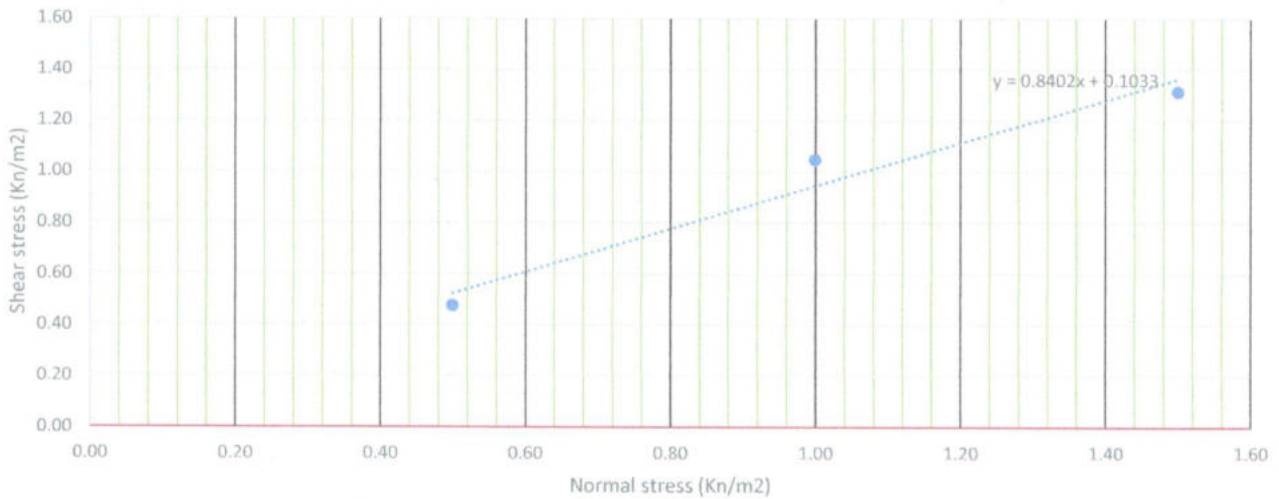
7

Depth=

3 m

Results From Graph

1	Angle of Internal Friction(°)	40.04
2	Cohesion C Kg/Cm2	0



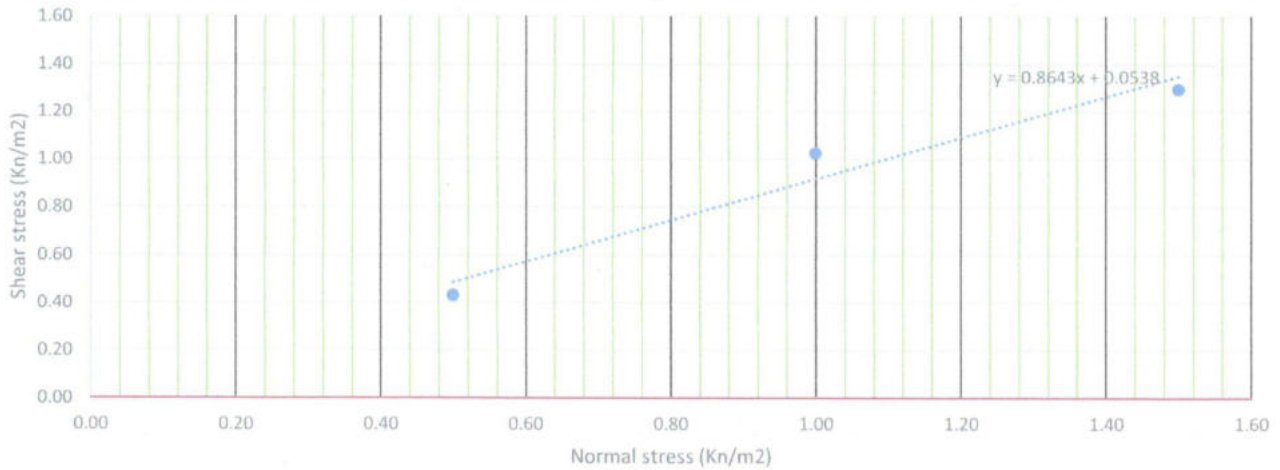
S. Lalakan
Sr. Supt. Rani Melakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chanderi, Ghy-03

DIRECT SHEAR TEST (IS 2720 Part-13 : 2009)

BH No. 7 Depth= 4.5 m

Results From Graph

1	Angle of Internal Friction(°)	40.84
2	Cohesion C Kg/Cm2	0

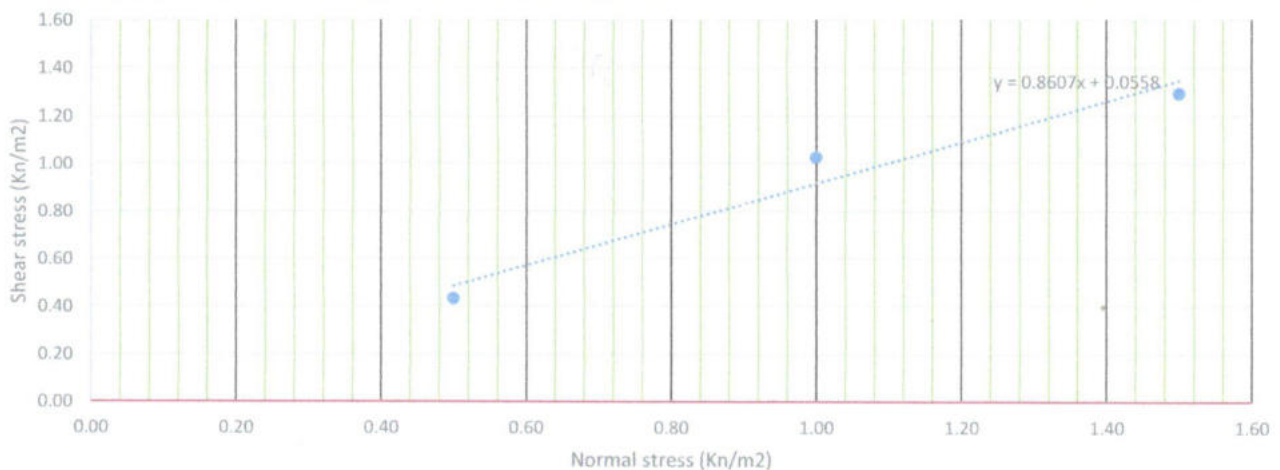


DIRECT SHEAR TEST (IS 2720 Part-13 : 2009)

BH No. 7 Depth= 6 m

Results From Graph

1	Angle of Internal Friction(°)	40.72
2	Cohesion C Kg/Cm2	0



S. Malakar
En. Silpi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-160030

DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No.

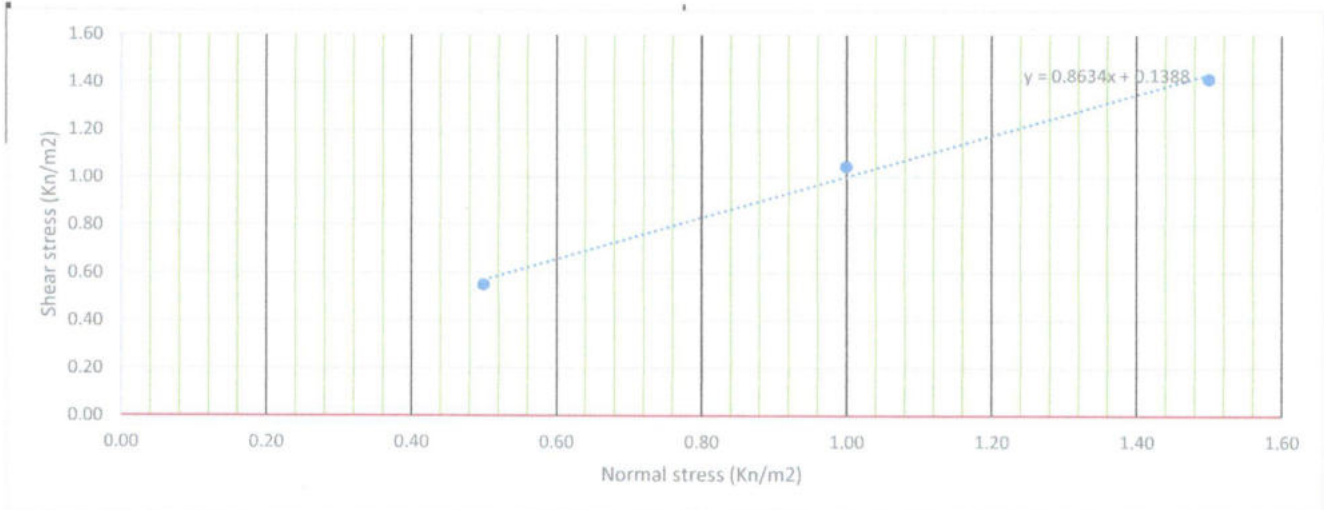
7

Depth=

7.5 m

Results From Graph

1	Angle of Internal Friction(°)	40.81
2	Cohesion C Kg/Cm2	0



DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No.

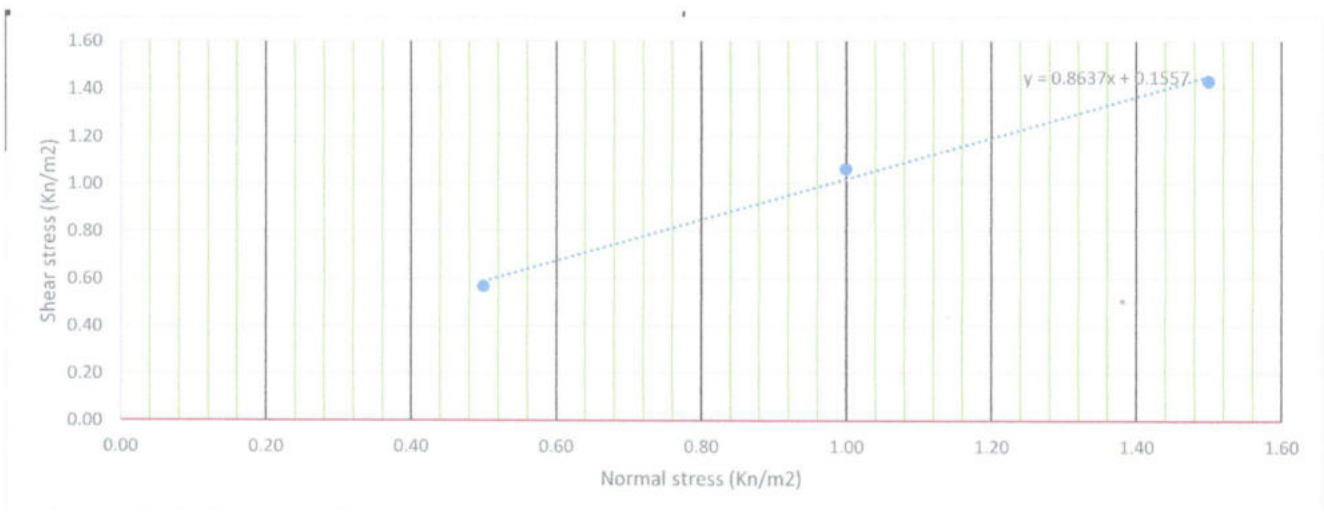
7

Depth=

9 m

Results From Graph

1	Angle of Internal Friction(°)	40.82
2	Cohesion C Kg/Cm2	0

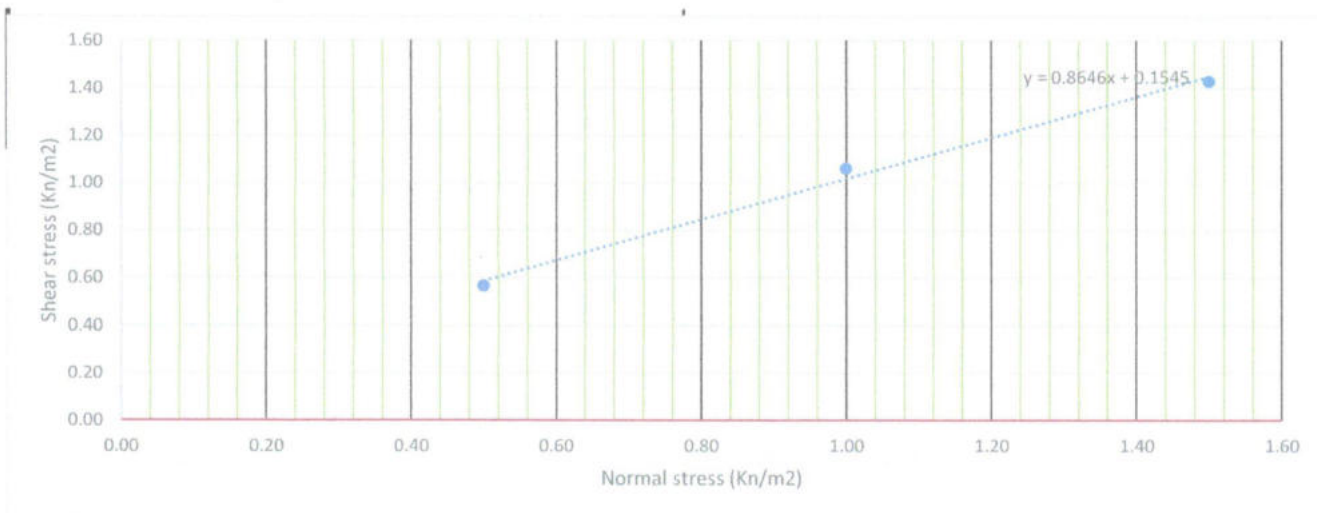


S. Malakar
Sr. Supt. Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandran Chy.03

BH No. 7 Depth= 10.5 m

Results From Graph

1	Angle of Internal Friction(°)	40.85
2	Cohesion C Kg/Cm2	0

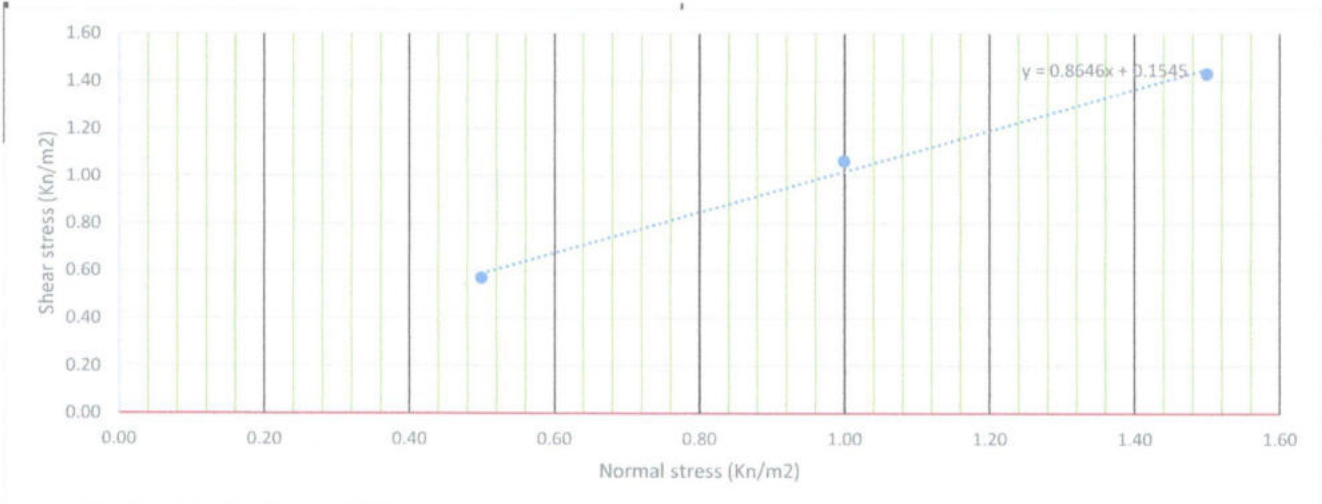


S. Lalakar
Er. Silpi Rani Melakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandanai Ghy.03

BH No. 7 Depth= 12 m

Results From Graph

1	Angle of Internal Friction(°)	40.88
2	Cohesion C Kg/Cm2	0

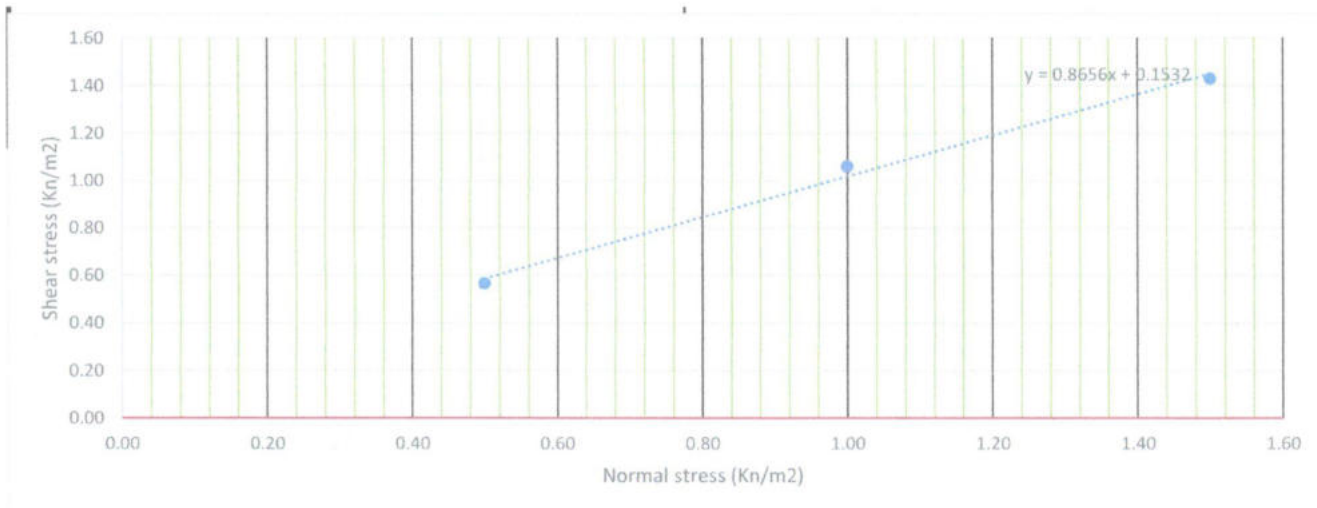


S. Malakar
Er. Silpi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandrari Ghy-03

BH No. 7 Depth= 13.5 m

Results From Graph

1	Angle of Internal Friction(°)	41.38
2	Cohesion C Kg/Cm2	0

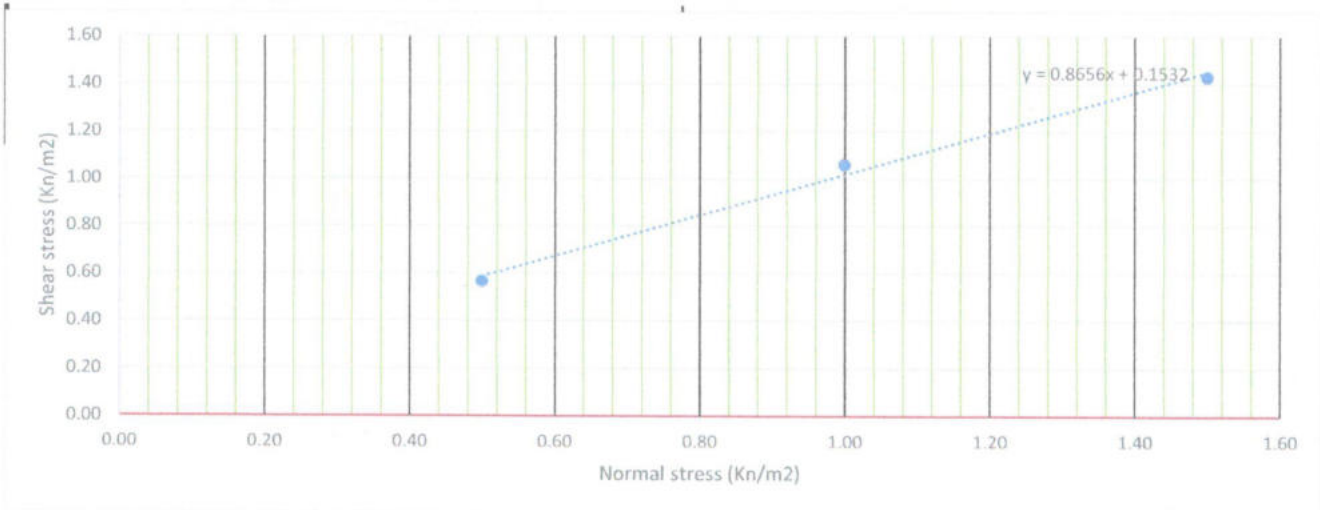


S. Lalakar
Ex. Sdri Bani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh, Ghy-03

BH No. 7 Depth= 15 m

Results From Graph

1	Angle of Internal Friction(°)	41.12
2	Cohesion C Kg/Cm2	0



Sivalakan
Er. Gilpi Ranj Nalakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-03

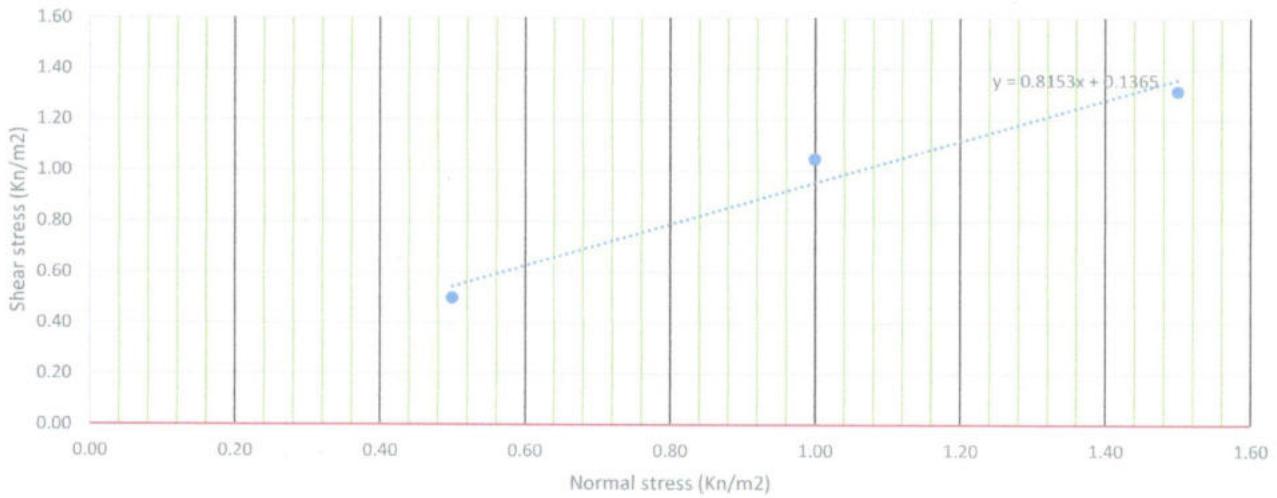
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 9 Depth= 4.5 m

Results From Graph

1	Angle of Internal Friction(°)	39.19
2	Cohesion C Kg/Cm2	0



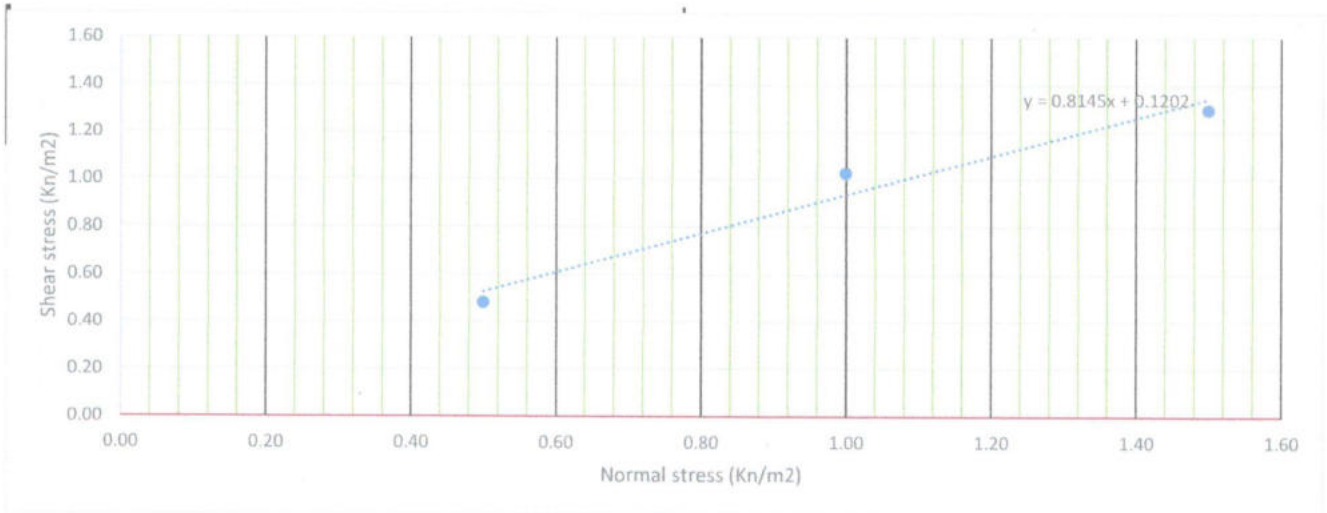
S. Lalakar
Er. Sdip. Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-03

DIRECT SHEAR TEST
(IS 2720 Part-13 : 2009)

BH No. 9 Depth= 6 m

Results From Graph

1	Angle of Internal Friction(°)	39.16
2	Cohession C Kg/Cm2	0

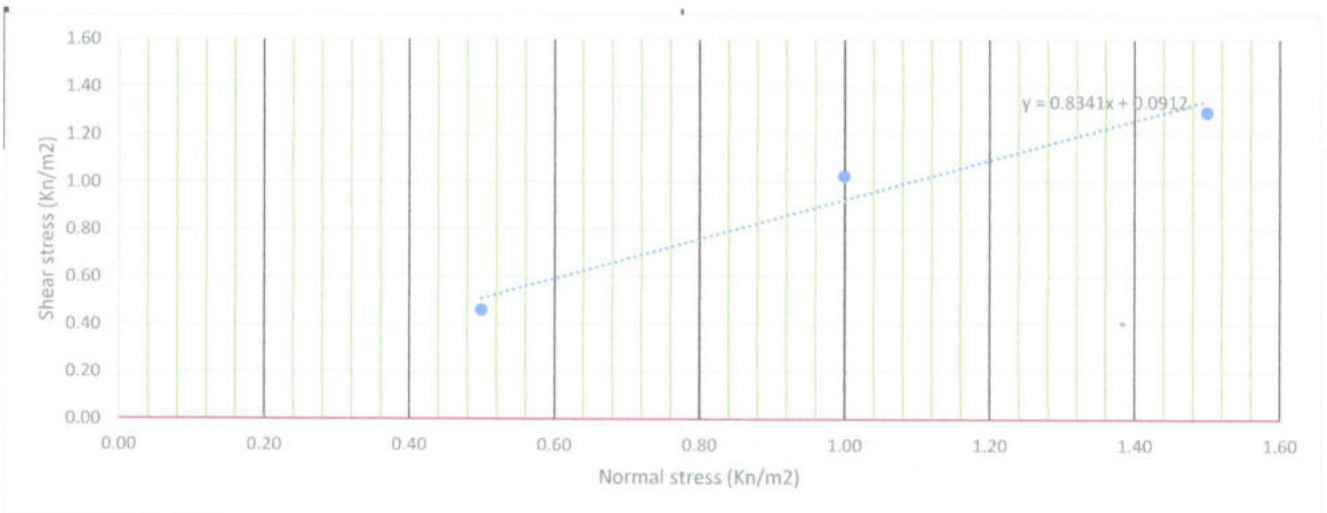


DIRECT SHEAR TEST
(IS 2720 Part-13 : 2009)

BH No. 9 Depth= 7.5 m

Results From Graph

1	Angle of Internal Friction(°)	39.83
2	Cohession C Kg/Cm2	0



S. Lalakan
En. S. Lalakan, B.Tech (Civil)
North East Engineer's
GMC Market, Chanderi-431003

DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No.

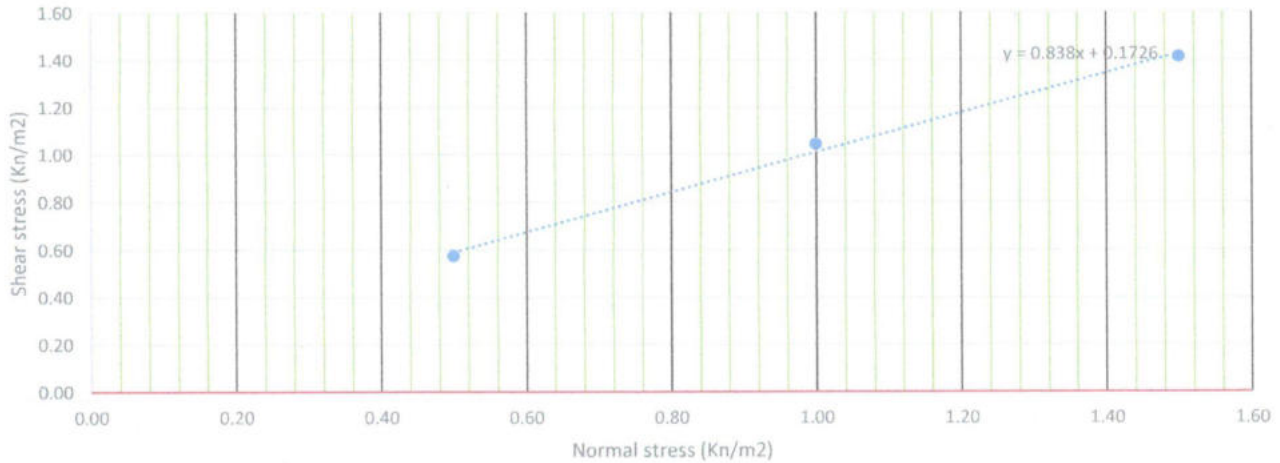
9

Depth=

9 m

Results From Graph

1	Angle of Internal Friction(°)	39.96
2	Cohesion C Kg/Cm2	0



DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No.

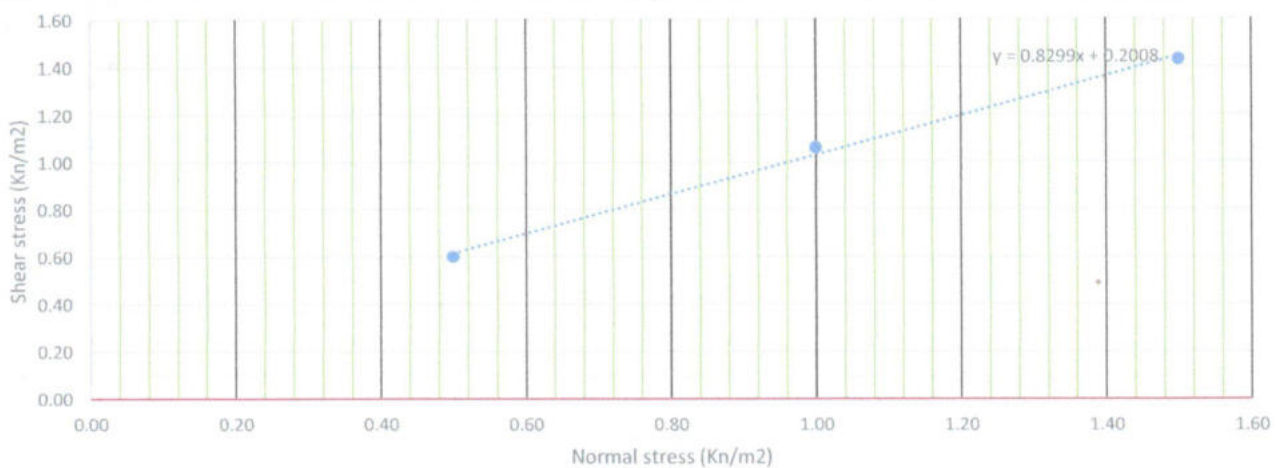
9

Depth=

10.5 m

Results From Graph

1	Angle of Internal Friction(°)	39.69
2	Cohesion C Kg/Cm2	0

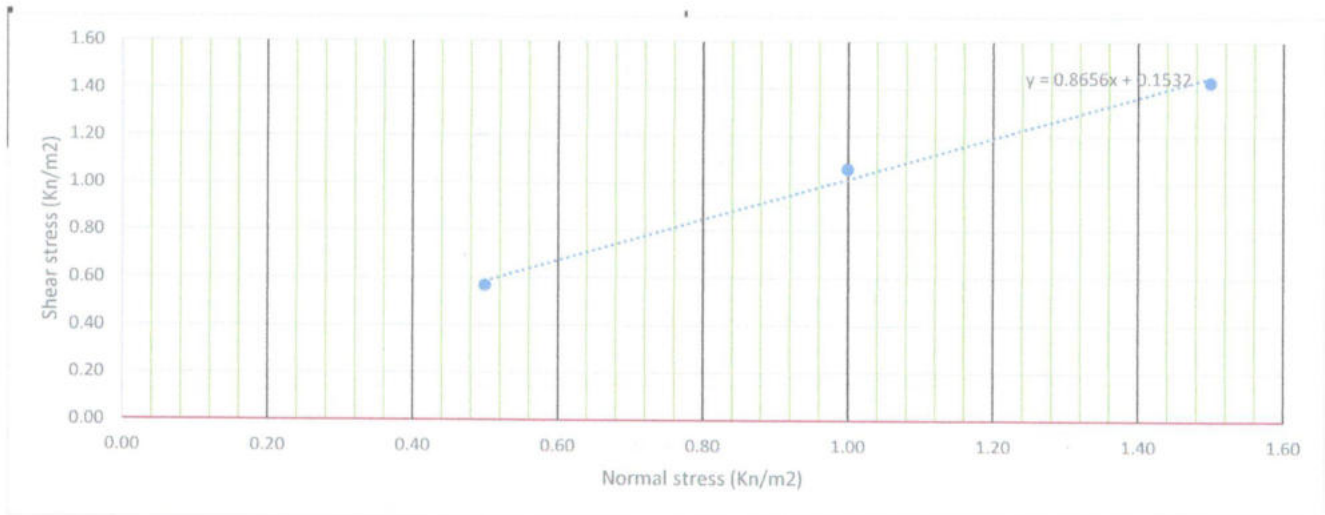


S. Malakar
Dr. Shri Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandman, Ghy-03

BH No. 9 Depth= 12 m

Results From Graph

1	Angle of Internal Friction(°)	40.88
2	Cohesion C Kg/Cm2	0

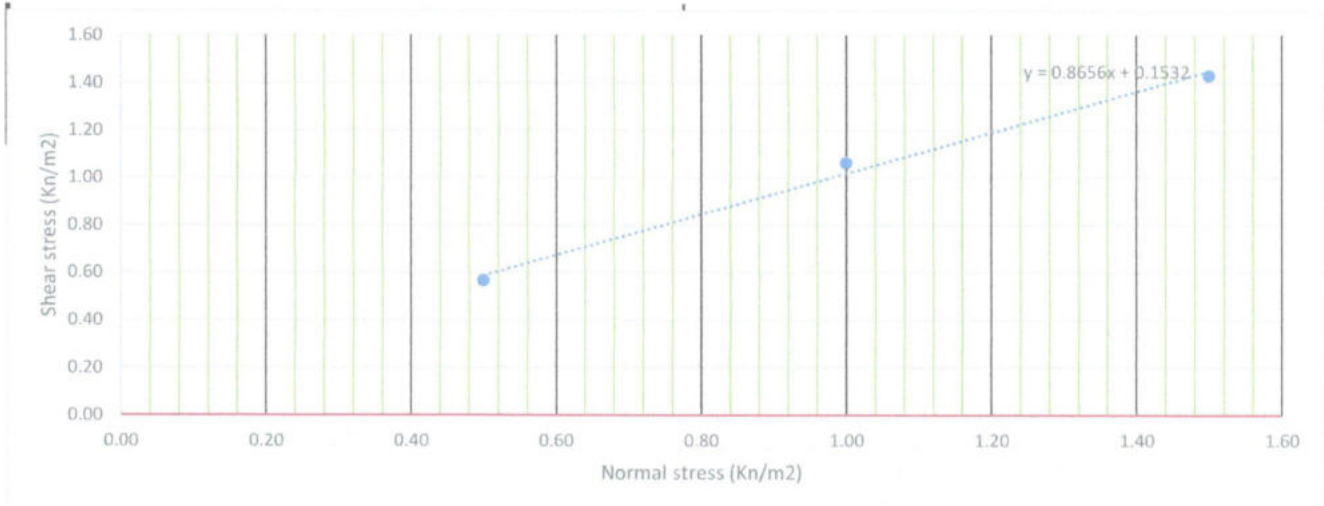


S. Malakar
En. Sibi Rami Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandman, Ghy-03

BH No.	9	Depth=	13.5 m
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Results From Graph

1	Angle of Internal Friction(°)	41.09
2	Cohession C Kg/Cm2	0

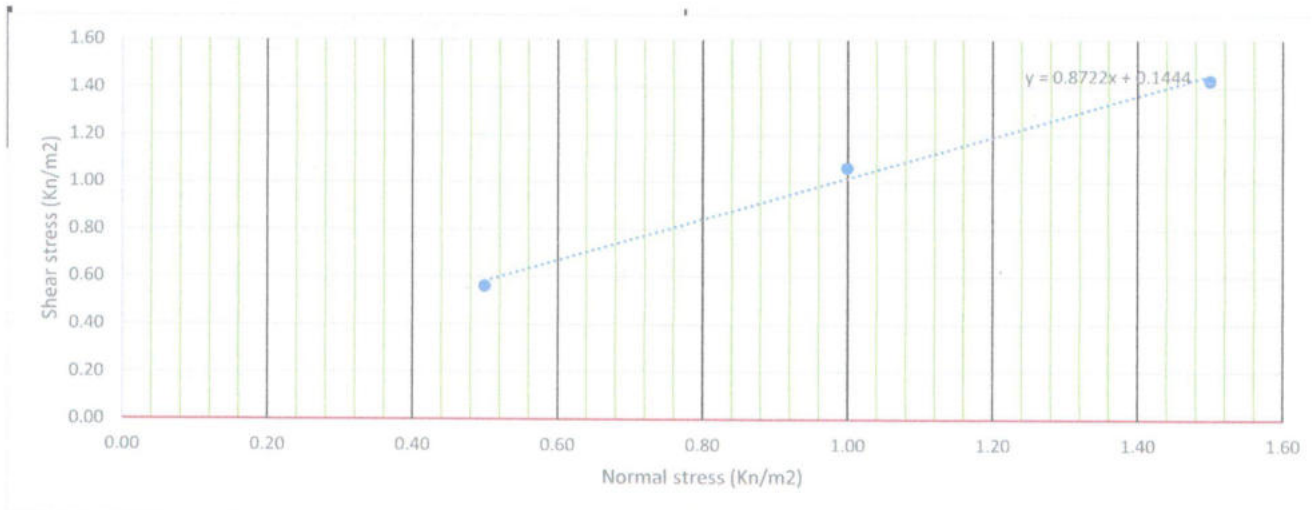


S. Malakar
 Er. Gopi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandigarh-03

BH No. 9 Depth= 15 m

Results From Graph

1	Angle of Internal Friction(°)	41.15
2	Cohession C Kg/Cm2	0



S. Lalakan
Er. Gopal Rani Meisakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh, Ghy-03

DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No.

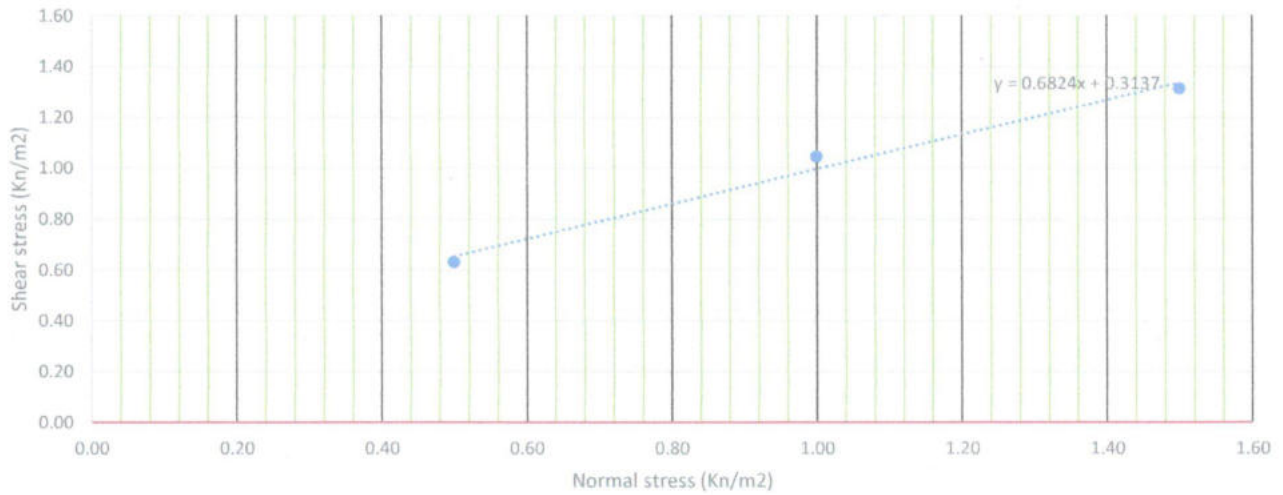
10

Depth=

9 m

Results From Graph

1	Angle of Internal Friction(°)	34.31
2	Cohesion C Kg/Cm2	0



S. Malakar
Dr. Gilpi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC, Market, Chandran, Ghy-03

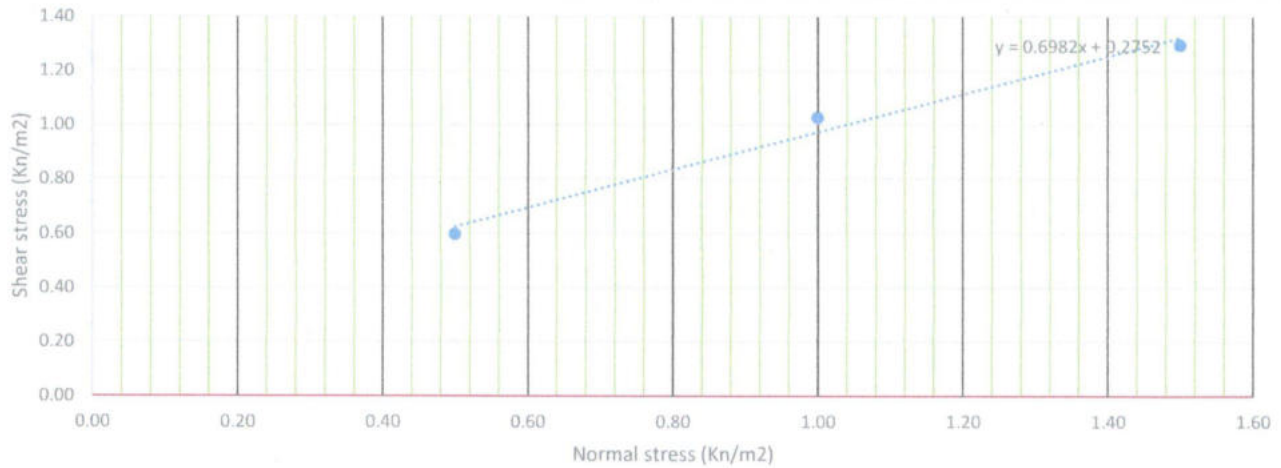
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 10 Depth= 6 m

Results From Graph

1	Angle of Internal Friction(°)	34.92
2	Cohesion C Kg/Cm2	0



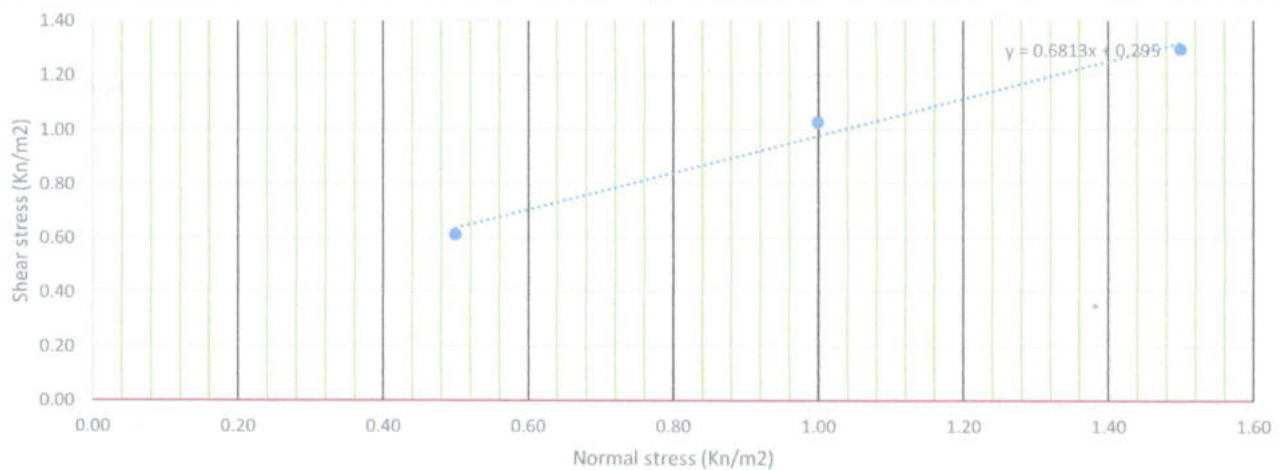
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 10 Depth= 7.5 m

Results From Graph

1	Angle of Internal Friction(°)	34.27
2	Cohesion C Kg/Cm2	0



S. Malakar
Ex. Gp1 Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandman, Ghy-03

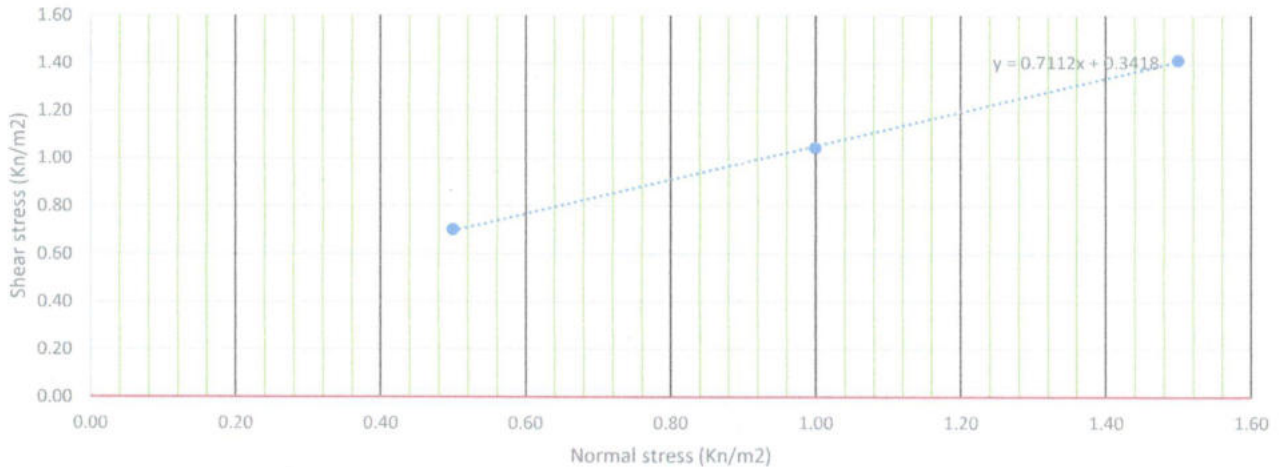
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 10 Depth= 9 m

Results From Graph

1	Angle of Internal Friction(°)	35.42
2	Cohesion C Kg/Cm2	0



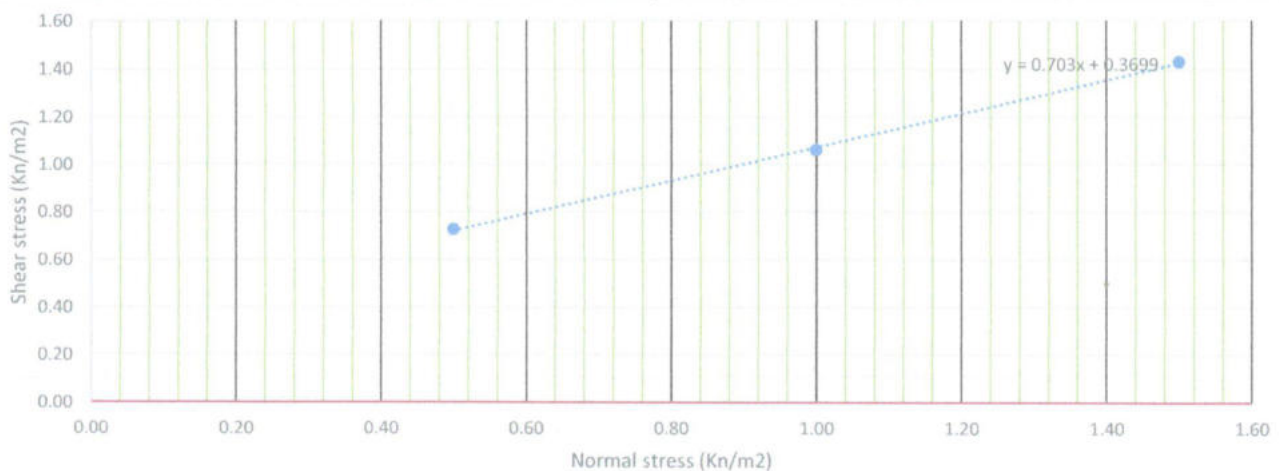
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 10 Depth= 10.5 m

Results From Graph

1	Angle of Internal Friction(°)	35.11
2	Cohesion C Kg/Cm2	0

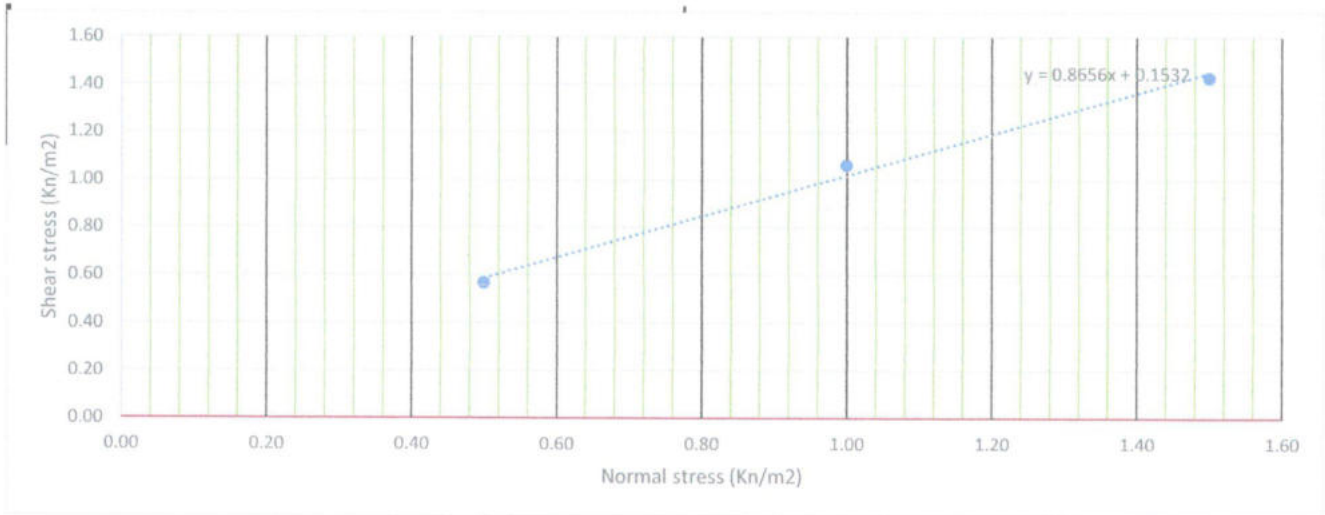


Sudhakar
Er. Dilip Rani Meisakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-03

BH No. 9 Depth= 12 m

Results From Graph

1	Angle of Internal Friction(°)	40.88
2	Cohesion C Kg/Cm2	0

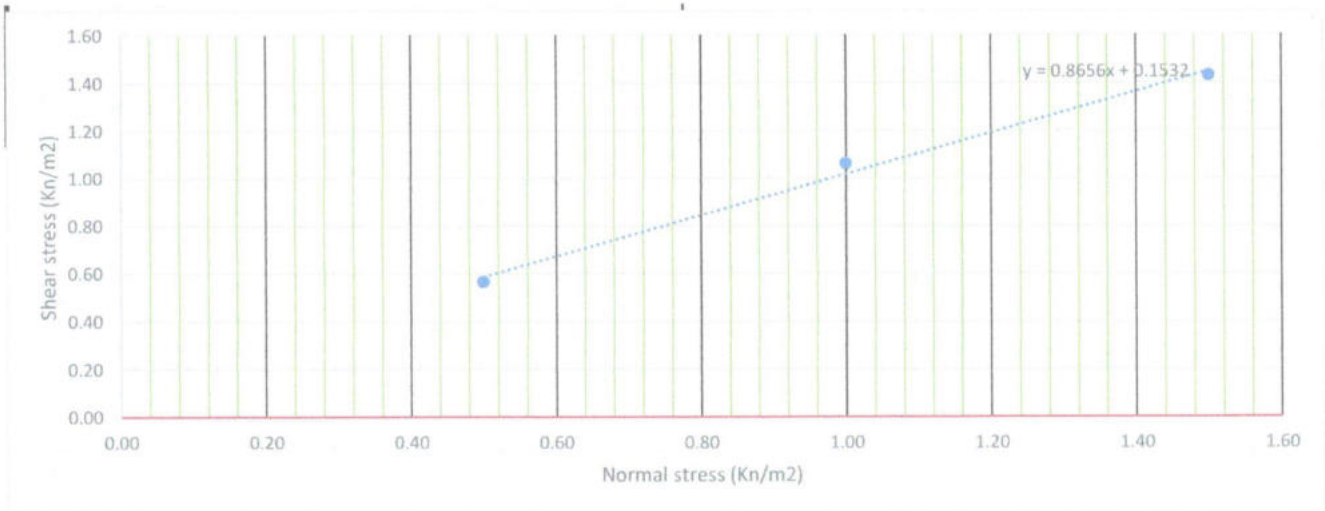


S. Lalakar
Et. Gopi Rani Molakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-160003

BH No. 9 Depth= 13.5 m

Results From Graph

1	Angle of Internal Friction(°)	41.09
2	Cohesion C Kg/Cm2	0

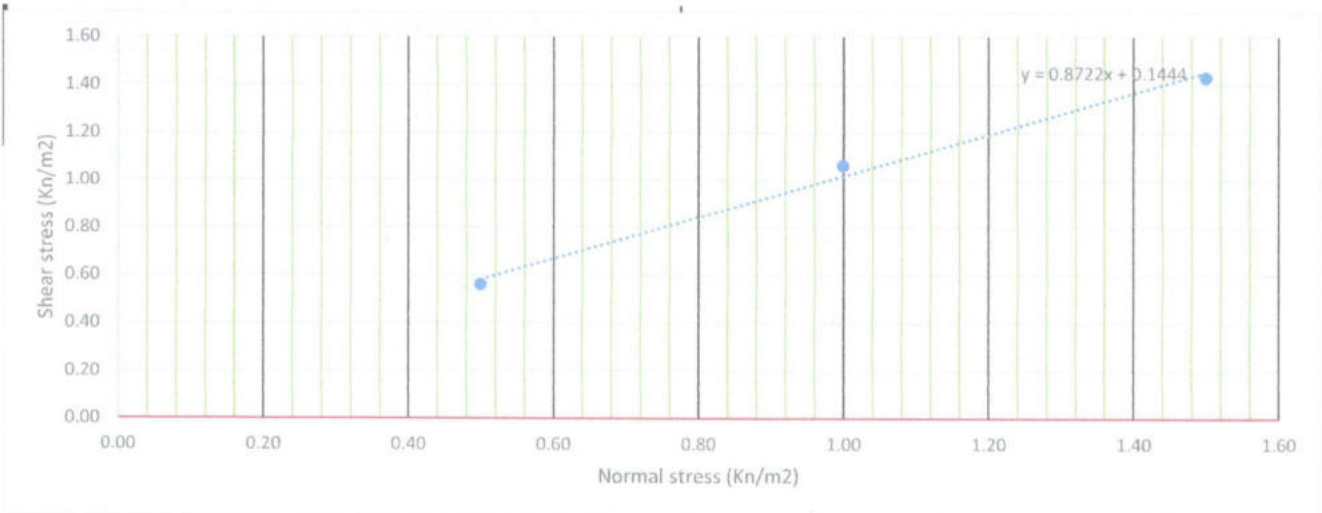


S. Lalakar
Sr. Civil Rani Metakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chanderpur, Chy-03

BH No. 9 Depth= 15 m

Results From Graph

1	Angle of Internal Friction(°)	41.15
2	Cohesion C Kg/Cm2	0



Singh
Er. Suresh Kumar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-03

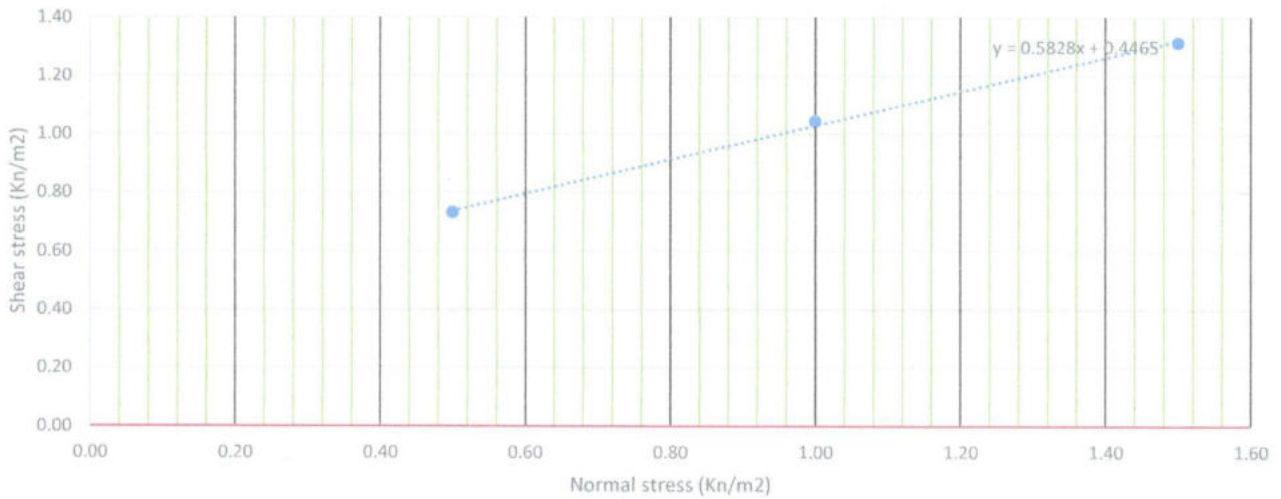
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 11 Depth= 7.5 m

Results From Graph

1	Angle of Internal Friction(°)	30.23
2	Cohession C Kg/Cm2	0



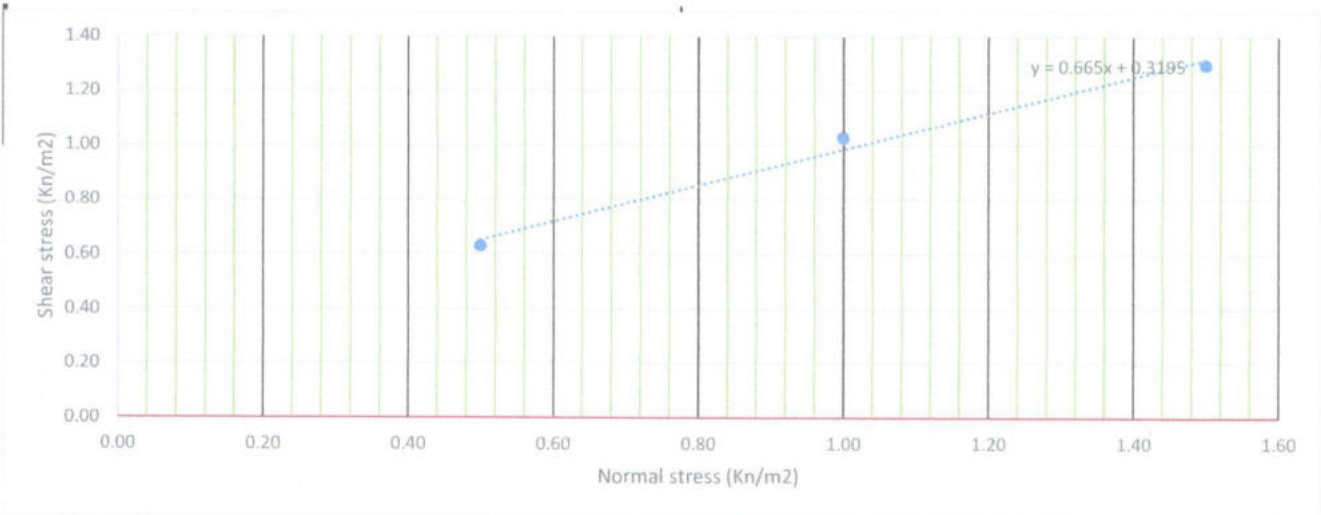
S. Malakar
Er. Sibi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandan, Ghy-03

DIRECT SHEAR TEST (IS 2720 Part-13 : 2009)

BH No. 11 Depth= 9 m

Results From Graph

1	Angle of Internal Friction(°)	33.63
2	Cohesion C Kg/Cm2	0

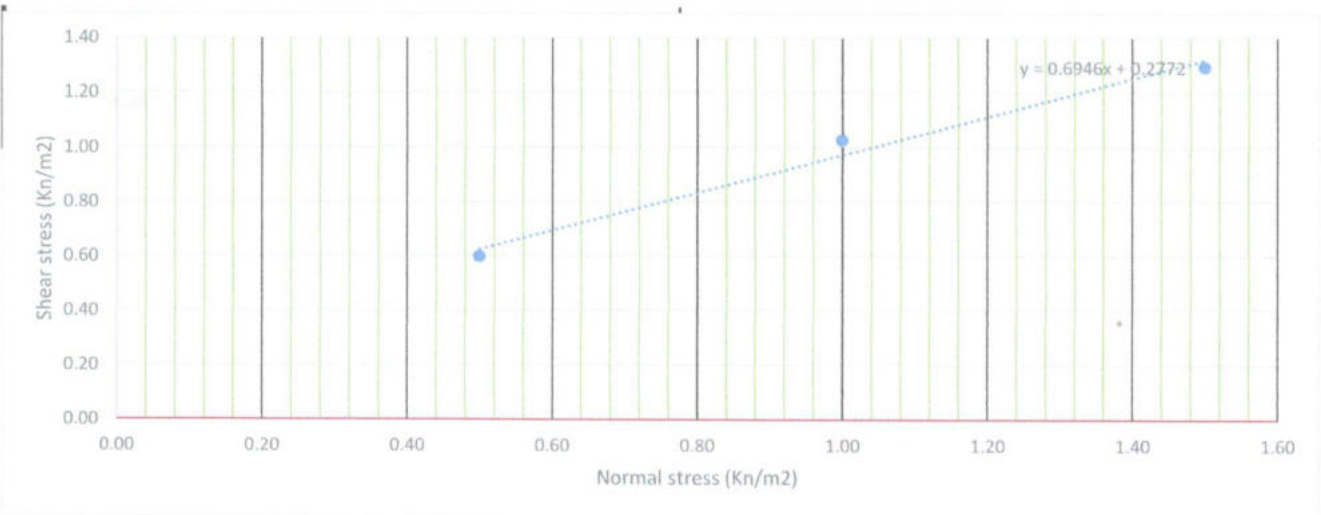


DIRECT SHEAR TEST (IS 2720 Part-13 : 2009)

BH No. 11 Depth= 10.5 m

Results From Graph

1	Angle of Internal Friction(°)	34.79
2	Cohesion C Kg/Cm2	0



S. Malakar
Er. Sibi Ravi Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-03

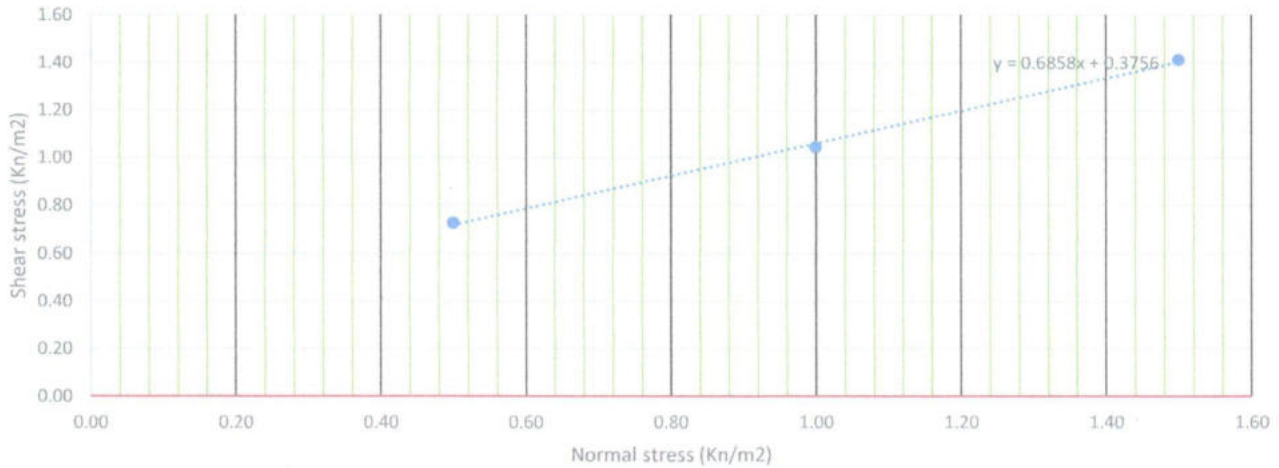
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 11 Depth= 12 m

Results From Graph

1	Angle of Internal Friction(°)	34.44
2	Cohesion C Kg/Cm2	0



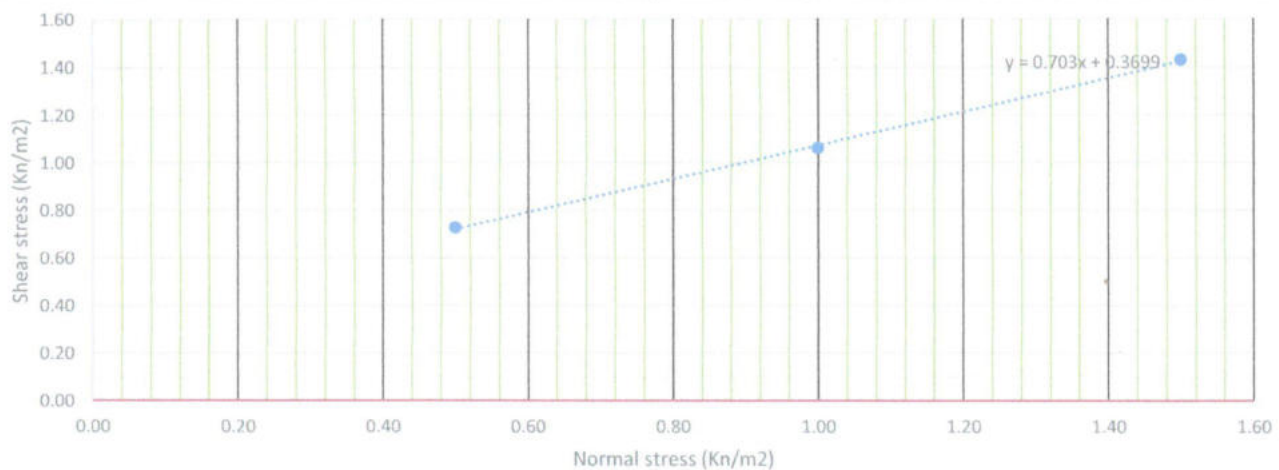
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 11 Depth= 13.5 m

Results From Graph

1	Angle of Internal Friction(°)	35.11
2	Cohesion C Kg/Cm2	0

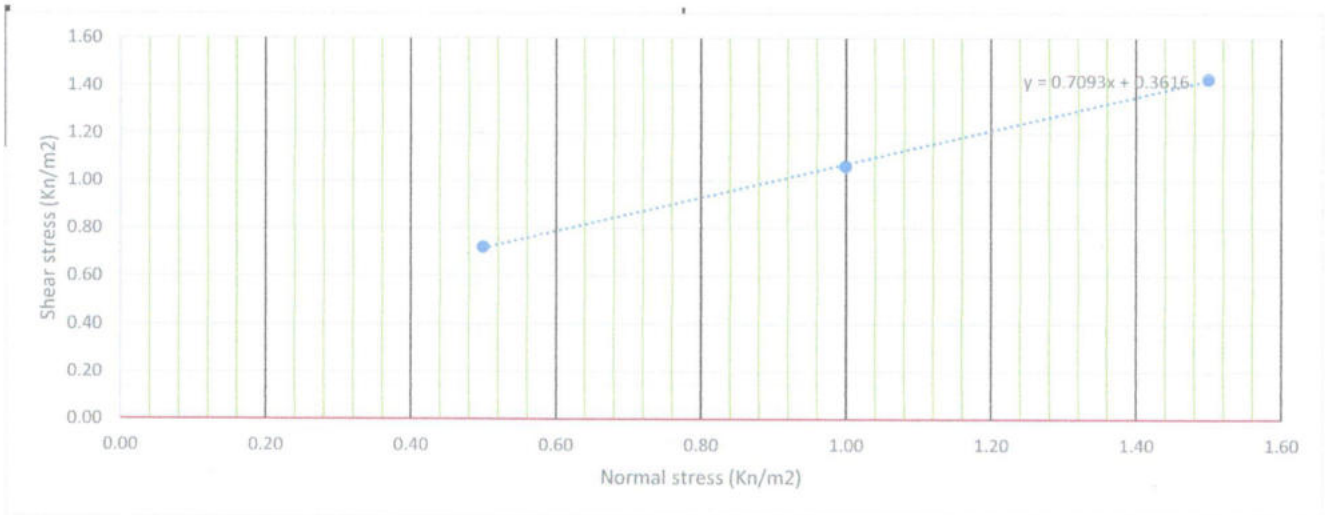


S. Malakar
Er. Sibi Rani Molakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandman, Ghy-03

BH No. 11 Depth= 15 m

Results From Graph

1	Angle of Internal Friction(°)	35.35
2	Cohesion C Kg/Cm2	0

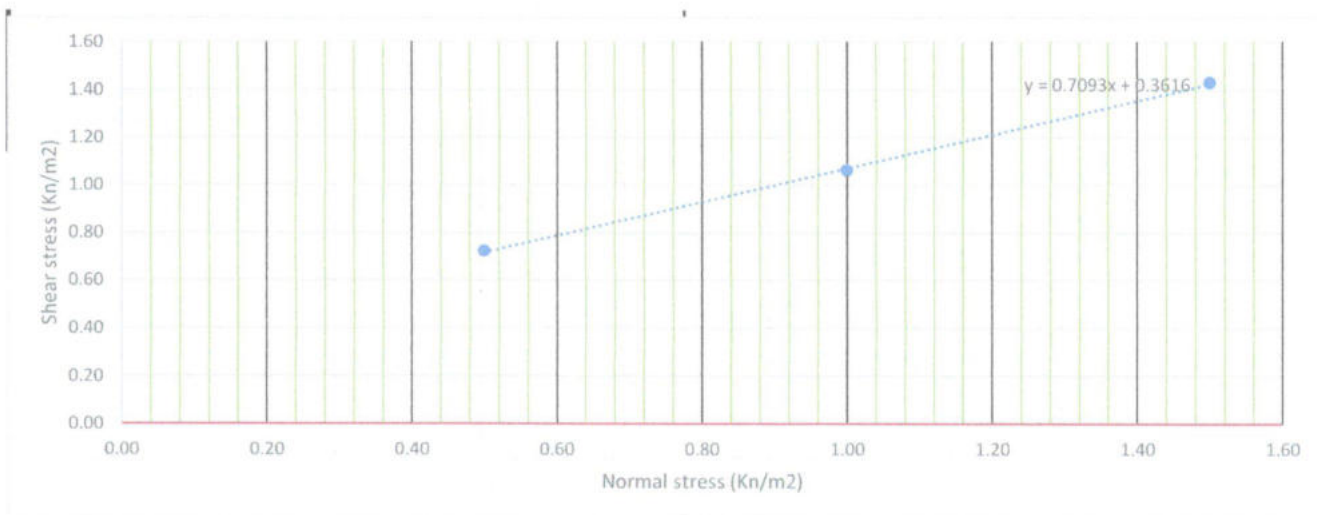


Sivalakan
Ex. Gilpi Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-03

BH No.	4	Depth=	13.5 m
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Results From Graph

1	Angle of Internal Friction(°)	34.38
2	Cohesion C Kg/Cm2	0

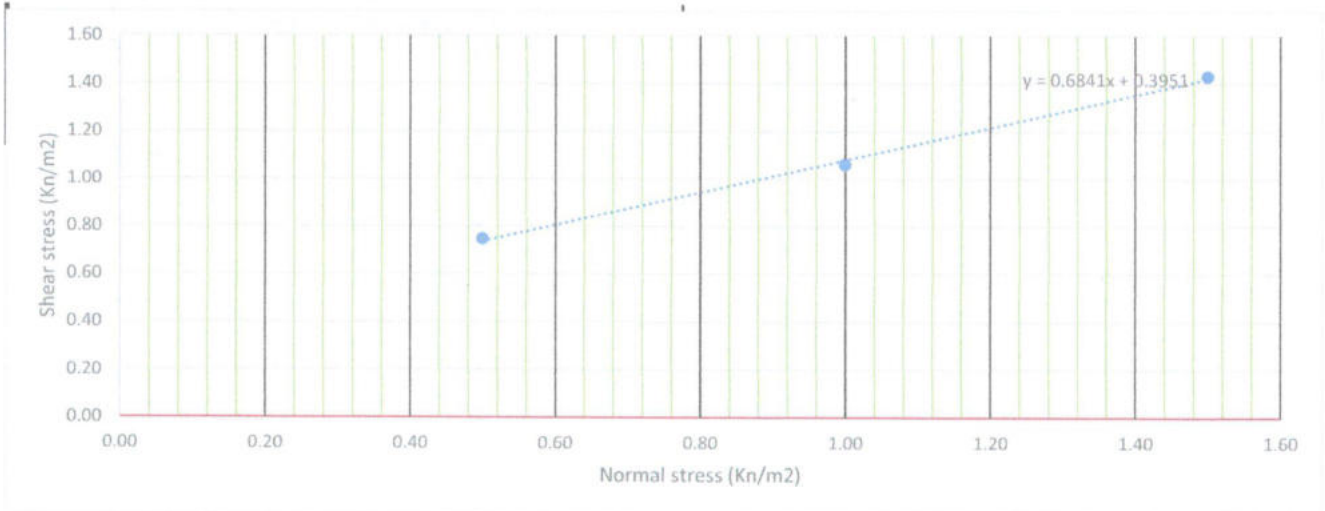


Sachin
 Er. Gopi Rani Melakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandmari, Ghy-03

BH No.	4	Depth=	15 m
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Results From Graph

1	Angle of Internal Friction(°)	34.43
2	Cohesion C Kg/Cm2	0



S. Lalakan
 Er. Gopi Rani Malakar, B.Tech (Civil)
 North East Engineer's
 GMC Market, Chandnari, Ghy. 03

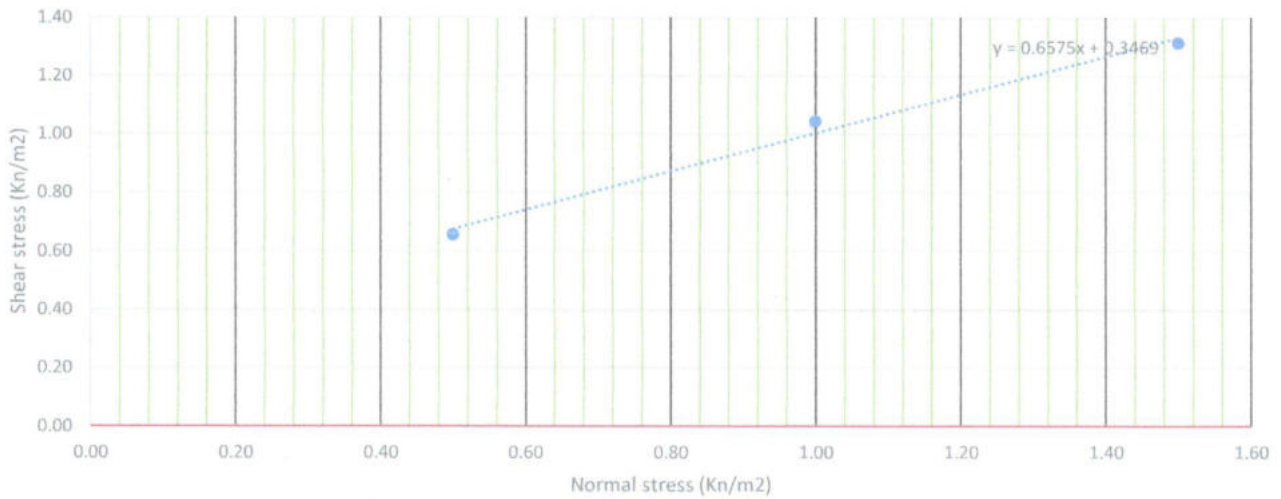
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 12 Depth= 4.5 m

Results From Graph

1	Angle of Internal Friction(°)	33.33
2	Cohession C Kg/Cm2	0



S. Lalakar
Mr. Gopi Rani Melakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh-03

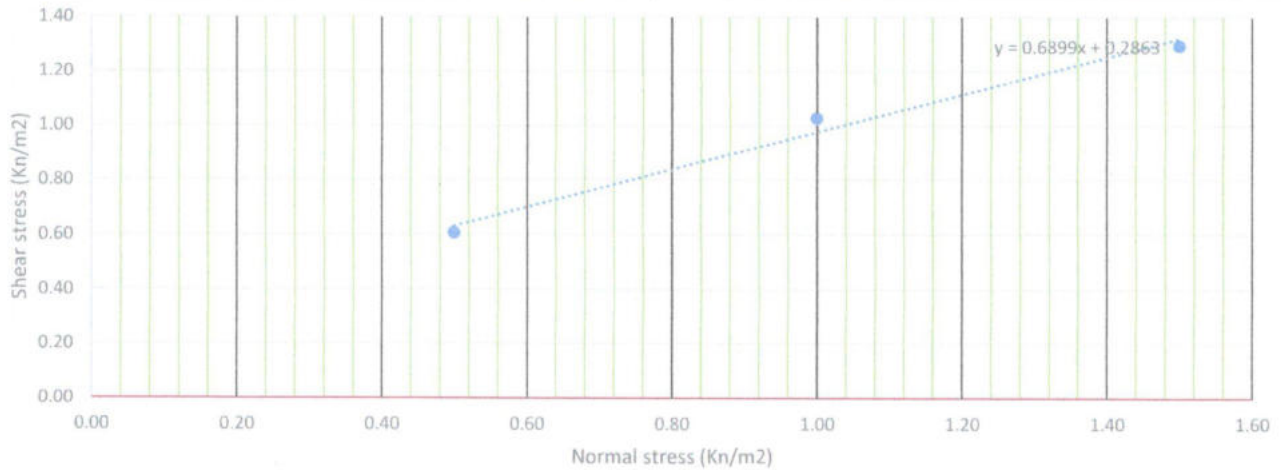
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 12 Depth= 6 m

Results From Graph

1	Angle of Internal Friction(°)	34.60
2	Cohesion C Kg/Cm2	0



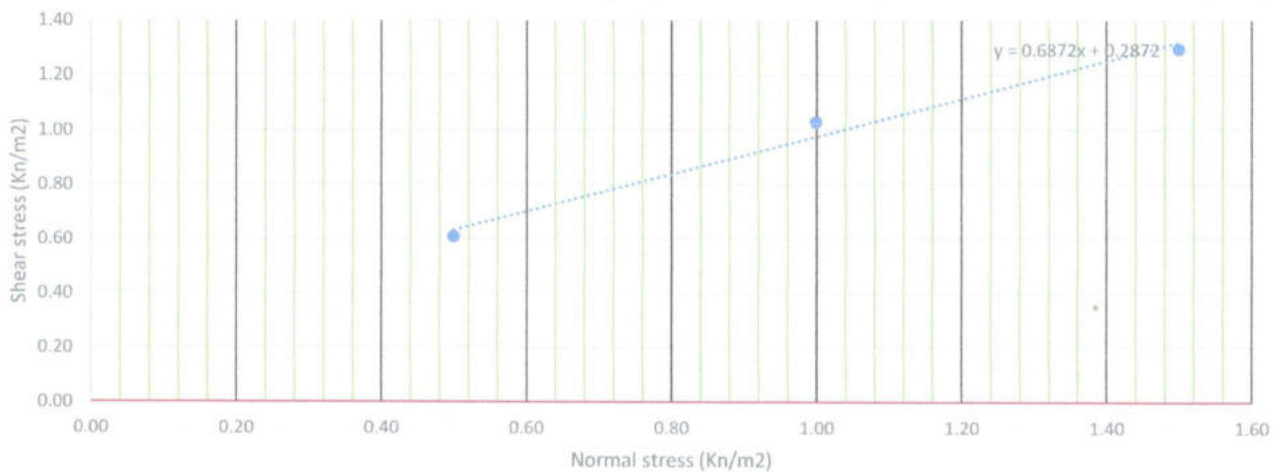
DIRECT SHEAR TEST

(IS 2720 Part-13 : 2009)

BH No. 12 Depth= 7.5 m

Results From Graph

1	Angle of Internal Friction(°)	34.50
2	Cohesion C Kg/Cm2	0



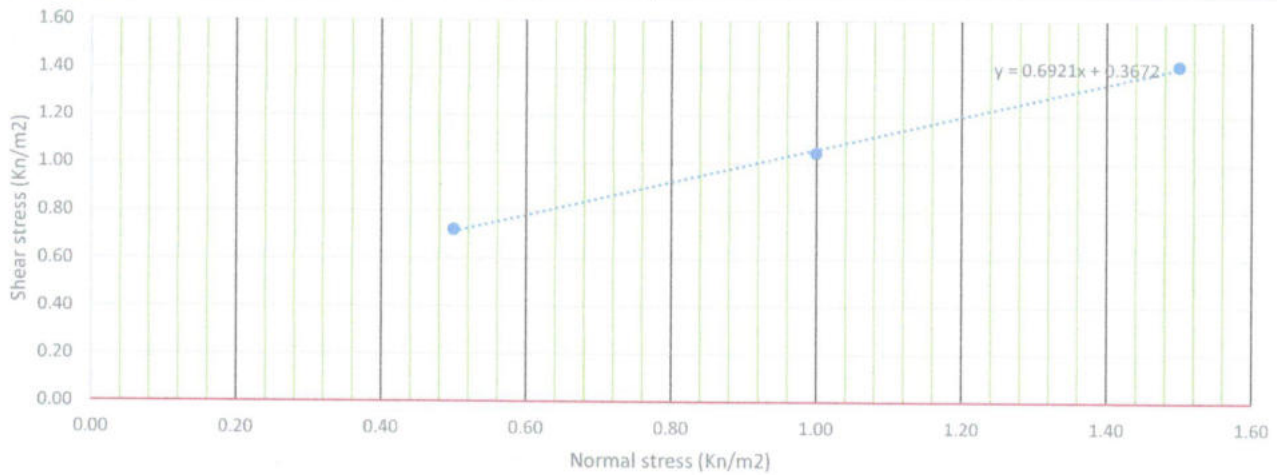
S. Malakar
Er. Sripriya Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chanderpur, Gh. 03

DIRECT SHEAR TEST
(IS 2720 Part-13 : 2009)

BH No. 12 Depth= 9 m

Results From Graph

1	Angle of Internal Friction($^{\circ}$)	34.69
2	Cohesion C Kg/Cm2	0

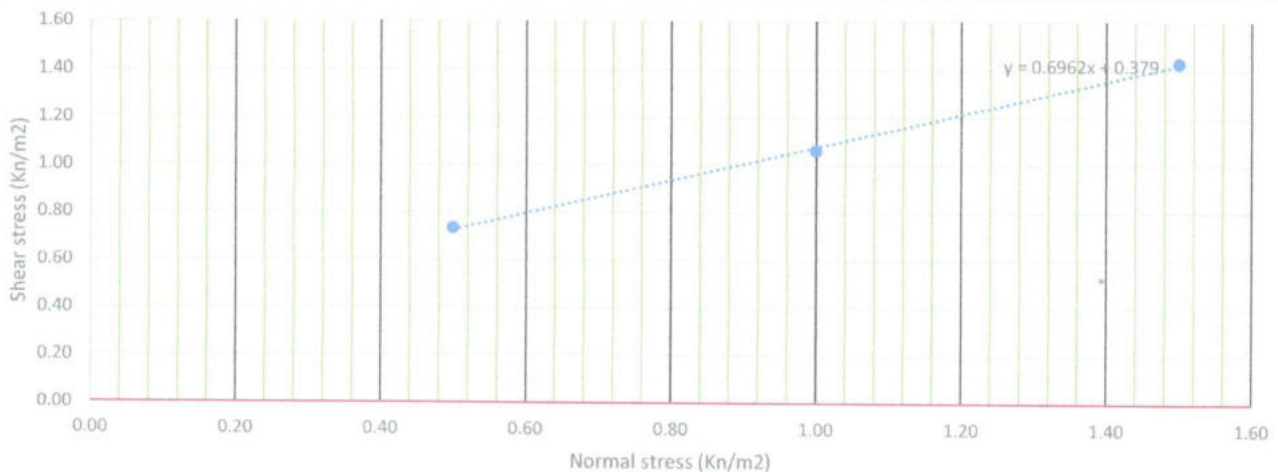


DIRECT SHEAR TEST
(IS 2720 Part-13 : 2009)

BH No. 12 Depth= 10.5 m

Results From Graph

1	Angle of Internal Friction($^{\circ}$)	34.84
2	Cohesion C Kg/Cm2	0

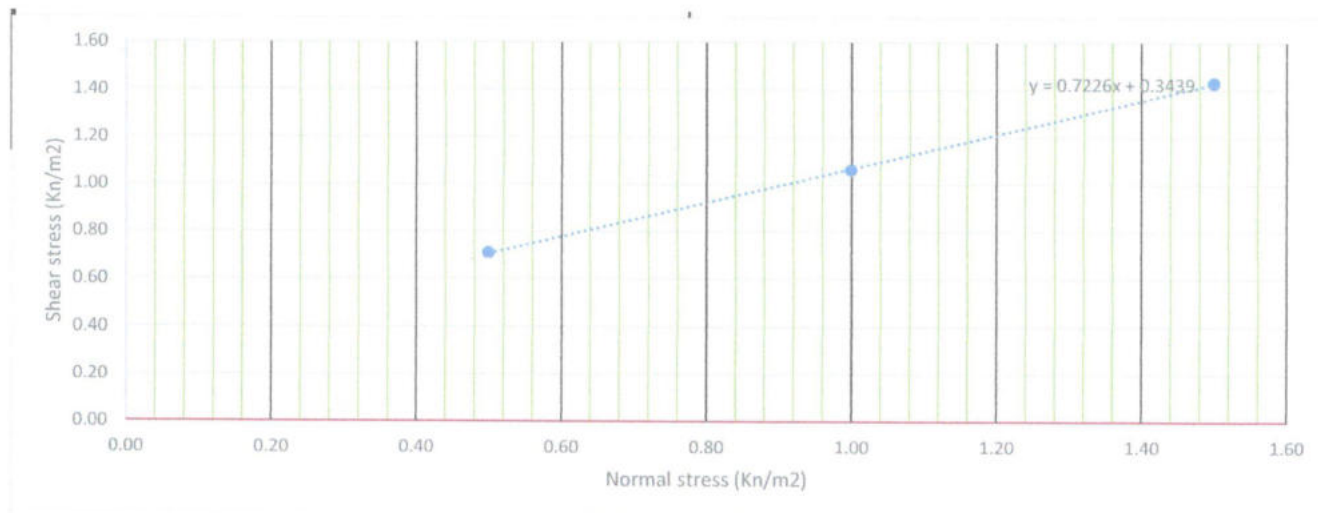


S. Lalakar
Er. Sibi Ravi Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandanpur Ghy-03

BH No. 12 Depth= 12 m

Results From Graph

1	Angle of Internal Friction(°)	35.85
2	Cohession C Kg/Cm2	0

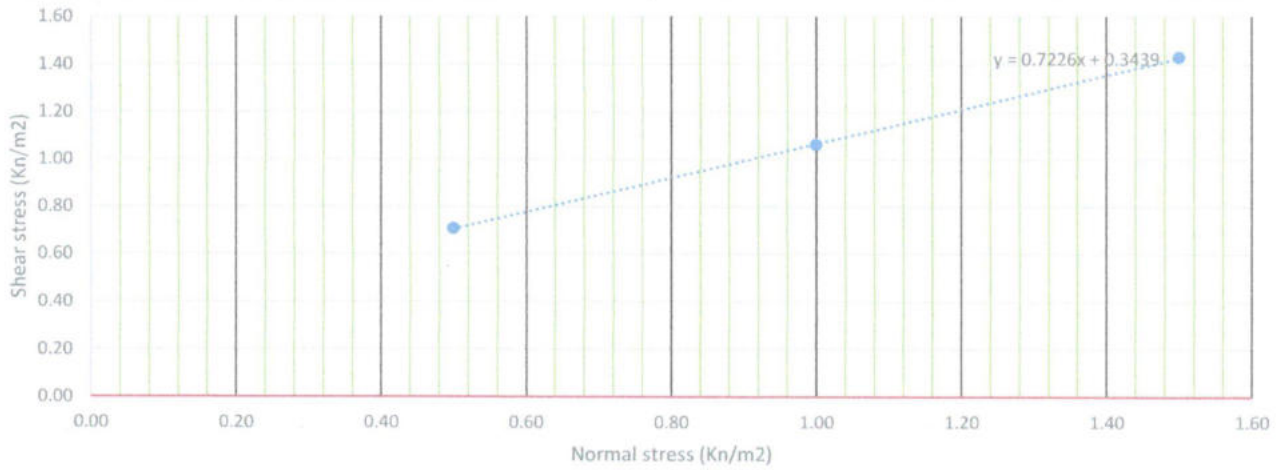


S. Malakar
Sr. Silpi Ravi Malakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh, Ghy-03

BH No. 12 Depth= 13.5 m

Results From Graph

1	Angle of Internal Friction(°)	34.92
2	Cohession C Kg/Cm2	0

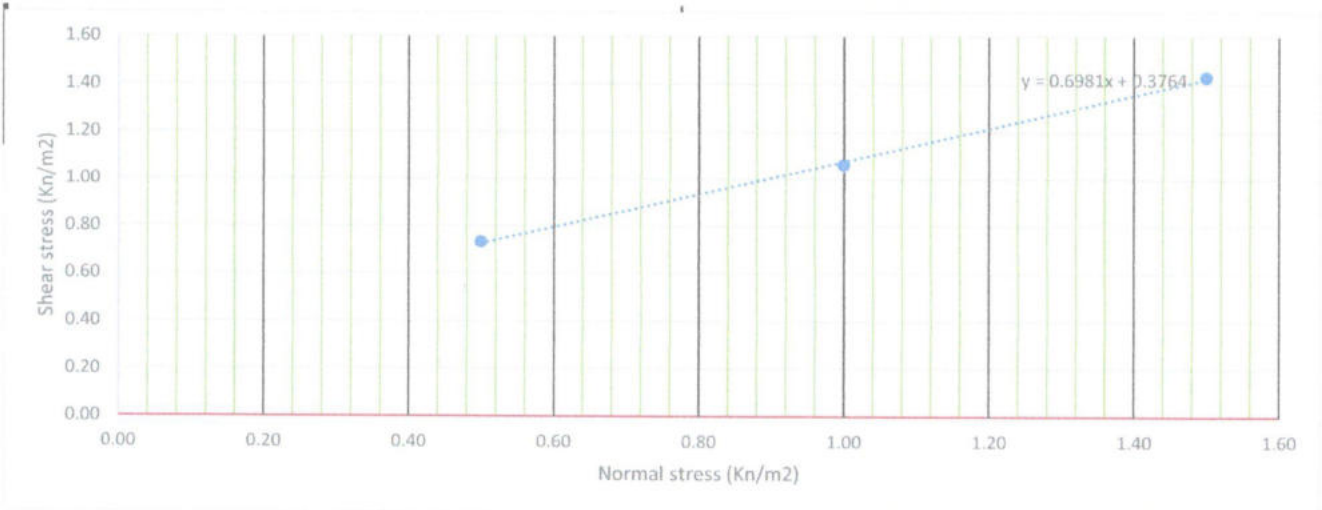


S. Malakar
Dr. Sisir Rani Malakar, B.Tech (Civil)
North East Engineer's
GMC, Market, Chandigarh-03

BH No. 12 Depth= 15 m

Results From Graph

1	Angle of Internal Friction(°)	35.01
2	Cohession C Kg/Cm2	0



S. Lalakar
Sr. Civil Engr. Molakar, B.Tech (Civil)
North East Engineer's
GMC Market, Chandigarh City-03

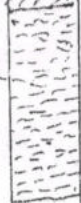
SOIL TEST BORE HOLE CHART

BORE HOLE NO. 1
TYPE OF BORING Manual Boring

DATE OF STARTED: 20/11/2022
DATE OF COMPLETED: 30/11/2022

NAME OF PROJECT 220/132KV GTS, Rumbur

GROUND WATER LEVEL: 6 m

DESCRIPTION	Depth (M)	strata	Sample Collected		S.P.T.			N-Value	Sign of visiting officer	REMARKS
					15cm	15cm	15cm			
Brownest / greyish silty clay from 0.0 m to 7.40 m	1.5 m		D/S	U/S	5	7	10	17		
	3 m				10	13	15	28		
	4.5 m				8	9	11	20		
greyish sandy clay from 7.40 m to 8.70 m	6 m		D/S	U/S	5	5	8	13		
	7.5 m				6	8	11	19		
	9 m									
greyish sand from 8.70 m to 10.5 explored depth	10.5 m		D/S	U/S						
	12 m									
	13.5 m									

Othman

22
30/11/22
@92

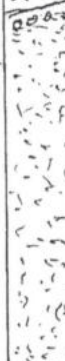
SOIL TEST BORE HOLE CHART

BORE HOLE NO.: 2
TYPE OF BORING: Manual Boring

DATE OF STARTED: 27/11/2022
DATE OF COMPLETED: 27/11/2022

NAME OF PROJECT: 220/132 KV GIS Sub Station, Khumtai

GROUND WATER LEVEL: 1.5 m

DESCRIPTION	Depth (M)	strata	Sample Collected		S.P.T.			N-Value	Sign of vigiting officer	REMARKS
					15cm	15cm	15cm			
Brownest/ greyish silty clay form E.G.L 4.20 m	1.5 m		D/S1	U/S	5	6	8	14		
	3 m		D/S2	U/S	4	4	5	9		
Brownest sand form 4.20 m to 6.40 m	4.5 m									
	6 m									
greyish sand form 6.40 m to 11 m	7.5 m									
	9 m									
greyish coarse sand form 11 m to 13.10 m	10.5 m									
	12 m									
greyish sandy clay form 13.10 m to 14 m	13.5 m				11	20	24	44		
greyish sand form 14 m to 22.00 m depth.	15 m									

Attacher

Subey

Qps

SOIL TEST BORE HOLE CHART

BORE HOLE NO.: **B 3**

TYPE OF BORING: **Manual Boring**

DATE OF STARTED: **28/11/2022**

DATE OF COMPLETED: **28/11/2022**

NAME OF PROJECT: **220/132KV GIS, Kluantai**

GROUND WATER LEVEL: **1.40 m**

DESCRIPTION	Depth (M)	strata	Sample Collected		S.P.T.			N-Value	Sign of visiting officer	REMARKS
			D/S	U/S	15cm	15cm	15cm			
Brownish / greyish silty clay from E.G.L to 2.30 m	1.5 m		D.S1		7	11	13	24		
	3 m		U.P.S2							
Brownish sand from 2.30 m to 8.30 m	4.5 m		U.P.S3							
	6 m		U.P.S							
	7.5 m		U.P.S							
greyish sand from 8.30 m to 13.20 m	9 m		U.P.S							
	10.5 m		U.P.S							
greyish sandy clay from 13.20 m to 14.10 m	12 m		U.P.S							
	13.5 m		D.S9		12	14	17	31		
greyish sand from 14.10 m to explored depth	15 m		U.P.S							

Attended

28/11/2022

Bgs

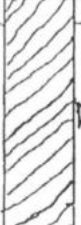
SOIL TEST BORE HOLE CHART

BORE HOLE NO.: 04
TYPE OF BORING: Manual Boring

DATE OF STARTED: 24/11/2022
DATE OF COMPLETED: 24/11/2022

NAME OF PROJECT: 220/132KV GIS, Raurkela

GROUND WATER LEVEL: 3.20m

DESCRIPTION	Depth (M)	strata	Sample Collected	S.P.T.			N-Value	Sign of visiting officer	REMARKS
				15cm	15cm	15cm			
Brownish greyish silty clay from E.G.L to 4m	1.5m		D/S						
			U/S						
Brownish sand from 4m to 5.50m	3m		DS1	6	10	13	23		
			DS2	6	7	9	16		
Greyish sand from 5.50m to explored depth	4.5m		UDS						
			UDS						
	6m		UDS						
	7.5m		UDS						
	9m		UDS						
	10.5m		UDS						
	12m		UDS						
	13.5m								
	15m								

Observed

Signature

Signature

SOIL TEST BORE HOLE CHART

BORE HOLE NO.: 5
TYPE OF BORING: Manual Boring

DATE OF STARTED: 29/11/2022
DATE OF COMPLETED: 29/11/2022

NAME OF PROJECT: 220/132KV GIS, Khumtai

GROUND WATER LEVEL:

DESCRIPTION	Depth (M)	strata	Sample Collected	S.P.T.			N-Value	Sign of vjgiting officer	REMARKS
				15cm	15cm	15cm			
Brownest sand born E.G.L to 3.8 m	1.5 m		D/S U/S						
	3 m		VD.81						
greyish sand born 8 m to emplaced depth			VD.82						
	4.5 m		VD.83						
	6 m		VD.84						
	7.5 m		VD.85						
	9 m		VD.86						
	10.5 m		VD.87						
	12 m		VD.88						
	13.5 m		VD.89						
	15 m		VD.90						

Chawan

Arif

Bojo

SOIL TEST BORE HOLE CHART

BORE HOLE NO: 06
TYPE OF BORING: Manual Boring

DATE OF STARTED: 19/11/2022
DATE OF COMPLETED: 19/11/2022

NAME OF PROJECT: 220/132KV GIS, Kumbhari

GROUND WATER LEVEL: 4.60 m

DESCRIPTION	Depth (M)	strata	Sample Collected	S.P.T.			N-Value	Sign of visiting officer	REMARKS
				15cm	15cm	15cm			
Brownest silty clay from E.S.L to 7 m	1.5 m		D.S1	6	11	12	23		
	3 m		D.S2	20	20	24	44		
greyish silt from 7 m to 10 m	4.5 m		D.S3	22	24	27	51		
	6 m		D.S4	18	21	23	44		
greyish medium sand from 10 m to explored depth	7.5 m		D.S5	23	25	27	52		
	9 m		D.S6	24	28	33	61		
	10.5 m		D.S7						
	12 m		D.S8						
	13.5 m		D.S9						
	15 m		D.S10						

Observed
19/11/22

W. S. S.

W. S. S.

SOIL TEST BORE HOLE CHART

BORE HOLE NO.: 07
TYPE OF BORING: Manual Boring

DATE OF STARTED: 21/11/2022
DATE OF COMPLETED: 21/11/2022

NAME OF PROJECT: 220/132KV GIS, Kumbhari

GROUND WATER LEVEL: 4.20m

DESCRIPTION	Depth (M)	strata	Sample Collected	S.P.T.			N-Value	Sign of visiting officer	REMARKS
				15cm	15cm	15cm			
Brownest Silt & clay form E.G.L to 2.5m	1.5m		D/S						
			U/S						
Brownest Sand form 2.5m to 3m	3m		D.S2	5	8	9	17		
			D.S2	24	29	34	63		
greyish sand from 3m to 4.5m	4.5m		D.S3						
			D.S4						
greyish sand from 4.5m to 6m	6m		D.S5						
			D.S6						
greyish sand from 6m to 7.5m	7.5m		D.S7						
			D.S8						
greyish sand from 7.5m to 9m	9m		D.S9						
			D.S10						
greyish sand from 9m to 10.5m	10.5m								
greyish sand from 10.5m to 12m	12m								
greyish sand from 12m to 13.5m	13.5m								
greyish sand from 13.5m to 15m	15m								

Chauhan
21/11/22

Vishal

Raj

SOIL TEST BORE HOLE CHART

BORE HOLE NO.: 8
TYPE OF BORING: Manual Boring

DATE OF STARTED: 20/11/2022
DATE OF COMPLETED: 20/11/2022

NAME OF PROJECT: 22d/12/2022 G.S. Khamtai

GROUND WATER LEVEL: 5 m

DESCRIPTION	Depth (M)	strata	Sample Collected	S.P.T.			N-Value	Sign of visiting officer	REMARKS
				15cm	15cm	15cm			
Brownest silty clay from F.G.L to 4 m	1.5 m		D.S1	5	9	11	20		
	3 m		D.S2	12	18	23	41		
greyish silty clay from 4 m to 5.5 m	4.5 m		D.S3	10	14	17	31		
greyish sand from 5.5 m to 13.10 m	6 m		D.S4	19	23	26	49		
greyish silty clay from 13.10 m to 14.90 m	7.5 m		D.S5						
	9 m		D.S6						
greyish sandy clay from 14.90 to explored depth.	10.5 m		D.S7						
	12 m		D.S8						
	13.5 m		D.S9	6	7	9	16		
	15 m		D.S10	20	22	26	46		

20/11/22

20/11/22

20/11/22

SOIL TEST BORE HOLE CHART

BORE HOLE NO.: 09
TYPE OF BORING: Manual Boring

DATE OF STARTED: 22/11/2022
DATE OF COMPLETED: 22/11/2022

NAME OF PROJECT: 228/132KV GIS, Khumtai

GROUND WATER LEVEL: 1.5 m

DESCRIPTION	Depth (M)	strata	Sample Collected		S.P.T.			N-Value	Sign of visiting officer	REMARKS
			D/S	U/S	15cm	15cm	15cm			
Brownish/greyish silty clay from E.G.L to 4.40 m	1.5m		DS1		4	5	7	12		
Brownest sand from 4.40 m to 7.30 m	3m		DS2		8	12	15	27		
	4.5m		DS3		24	28	34	62		
greyish sand from 7.30 m to explored depth	6m		U-DS4							
	7.5m		U-DS5							
	9m		DS6							
	10.5m		DS7							
	12m		DS8							
	13.5m		DS9							
	15m		DS10							

22-11-2022
J.M. REGEL
220KV, MISS

22/11/22

22-11-2022

SOIL TEST BORE HOLE CHART

BORE HOLE NO.: 10
TYPE OF BORING: manual Boring

DATE OF STARTED: 23/11/2022
DATE OF COMPLETED: 23/11/2022

NAME OF PROJECT: 220/132KV GIS, Khamtai

GROUND WATER LEVEL: 4 CM

DESCRIPTION	Depth (M)	strata	Sample Collected	S.P.T.			N-Value	Sign of vigiting officer	REMARKS
				15cm	15cm	15cm			
Brownish / greyish Silty clay form E.G.L to 8.90 m	1.5 m		D.S1	7	9	12	21		
	3 m		D.S2	6	7	9	16		
greyish sand form 8.90 m to explored depth	4.5 m		D.S3	14	17	23	40		
	6 m		D.S4	5	7	9	16		
	7.5 m		D.S5	10	16	19	35		
	9 m		D.S6						
	10.5 m		D.S7						
	12 m		D.S8						
	13.5 m		D.S9						
	15 m		D.S10						

[Signature]
23/11/22

Nike
23/11/22

[Signature]

SOIL TEST BORE HOLE CHART

BORE HOLE NO.: 11
 TYPE OF BORING: Manual Boring

DATE OF STARTED: 25/11/2022
 DATE OF COMPLETED: 25/11/2022

NAME OF PROJECT: 220/132KV GIS, Kluantan

GROUND WATER LEVEL: 2 m

DESCRIPTION	Depth (M)	strata	Sample Collected		S.P.T.			N-Value	Sign of visiting officer	REMARKS
			D/S	U/S	15cm	15cm	15cm			
BROWN red / greyish silty clay from E.G.L to 7.40 m	1.5 m		DS1		5	7	10	17		
	3 m		DS2		8	14	18	32		
greyish sandy clay from 7.40 m to 8.50 m	4.5 m		DS3		5	7	9	16		
	6 m		DS4		7	7	11	18		
greyish sand from 8.50 m to explored depth	7.8 m		DS5		5	5	7	12		
	9 m		VS							
	10.5 m		VS							
	12 m		VS							
	13.5 m		VS							
	15 m		VS							

Thawson

Thawson

Thawson

SOIL TEST BORE HOLE CHART

BORE HOLE NO.: 12
TYPE OF BORING: Manual Boring

DATE OF STARTED: 26/11/2022
DATE OF COMPLETED: 26/11/2022

NAME OF PROJECT: 220/132 KYGIS, Kluantai

GROUND WATER LEVEL: 1 m

DESCRIPTION	Depth (M)	strata	Sample Collected		S.P.T.			N-Value	Sign of visiting officer	REMARKS
			D/S	U/S	15cm	15cm	15cm			
Brownest/greyish silty clay from E.G.L to 4.40 m	1.5 m		DS1		3	5	8	13		
	3 m		DS2		7	8	9	17		
greyish Sand from 4.40 m to 8.40 m	4.5 m		DS3							
	6 m		U.D.S							
core greyish Sand from 8.40 m to 11.60 m	7.5 m		U.D.S							
	9 m		U.D.S							
greyish silt from 11.60 m to end of depth	10.5 m		U.D.S							
	12 m		U.D.S							
	13.5 m		U.D.S							
	15 m		U.D.S							

Othman

Amir

Agg

SOIL TEST BORE HOLE CHART

BORE HOLE NO. 2
TYPE OF BORING con test (D.C.P.T)

DATE OF STARTED: 3/12/2022
DATE OF COMPLETED: 3/12/2022

NAME OF PROJECT R.S. Infra project PW (70. (224/244 GTS) GROUND WATER LEVEL:

DESCRIPTION	Depth (M)	strata	Sample Collected		S.P.T			N-Value	Sign of visiting officer	REMARKS
			D/S	U/S	15cm	15cm	15cm			
	0.30 m				21					
	0.60				8					
	0.90				6					
	1.20 m				4					
	1.50 m				14					
	1.80 m				10					
	2.00 m				16					
	2.00.40				17					
	2.00.70				21					
	2.00 m				27					
	3.30 m				24					
	3.60				50					
	3.90									
	4.20									

Attended
03/12/22
(AEGEL)

Observed
03/12/22
(PMC)

Refused 3.40 m
at 3.40 m

Refused

Refused

SOIL TEST BORE HOLE CHART

BORE HOLE NO. : con test (2) (D.C.P.T.)
 TYPE OF BORING :

DATE OF STARTED : 3/12/2022
 DATE OF COMPLETED : 3/12/2022

NAME OF PROJECT : 220/182KV GIS Khumtai

GROUND WATER LEVEL :

DESCRIPTION	Dept (M)	Strata	Sample Collected		S.P.T.			N-Value	Sign of Visiting officer	Remarks
			D/S	U/S	15cm	15cm	15cm			
	30cm				17					
	60cm				6					
	90cm				6					
	120cm				4					
	1.50m				10					
	1.80				9					
	2.10				10					
	2.40				12					
	2.70				13					
	3.00m				14					
	3.30				50	27	32			Refused at 3.10 Mtr
	3.60									Refused
	3.90									
	4.20									
	4.50									

Thangson
 03/12/22
 (AEGCL)

D. Bhandari
 03/12/22
 (PMC)

Prasanna

NORTH EAST ENGINEERS

FIELD DATE SHEET

SL. NO. : 1

DATE OF TEST : 6.12.22

DATE OF CASTING :

NAME OF SITE : 220/122KV Substation at Khundaj

DESIGN LOAD :

NAME OF CONTRACTOR : R.S. Infra pvt

NAME OF DEPTT. :

TYPE OF PILE :

TYPE OF TEST :

DEPTH OF PILE :

DIA OF PILE :

ULTIMATE LOAD :

PILE NO. :

plate load test

8MT

DATE	TIME IN HOURS	LOAD APPLIED IN MT.	DIAL GAUGE READING IN MM				MEAN	REMARKS
			A	B	C	D		
6.12.22	9:25 A.M	2 MT	2.62	2.25				
	1	"	2.62	2.25				
	2	"	2.62	2.25				
	4	"	2.62	2.25				
	6	"	2.62	2.25				
	9	"	2.62	2.25				
	16	"	2.62	2.25				
	25	"	2.62	2.25			2.44	
	9:50	4 MT	4.45	4.25				
	1	"	4.47	4.25				
	2	"	4.49	4.25				
	4	"	4.49	4.25				
	6	"	4.49	4.25				
	9	"	4.51	4.26				
	16	"	4.52	4.27				
	25	"	4.53	4.27			4.40	

UKP

North East Engineers

Contractor R.S. Infra

P.M.E.

A.E.G.E.L

[Signature]

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[Signature]

[Signature]
06/12/22

FIELD DATE SHEET

SL. NO. : 2

TYPE OF PILE	:	
TYPE OF TEST	:	Plate load test
DEPTH OF PILE	:	
DIA OF PILE	:	
ULTIMAGE LOAD	:	8MT
PILE NO.	:	

[illegible]

UKP

North East Engineers Contracto R. S. Infra P.M.C A.F.B.C-L

Dulla

Ag

Bloemah

Alhassan
06/12/22