



NATIONAL HIGHWAYS AUTHORITY OF INDIA (NHAI)

Consultancy Services for Preparation of Feasibility Report of Access Controlled Delhi-Jaipur Expressway (Greenfield): Additional Works



**DRAFT FEASIBILITY REPORT INCLUDING SCHEDULES TO
THE CONCESSION AGREEMENT**

DWARKA EXPRESSWAY

PACKAGE -3 (Km 9+500 to Km 19+700)

Geotechnical Investigations Report

December, 2017

AECOM

9th Floor, Infinity Tower –'C',
DLF Cyber City, DLF Phase II,
Gurugram, Haryana, India, Pin 122002

Table of Contents

	PAGE NO.
1.0 INTRODUCTION	1
2.0 BRIEF DESCRIPTION OF GEOLOGY	1
3.0 SCOPE OF WORK	2
4.0 SITE EXPLORATION CONDUCTED	4
5.0 LABORATORY TESTINGS	5
6.0 FINDINGS OF GEOTECHNICAL INVESTIGATION	11
7.0 PROPOSED DEPTH & TYPE OF FOUNDATIONS	15
8.0 CHEMICAL ANALYSIS	15
10.0 CONCLUSION & RECOMMENDATIONS	16
Appendix-A	
Appendix-B	
Appendix-C	
Appendix - D	

1.0 **INTRODUCTION**

A geotechnical exploration has been conducted for comprehensive study and to confirm the subsoil conditions and to establish the various soil parameters and its behavior. Site has been explored to assess the general stability of site proposed for crossings to enable an adequate and economic design, to determine the changes that may arise in ground and environmental conditions and to plan the best method of construction etc. **This Report presents the results of BH-1 to 4 at Basai Road chainage 10+900, 13+000, 15+100 and 18+000.**

2.0 **BRIEF DESCRIPTION OF GEOLOGY**

The Indo-Gangetic alluvial tract is in the nature of a synclinal basin formed concomitantly with the elevation of the Himalayas to its north. It was formed during the later stages of the Himalayan Orogeny by the buckling down of the northern border of the peninsular shield beneath the sediments thrust over it from the north.

The older alluvium is rather dark colored (locally called “Bhanger”), is encountered in the project area. It is generally, rich in concretions or nodules of impure calcium carbonate (kankars). The kankars are of all shapes and sizes, varying from small sand sized grains to big grains and big lumps. The age of the “Bhanger” alluvium is Middle to Upper Pleistocene.

The newer alluvium (locally called “Khadar”) is light colored and poor in concretions. It is met in the areas close to the Yamuna River and other rivers and is not encountered in the project area. It contains lenticular beds of sand and gravel as well as peat beds. It is merged by insensible gradations into the Recent or deltaic alluvia and its age is Upper Pleistocene to Recent.

3.0 **SCOPE OF WORK**

The scope of soil exploration for this project included the following:

- 3.1 Mobilization of men and equipments to the proposed site, setting up of the equipment and conducting the field investigations on land and demobilization after fieldwork is completed satisfactorily.
- 3.2 The field work to be done at site comprised of:

- 3.2.1 Making 150 mm diameter bore holes at specified locations using power operated winch driven shell & auger equipment upto 30 m depth or refusal whichever occurs earlier. Sinker bars were to be used depending on the requirement. Chiseling was to be done to penetrate hard strata, to puncture the local obstruction like boulder or to confirm the commencement of rock strata.
- 3.2.2 Conducting standard penetration tests in bore holes in all types of soils, disintegrated/weathered rocks during boring activity at 1.5 m interval or at every change of strata whichever occurs earlier.
- The blow counts for SPT Test shall be terminated when combined blow count exceeds 100 (called as refusal) for the last 300 penetration of the sampler.
- 3.2.3 Collecting undisturbed & disturbed soil samples in soil strata at regular intervals
- 3.2.4 Recording the depth of ground water table on its full stabilization in all the bore holes in case of its occurrence.
- 3.3 Testing the representative soil/rock/water samples/as per approved schedule of tests in the laboratory.

A) On soil Samples

- a) Natural moisture content
- b) Dry density
- c) Particle size analysis
- d) After berg's limits
- e) Unconfined compression Test
- f) Triaxial shear test (UU, CD&CU)
- g) Direct shear test
- h) Consolidation test on cohesive samples

B) Chemical Test on Water/Soil sample

- a) pH value
- b) Sulphate content
- c) Chloride content

- 3.4 Describing sub-soil strata and preparation of bore logs.
- 3.5 Preparing & submitting the geotechnical report in triplicate after summarizing the field and laboratory tests for comments of client/engineering consultant.

The geotechnical investigation report included as follows:

- a) Geological history and geographical background of the area
- b) Total scope of work and a plot plan showing locations of all tests.
- c) Brief description of procedure adopted for field and laboratory tests.
- d) Detailed Bore log in approved format indicating all field observations and results including R.L, co-ordinate, GWT after proper modifications in light of laboratory test alongwith commencement and completion date. Observations of peculiar conditions such as artesian conditions, sand blow, water loss, sudden penetration of drill rod etc.
- e) Laboratory identification and results in approved tabular and graphical form with a summary of all test results for individual borehole/field test
- f) True cross sections/profile of all boreholes &/or trial pits with reduced levels, position of borehole/trial pit, thickness and classification of each stratum, GWT, N value, other in-situ tests, sampling, at different depths for obtaining realistic idea about the stratigraphy and consistency.
- g) All geotechnical parameters like natural moisture content & bulk density, specific gravity, consistency limits and particle size distributions, shear strength test (c, E etc.), earth pressure co-efficient (Ko, Ka, Kp) etc. whichever is applicable along with all relevant graphs, charts, diagrams like stress-strain curves, Mohr's Circle, grain size curve.
- h) Recommendations on Geological and litho logical information of the area including that of faults, folds nature of fracture, spacing, thickness of discontinuity and seismic history (previous earthquakes and its time, period, duration, magnitude, max, ground
- i) Recommendations for the foundation system. For shallow foundation, Net Safe Bearing Capacity along with settlement for various foundation sizes for different depths. For foundations on soil IS: 6403, IS: 8009 (Part I & Part II), IS: 2911, IRC: 78 etc. as applicable

4.0 SITE EXPLORATION:

- 4.1 The required equipment and team were mobilized to the site for carrying out the required field work. The locations for bore holes and depths adopted were given by the engineer - in- charge. All the boreholes and tests were carried out in the presence of the representative of site-in-charge. All locations are exhibited in site plan.
- 4.2 For boring, power operated winch driven shell and auger method was adopted as per IS: 1892-1979. Casings were used as per requirement to retain the boreholes in position. All the boreholes were advanced up to the required depth.
- 4.3 The standard penetration tests were conducted at 1.5 m intervals up to 30 m depth during the advancement of boreholes;
For conducting SPT, IS Code: 2131-1981 / was followed. After reaching the required depth of test, the bottom of the bore hole was cleaned properly and spoon is properly and centrally seated in position in the borehole. Standard split spoon sampler attached to lower end of “A” drill rods was driven in the bore holes by means of standard hammer of 63.5 kg falling freely from a height of 75 cm. The sampler was driven 45 cm. and the number of blows required for each 15 cm. penetration were recorded. The number of blows for the first 15 cm. penetration was considered as seating drive. The number of blows for last 30 cm penetration was designated as SPT ‘N’ value. SPT soil samples obtained from standard split spoon sampler for all the above standard penetration tests were collected in polythene bags, sealed, labeled and sent to the laboratory for testing.
- 4.4 The undisturbed soil samples were collected in good quality thin walled seamless tubes, of min. dia of 75 mm and length of 450 mm with area ratio less than 15%. The UDS tubes are gently pushed in soil using hydraulic push rig/gently hammering action. After retrieval of UDS tube from the borehole, ends of the tube with sample were sealed with freshly molten wax of minimum 20mm thick, properly labeled, marked an arrow showing upward direction and dispatched to laboratory for testing. At site sample tubes were covered with wet gunny bags.
- 4.5 On encountering the water table, its depth was recorded everyday in each borehole prior to resumption of day’s work. The observation of depth of water table was

continued for next seven days in the completed boreholes. When it was fully stabilized, the depth was recorded as depth of water table.

- 4.6 Ground water samples were collected from bore holes in an airtight clean bottle, properly labeled, sealed and sent to the laboratory of its chemical analysis test. Before collecting ground water sample, it was ensured that no external water was added before collection of sample.
- 4.7 Soil sample were collected from bore holes as per approved schedule and chemical test was conducted on it in the laboratory.

5.0 **LABORATORY TESTING**

5.1 **GRAIN SIZE ANALYSIS**

For this purpose an oven dry pulverized soil sample is sieved through the set of sieves 20mm, 10mm, 4.75mm, 2.0mm, 1.0mm, 600micron, 300micron, 150micron and 75micron. The amounts of soil retained on each sieve are noted down. The % retained, cumulative % retained and % passing are computed by these retained weights.

If the % passing 75 micron sieve is appreciable, Hydrometer method is used to find the % fraction of particle sizes from 75micron to 2micron.

5.2 **LIQUID LIMIT**

For liquid limit Casagrande apparatus is used. For this test air dry soil sample passing 425micron is taken and mixed with distilled water to give a stiff and homogeneous paste and is left for sufficient time for maturing in an air tight container.

A portion of the above paste is kept in the cup of Casagrande apparatus, a groove is cut with groove cutting tool and blows are imparted by turning the handle at the rate of 2 revolutions per second. The numbers of blows are counted till the continuous contact of the bottom of the groove occurs.

Few quantity of soil from the close portion of the groove after the contact occurs, are taken and its water content is determined by oven drying method.

The liquid limit (WL) is computed by the equation.

$$WL = W_n(n/25)^e$$

Where W_n = water content (% corresponding to n blows)

$e = 0.092$ for soils with $WL < 50$

=0.12 for soils with WL>50

5.3 PLASTIC LIMIT

For this test sample is prepared in the same way as for liquid limit test. A ball is formed of sub sample weighting about 5 gm. This ball is rolled between the fingers of one hand and the glass plate with pressure sufficient to reduce the mass into a thread of about 3 mm in 5 to 10 complete forward and back movements. When a diameter of 3 mm is reached, soil is again remolded into a ball.

The process of rolling and remolding is repeated until the thread starts just crumbing at a diameter of 3 mm.

The crumbled thread is immediately transferred to an airtight container for determination of its moisture content by oven drying method.

This water content is termed as plastic limit. (WP)

5.4 PLASTICITY INDEX

The plasticity index I_p is given by

$$I_p = WL - WP$$

5.5 WATER CONTENT

For this test the soil sample of known quantity (W_m) is taken in a container. The container with this soil sample is placed in an oven for drying at 105-110°C for 16-24 hours. After drying the dry sample is again weighed to determine the dry weight of sample (W_d)

The moisture content is computed by the following equation:

$$W_n = (W_m - W_d) / W_d$$

5.6 DRY DENSITY & BULK DENSITY

For determination of bulk density, a sample of known volume 'V' is extracted from the undisturbed sample. Its bulk weight 'W' and moisture content 'Wn' is determined by oven drying method.

The bulk density is determined by following equation

$$\gamma_b = W/V \text{ and dry density } \gamma_d = \gamma_b / (1 + W_n)$$

5.7 SPECIFIC GRAVITY

The specific gravity of soil sample is determined by density bottle method. For this test 5-10g (W2) sample of oven dry, cool soil is taken in 50ml capacity density bottle and its weight is noted down. The soil is covered with distilled water and left for sufficient period for suitable soaking. The entrapped air is removed by vacuum. The soil in bottle is filled full with water and its is noted down as w3. The mass of empty bottle (w1) and bottle with full distilled water also noted (w4).

The specific gravity is found by the following equation.

$$G = \frac{w_2 - w_1}{[(w_2 - w_1) - (w_3 - w_4)]}$$

5.8 DIRECT SHEAR TEST

For this test shear box test apparatus is used. The prepared specimen from remolded/undisturbed sample is placed carefully in the box. The plain grid is kept on top of the specimen with its serrations at right angles to the direction of shear. The upper porous stone is placed on the grid and loading pad on the stone. The box with specimen is gently placed in the container (water jacket). The specimen is submerged with water. The container is mounted with the shear box and the specimen inside, on the shearing machine. The upper part of the box is so adjusted that it touches the proving ring. The jack is brought forward to bear up against the box container. The proving ring dial gauge is set to read zero.

The steel ball is placed in the recess of the loading pad. The loading yoke is set in contact with the steel ball on the loading pad. Vertical displacement dial gauge to read zero in contact with the top of the yoke. The normal load is applied and any change in thickness of specimen is recorded. Shear displacement dial gauge is also set to read zero. The locking screw is now removed and two parts of the shear box are separated by advancing the spacing screws.

The specimen is sheared at constant rate of strain. The readings of the proving ring dial gauge are noted down every 15 seconds for the first one-minute and then every 30 seconds thereafter. The reading of change in the thickness dial gauge and shear displacement dial gauge are also recorded at the same time interval. The test is continued until the specimen fails. The specimen is assumed to fail when the proving

ring dial gauge starts receding or at shear displacement of approximately 15% of the length takes place.

The soil is removed from the box and test is repeated on the identical specimen under increased normal load.

For consolidated undrained test the specimen is prepared and set in the apparatus as above and after submergence, the specimen is allowed to consolidate fully under normal loads. The specimen is then sheared as in undrained test. At the end of the test, the specimen is removed and its final water content is determined. The test is repeated on other identical specimen in similar way under increasing normal loads.

For drained test, after completion of consolidation under a particular normal load, specimen is sheared at a slow rate to allow the pore water inside the specimen drain out. Final water content of failed specimen is determined. The test is repeated on other identical specimen after consolidation under increasing normal loads.

5.9 TRIAXIAL SHEAR TEST

For this test Triaxial Shear Test apparatus with pore pressure measurement apparatus is used. The porous disc or plain disc, depending on the test conditions is placed on the pedestal of the triaxial cell. The specimen is placed centrally on the disc. A correct size membrane is fitted inside the stretcher with ends of membrane folded over those of the stretcher. Vacuum is applied to stretch the membrane to the inside surface of the stretcher is carefully slipped around the specimen kept on the pedestal. The vacuum on the membrane is released. Its bottom part is rolled down into the pedestal. Depending on the type of test porous or plain disc is placed on the top of the specimen and then pressure pad is placed. The top part of membrane is rolled on to the pressure pad. Now the stretcher is removed and ends are sealed with 'O' rings.

With the properly sealed specimen placed centrally on the pedestal, the cell is assembled, keeping the loading piston initially clear of the pressure pad of the specimen. The assembly is placed in the loading frame.

For unconsolidated undrained test, the bottom drainage valve (BDV) and top drainage valve (TDV) of cell, is closed and air release valve (ARV) is opened. The cell is filled with water through the cell water valve CWV. ARV is closed when water begins to

escape through it. The cell pressure is raised to the desired value and kept constant till the end of the test.

If initially unsaturated specimen is to be saturated before the test, the specimen is mounted in the cell with porous disc. The specimen is saturated by back pressure saturation method.

When the cell pressure is applied, the load piston rises upward, the loading machine is operated at the anticipated rate to bring the load piston slightly above the pressured pad of the specimen and the load measuring dial gauge on proving ring is set to zero.

The piston is brought just in contact with pressure pad by hand operation of the machine. The axial compression dial gauge is mounted and set to read zero.

The axial loading is started at constant rate of strain. Simultaneous readings on the load and compression dial gauges are noted down. The test is continued until a recession of the axial load is observed.

After failure, the specimen is unloaded by reversing the loading machine, cell pressure is reduced and cell water is drained out after opening the ARV. The cell is dismantled and the specimen is taken out rubber membrane is removed and weight of the failed sample and its water content is determined.

The test is repeated on two more identical specimens with increasing cell pressure.

For consolidated undrained test, first the specimen is saturated by back pressure saturation. The saturated specimen is then consolidated fully under a cell pressure. After consolidation is complete, the axial load is applied and the test is conducted as for undrained test. The pore pressure developed during the undrained test portion is measured by the pore pressure measuring system. After the completion of test, pore pressure apparatus and mercury control system is disconnected, cell is dismantled and sample is taken outside to determine its weight and final water content. The test is repeated on three identical specimens using increasing cell pressure for consolidation.

For consolidated drained test, the specimen is first allowed to consolidate under a confining pressure as in consolidated undrained test. Then sample is failed under drained condition. After consolidation is complete, the axial load is applied and the test is conducted as for undrained test. The pore pressure developed during the undrained test portion is measured by the pore pressure apparatus. After completion of test the

pore pressure apparatus. After completion of test the pore pressure apparatus and mercury control system is disconnected, cell is dismantled and sample is taken outside to determine its weight and final water content. The test is repeated on three identical specimens using increasing cell pressure for consolidation.

6.0 **FINDINGS OF GEOTECHNICAL INVESTIGATION**

6.1 The classification of subsoil strata met at this site was done according to IS: 1498-1970.

The test results can be summarized as below-

BH-2, 3 and 4 (CH 15100, 13000 & 10900): The subsoil strata from 0.0 to 30.0 m depth consist of Silty sand SM to final explored depth of 30.0 m.

Table no. 1 Bore Hole Wise Details Of Subsoil Strata.

Depth, m		Soil Classification	Range of N value	Soil properties
From	To			
0	9.0	Silty sand (SM)	2-9	DST $c=0$, $\phi=29^\circ$
9.0	15.0	Silty sand (SM)	12-21	DST $c=0$, $\phi=30^\circ$
15.0	20.0	Silty sand (SM)	25-44	DST $c=0$, $\phi=31^\circ$
20.0	25.0	Silty sand (SM)	45-50	DST $c=0$, $\phi=32^\circ$
25.0	30.0	Silty sand (SM)	>50	DST $c=0$, $\phi=33^\circ$
WATER TABLE: Not Met				

BH-1, (CH 18000): The subsoil strata from 0.0 to 5.0 m depth consist of Silty sand SM underlain by clayey silt to final explored depth of 30.0 m.

Depth, m		Soil Classification	Range of N value	Soil properties
From	To			
0	5.0	Silty sand (SM)	1-8	DST $c=0$, $\phi=29^\circ$
5.0	10.0	Clayey silt (CI)	12-22	UUT $c=0.95$, $\phi=10^\circ$
10.0	16.0	Clayey silt (CI)	26-33	UUT $c=1.00$, $\phi=10^\circ$
16.0	25.0	Clayey silt (CI)	>50	DST $c=1.30$, $\phi=10^\circ$
25.0	30.0	Clayey silt (CI)	>50	DST $c=1.65$, $\phi=10^\circ$
WATER TABLE: Not Met				

The layer wise properties of the subsoil strata encountered at this site and used in design are given in following table no. 2.

BH-2 and 3, 4

Depth, m		Effective unit Weight, gm/cc	Shear Parameters		Earth Pressure Coefficients		
From	To		C (kg/cm ²)	Ø (degree)	k ₀	k _a	k _p
0	9.0	1.60	0	29	0.51	0.35	2.88
9.0	15.0	0.65	0	30	0.50	0.33	3.00
15.0	20.0	0.70	0	31	0.48	0.32	3.12
20.0	25.0	0.80	0	32	0.47	0.31	3.25
25.0	30.0	0.85	0	33	0.45	0.29	3.39

Table No. 2 Layerwise Properties of Subsoil Strata

BH-1

Depth, m		Effective unit Weight, gm/cc	Shear Parameters		Earth Pressure Coefficients		
From	To		C (kg/cm ²)	Ø (degree)	k ₀	k _a	k _p
0	5.0	1.60	0	29	0.51	0.35	2.88
5.0	10.0	1.65	0.95	10	0.50	0.33	3.00
10.0	16.0	0.70	1.00	10	0.48	0.32	3.12
16.0	25.0	0.80	1.30	10	0.47	0.31	3.25
25.0	30.0	0.85	1.65	10	0.45	0.29	3.39

The Detail description of subsoil strata encountered along with various laboratory test results are presented in the respective bore log given in table no. 1 to 7 enclosed with this report.

The subsoil profile depicting the distribution of the various subsoil strata along the alignment along with N values (observed/corrected) and other strength parameters with depth are given in subsoil profile enclosed with this report.

The SPT Curve & Table (No/Nc), Grain Size Analysis Curve, Mohr Circle Diagrams etc. are enclosed with this report.

6.2 GROUND WATER

The ground water table was not encountered below existing ground surface during boring activities at site. However, as the surface water may percolate in heavy rainy season hence for the design purposes, effect of ground water table can be considered at 8.0 m below ground surface.

7.0 PROPOSED DEPTH & TYPE OF FOUNDATIONS

Depending upon the visual examination of soil & field strata, field and laboratory test results and the type of structures proposed at this site, the safe bearing capacity of sub-soil strata for proposed bridge (Raft footing/open foundation) have been analyzed. Scour is considered negligible for the purpose of analysis. The details of the proposed foundations are presented in the following paragraph:

- a) Since the N-values are very low to 6-9 m depth, open foundations are not feasible at site
- b) We recommend the RCC bored-cast-in-situ Piles to support the structural loads.

8.0 CHEMICAL ANALYSES OF SUBSOIL AND GROUND WATER SAMPLES:-

The chemical analysis tests on subsoil sample indicates (ref. table no. 2) that the pH value, chloride content and sulphate content are within permissible limits and Ordinary Portland Cement or Portland Slag Cement or Portland Pozzolana Cement can be used for RCC work. The minimum cement content and maximum free water-cement ratio shall be maintained as per IS: 456, 2000.

10.0 CONCLUSION WITH RECOMMENDATIONS:

On the basis of above Geotechnical investigation the following recommendations are suggested:

- 10.1** We recommend the use of 1000 mm and 1200 mm diameter bored cast-in-situ piles to support the structural loads. The cut-off-level of the pile is assumed as 1.5 m below the existing ground level.

Table No. 3: Recommended Pile Capacities**BH 2, 3 and 4**

Pile diameter, mm	Pile length, (m)	Recommended Pile Capacity, Tonnes		
		Compression	Uplift	Lateral
1000	18	266	100	32.8
	20	318	119	
	22	345	137	
	25	417	166	
1200	18	376	123	46.9
	20	453	147	
	22	489	172	
	25	595	212	

BH 1

Pile diameter, mm	Pile length, (m)	Recommended Pile Capacity, Tonnes		
		Compression	Uplift	Lateral
1000	18	180	91	32.8
	20	199	104	
	22	218	118	
	25	257	139	
1200	18	231	110	46.9
	20	256	127	
	22	280	144	
	25	332	170	

The above values include a safety factor of 2.5. The pile capacities should be confirmed by conducting sufficient number of initial pile load tests.

- 10.2** The ground water table was not encountered below existing ground level in the boreholes during boring activities at site. The measured ground water table may fluctuate due to variation in climatic conditions and in rate of surface evaporation. For design purposes the ground water table can be considered at 8.0 m below ground surface.
- 10.3** Layer wise properties of the encountered subsoil strata may be adopted from table no. 1 & 2 given in clause 6.0.
- 10.4** As the water table is not met; water table may not be encountered during excavation. So dewatering need not to be done.

- 10.5** The chemical analysis tests on ground water sample (ref table no. 2 indicate that chloride content, sulphate content and pH value are within permissible limits and the ground water is fit for construction purposes.
- The chemical analysis tests on subsoil sample indicates (ref. table no. 2) that the Ordinary Portland Cement or Portland Slag Cement or Portland Pozzolana Cement can be used for RCC work. The minimum cement content and maximum free water-cement ratio shall be maintained as per IS: 456, 2000.
- 10.6** The slope of the excavated pit may be kept upto 1 vertical on 0.3-0.4 horizontal during excavation. However, if space is constraint then suitably designed bracing and strutting system should be adopted.
- 10.7** As per IS 1893:2002, the site falls under earthquake zone-iv. In the topsoil layers, (0.0-4.0 m) SPT values are less than 15, but water table is not met, which is not liable to liquefy. In our analysis for calculating bearing capacities and pile capacities, the liquefaction potential has been ignored.
- 10.8** We recommend that load tests be conducted on piles in order to confirm the static capacities and to ensure proper performance of the piles. The load tests (Initial and Routine) should be conducted on sufficient number of piles as per IS: 2911 part-iv.
- 10.9** The above recommendations have been made on the basis of in situ tests and laboratory tests conducted on the samples collected from limited number of bore holes bored at the locations given by the client. If during construction, any unusual or abnormal features are noticed, these may be brought to the attention of Geotechnical Consultants for further suggestions.

SOIL PROFILE				Project : Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway				BH.No. 1		TERMINATION DEPTH		TABLE NO. 1a							
								Date of Start : 03.12.2017		WATER TABLE :		30.00m		JOB NO.					
				Date of Finish : 04.12.2017		Not met				Chainage : 10+900 (Basai Road)					21711-A				
N-Value	Depth (m)	Sample No.	Symbol			SOIL DESCRIPTION	Grain Size Analysis				Atterberg Limits			Specific Gravity	Natural Density gms/cm ³	Dry Density gms/cm ³	Moisture Content %	Triaxial Test	
				Gravel %	Sand %		Silt %	Clay %	Liquid %	Plastic %	Plasticity Index %	Type of Test	Cohesion Intercept Kg/cm ²					Angle of Internal Friction	
3	0.50	DS1	[Symbol]	Light Grey Silty Sand (SM)															
	1.50	SPT1																	
	2.50	UDS1			0	63	37	0				2.62	1.65	1.53	9.4				
3	3.00	SPT2																	
5	4.50	SPT3																	
6	5.50	UDS2			0	64	36	0	N	P	-		1.67	1.55	9.8	DST	0	30	
	6.00	SPT4																	
	7.50	SPT5																	
9	8.50	UDS3			0	65	35	0	N	P	-	2.63	1.69	1.57	10.5				
	9.00	SPT6																	
	10.50	SPT7																	

(Cont'd on Table No.1b)

SOIL PROFILE				Project : Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway				BH.No. 1		TERMINATION DEPTH 30.00m		TABLE NO. 1b							
						Date of Start : 03.12.2017		WATER TABLE :		Chainage : 10+900 (Basai Road)		JOB NO.							
						Date of Finish : 04.12.2017		Not met				21711-A							
N-Value	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis				Atterberg Limits			Specific Gravity	Natural Density gms/cm³	Dry Density gms/cm³	Moisture Content %	Triaxial Test			
					Gravel %	Sand %	Silt %	Clay %	Liquid %	Plastic %	Plasticity Index %					Type of Test	Cohesion Intercept Kg/cm²	Angle of Internal Friction	
14	11.50	UDS4		Light Grey Silty Sand (SM)	0	60	40	0	N	P	-	2.64	1.74	1.58	11.2	DST	0	32	
	12.00	SPT8																	
	13.50	SPT9																	
	14.50	UDS5			0	76	24	0	N	P	-		1.77	1.63	12.1				
26	15.00	SPT10																	
29	16.50	SPT11																	
39	17.50	UDS6			0	74	26	0	N	P	-	2.65	1.82	1.71	15.2	DST	0.00	35	
	18.00	SPT12																	
	19.50	SPT13																	
44	20.50	UDS7			0	70	30	0	N	P	-								
53	21.00	SPT14																	

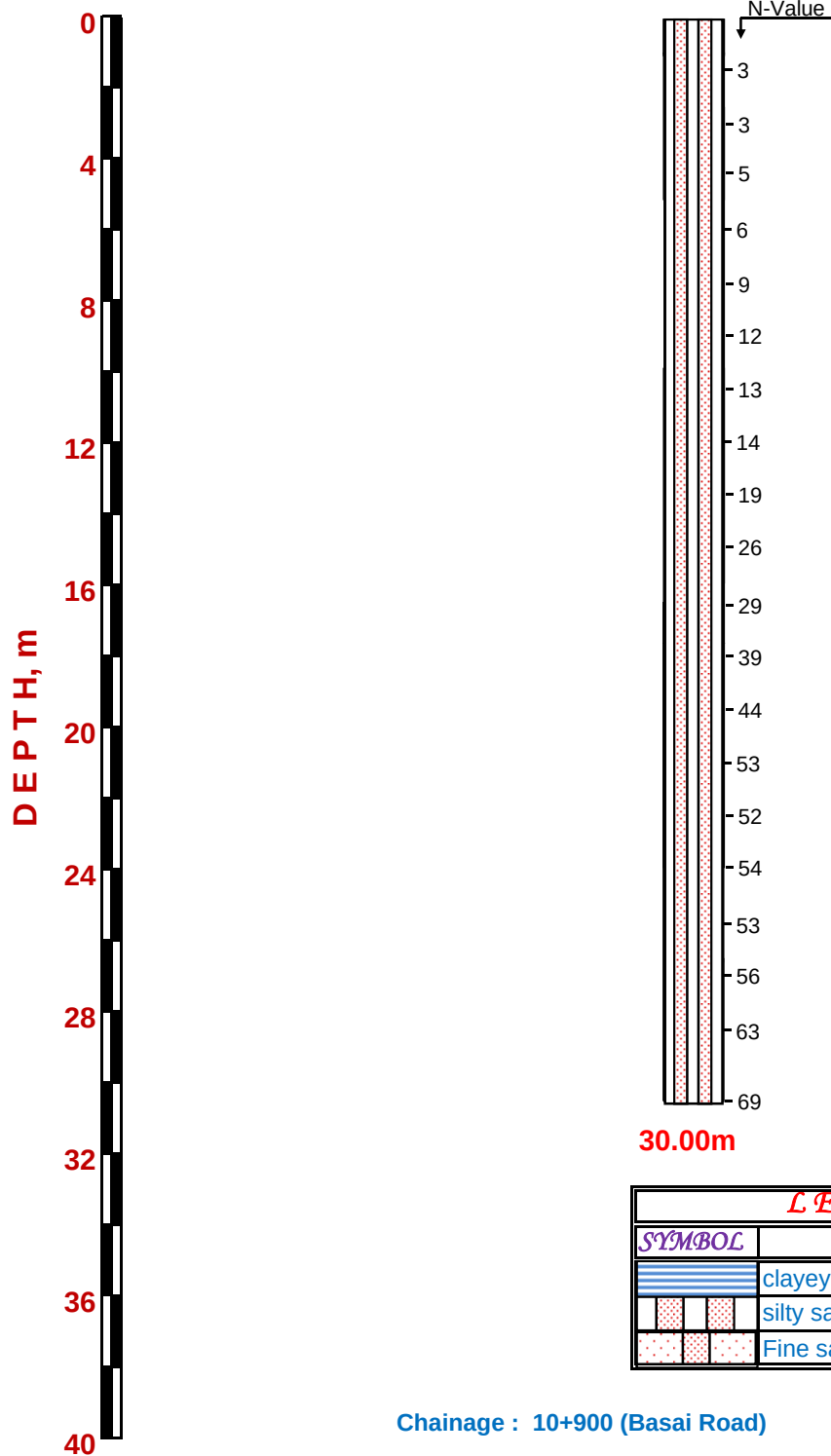
(Cont'd on Table No.1c)

CHEMICAL TEST RESULTS**SOIL-WATER EXTRACT:**

<i>Borehole No.</i>	<i>Depth, (m)</i>	<i>Sulphate Content (SO₃) , %</i>	<i>Chloride Content , %</i>	<i>pH Value</i>
1	2.50	0.12	0.02	8.2

Chainage : 10+900 (Basai Road)***Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway***

BH-1



LEGEND	
SYMBOL	DESCRIPTION
	clayey silt (CI)
	silty sand (SM)
	Fine sand (SP-SM)

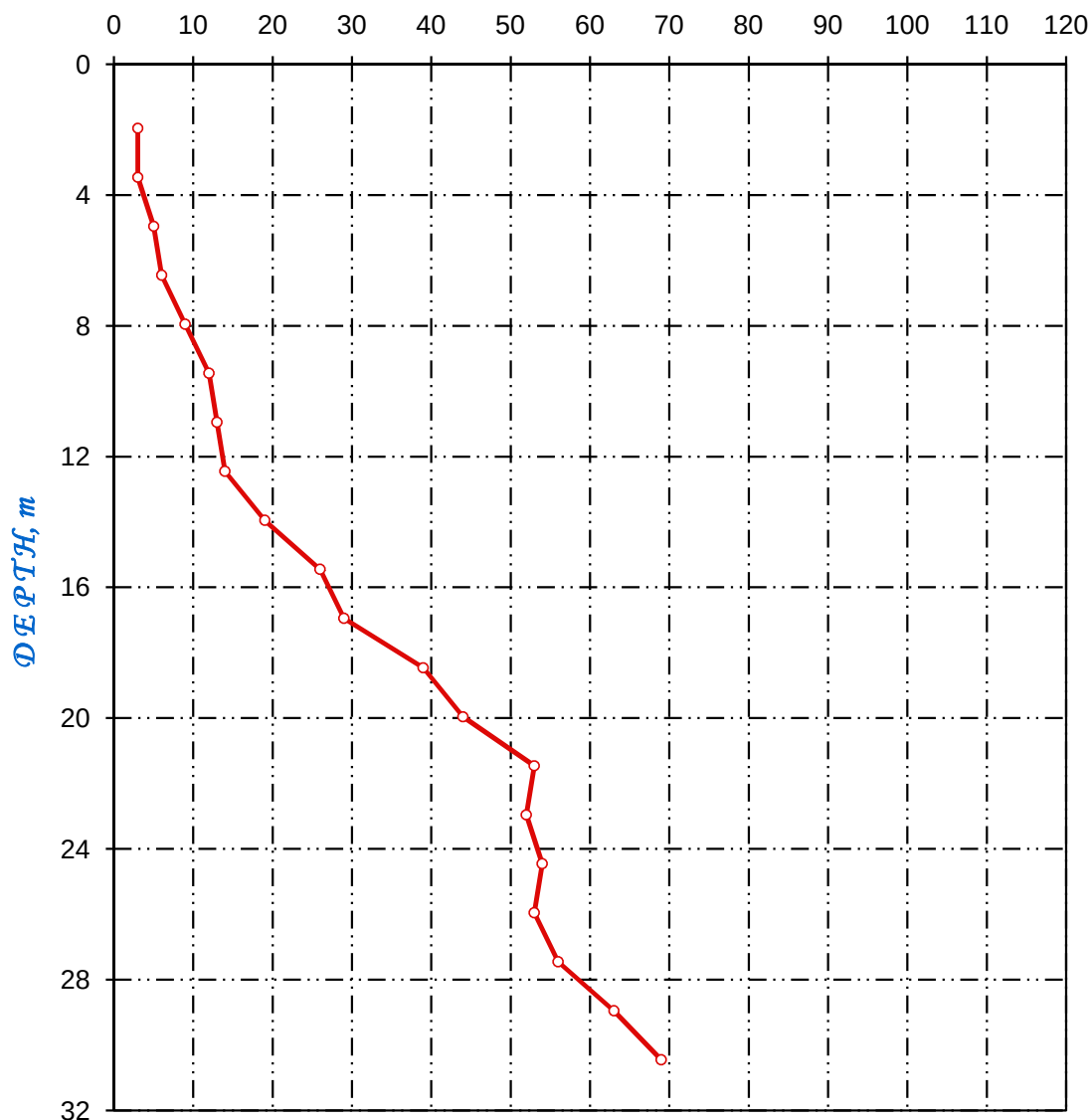
Chainage : 10+900 (Basai Road)

Summary of Borehole Profiles

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

STANDARD PENETRATION TEST

FIELD "N" VALUE



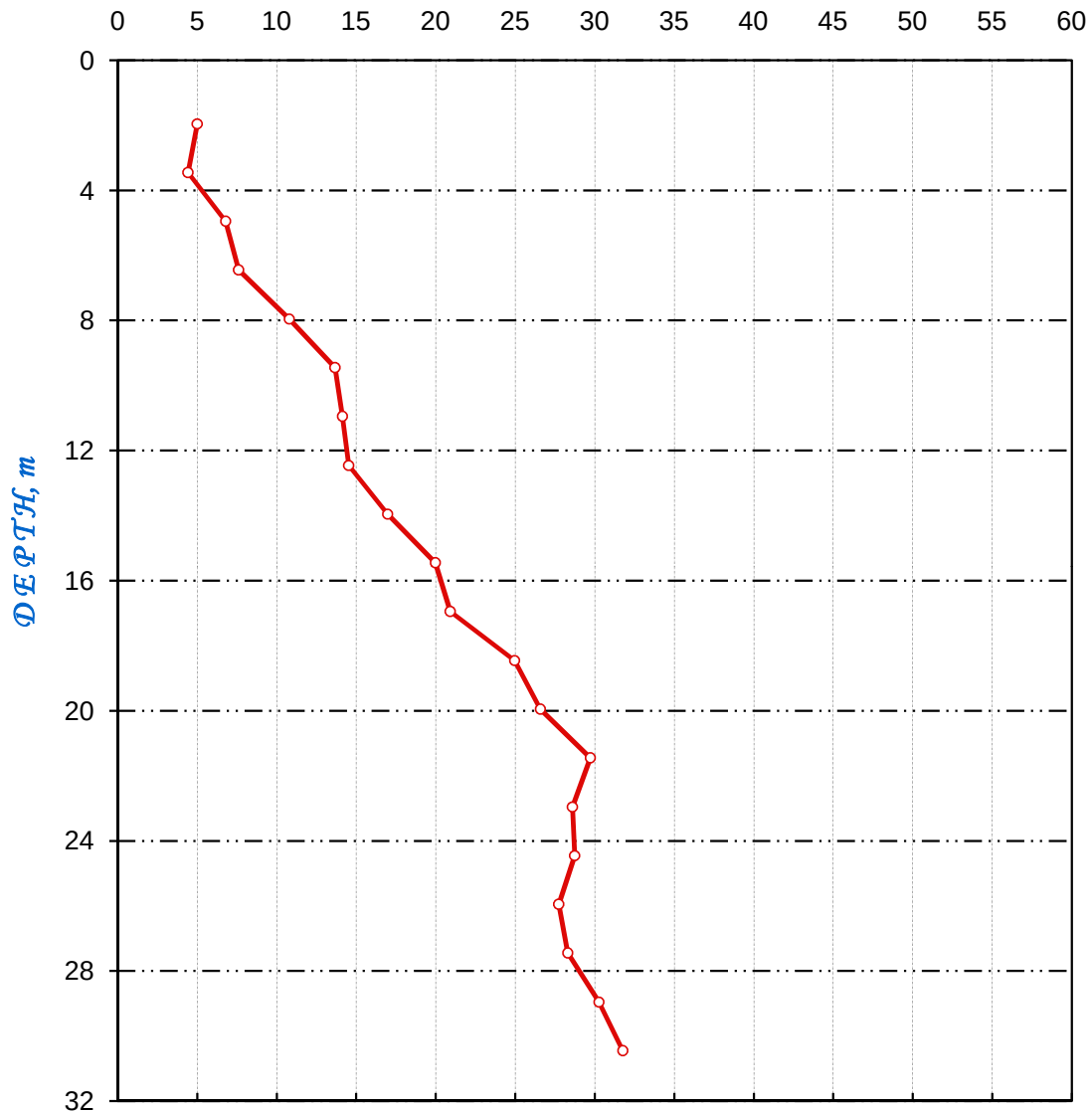
LEGEND	
Symbol	BH.No.
—○—	1

Chainage : 10+900 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

STANDARD PENETRATION TEST

CORRECTED "N" VALUE

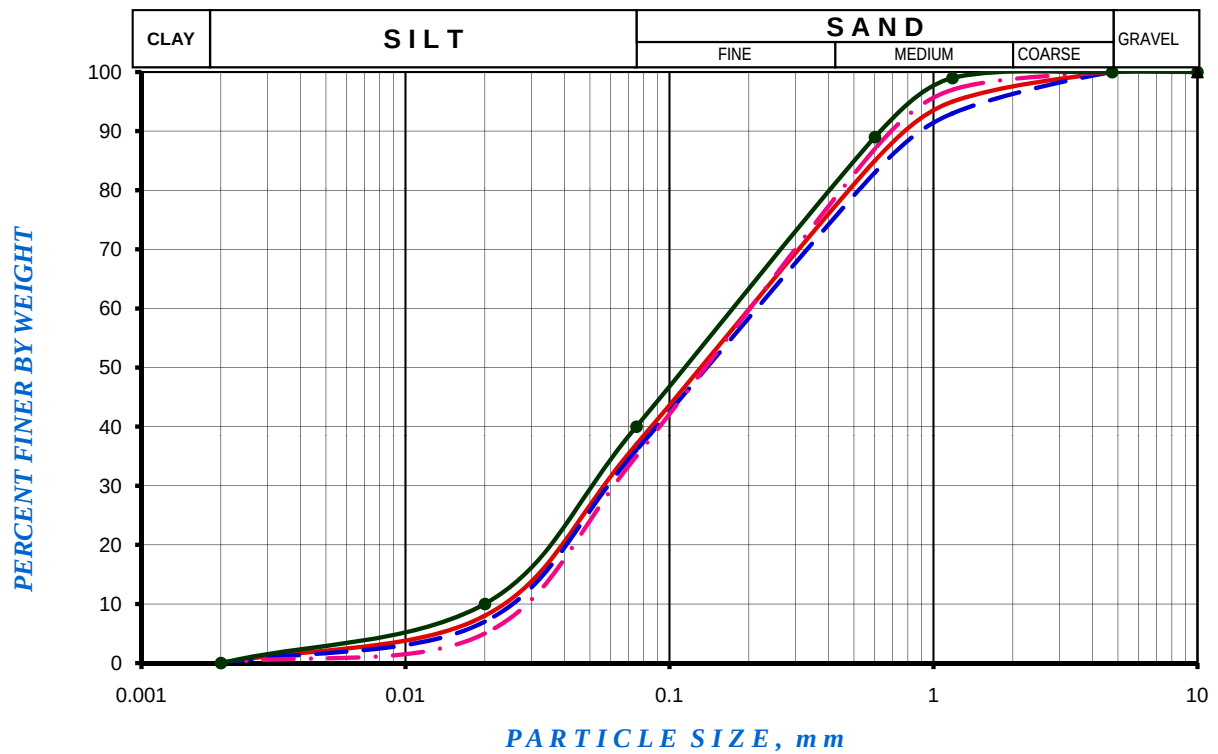


LEGEND	
Symbol	BH.No.
—○—	1

Chainage : 10+900 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

GRAIN SIZE ANALYSIS

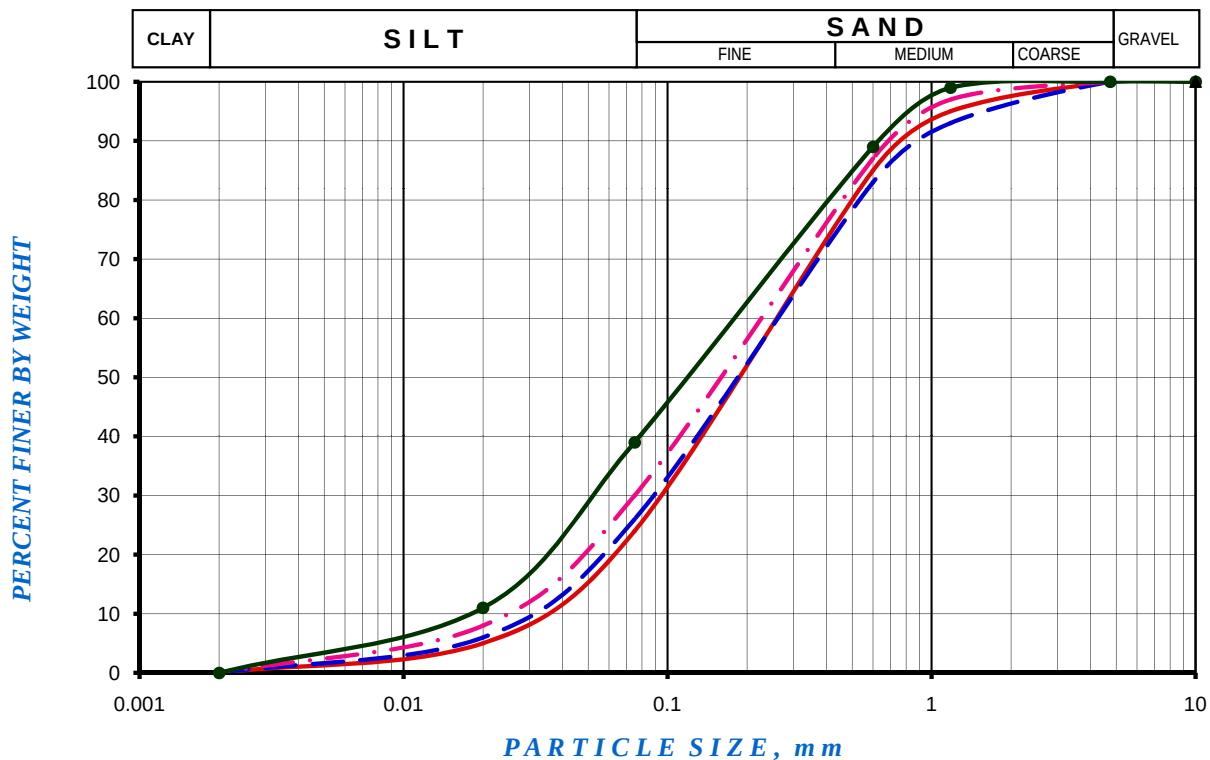


SYMBOL	BORE HOLE	DEPTH m	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
—	1	2.50	Silty Sand (SM)	0	63	37	0
- - - -	1	5.50	Silty Sand (SM)	0	64	36	0
-	1	8.50	Silty Sand (SM)	0	65	35	0
—●—●—	1	11.50	Silty Sand (SM)	0	60	40	0

Chainage : 10+900 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

GRAIN SIZE ANALYSIS

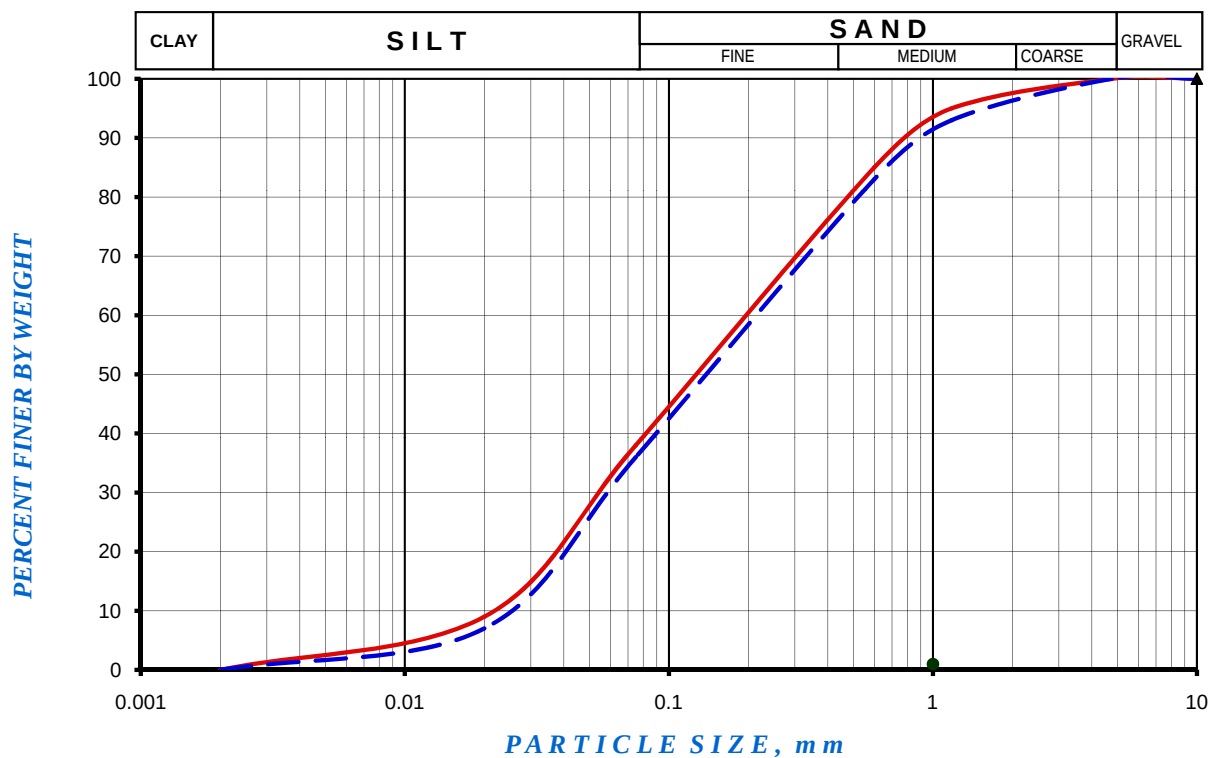


SYMBOL	BORE HOLE	DEPTH m	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
————	1	14.50	Silty Sand (SM)	0	76	24	0
- - - - -	1	17.50	Silty Sand (SM)	0	74	26	0
-	1	20.50	Silty Sand (SM)	0	70	30	0
—●—●—	1	23.50	Silty Sand (SM)	0	61	39	0

Chainage : 10+900 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

GRAIN SIZE ANALYSIS

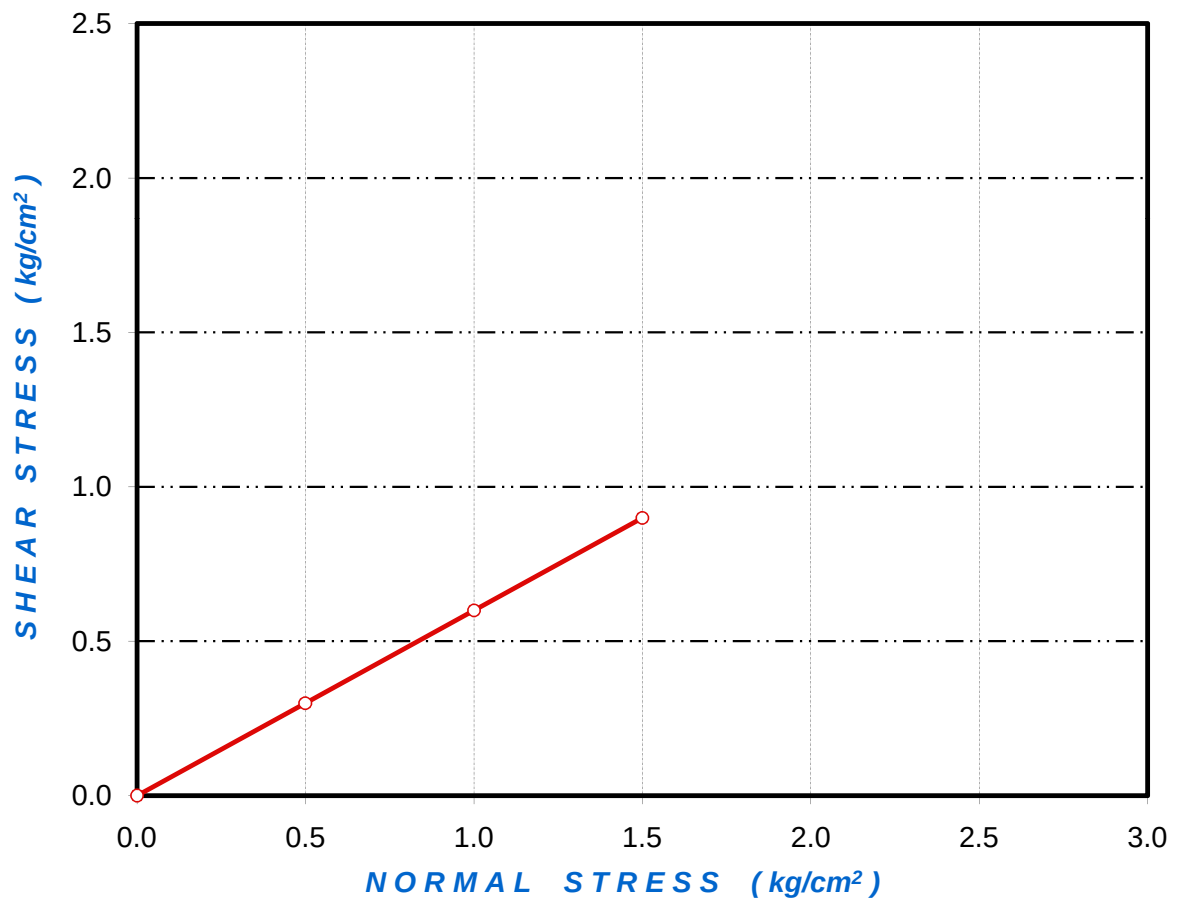


SYMBOL	BORE HOLE	DEPTH m	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
—	1	26.50	Silty Sand (SM)	0	62	38	0
- - - -	1	29.50	Silty Sand (SM)	0	64	36	0

Chainage : 10+900 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

Borehole No. :	1
Depth, m :	5.5
Dry Density, gm/cc :	1.55
"c" Value :	
kg / cm ²	0
φ, Value	30
DEGREE:	

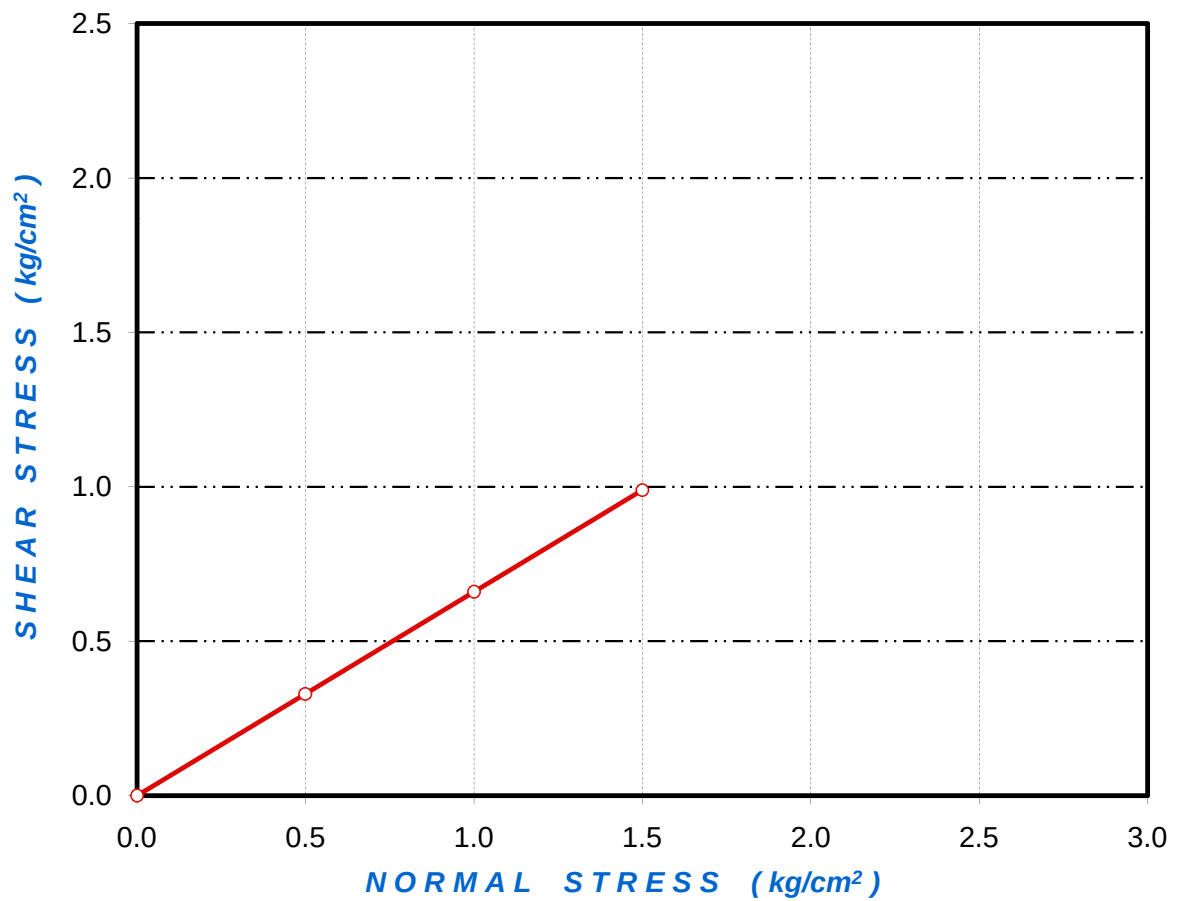


DRAINED DIRECT SHEAR TEST

Chainage : 10+900 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwaraka Expressway

Borehole No. :	1
Depth, m :	11.5
Dry Density, gm/cc :	1.58
"c" Value :	
kg / cm ²	0
φ, Value	32
DEGREE:	

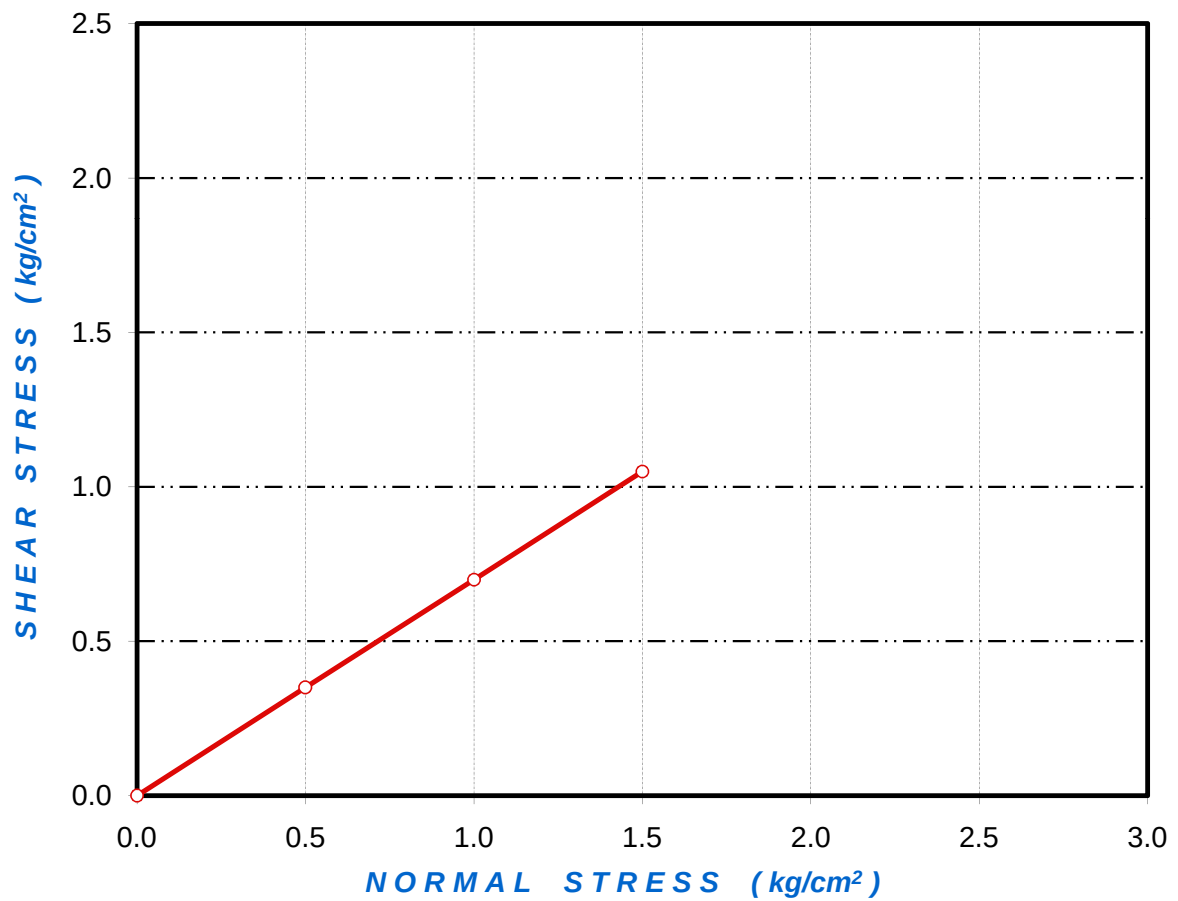


DRAINED DIRECT SHEAR TEST

Chainage : 10+900 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwaraka Expressway

Borehole No. :	1
Depth, m :	17.5
Dry Density, gm/cc :	1.71
"c" Value :	
kg / cm ²	0
φ, Value	35
DEGREE:	

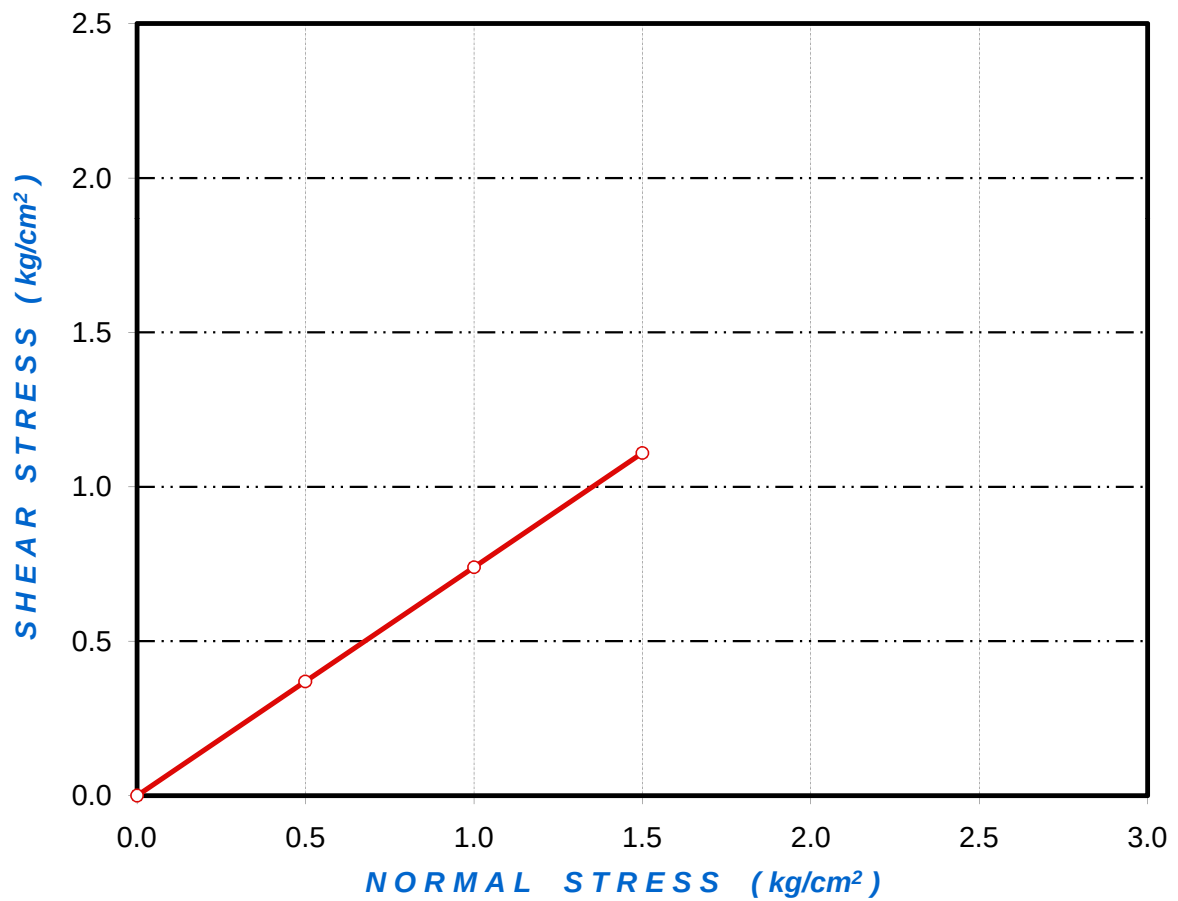


DRAINED DIRECT SHEAR TEST

Chainage : 10+900 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwaraka Expressway

Borehole No. :	1
Depth, m :	26.5
Dry Density, gm/cc :	1.77
"c" Value :	
kg / cm ²	0
φ, Value	37
DEGREE:	



DRAINED DIRECT SHEAR TEST

Chainage : 10+900 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwaraka Expressway



Chainage : 10+900 (Basai Road)

Site Photograph

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

SOIL PROFILE				Project : Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway						BH.No. 3		TERMINATION DEPTH				TABLE NO. 1a			
						Date of Start : 25.11.2017				WATER TABLE :		30.00m				JOB NO.			
						Date of Finish : 26.11.2017				Not met		Chainage : 13+000 (Basai Road)				21711-A			
N-Value	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis				Atterberg Limits			Specific Gravity	Natural Density gms/cm ³	Dry Density gms/cm ³	Moisture Content %	Triaxial Test			
					Gravel %	Sand %	Silt %	Clay %	Liquid %	Plastic %	Plasticity Index %					Type of Test	Cohesion Intercept Kg/cm ²	Angle of Internal Friction	
3	0.50	DS1		Light Grey Silty Sand (SM)															
	1.50	SPT1																	
	2.50	UDS1			0	62	38	0				2.61	1.66	1.51	9.2				
4	3.00	SPT2																	
5	4.50	SPT3																	
	5.50	UDS2			0	63	37	0	N	P	-		1.68	1.53	9.7	DST	0	31	
6	6.00	SPT4																	
8	7.50	SPT5																	
	8.50	UDS3			0	60	40	0	N	P	-	2.62	1.70	1.55	10.4				
9	9.00	SPT6																	
12	10.50	SPT7																	

(Cont'd on Table No.1b)

SOIL PROFILE				Project : Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway				BH.No. 3		TERMINATION DEPTH 30.00m		TABLE NO. 1a							
						Date of Start : 25.11.2017		WATER TABLE :		Chainage : 13+000 (Basai Road)		JOB NO.							
						Date of Finish : 26.11.2017		Not met				21711-A							
N-Value	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis				Atterberg Limits			Specific Gravity	Natural Density gms/cm³	Dry Density gms/cm³	Moisture Content %	Triaxial Test			
					Gravel %	Sand %	Silt %	Clay %	Liquid %	Plastic %	Plasticity Index %					Type of Test	Cohesion Intercept Kg/cm²	Angle of Internal Friction	
16	11.50	UDS4		Light Grey Silty Sand (SM)	0	65	35	0	N	P	-	2.64	1.73	1.57	11.3	DST	0	33	
	12.00	SPT8																	
	21	13.50			SPT9														
	14.50	UDS5			0	75	25	0	N	P	-		1.74	1.62	12.2				
	26	15.00			SPT10														
	30	16.50			SPT11														
	17.50	UDS6			0	73	27	0	N	P	-	2.65	1.81	1.66	14.6	DST	0.00	36	
	41	18.00			SPT12														
	44	19.50			SPT13														
	20.50	UDS7			0	72	28	0	N	P	-								
48	21.00	SPT14																	

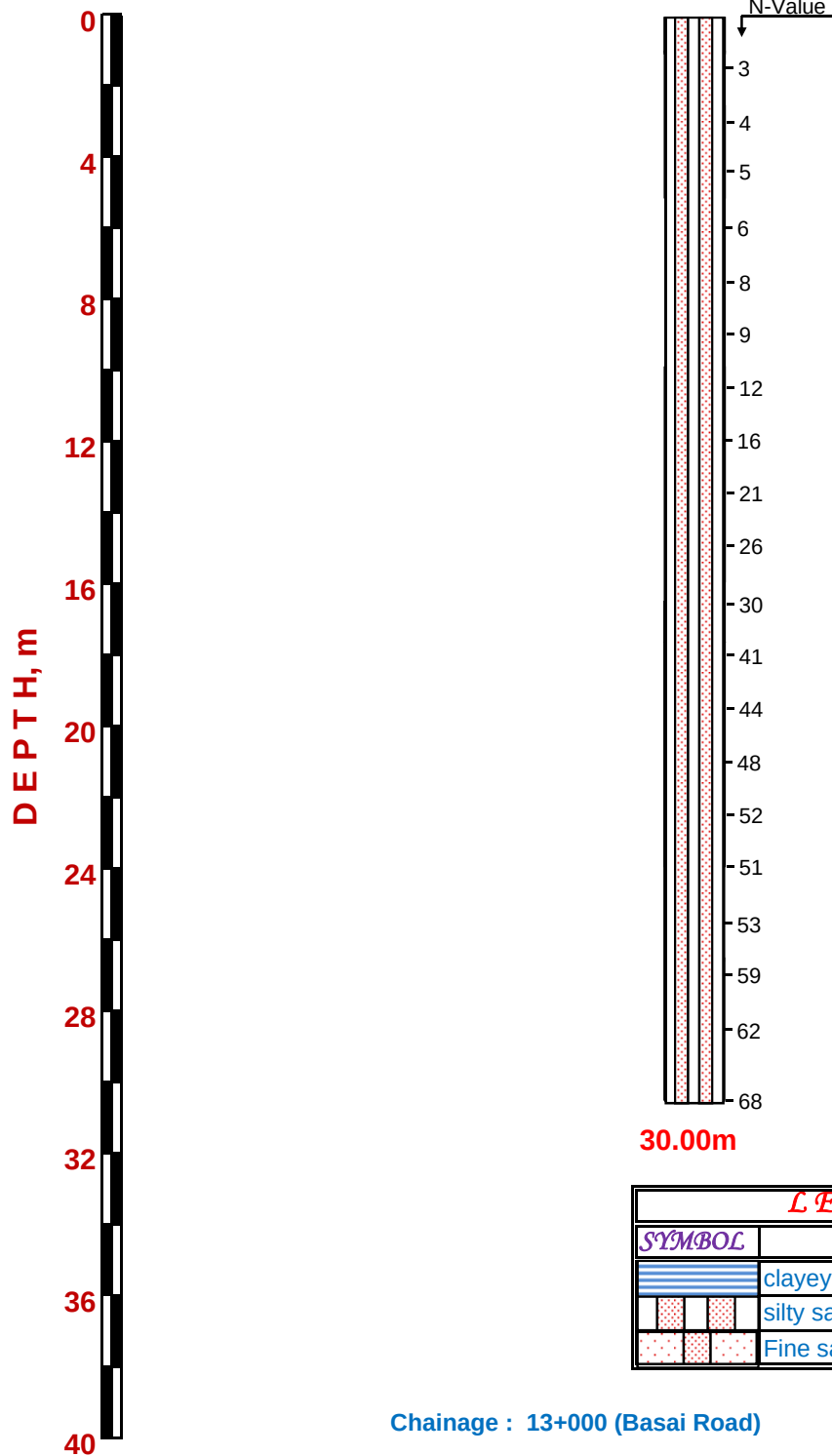
(Cont'd on Table No.1c)

CHEMICAL TEST RESULTS**SOIL-WATER EXTRACT:**

<i>Borehole No.</i>	<i>Depth, (m)</i>	<i>Sulphate Content (SO₃) , %</i>	<i>Chloride Content , %</i>	<i>pH Value</i>
3	3.00	0.13	0.02	8.3

Chainage : 13+000 (Basai Road)*Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway*

BH-3



LEGEND	
SYMBOL	DESCRIPTION
	clayey silt (CI)
	silty sand (SM)
	Fine sand (SP-SM)

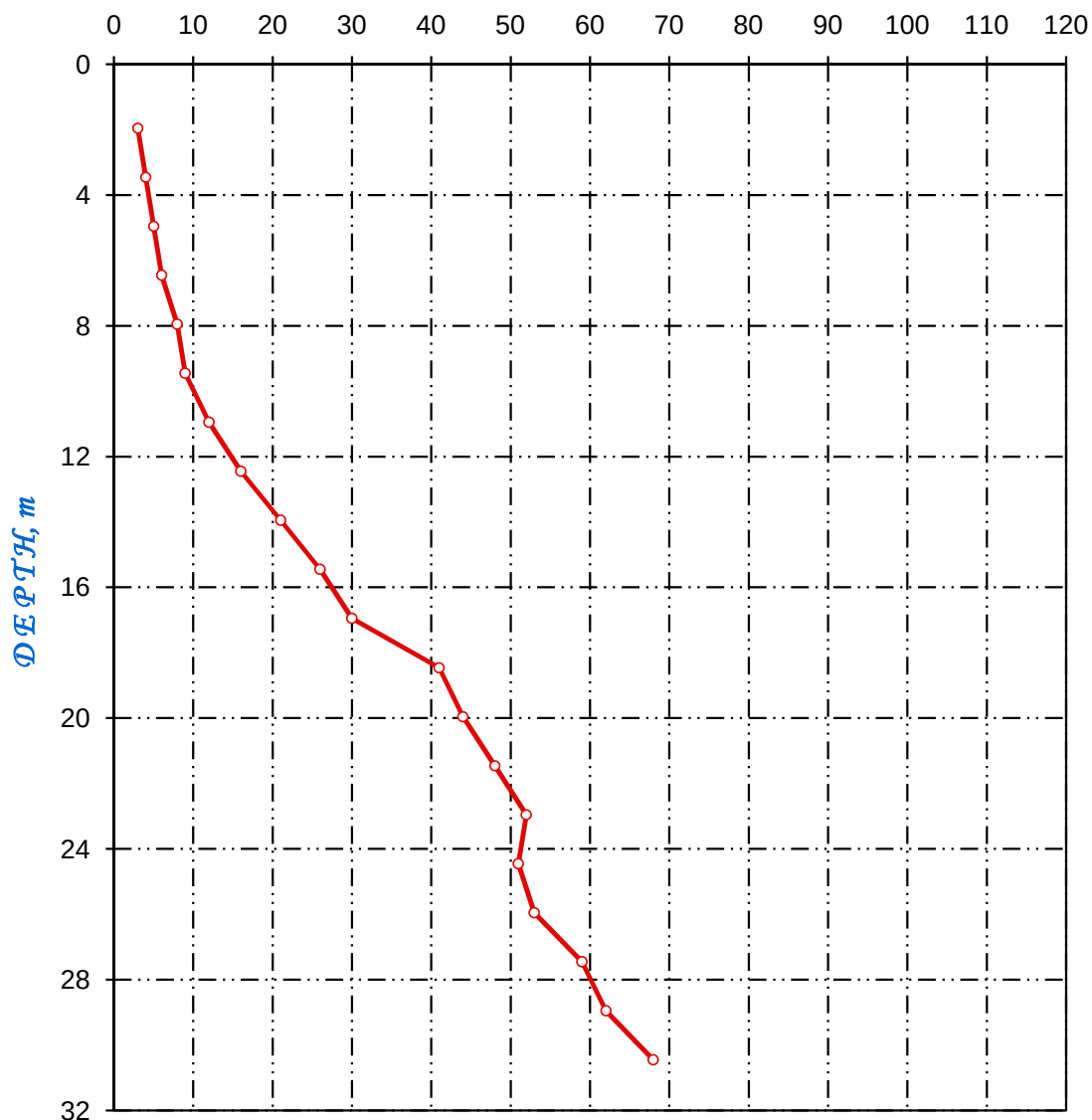
Chainage : 13+000 (Basai Road)

Summary of Borehole Profiles

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

STANDARD PENETRATION TEST

FIELD "N" VALUE



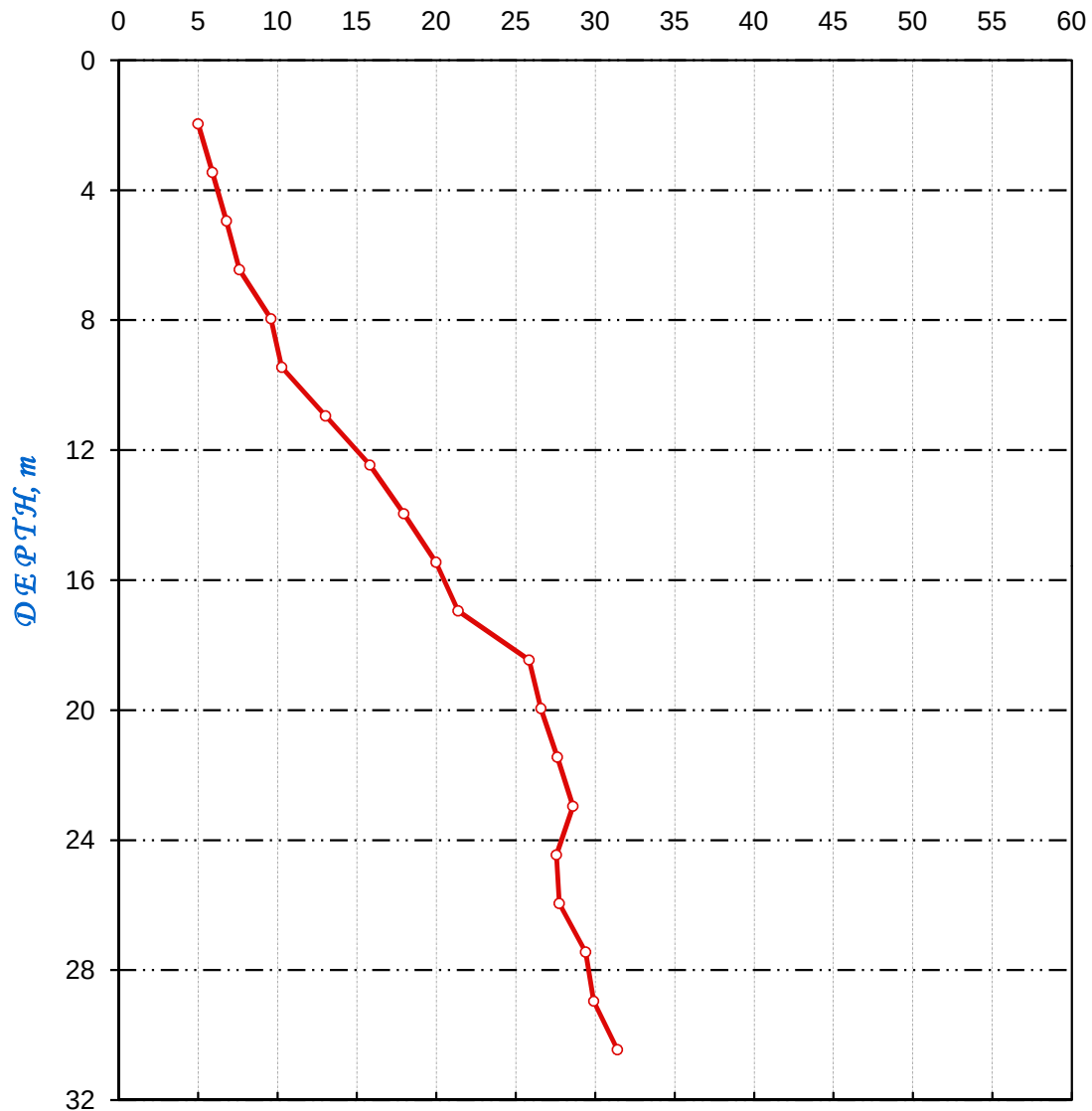
LEGEND	
Symbol	BH.No.
—○—	3

Chainage : 13+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

STANDARD PENETRATION TEST

CORRECTED "N" VALUE

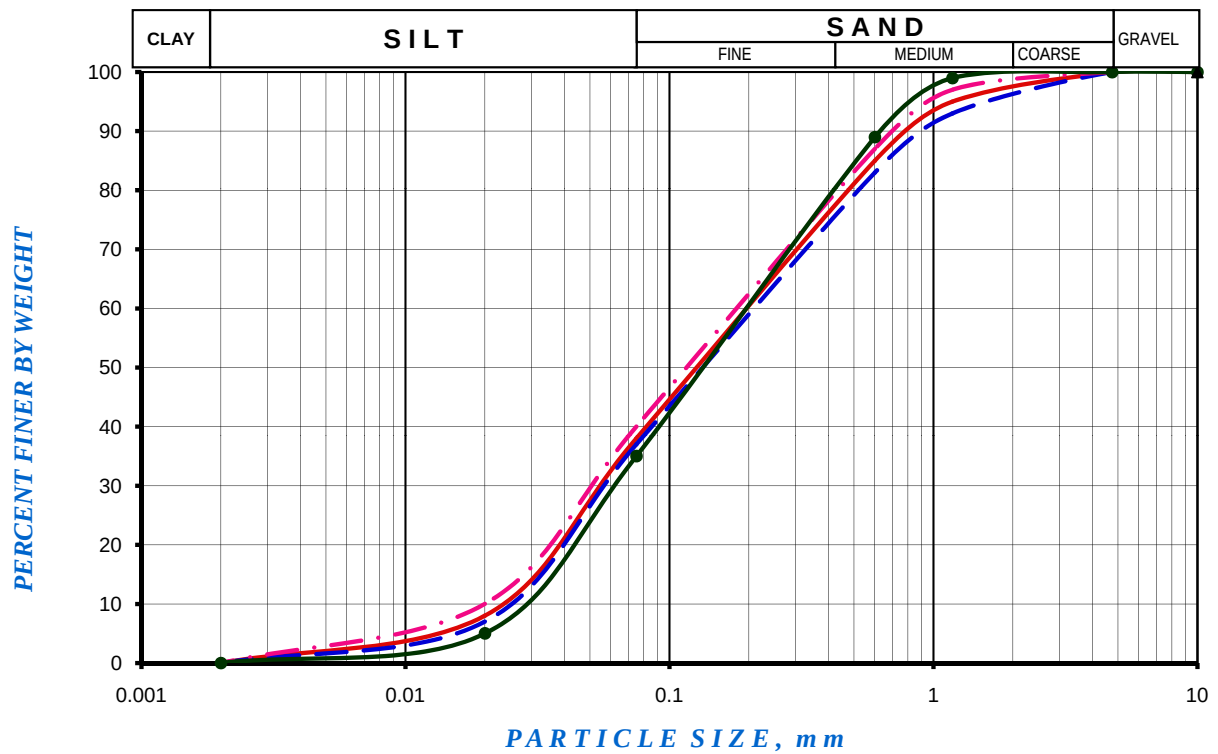


LEGEND	
Symbol	BH.No.
—○—	3

Chainage : 13+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

GRAIN SIZE ANALYSIS

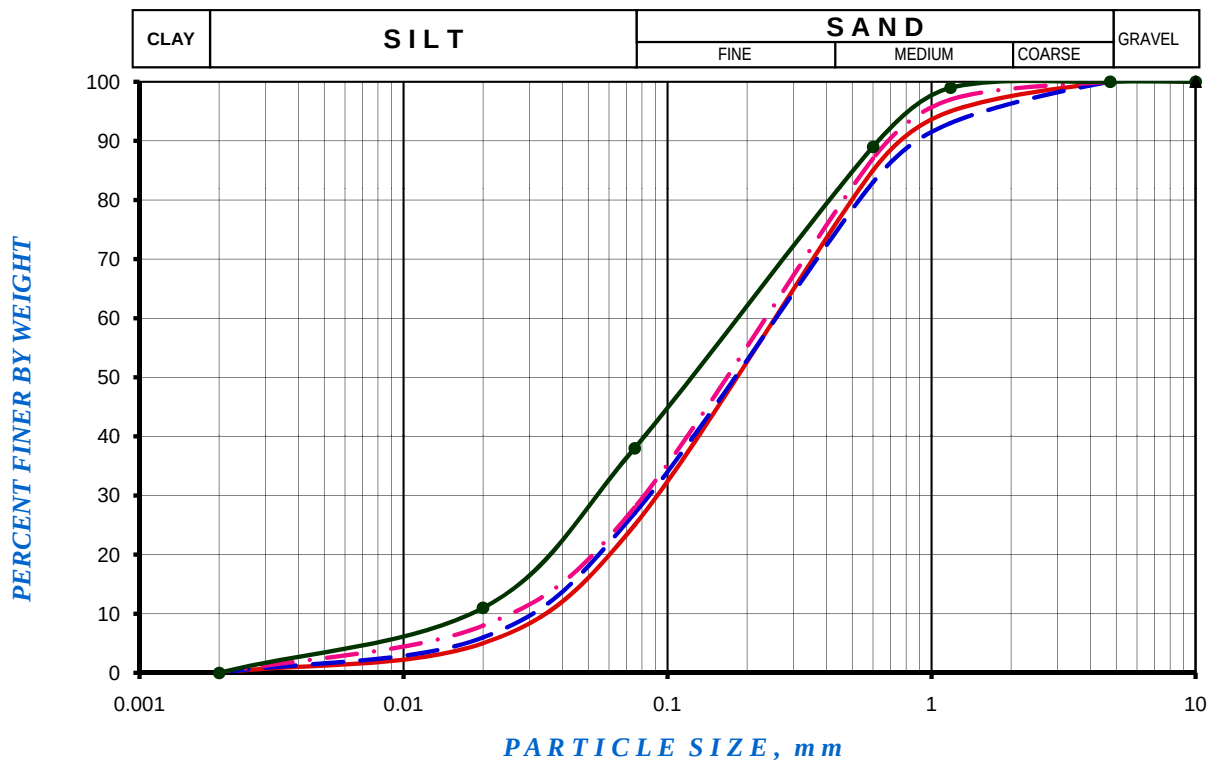


SYMBOL	BORE HOLE	DEPTH m	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
————	3	2.50	Silty Sand (SM)	0	62	38	0
- - - - -	3	5.50	Silty Sand (SM)	0	63	37	0
-	3	8.50	Silty Sand (SM)	0	60	40	0
—●—●—	3	11.50	Silty Sand (SM)	0	65	35	0

Chainage : 13+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

GRAIN SIZE ANALYSIS

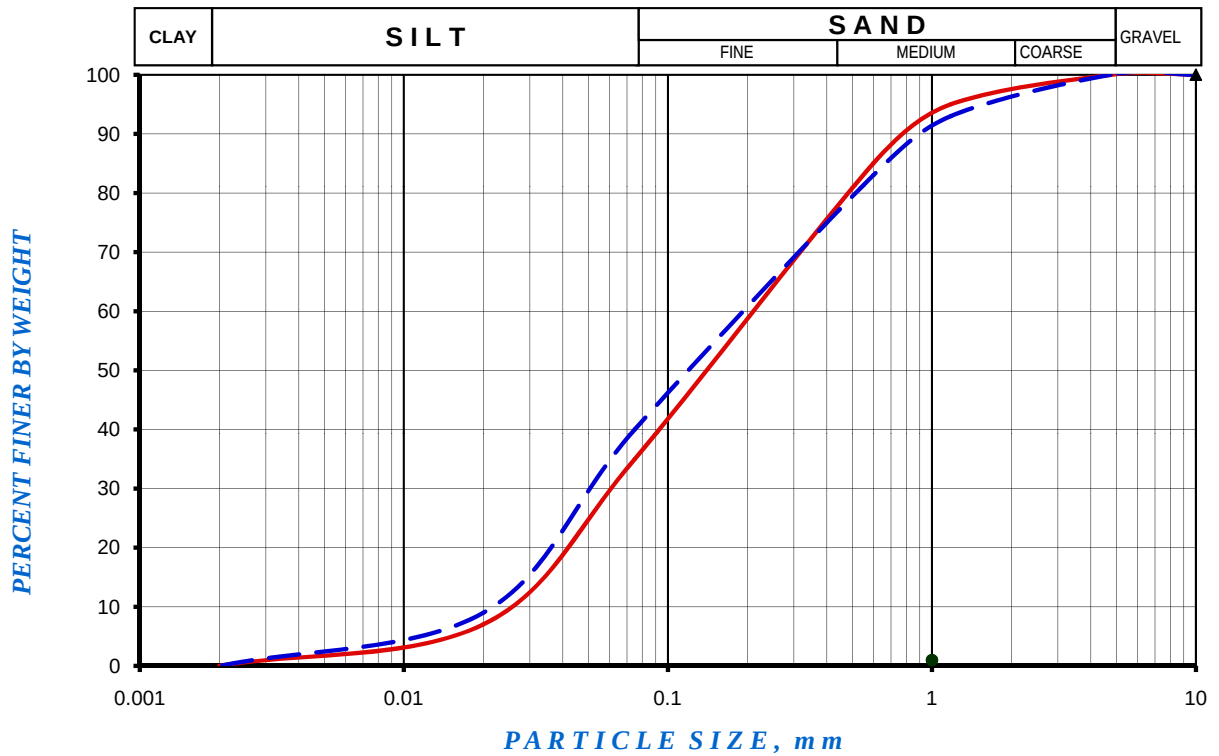


SYMBOL	BORE HOLE	DEPTH m	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
—	3	14.50	Silty Sand (SM)	0	75	25	0
- - - -	3	17.50	Silty Sand (SM)	0	73	27	0
-	3	20.50	Silty Sand (SM)	0	72	28	0
—●—●—	3	23.50	Silty Sand (SM)	0	62	38	0

Chainage : 13+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

GRAIN SIZE ANALYSIS

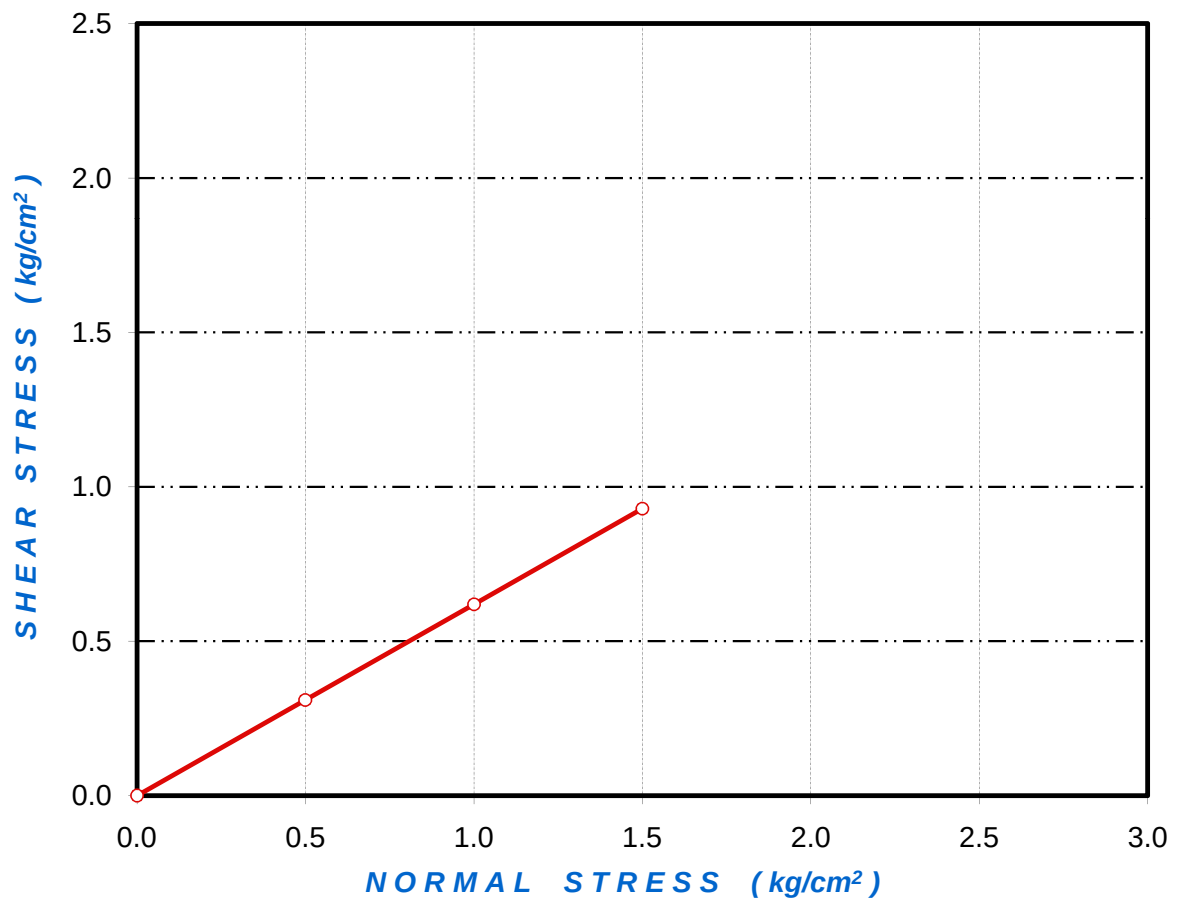


SYMBOL	BORE HOLE	DEPTH m	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
—	3	26.50	Silty Sand (SM)	0	65	35	0
- - - -	3	29.50	Silty Sand (SM)	0	60	40	0

Chainage : 13+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

Borehole No. :	3
Depth, m :	5.5
Dry Density, gm/cc :	1.53
"c" Value : kg / cm ²	0
φ, Value DEGREE:	31

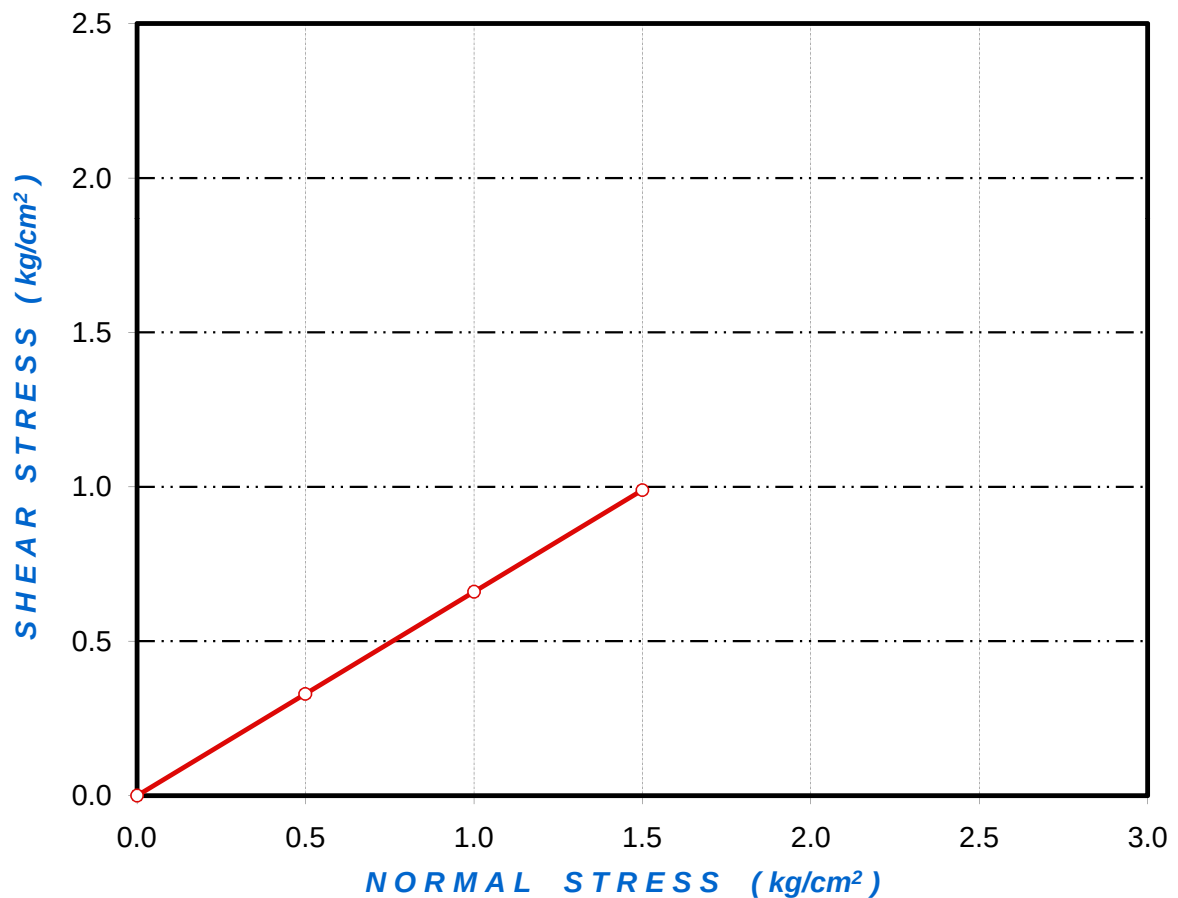


DRAINED DIRECT SHEAR TEST

Chainage : 13+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwaraka Expressway

Borehole No. :	3
Depth, m :	11.5
Dry Density, gm/cc :	1.57
"c" Value :	
kg / cm ²	0
φ, Value	33
DEGREE:	

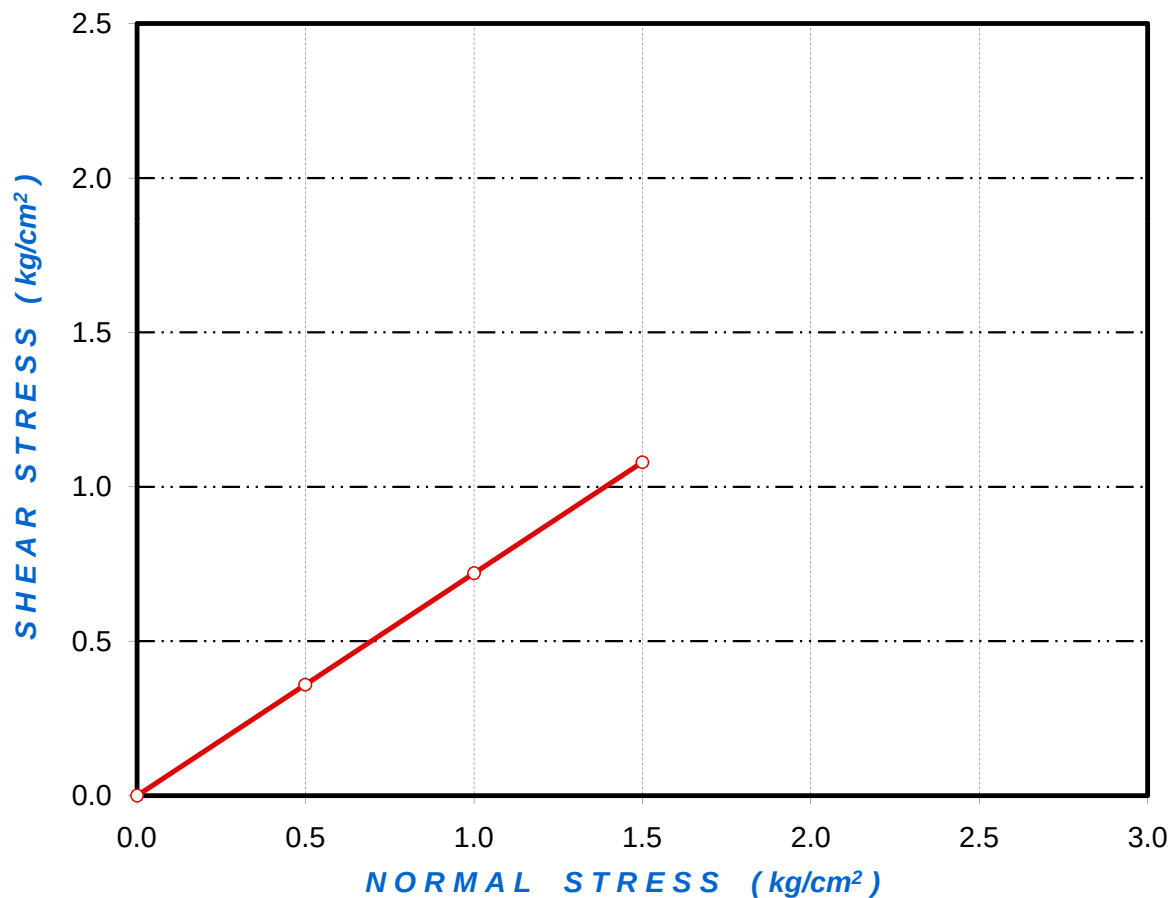


DRAINED DIRECT SHEAR TEST

Chainage : 13+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwaraka Expressway

Borehole No. :	3
Depth, m :	17.5
Dry Density, gm/cc :	1.66
"c" Value :	
kg / cm ²	0
φ, Value	36
DEGREE:	

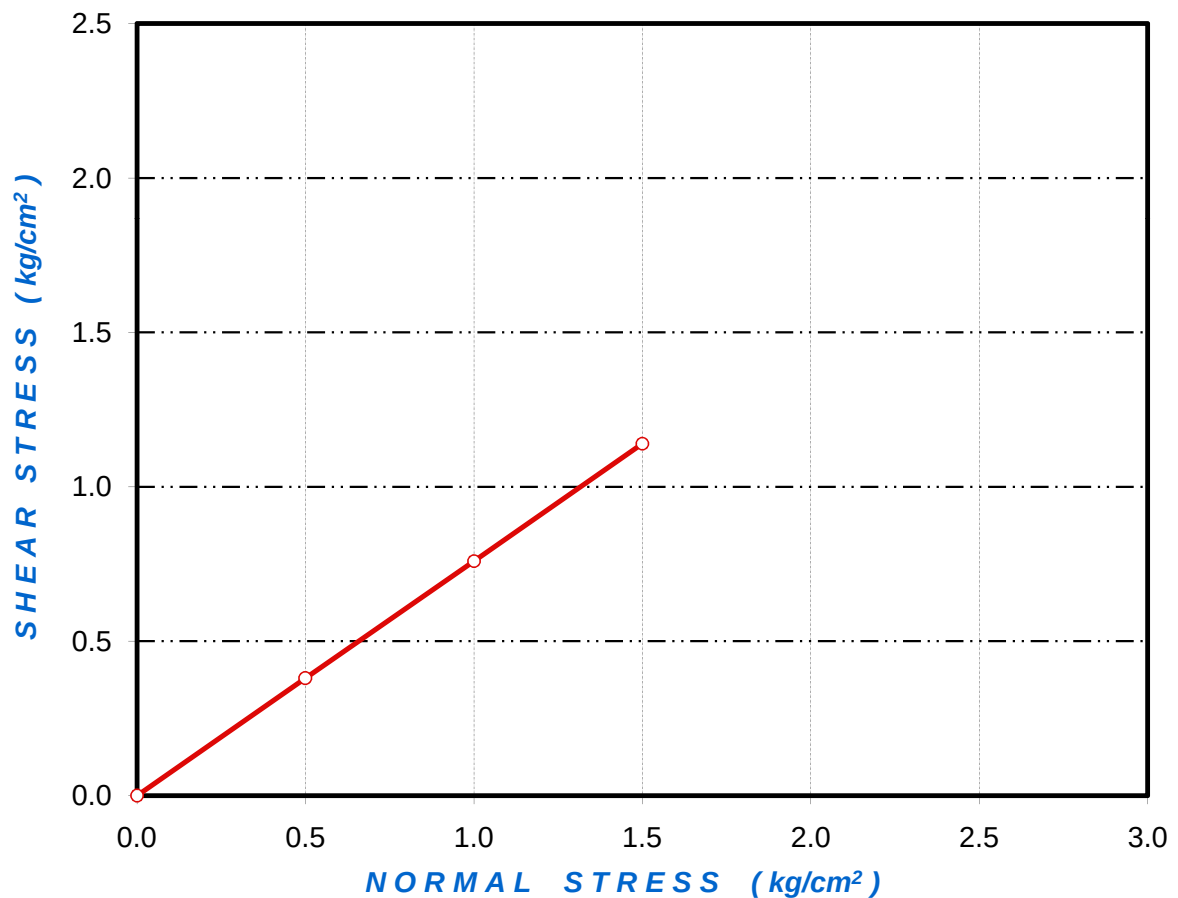


DRAINED DIRECT SHEAR TEST

Chainage : 13+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

Borehole No. :	3
Depth, m :	26.5
Dry Density, gm/cc :	1.75
"c" Value :	
kg / cm ²	0
φ, Value	38
DEGREE:	



DRAINED DIRECT SHEAR TEST

Chainage : 13+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwaraka Expressway



Chainage : 13+000 (Basai Road)

Site Photograph

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

SOIL PROFILE				Project : Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway				BH.No. 2		TERMINATION DEPTH		TABLE NO. 1a							
								Date of Start : 26.11.2017		WATER TABLE :		30.00m		JOB NO.					
				Date of Finish : 27.11.2017		Not met				Chainage : 15+100 (Basai Road)		21711-B							
N-Value	Depth (m)	Sample No.	Symbol			SOIL DESCRIPTION	Grain Size Analysis				Atterberg Limits			Specific Gravity	Natural Density gms/cm ³	Dry Density gms/cm ³	Moisture Content %	Triaxial Test	
				Gravel %	Sand %		Silt %	Clay %	Liquid %	Plastic %	Plasticity Index %	Type of Test	Cohesion Intercept Kg/cm ²					Angle of Internal Friction	
2	0.50	DS1	SOIL PROFILE	Light Grey Silty Sand (SM)															
	1.50	SPT1																	
	2.50	UDS1			0	63	37	0				2.60	1.67	1.52	9.3				
3	3.00	SPT2																	
4	4.50	SPT3																	
7	5.50	UDS2			0	61	39	0	N	P	-		1.69	1.54	9.8	DST	0	30	
	6.00	SPT4																	
7	7.50	SPT5																	
10	8.50	UDS3			0	65	35	0	N	P	-	2.61	1.71	1.56	10.5				
	9.00	SPT6																	
13	10.50	SPT7																	

(Cont'd on Table No.1b)

SOIL PROFILE				Project : Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway				BH.No. 2		TERMINATION DEPTH 30.00m		TABLE NO. 1a						
						Date of Start : 26.11.2017		WATER TABLE :		Chainage : 15+100 (Basai Road)		JOB NO.						
						Date of Finish : 27.11.2017		Not met				21711-B						
N-Value	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis				Atterberg Limits			Specific Gravity	Natural Density gms/cm³	Dry Density gms/cm³	Moisture Content %	Triaxial Test		
					Gravel %	Sand %	Silt %	Clay %	Liquid %	Plastic %	Plasticity Index %					Type of Test	Cohesion Intercept Kg/cm²	Angle of Internal Friction
17 20 25 29 40 42 49	11.50	UDS4		Light Grey Silty Sand (SM)	0	60	40	0	N	P	-	2.63	1.72	1.58	11.2	DST	0	32
	12.00	SPT8																
	13.50	SPT9																
	14.50	UDS5			0	74	26	0	N	P	-		1.75	1.61	12.4			
	15.00	SPT10																
	16.50	SPT11																
	17.50	UDS6			0	72	28	0	N	P	-	2.64	1.82	1.65	14.3	DST	0.00	35
	18.00	SPT12																
	19.50	SPT13																
	20.50	UDS7			0	70	30	0	N	P	-							
21.00	SPT14																	

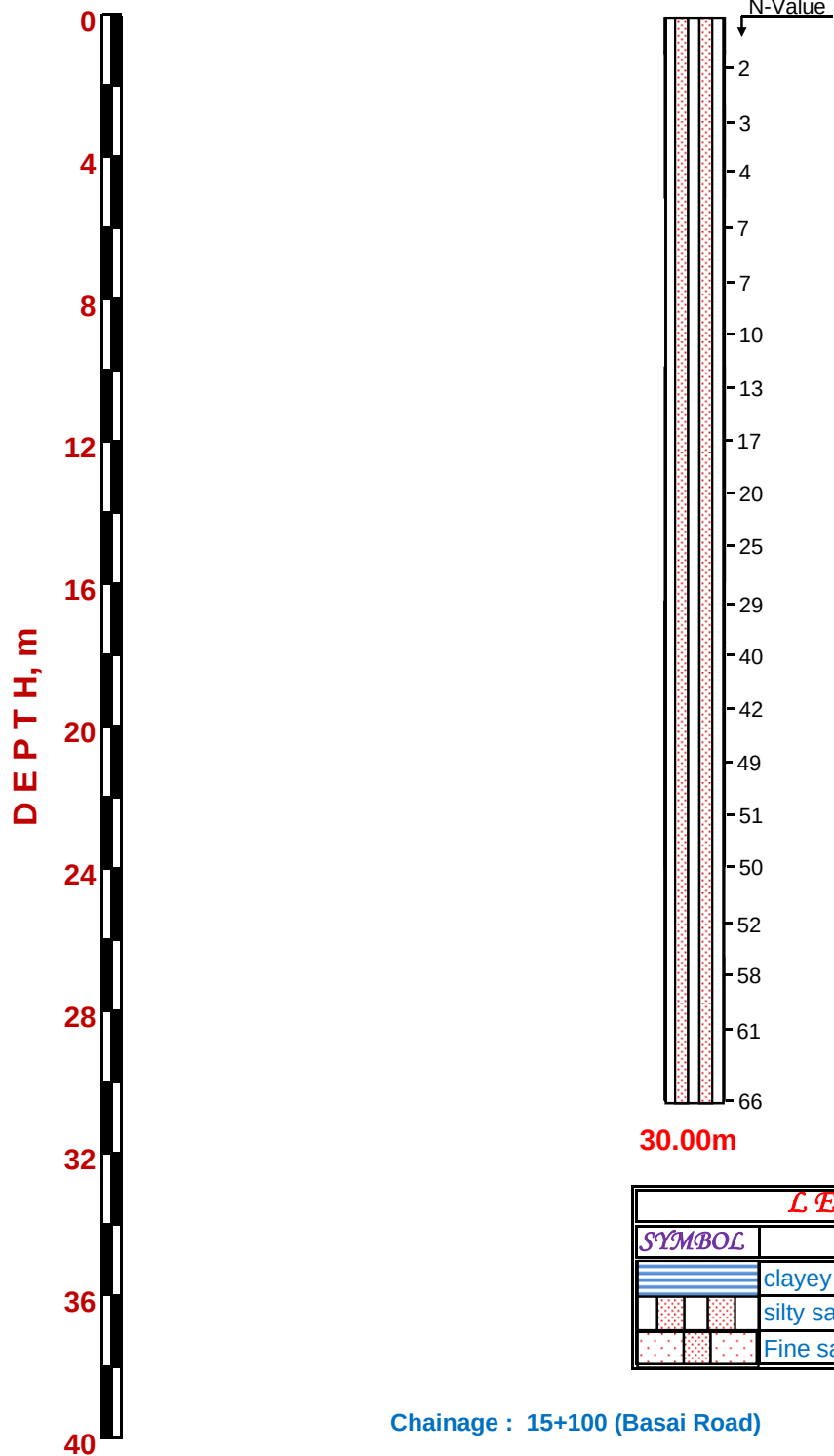
(Cont'd on Table No.1c)

CHEMICAL TEST RESULTS**SOIL-WATER EXTRACT:**

<i>Borehole No.</i>	<i>Depth, (m)</i>	<i>Sulphate Content (SO₃) , %</i>	<i>Chloride Content , %</i>	<i>pH Value</i>
2	2.50	0.12	0.03	8.2

Chainage : 15+100 (Basai Road)*Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway*

BH-2



LEGEND	
SYMBOL	DESCRIPTION
	clayey silt (CI)
	silty sand (SM)
	Fine sand (SP-SM)

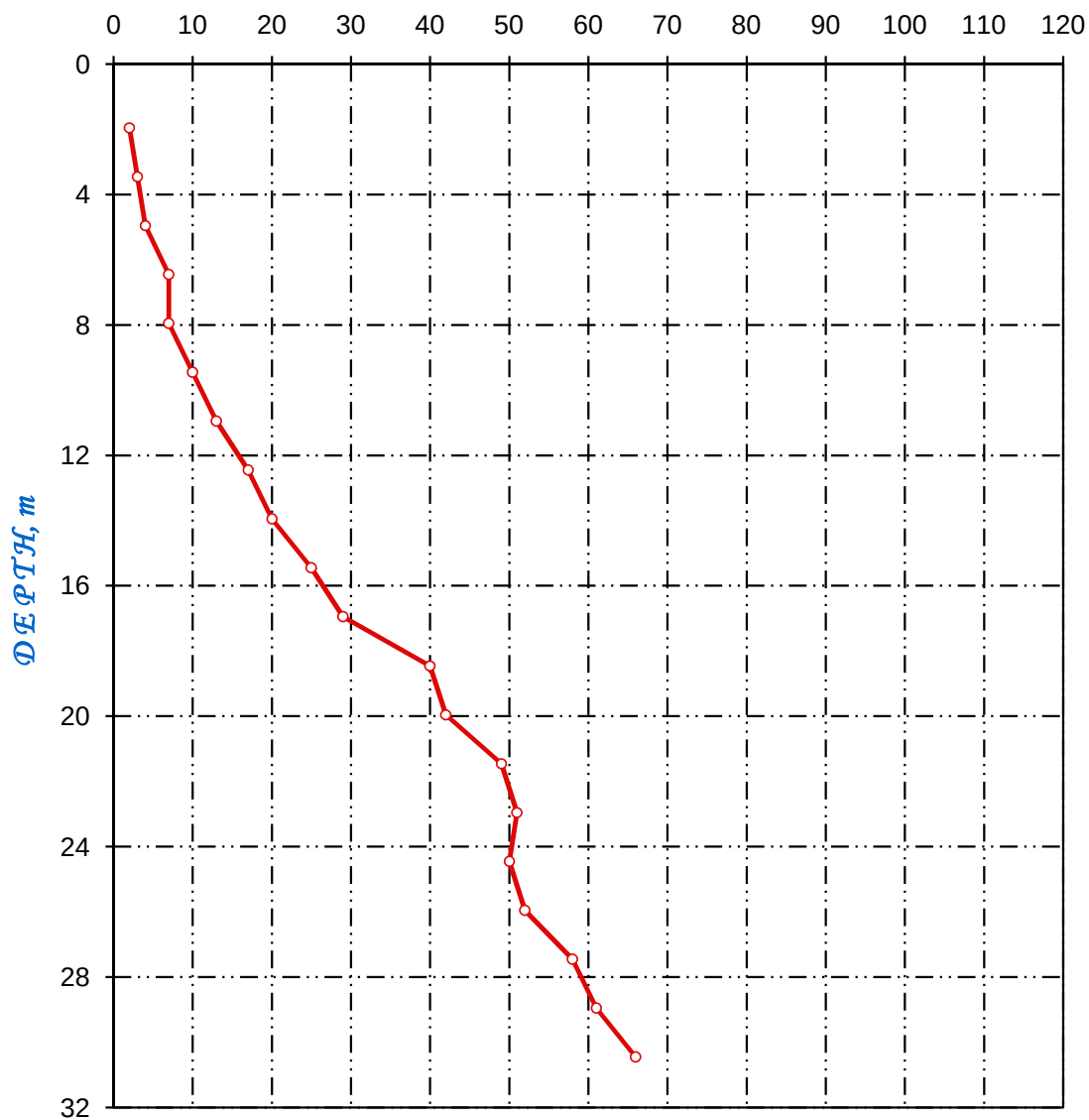
Chainage : 15+100 (Basai Road)

Summary of Borehole Profiles

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

STANDARD PENETRATION TEST

FIELD "N" VALUE



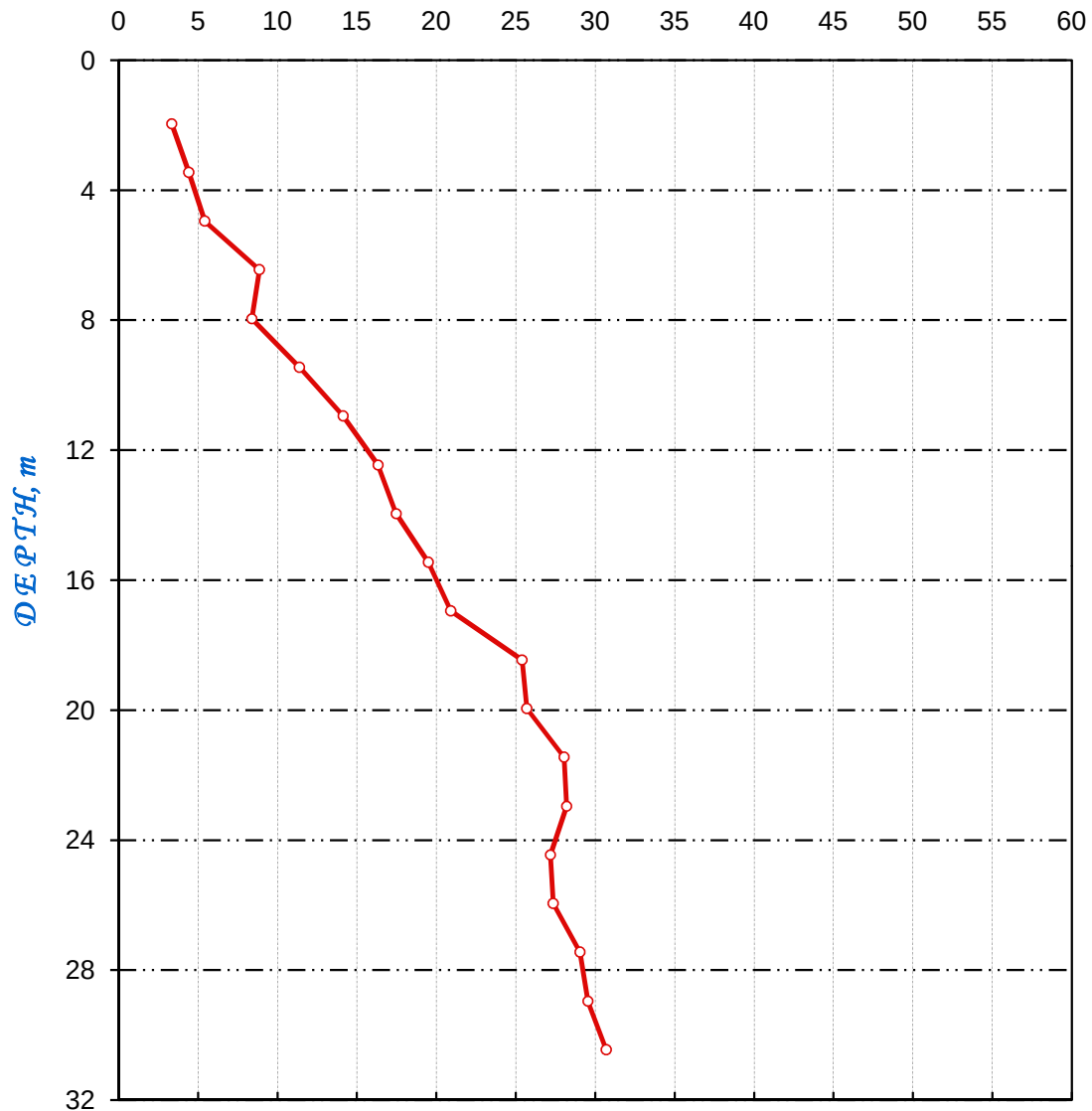
LEGEND	
Symbol	BH.No.
—○—	2

Chainage : 15+100 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

STANDARD PENETRATION TEST

CORRECTED "N" VALUE

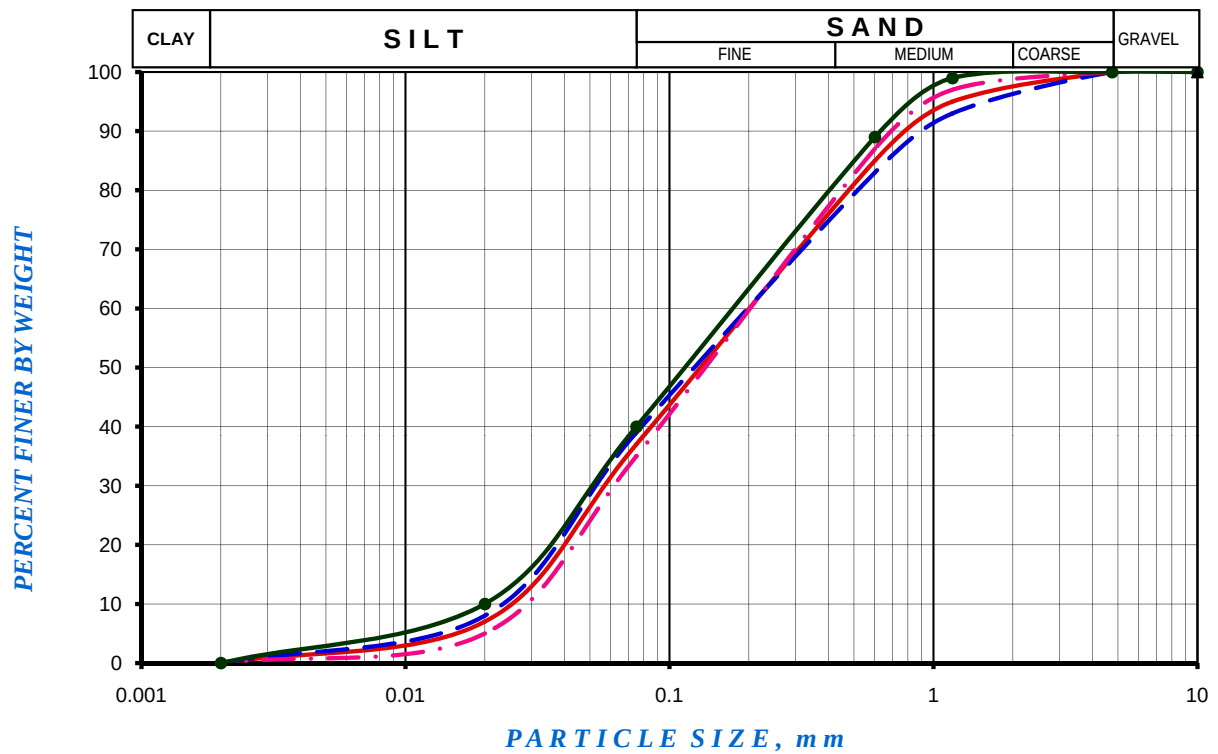


LEGEND	
Symbol	BH.No.
—○—	2

Chainage : 15+100 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

GRAIN SIZE ANALYSIS

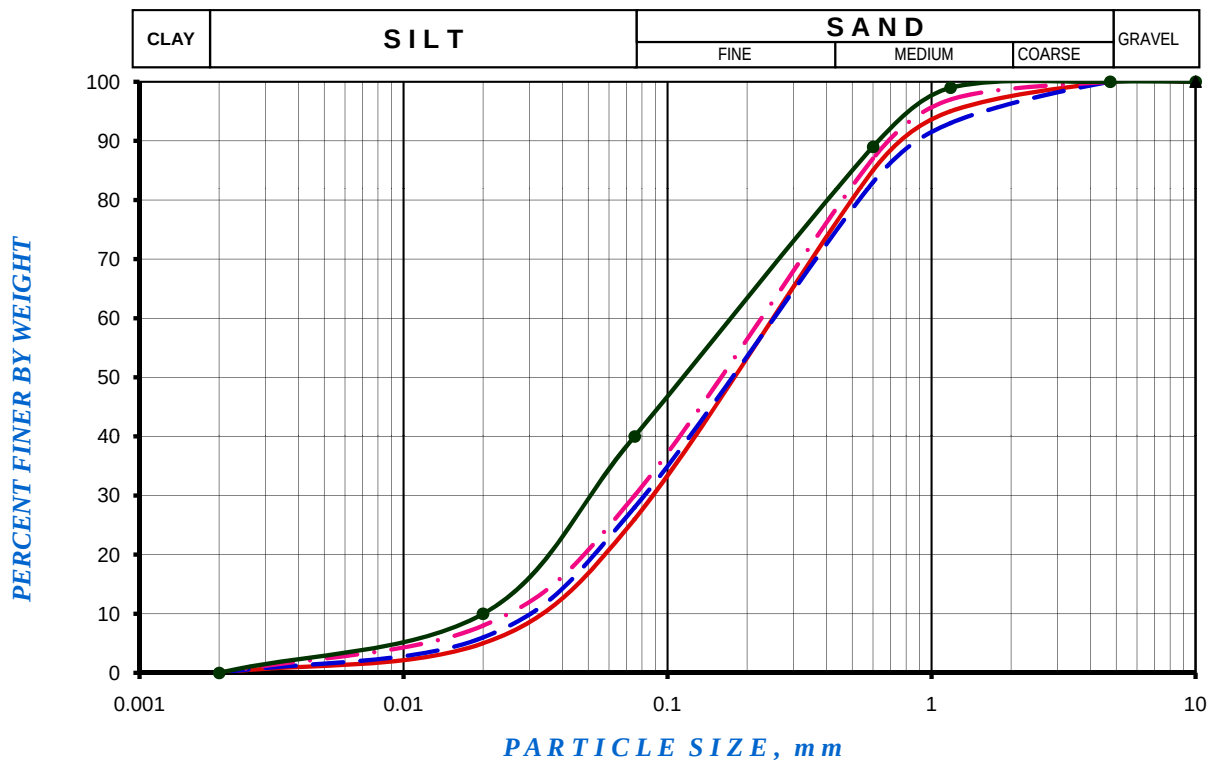


SYMBOL	BORE HOLE	DEPTH m	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
—	2	2.50	Silty Sand (SM)	0	63	37	0
- - - -	2	5.50	Silty Sand (SM)	0	61	39	0
-	2	8.50	Silty Sand (SM)	0	65	35	0
—●—●—	2	11.50	Silty Sand (SM)	0	60	40	0

Chainage : 15+100 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

GRAIN SIZE ANALYSIS

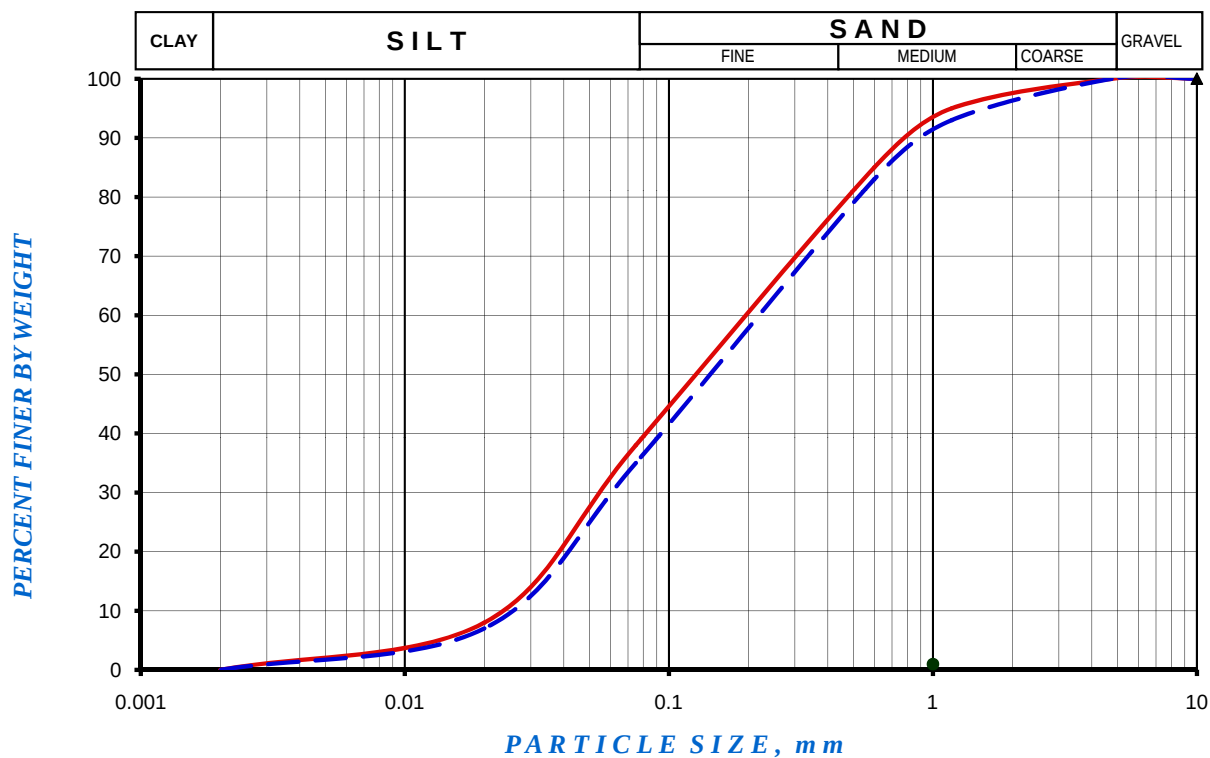


SYMBOL	BORE HOLE	DEPTH m	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
—	2	14.50	Silty Sand (SM)	0	74	26	0
- - - -	2	17.50	Silty Sand (SM)	0	72	28	0
-	2	20.50	Silty Sand (SM)	0	70	30	0
—●—●—	2	23.50	Silty Sand (SM)	0	60	40	0

Chainage : 15+100 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

GRAIN SIZE ANALYSIS

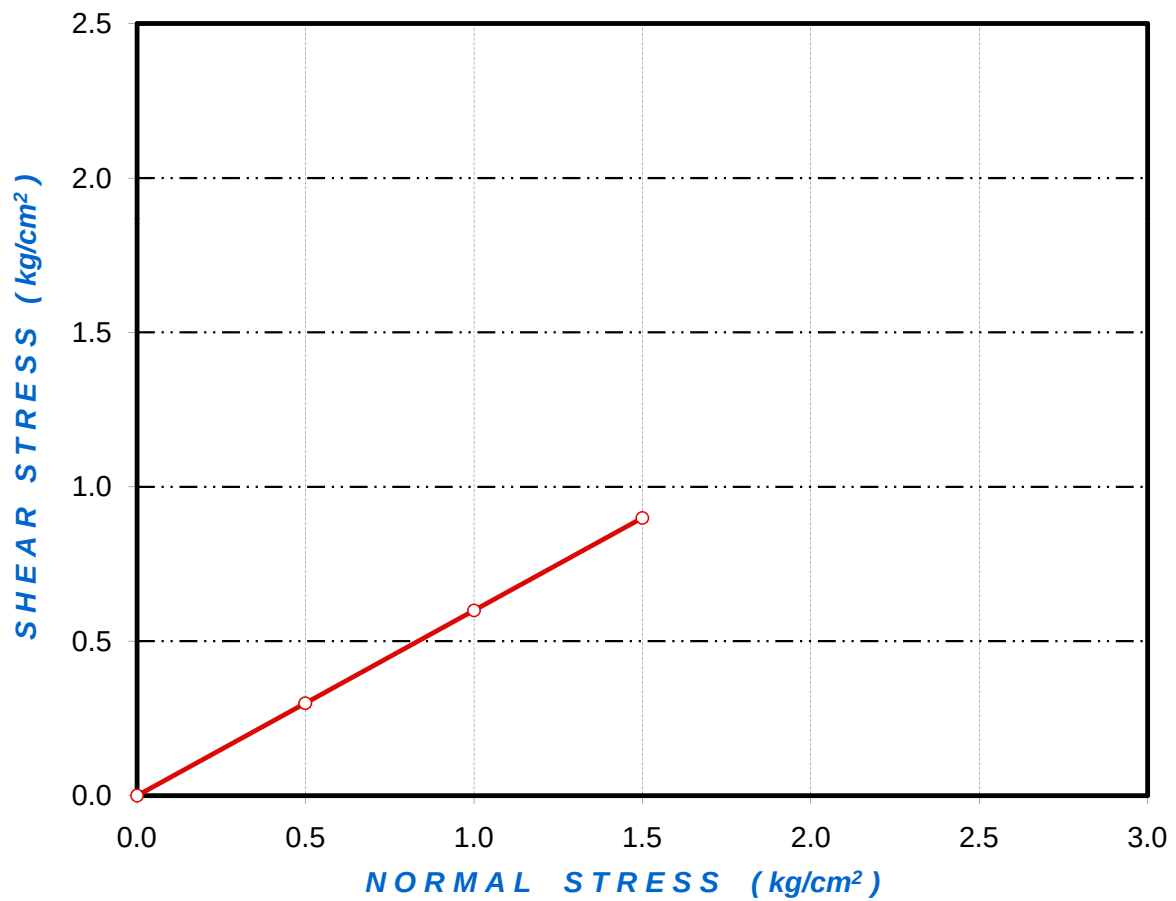


SYMBOL	BORE HOLE	DEPTH m	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
—	2	26.50	Silty Sand (SM)	0	62	38	0
- - - -	2	29.50	Silty Sand (SM)	0	65	35	0

Chainage : 15+100 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

Borehole No. :	2
Depth, m :	5.5
Dry Density, gm/cc :	1.54
"c" Value :	
kg / cm ²	0
φ, Value	30
DEGREE:	

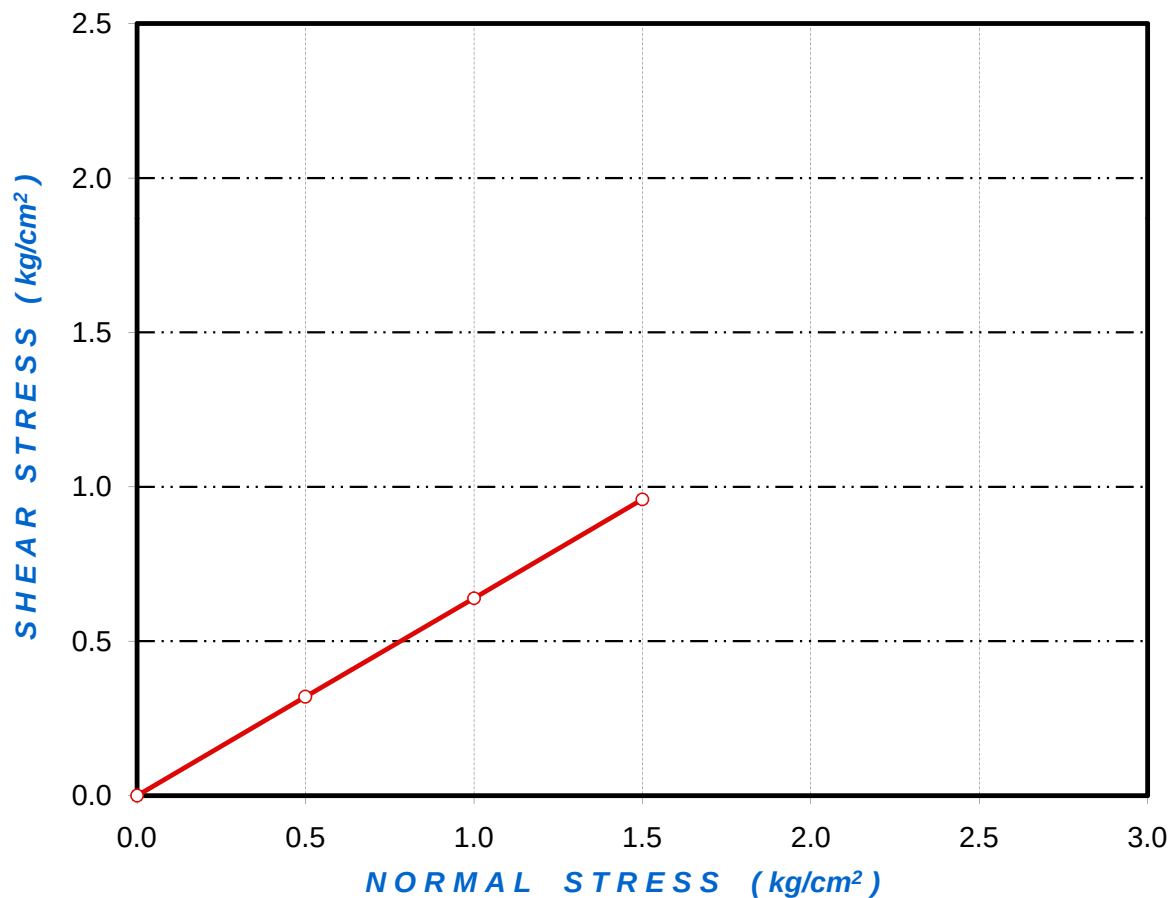


DRAINED DIRECT SHEAR TEST

Chainage : 15+100 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwaraka Expressway

Borehole No. :	2
Depth, m :	11.5
Dry Density, gm/cc :	1.58
"c" Value :	
kg / cm ²	0
φ, Value	32
DEGREE:	

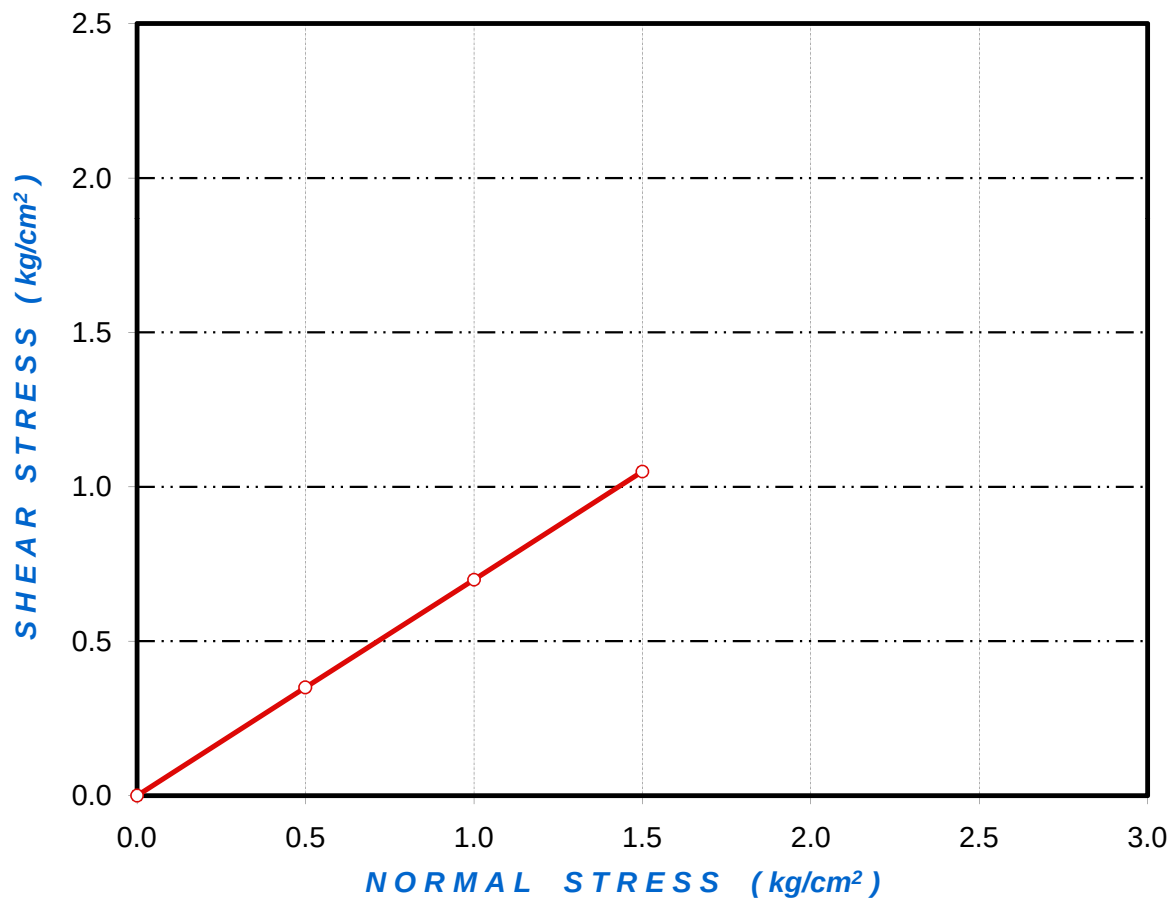


DRAINED DIRECT SHEAR TEST

Chainage : 15+100 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwaraka Expressway

Borehole No. :	2
Depth, m :	17.5
Dry Density, gm/cc :	1.65
"c" Value :	
kg / cm ²	0
φ, Value	35
DEGREE:	

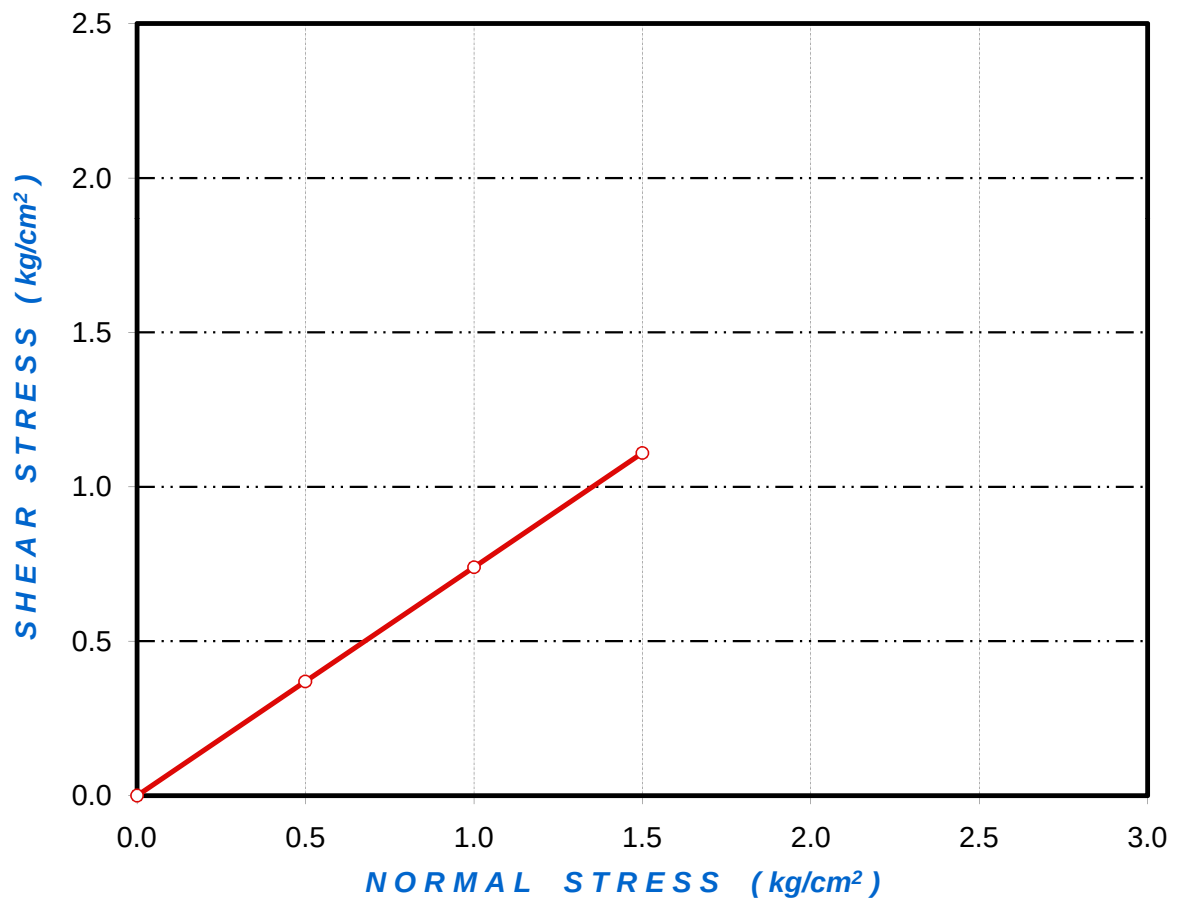


DRAINED DIRECT SHEAR TEST

Chainage : 15+100 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwaraka Expressway

Borehole No. :	2
Depth, m :	26.5
Dry Density, gm/cc :	1.72
"c" Value :	
kg / cm ²	0
φ, Value	37
DEGREE:	



DRAINED DIRECT SHEAR TEST

Chainage : 15+100 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway



Chainage : 15+100 (Basai Road)

Site Photograph

Geotechnical Investigation For Draft Feasibility Report For Dwaraka Expressway

SOIL PROFILE				Project : Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway				BH.No. 1		TERMINATION DEPTH		TABLE NO. 1a							
						Date of Start : 25.11.2017		WATER TABLE :		30.00m		JOB NO.							
						Date of Finish : 26.11.2017		Not met											
								Chainage : 18+000 (Basai Road)		21701-C									
N-Value	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis				Atterberg Limits			Specific Gravity	Natural Density gms/cm ³	Dry Density gms/cm ³	Moisture Content %	Triaxial Test			
					Gravel %	Sand %	Silt %	Clay %	Liquid %	Plastic %	Plasticity Index %					Type of Test	Cohesion Intercept Kg/cm ²	Angle of Internal Friction	
1	0.50	DS1		Light Grey Silty Sand (SM)															
	1.50	SPT1																	
	2.50	UDS1			0	65	35	0				2.61	1.65	1.52	9.1	DST	0	30	
2	3.00	SPT2		(5.0m) Light brown clayey silt of medium plasticity (CI)															
8	4.50	SPT3																	
	5.50	UDS2			0	6	73	21	43	23	20	2.64							
12	6.00	SPT4																	
20	7.50	SPT5																	
	8.50	UDS3			0	4	76	20	42	23	19	2.65	1.72	1.55	16.5	UUT	0.95	11	
22	9.00	SPT6																	
26	10.50	SPT7																	

(Cont'd on Table No.1b)

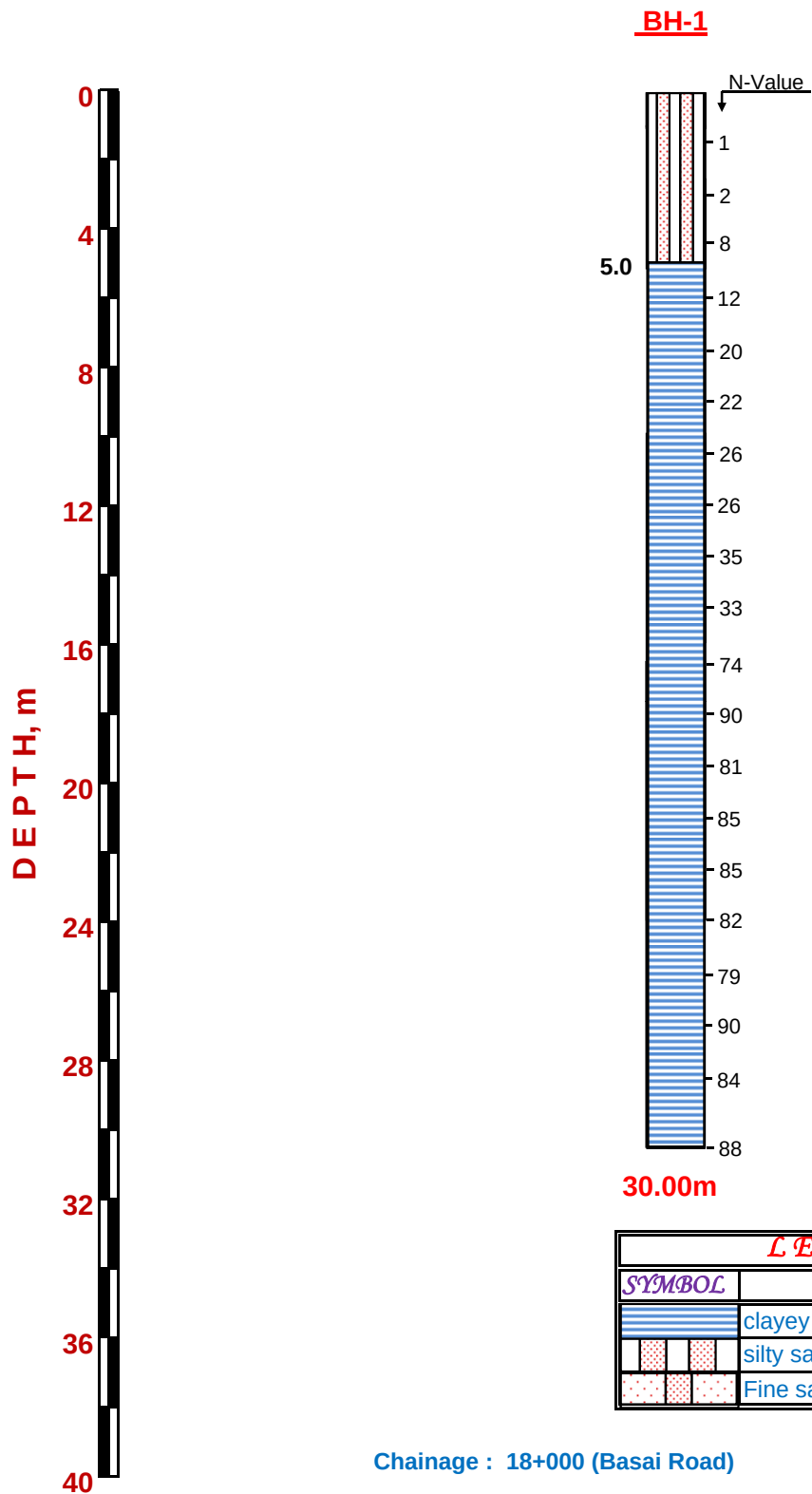
SOIL PROFILE				Project : Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway				BH.No. 1		TERMINATION DEPTH 30.00m		TABLE NO. 1b						
						Date of Start : 25.11.2017		WATER TABLE :		Chainage : 18+000 (Basai Road)		JOB NO.						
						Date of Finish : 26.11.2017		Not met				21701-C						
N-Value	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis				Atterberg Limits			Specific Gravity	Natural Density gms/cm³	Dry Density gms/cm³	Moisture Content %	Triaxial Test		
					Gravel %	Sand %	Silt %	Clay %	Liquid %	Plastic %	Plasticity Index %					Type of Test	Cohesion Intercept Kg/cm²	Angle of Internal Friction
26 35 33 74 90 81 85	11.50	UDS4		Light brown clayey silt of medium plasticity (CI)	0	7	71	22	42	21	21	2.66	1.74	1.54	16.8	UUT	1.15	9
	12.00	SPT8																
	13.50	SPT9																
	14.50	UDS5			0	5	74	21	42	20	22							
	15.00	SPT10																
	16.50	SPT11																
	17.50	UDS6			0	6	70	24	43	23	20	2.68	1.78	1.58	18.3			
	18.00	SPT12																
	19.50	SPT13																
	20.50	UDS7			0	4	74	22	42	21	21							
21.00	SPT14																	

(Cont'd on Table No.1c)

CHEMICAL TEST RESULTS**SOIL-WATER EXTRACT:**

<i>Borehole No.</i>	<i>Depth, (m)</i>	<i>Sulphate Content (SO₃) , %</i>	<i>Chloride Content , %</i>	<i>pH Value</i>
1	2.50	0.12	0.02	8.1

Chainage : 18+000 (Basai Road)*Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway*



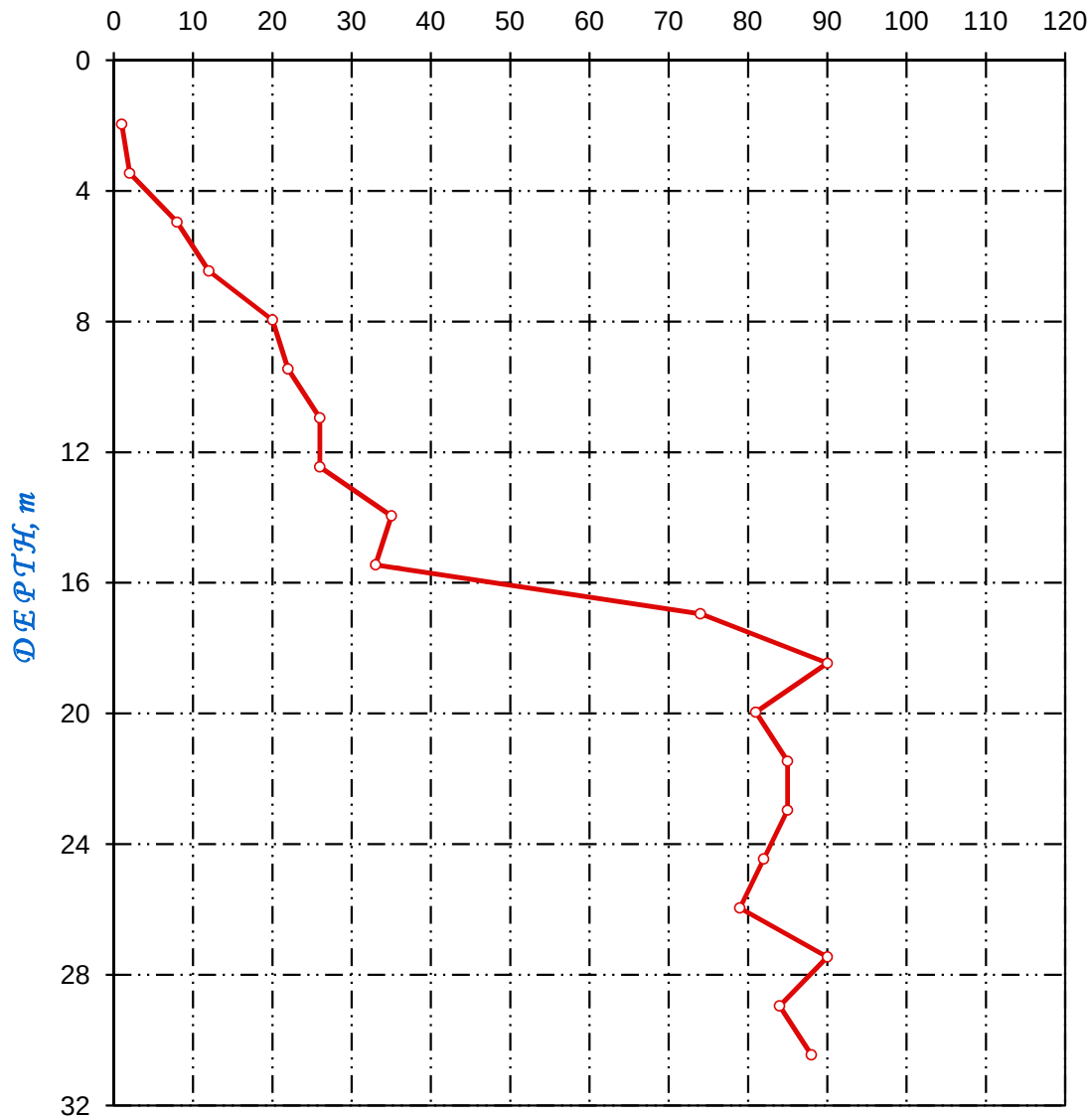
Chainage : 18+000 (Basai Road)

Summary of Borehole Profiles

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

STANDARD PENETRATION TEST

FIELD "N" VALUE



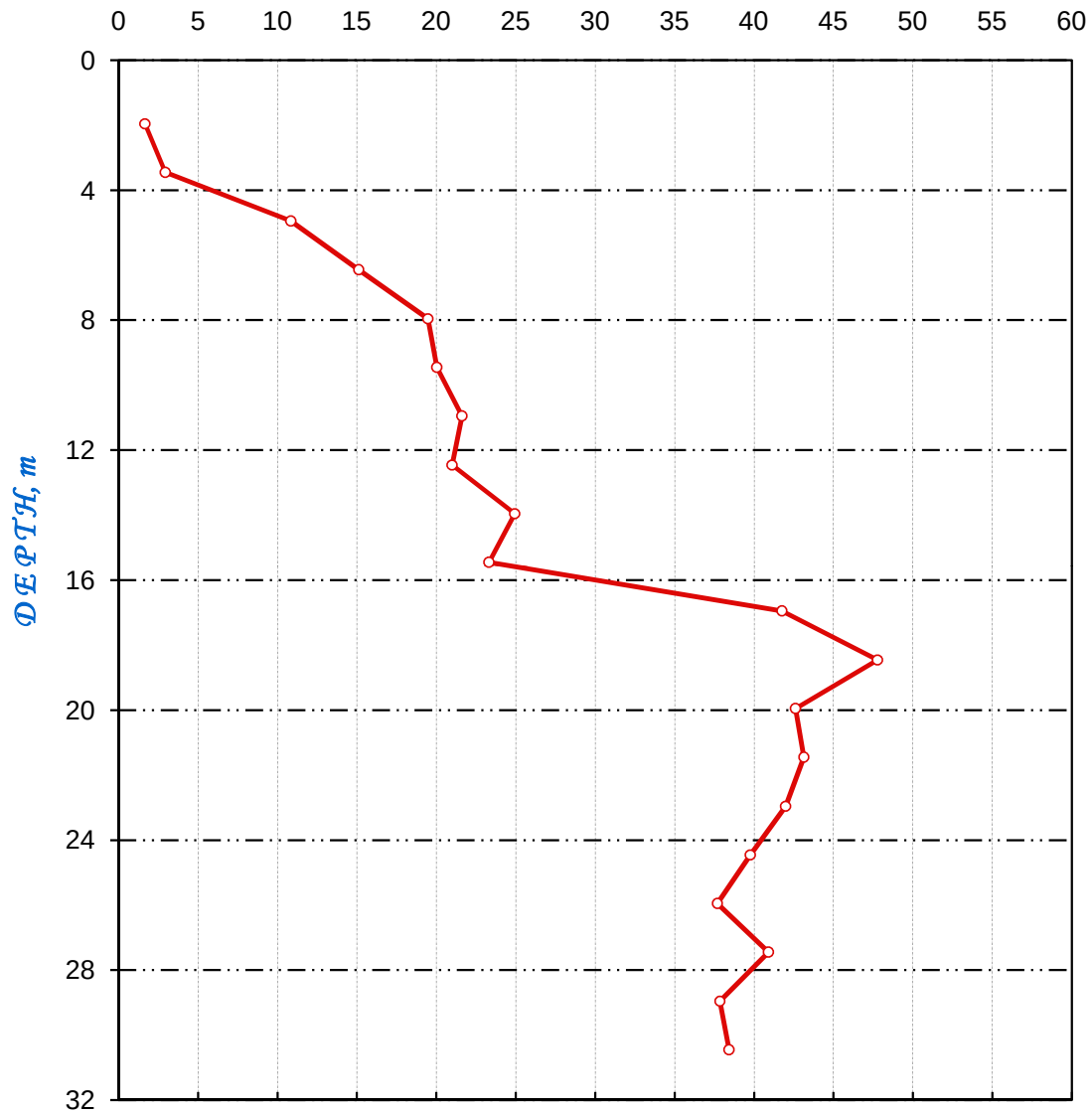
LEGEND	
Symbol	BH.No.
—○—	1

Chainage : 18+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

STANDARD PENETRATION TEST

CORRECTED "N" VALUE

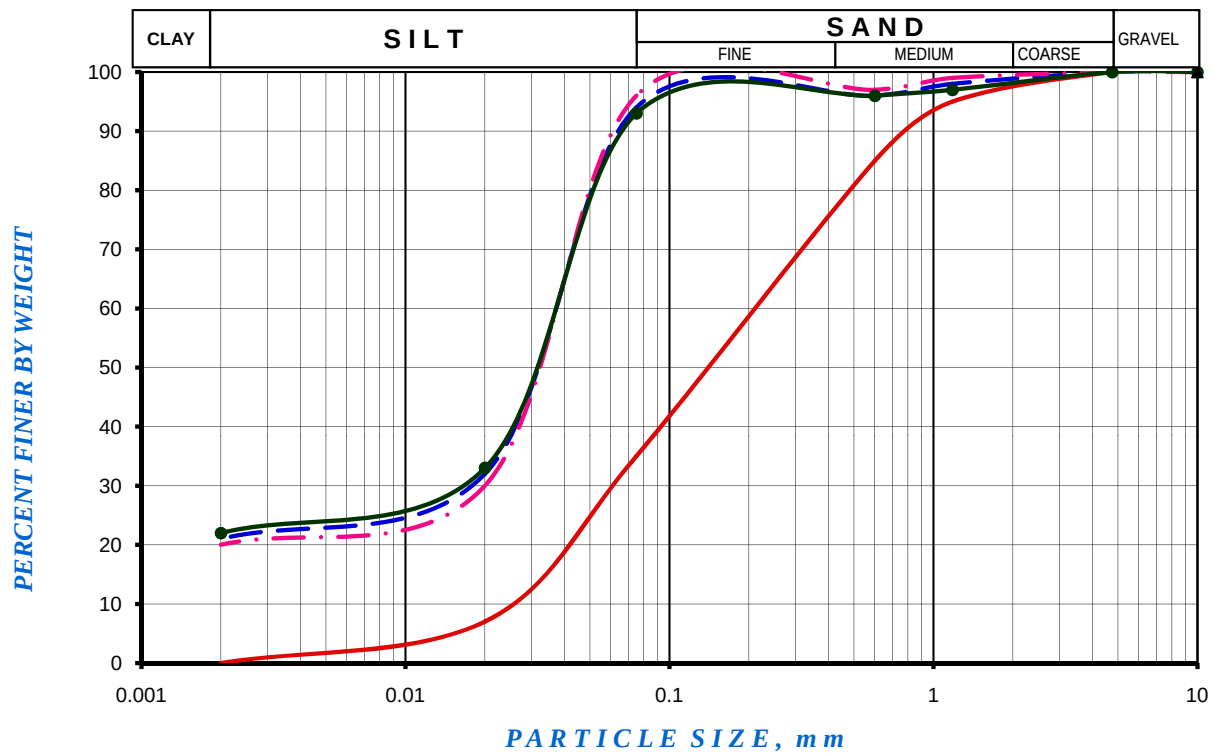


LEGEND	
Symbol	BH.No.
—○—	1

Chainage : 18+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

GRAIN SIZE ANALYSIS

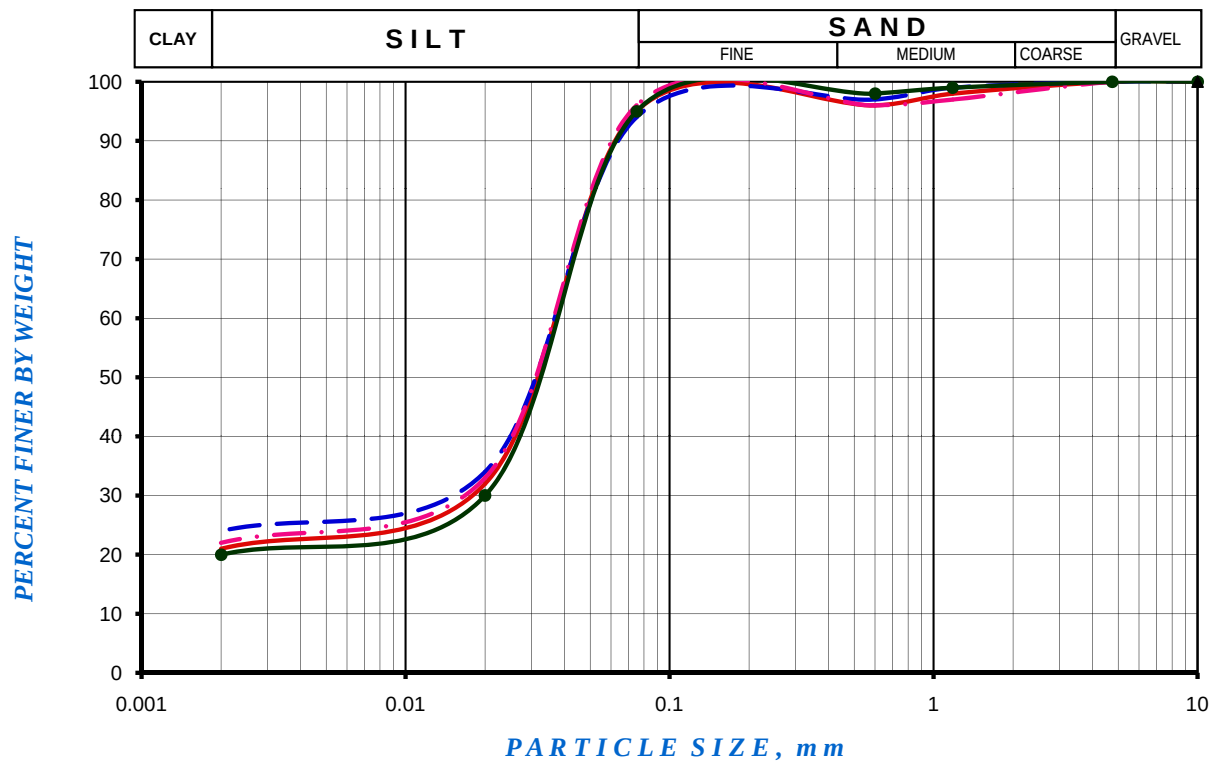


SYMBOL	BORE HOLE	DEPTH m	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
—	1	2.50	Silty Sand (SM)	0	65	35	0
- - - -	1	5.50	Clayey Silt (CI)	0	6	73	21
- . - . - .	1	8.50	Clayey Silt (CI)	0	4	76	20
—●—●—	1	11.50	Clayey Silt (CI)	0	7	71	22

Chainage : 18+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

GRAIN SIZE ANALYSIS

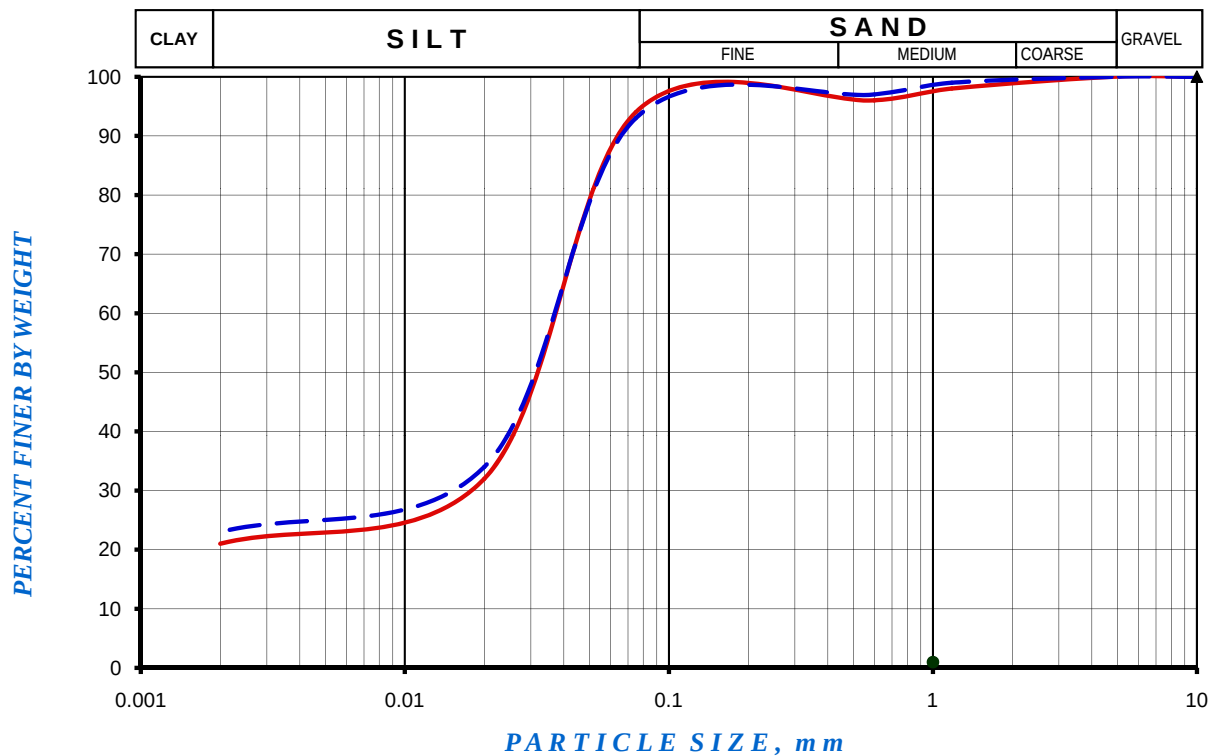


SYMBOL	BORE HOLE	DEPTH m	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
—	1	14.50	Clayey Silt (CI)	0	5	74	21
- - - -	1	17.50	Clayey Silt (CI)	0	6	70	24
.	1	20.50	Clayey Silt (CI)	0	4	74	22
—●—●—	1	23.50	Clayey Silt (CI)	0	5	75	20

Chainage : 18+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

GRAIN SIZE ANALYSIS

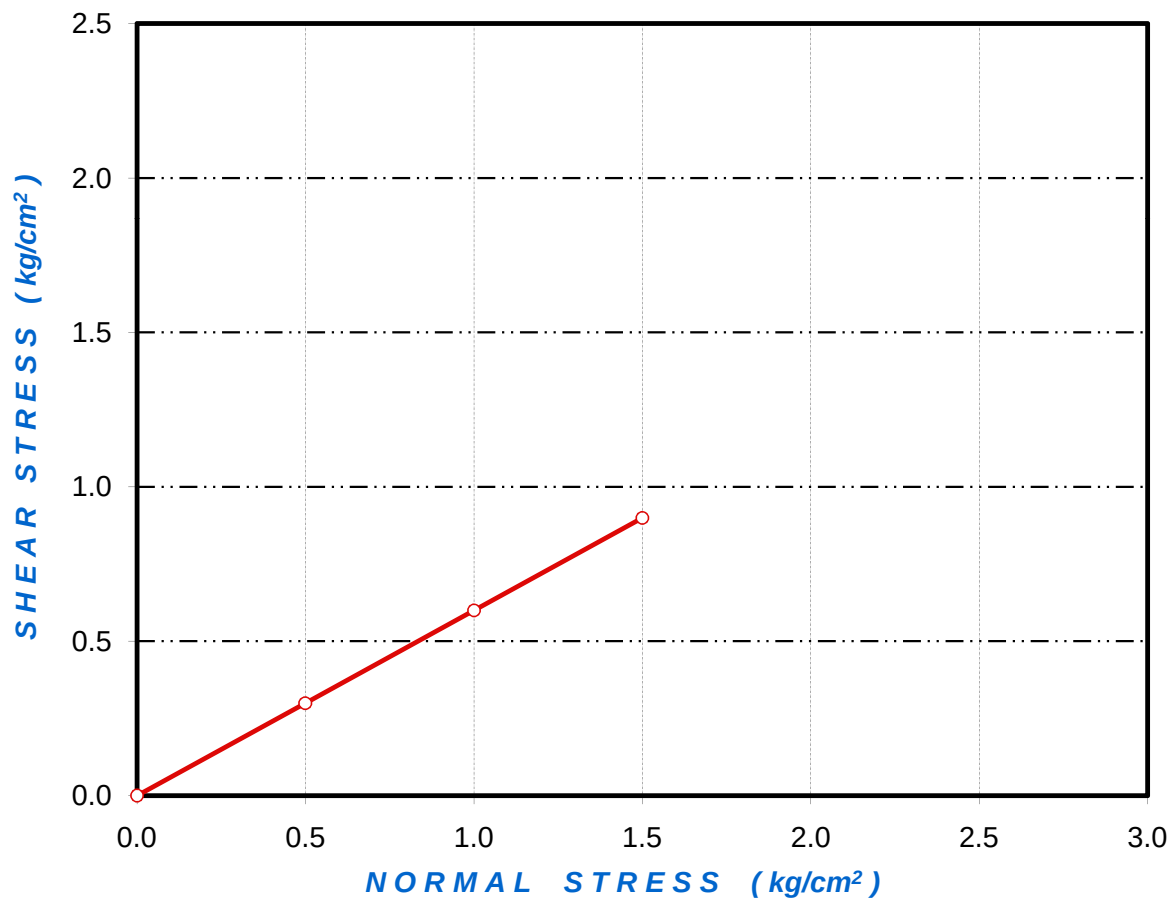


SYMBOL	BORE HOLE	DEPTH m	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
—	1	26.50	Clayey Silt (CI)	0	6	73	21
- - - -	1	29.50	Clayey Silt (CI)	0	7	70	23

Chainage : 18+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

Borehole No. :	1
Depth, m :	2.5
Dry Density, gm/cc :	1.52
"c" Value : kg / cm ²	0
φ, Value DEGREE:	30

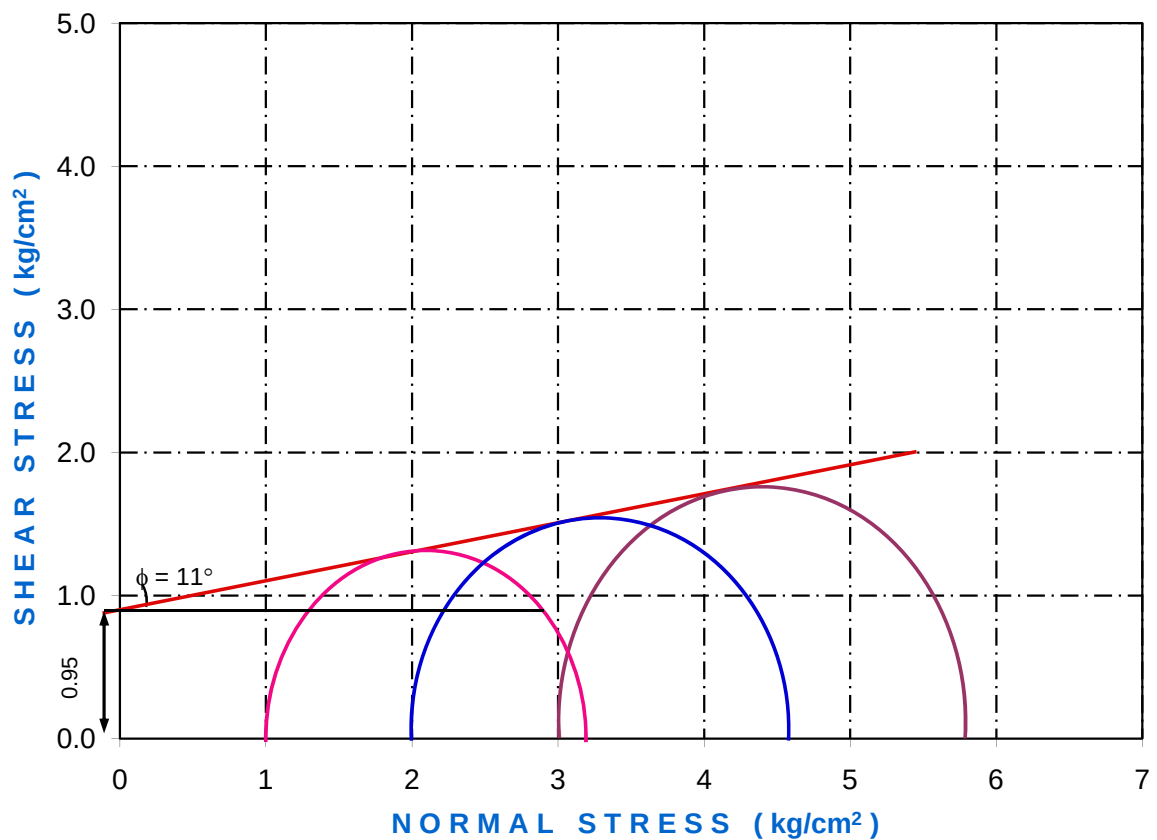


DRAINED DIRECT SHEAR TEST

Chainage : 18+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwaraka Expressway

Borehole No.	: 1
Depth, m	: 8.5
Dry Density	: 1.55
gm/cc	
"c" Value	: 0.95
kg / cm ²	
ϕ , Value	: 11
DEGREE	

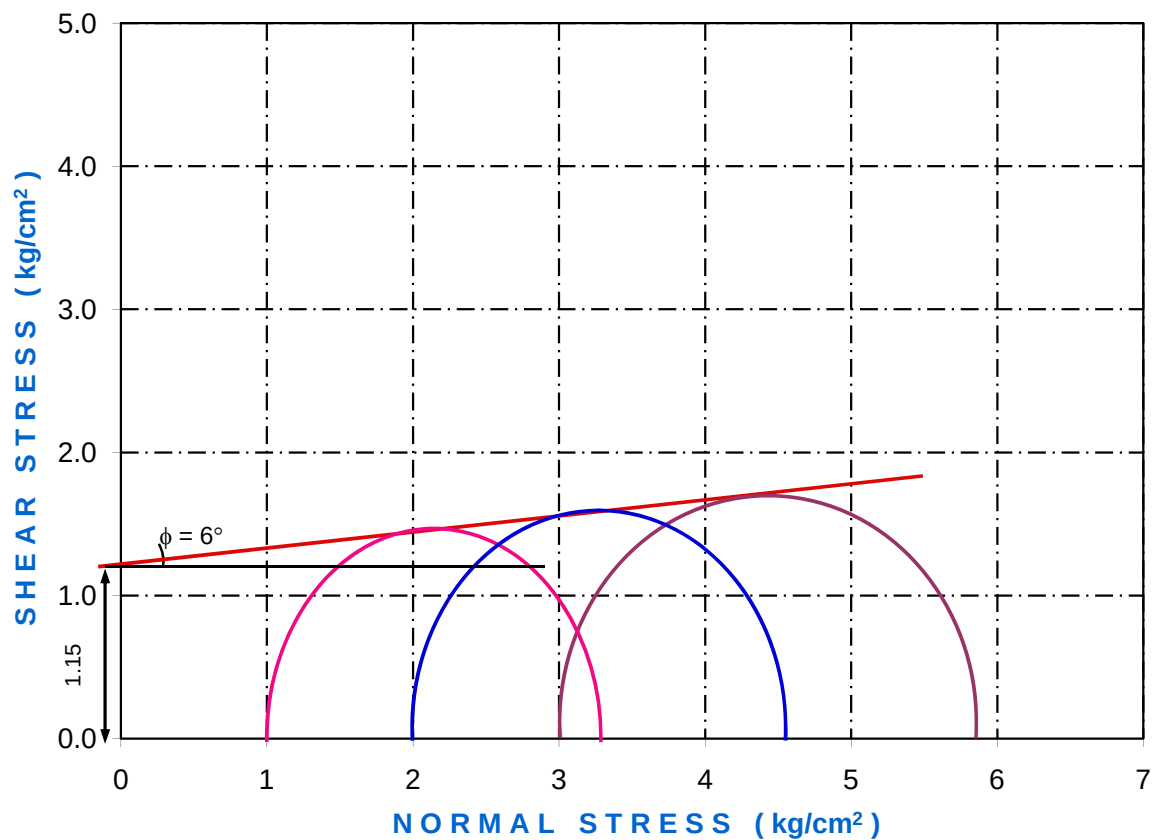


'UNCONSOLIDATED UNDRAINED TRIAXIAL TEST'

Chainage : 18+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

Borehole No.	: 1
Depth, m	: 17.5
Dry Density	: 1.58
gm/cc	
"c" Value	: 1.15
kg / cm ²	
ϕ , Value	: 9
DEGREE	

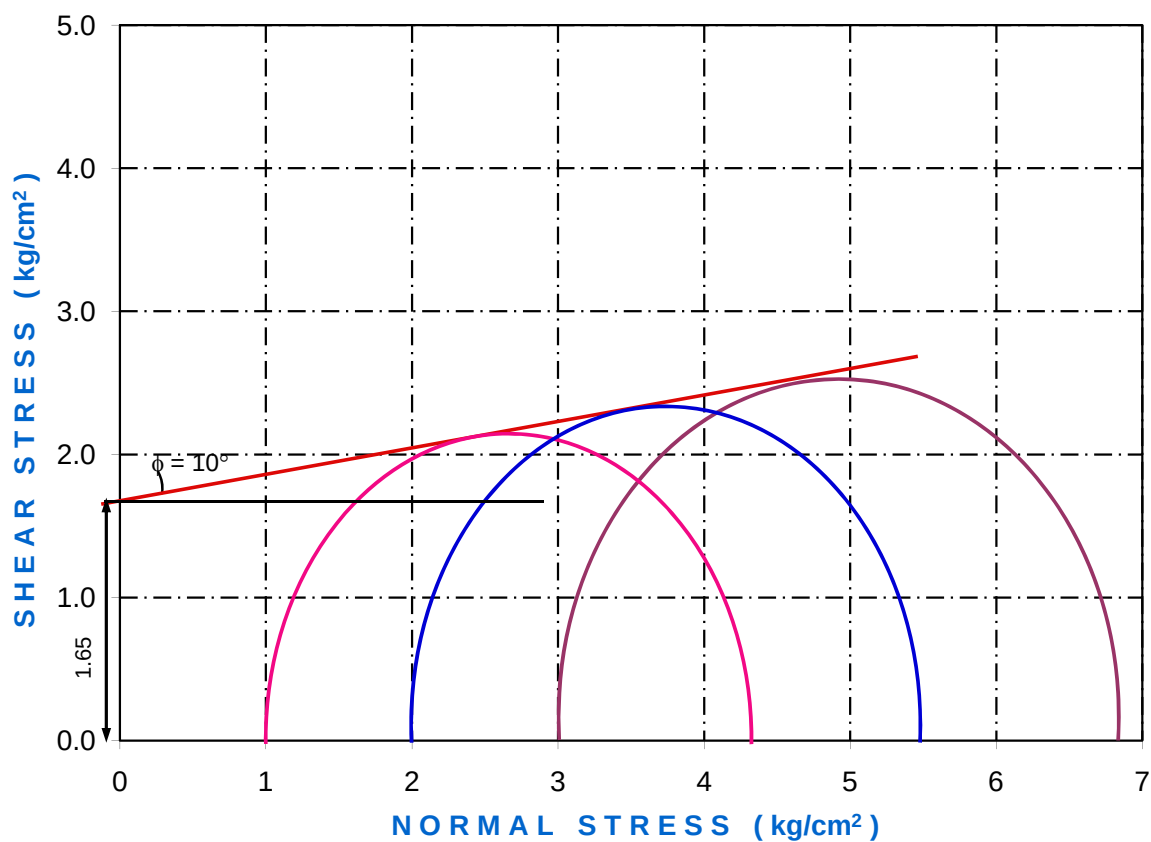


'UNCONSOLIDATED UNDRAINED TRIAXIAL TEST'

Chainage : 18+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway

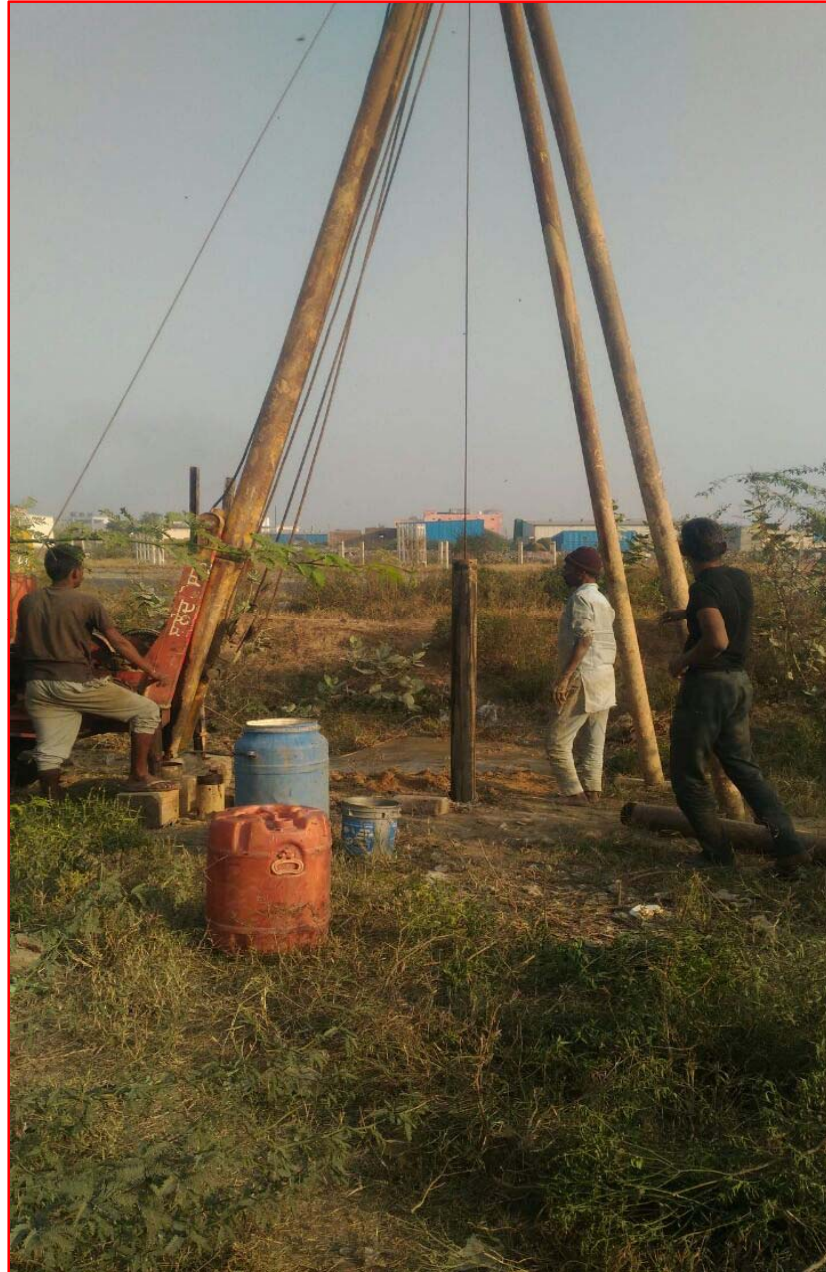
Borehole No.	: 1
Depth, m	: 23.5
Dry Density	: 1.66
gm/cc	
"c" Value	: 1.65
kg / cm ²	
ϕ , Value	: 10
DEGREE	



UNCONSOLIDATED UNDRAINED TRIAXIAL TEST

Chainage : 18+000 (Basai Road)

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway



Chainage : 18+000 (Basai Road)

Site Photograph

Geotechnical Investigation For Draft Feasibility Report For Dwarka Expressway