



Ministry of Road Transport and Highways

Regional Office, Hyderabad



UP-GRADATION TO 2/4 LANE WITH PAVED SHOULDERS CONFIGURATION OF NEWLY DECLARED NH 167K STARTING FROM ITS JUNCTION WITH NH-167 NEAR KALWAKURTHY CONNECTING NAGARKURNOOL, KOLLAPUR, RAMPUR IN THE STATE OF TELANGANA, MANDUGULA, SIVAPURAM, KARIVENA AND TERMINATING AT ITS JUNCTION WITH NH 40 NEAR NANDYAL IN THE STATE OF ANDHRA PRADESH FOR A LENGTH OF 185.90 KMS (APPROX) INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

Geotechnical & Geophysical Report

Client :							
Independent Engineer :							
Project Name :	Project Management Consultancy for Up-Gradation to 2/4 Lane with Paved Shoulders Configuration of Newly Declared NH 167k Starting from it's Junction with NH-167 near Kalwakurthy connecting Nagarkurnool, Kollapur, Rampur in The State of Telangana, Mandugula, Sivapuram, Karivena and terminating at it's Junction with NH 40 Near Nandyal in the State of Andhra Pradesh for A length of 185.90 Kms (Approx.) Including Four Lane Major Bridge Across River Krishna.						
Report Title :	Geotechnical Investigation Report for MNB & MJB between Kalwakurthy and Rampur in Telangana						
Report No:							
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1 INTRODUCTION

_____ has awarded the work of conducting Geotechnical investigation for the proposed construction Minor Bridge (MNB) and Major Bridges (MJB) for up-gradation of NH 167k starting it's junction with NH-167 near Kalwakurthy connecting Nagarkurnool, Kollapur, Rampur in Telangana stage and Mandugula, Sivapuram, Karivena and terminating at junction with NH -40 near Nandyal in Andhra Pradesh state project to M/s Siri Geo Solutions Pvt Ltd., Hyderabad.

Objective of the geotechnical investigation is to ascertain sub-soil parameters for appropriate design of the foundation system.

This report covers the scope of geotechnical investigation from MNB & MJB between Kalwakurthy to Rampur, including major bridge across Krishna river in Telangana.

2 SCOPE OF WORK

The scope of work is to make specified number of standard geotechnical boreholes for the proposed construction of MNB & MJB as per the specifications and direction given by the client.

The detailed scope of work includes the following

-  Making twenty five standard geotechnical boreholes at twelve structures proposed structure location.
-  Drilling through soil and rock strata as per client directions.
-  Conducting standard penetration test at 1.5m depth intervals below proposed foundation level.
-  Collecting disturbed and undisturbed soil samples.
-  Conducting relevant field and laboratory tests.
-  Submitting comprehensive geotechnical report which covering all field works, laboratory test results and recommendations for the foundation system

3 FIELD WORK

Field investigations were carried out during the month of February 2022. Brief methodologies of boring and other field works are given below.

3.1 Soil Boring

Exploratory boreholes of 150mm diameter were drilled in soil strata by rotary drilling machine with bentonite circulation technique. The description of sub soil stratum with SPT 'N' values at regular intervals and ground water table was recorded in the bore logs and presented in Annexure -II.

3.2 Rock Drilling

Drilling in rock was resorted to in boreholes after encountering 'Refusal' condition. Standard rotary drilling machine, driven by diesel-operated engine and fitted with diamond bits of 'NX' size with single tube core barrel was used in drilling through rock strata with conventional water circulation technique. Standard Penetration Tests were conducted in drill holes at no appreciable core recovery was possible. Core recovery (CR) and Rock Quality Designation (RQD) percentage were measured and recorded in drill-logs. Rock core samples were preserved sequentially in wooden core boxes.

Details of boreholes, depth of exploration and ground levels are presented in the table below.

SI No.	Structure	Location CH	BH No.	Depth Explored (m)	Ground water table
1	MNB 1	10+300	BH-1	20.0	2.9
2	MNB 3	15+700	BH-1	20.0	1.5
3			BH-2	20.0	1.3
4	MJB 1	20+600	BH-1	7.5	1.8
5			BH-2	3.3	0.5
6			BH-3	11.0	1.7
7			BH-4	12.5	1.8
8	MNB 4	20+965	BH-1	9.0	2.6
9	MNB 5	22+715	BH-1	20.0	2.0
10	MNB 6	24+800	BH-1	20.0	3.0
11	MJB 2	31+550	BH-1	20.0	1.8
12			BH-2	20.0	2.2

SI No.	Structure	Location CH	BH No.	Depth Explored (m)	Ground water table
13	MNB 7	37+150	BH-1	20.0	1.5
14	MNB 8	37+550	BH-1	10.0	1.5
15			BH-2	14.5	1.2
16	MNB 11	43+350	BH-1	20.0	1.6
17	MNB 13	46+300	BH-1	16.5	1.4
18	MNB 15	52+505	BH-1	20.0	2.5
19	MNB 18	60+600	BH-1	15.0	2.2
20	MNB 33	77+470	BH-1	11.0	1.5
21	MJB 3	88+100	BH-1+	20.0	Not met
22			BH-2+	25.0	2.9m
23			BH-3*	15.0	Not met
24			BH-4*	20.0	3.5m
25			BH-5*	20.0	3.8m

Note: +MJB-3 Telangana side, * MJB-3 Andhra side, Ground water table is not meet at the time of investigation,

3.3 Sampling

Disturbed soil samples were collected from SPT spoon collected at representative depth during boring and subsequently sent to laboratory for visual examination and laboratory tests.

3.4 Standard Penetration Test

In all boreholes, standard penetration tests were conducted at 1.5m intervals for full depth of the borehole or change in strata as per Indian Standard, IS:2131-1981 and split spoon sampler used conformed to the Indian Standard, IS:9640-1980. These tests were performed by driving the sampler with 63.5kg hammer falling from a height of 75cm. Number of blows required to effect each 15cm penetration is recorded. The first 15cm penetration is considered to be the seating drive. The sum of the total blows required for a second and third 15cm (total 30cm) penetration is termed the penetration resistance SPT 'N' value and the same is reported. Filed SPT 'N' values is given in bore logs in Annexure-II.

4 LABORATORY TESTS

Laboratory tests were carried out on soil samples as per the relevant Indian Standard Specifications. Details of various tests conducted are presented below.

A) Tests on soil samples:

The following tests have been performed for soil samples:

- ✚ Grain size analysis tests as per IS:2720 (Part -4)
- ✚ Atterberg's limits-liquid limit and plastic limit as per IS: 2720 (Part-5)
- ✚ Specific Gravity tests as per IS:2720 (Part -3)
- ✚ Director Shear test as per IS: 2720 (Part-13)

On sandy samples grain size distribution analysis test were conducted using both dry and wet sieve analysis techniques. These tests are completed primarily to classify and to find out the gradation characteristics.

In general on clayey samples Atterberg's Limit tests are conducted to derive the engineering characteristic.

B) Tests on rock samples

Rock samples were inspected by engineering geologist and selected core samples were tested.

The following test has been performed for rock samples:

- a) Unconfined Compressive Strength as per IS:9143
- b) Point load index as per IS : 8764

Laboratory test results of soil and rock results are given in Annexure -III.

5 SUBSOIL CONDITION

Twenty five boreholes were drilled for twelve structures in the section. These boreholes were terminated as directed by the client. Details of the SPT"N" values conducted at various depths are presented in individual bore logs with IS classification in Annexure-II.

Structure	Location CH	BH No.	Stratum From - to (m)	Type of soil / stratum
MNB 1	10+300	BH-1	0.0 - 3.0	Fine to medium sand with gravel (SM)
			3.0 – 12.0	Very dense moorum /Soft Disintegrated rock (SDR)

Geotechnical Investigation Report for MNB & MJB between Kalwakurthy and Rampur in Telangana Including Major Bridge Across River Krishna.

Structure	Location CH	BH No.	Stratum From - to (m)	Type of soil / stratum
MNB 1	10+300	BH-1	12.0 -20.0	Highly weathered rock
MNB 3	15+700	BH-1	0.0 – 6.0	Clayey sand (SC)
			6.0 -18.0	Very dense moorum /Soft Disintegrated rock (SDR)
			18.0 -20.0	Highly weathered rock
		BH-2	0.0 -2.0	Silty clay (CI)
			2.0 -4.5	Fine to medium sand (SM)
			4.5 – 18.0	Very dense moorum /Soft Disintegrated rock (SDR)
			18.0 -20.0	Highly weathered rock
MJB 1	20+600	BH-1	0.0 -2.5	Silty clay (CI)
			2.5 – 3.5	Very dense moorum /Soft Disintegrated rock (SDR)
			3.5 -7.5	Hard rock
		BH-2	0.0 – 0.3	Soil
			0.3-3.3	Hard rock
		BH-3	0.0 -8.0	Fine to medium sand (SM)
			8.0 -11.0	Hard rock
		BH-4	0.0 – 7.5	Fine to medium sand (SM)
			7.5 -12.5	Hard Rock
MNB 4	20+965	BH-1	0.0 -2.0	Fine to medium sand (SM)
			2.0 -5.0	Silty clay (CI)
			5.0 – 9.0	Hard rock
MNB 5	22+715	BH-1	0.0 -4.0	Silty clay (CI)
			4.0 – 20.0	Very dense moorum /Soft Disintegrated rock (SDR)
MNB 6	24+800	BH-1	0.0 -2.0	Silty clay (CL)
			2.0 -5.0	Clayey sand (SC)
			5.0 -20.0	Very dense moorum /Soft Disintegrated rock (SDR)
MJB 2	31+550	BH-1	0.0 - 3.0	Silty clay (CH)
			3.0 -7.0	Silty fine sand (SM)
			7.0 - 9.0	Clayey sand (SC)
			9.0 - 13.0	Very dense moorum /Soft Disintegrated rock (SDR)
			13.0 - 20.0	Highly weathered rock
MJB 2	31+550	BH-2	0.0 – 3.0	Silty clay (CH)
			3.0 – 6.5	Silty clay (CI)
			6.5 – 9.0	Clayey sand (SC)

Geotechnical Investigation Report for MNB & MJB between Kalwakurthy and Rampur in Telangana Including Major Bridge Across River Krishna.

Structure	Location CH	BH No.	Stratum From - to (m)	Type of soil / stratum
MJB 2	31+500	BH-2	9.0-11.0	Very dense moorum /Soft Disintegrated rock (SDR)
			11.0 -20.0	Highly weathered rock
MNB 7	37+150	BH-1	0.0 – 3.0	Silty sand (SM)
			3.0-20.0	Very dense moorum /Soft Disintegrated rock (SDR)
MNB 8	37+550	BH-1	0.0-2.5	Sandy clay (SC)
			2.5-7.0	Weathered rock
			7.0-10.0	Hard rock
		BH-2	0.0 -3.5	Sandy clay (SC)
			3.5 -7.0	Hard rock (Bouldera)
			7.0-10.0	Sandy clay (SC)
			10.0-11.5	Very dense moorum /Soft Disintegrated rock (SDR)
			11.5-14.5	Hard rock
MNB 11	43+350	BH-1	0.0-2.0	Greyish silty clayeysand
			2.0-4.5	Clayey sand
			4.5-9.0	Very dense moorum /Soft Disintegrated rock
			9.0-13.5	Weathered Rock
			13.5-20.0	Very dense moorum /Soft Disintegrated rock (SDR)
MNB 13	46+300	BH-1	0.0 -4.5	Greyish silty clayeysand
			4.5 -7.5	Fine to medium sand
			7.5-13.5	Very dense moorum /Soft Disintegrated rock
			13.5-16.5	Hard Rock
MNB 15	52+505	BH-1	0.0 -3.5	Greyish clayeysand
			3.5 -6.5	Fine to medium sand with gravel
			3.5 -6.5	Very dense moorum /Soft Disintegrated rock
MNB 18	60+600	BH-1	0.0-2.0	Greyish clayeysand
			2.0-6.0	Fine to medium sand
			6.0-10.5	Very dense moorum /Soft Disintegrated rock
			10.5-13.0	Weathered Rock
			13.0-15.0	Hard Rock

Structure	Location CH	BH No.	Stratum From - to (m)	Type of soil / stratum
MNB 33	77+470	BH-1	0.0-2.0	Greyish silty clayey sand
			2.0-4.5	Fine to medium sand
			4.5-11.0	Weathered Rock
MJB 3	88+100	BH-1	0.0-3.0	Silty clay
			3.0-6.0	Clayey sand
			6.0-10.5	Silty clay with gravel
			10.5-20.0	Very dense clayey sand with gravel
		BH-2	0.0-2.5	Silty clay
			2.5-11.0	Clayey sand with gravel
			11.0-22.0	Very dense silty sand with gravel
			22.0-25.0	Weathered Rock
		BH-3	0.0-6.0	Very dense moorum /Soft Disintegrated rock
			6.0-9.0	Weathered Rock
			9.0-10.0	Hard Rock
			10.0-12.0	Weathered Rock
			12.0-15.0	Hard Rock
		BH-4	0.0-4.5	Silty clay
			4.5-10.5	Very dense silty sand with gravel
			10.5-12.0	Weathered rock
			12.0-14.0	Hard rock
			14.0-19.0	Weathered rock
			19.0-20.0	Hard Rock
		BH-5	0.0-9.0	Very dense moorum /Soft Disintegrated rock
			9.0-17.0	Weathered Rock
			17.0-20.0	Hard Rock

Comprehensive sub soil profiles are shown in Annexure -I.

6 ENGINEERING APPRAISAL

General Discussion

As per the field and laboratory test results the sub soil stratum for each bridge is presented in comprehensive sub soil profile. Considering the incidence of structural load and natural soil below the existing ground level isolated foundation is preferable for this structure.

A. Shallow Foundation

Foundation Analysis

The safe bearing capacity is arrived based on the shear failure criteria and settlement criteria. The estimated safe bearing capacity is calculated as per IS: 6403-1981 code and IS: 8009 (Part-1)-1976 with available soil profile.

A properly designed foundation has to satisfy two limit states.

- 1) Limit state of collapse (ie., Shear strength)
- 2) Limit state of serviceability (ie., Settlement)

Shear Criteria

The first criterion is depending on shear strength. The calculations are based on "TERZAGHI" bearing capacity equation as recommended by IS:6403 (with factor of Safety 2.5) which takes care of L/B ratio (shape), foundation depth etc., along with other parameters.

The intensity of loading at the base of the foundation, which would cause shear failure of the soil support, is termed as ultimate bearing capacity (UBC).

The following equation is used to calculate ultimate bearing capacity,

$$Net\ UBC = C * N_c * S_c * d_c + q * (N_q - 1) * S_q * d_q + 0.5 * B * \gamma * N_{\gamma} * S_{\gamma} * d_{\gamma} * W'$$

Safe bearing capacity (SBC) is the maximum intensity of loading that the foundation will safely carry without the risk of shear failure of soil irrespective of any settlement that may occur. Safe bearing capacity can be obtained by dividing the UBC with suitable factor of safety (2.5).

$$SBC = UBC / 2.5$$

Settlement Criteria:

The intensity of loading that will cause a permissible settlement or specified settlement of the structure is termed as allowable bearing pressure.

The elastic settlement of granular soil and consolidated settlement of cohesive soils are calculated using SPT 'N' values and laboratory test results. Settlement is predicted using IS: 8009 (part-1)-1976.

B. Pile Foundation

The bearing capacity of pile is arrived based on the static approach. Separate evaluation of shaft friction and end bearing forms the basis of this approach. Safe bearing capacities of piles are calculated for 1000mm and 1200 mm dia bored cast-in-situ piles considering pile socketing as 2.5D into weathered rock, where D is diameter of the pile. The estimated pile capacities are as per IS code with available soil data and depth at which weathered rock layer is recorded in the boreholes. The actual capacities are to be arrived from pile load tests. Lateral load capacities are estimated based on allowable lateral deflection of 1% of pile diameter.

1) Piles in Weathered Rock: (Method-2)

Ultimate bearing capacity (Q_u) of pile in granular soils is given by the following formula.

$$Q_u = R_e + R_{af} = c_{ub} \cdot N_c A_b + c_{us} A_s$$

$$Q_{allow} = R_e/3 + R_{af}/6$$

Where:

Q_u - Ultimate capacity of pile

Q_{allow} - Allowable capacity of pile

A_b - Cross sectional area of pile toe

A_s - Surface area of socket

c_{ud} - Average shear strength below base of pile for the depth twice the diameter / least lateral dimension of pile

γ - Effective unit weight of soil at pile toe

c_{us} - Ultimate shear strength along socket length

Discussions on strength parameters

All the strength properties are verified and corroborated based on well-known correlations between SPT values and strength parameters.

Relative density (D_r) and angle of shearing resistance (ϕ) are obtained based on penetration test data and based on the laboratory results on remoulded disturbed samples from non-cohesive soils. IS 6403: 1981 gives the correlation between corrected SPT values 'N' and ϕ .

Depth of foundation for river bridges:

Depth of foundation for the river bridges is mainly depends on scour depth. The minimum depth of foundation should be provided as per IRC 78-2000 clause 705. The silt factor and scour depths are calculated as per IRC 78-2000 and IRC 5-1998.

Form the grain size analysis weighted mean particle diameter and silt factors are tabulated below;

Sl No.	Type of Structure	Chainage	Average Particle Diameter (d_m)	Silt factor $=1.76$ $(d_m)^{1/2}$
1	MNB 1	10+300	0.19	1.92
2	MNB 3	15+700	1.06	1.81
3	MJB 1	20+600	1.18	1.91
4	MNB 4	20+965	0.97	1.73
5	MNB 5	22+715	0.72	1.49
6	MNB 6	24+800	0.67	1.44
7	MJB 2	31+550	0.75	1.52
8	MNB 7	37+150	1.35	2.04
9	MNB 8	37+550	1.04	1.79
10	MNB 11	43+350	0.60	1.36
11	MNB 13	46+300	0.67	1.44
12	MNB 15	52+505	1.06	1.81
13	MNB 18	60+600	1.24	1.96
14	MNB 33	77+470	1.20	1.93
15	MJB 3	88+100	0.71	1.48

A typical calculation for estimating the bearing capacity of shallow foundation and pile capacity are given in annexure- IV.

7 RECOMMENDATION

Based on the field and laboratory tests the following recommendations are given

- ✚ Open foundations are recommended in the form of isolated footing
- ✚ The recommended safe bearing capacity and depth of foundation is tabulated below.

Chainage & Structure		Ref BH	Foundation Location	Proposed Foundation level from NGL	Net safe bearing capacity (KN/Sq.m)	Founding strata
MNB-1	10+300	BH-1	Abutment & Pier	3.5 m	400	SDR
MNB-3	15+700	BH-1&2	Abutment & Pier	3.0m	250	Clayey sand
				6.5m	400	SDR
MJB-1	20+600	BH-1	Abutment -1	3.0m	400	SDR
				4.0m	600	H. Rock
		BH-2	Pier-P1	2.0m	600	H. Rock
				3.5m	350	Sand
		BH-3	Pier-P2	8.5m	600	H. Rock
				3.5m	350	Sand
MNB-4	20+965	BH-1	Abutment & Pier	3.5m	600	H. Rock
				2.5m	100	Silty clay
MNB-5	22+715	BH-1	Abutment & Pier	2.5m	250	Silty clay
				4.5m	400	SDR
MNB-6	24+800	BH-1	Abutment & Pier	2.5m	350	Clayey sand
MJB-2	31+550	BH-1	Abutment	3.5m	300	Sand
		BH-2	Pier	3.5m	200	Silty clay
				7.0m	350	Clayey sand
MNB-7	37+150	BH-1	Abutment & Pier	3.0m	400	SDR
MNB-8	37+550	BH-1 & 2	Abutment & Pier	3.0m	450	W. Rock
MNB-11	43+350	BH-1	Abutment & Pier	2.5m	300	Clayey sand
MNB-13	46+300	BH-1	Abutment & Pier	3.0m	150	Silty clay
				5.0m	300	Sand

Geotechnical Investigation Report for MNB & MJB between Kalwakurthy and Rampur in Telangana Including Major Bridge Across River Krishna.

Chainage & Structure		Ref BH	Foundation Location	Proposed Foundation level from NGL	Net safe bearing capacity (KN/Sq.m)	Founding strata
MNB-15	52+505	BH-1	Abutment & Pier	3.5m	300	Sand
MNB-18	60+600	BH-1	Abutment & Pier	2.5m	300	Sand
MNB -33	77+470	BH-1	Abutment & Pier	2.5	300	Sand

Note: for the bridges if the recommended foundations depths are within the scour depth, in that case the foundation depth should be minimum 2.0m below scour depth for foundations resting in soil, 0.6m in case of foundations on hard rock and 1.5m for all other cases.

- 🚧 All foundation works should be done in dry condition and foundation pits should be backfilled with well compacted soil.
- 🚧 Foundation should rest on 100mm thick 1:4:8 concrete mat.
- 🚧 All foundation works should be done in dry condition and foundation pits should be backfilled with well compacted soil.

For Major Bridge MJB-3 at CH 88+100 across Krishna rive pile foundation are recommended, the recommended pile capacity are tabulated below

Pile Capacity Recommendations – MJB-3 @ CH 88+100										
BH. No.	Dia of pile (M)	Length of socket	Pile Termination depth from EGL (M)	Pile length below cutoff level (M)	Safe Pile capacity Compression (KN)	Safe Pile capacity Tension (KN)	Safe Horizontal capacity (KN)	Vertical Spring Stiffness (KN/m)	Horizontal Spring Stiffness (KN/m)	Stratum at pile tip
BH-2+	1.0	3D	27.0	25.0	7500	4000	300	625000	30000	WR
	1.2	3D	27.6	25.6	10000	6000	500	800000	41000	WR
	1.5	3D	28.5	26.5	15000	10000	850	1250000	56000	WR
BH-3*	1.0	3D	17.0	15.0	7500	4000	300	625000	30000	WR
	1.2	3D	17.6	15.6	10000	6000	500	800000	41000	WR
	1.5	3D	18.5	16.5	15000	10000	850	1250000	56000	WR

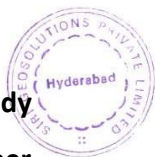
Note : + Telangana side * Andhra Pradesh side , Weathered rock WR (SPT>100 or RQD nil)
stratum,

The above estimated pile capacities are theoretical values. It is recommended to carry out Initial load test both axial capacity and lateral capacity in according with the India Standard IS 2911 (part4) -2013 are recommended.

V. Sukanya

V. Sukanya Reddy

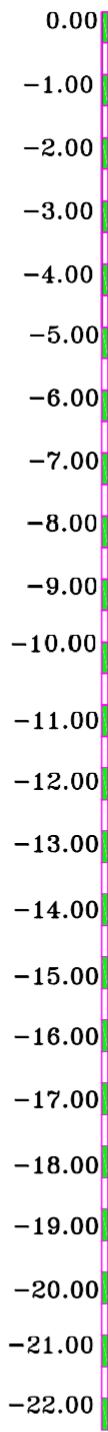
Geotech Engineer



Annexure – I

Comprehensive Sub Soil Profile

Depth Below
EGL

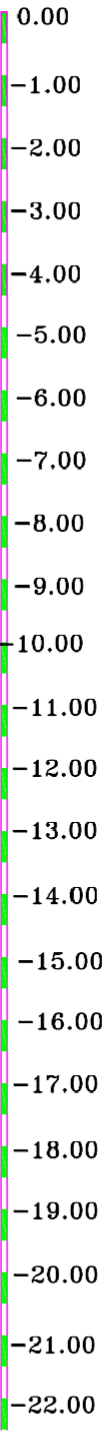


BH-1
(CH 10+300)

N=33
N>100
N>100
N>100
N>100
N>100
N>100
N>100
CR/RQD
22%/Nil
35%/28%
19%/Nil
16%/Nil
5%/Nil
13%/Nil
21%/11%
31%/12%



Depth Below
EGL



- LEGEND:
- BORE HOLES.
 - SILTY SAND.
 - SOFT DISINTEGRATED ROCK.
 - HIGHLY WEATHER ROCK

SCALE :- NOT TO SCALE.

CONSULTANTS:	CLIENT:	TITLE: COMPREHENSIVE SUB SOIL PROFILE	PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.
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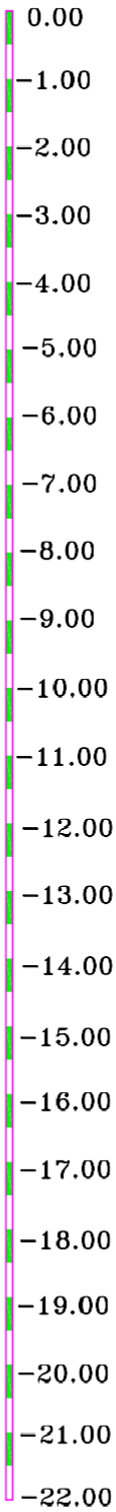
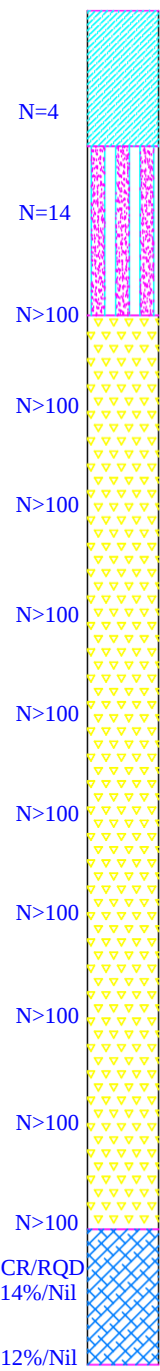
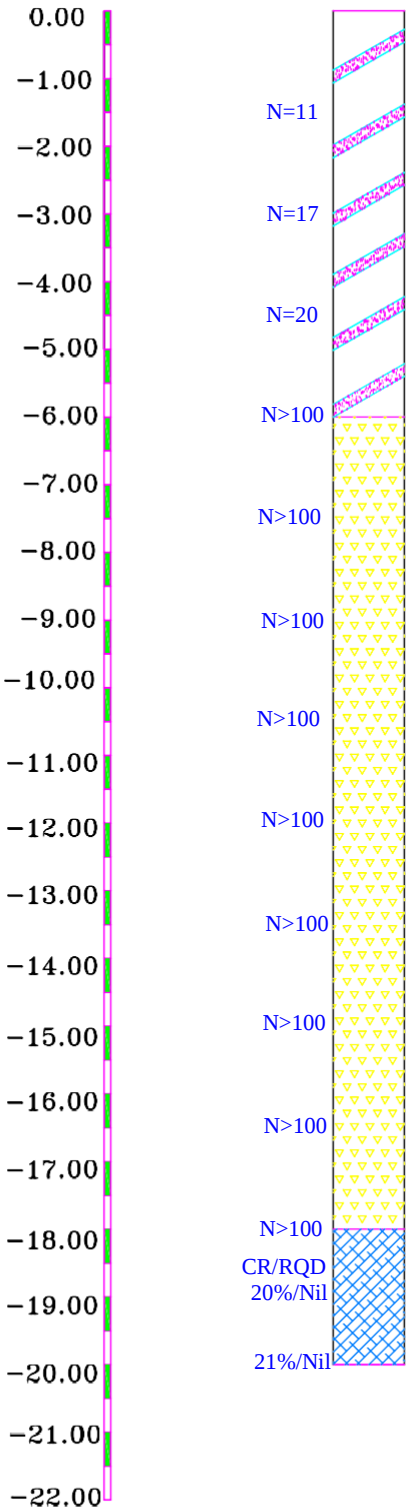
CH-15+700

Depth Below
EGL

BH-1

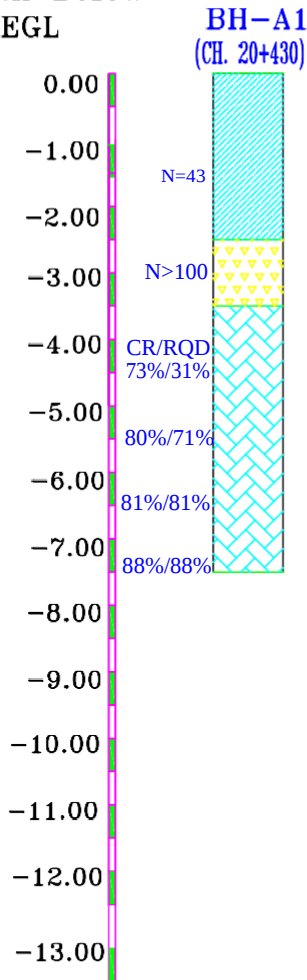
BH-2

Depth Below
EGL

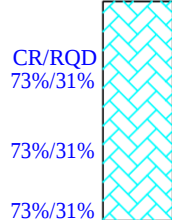


- LEGEND:
- BORE HOLES.
 - SILTY SAND.
 - CLAYEY SAND (SC).
 - SILTY CLAY (CI).
 - SOFT DISINTEGRATED ROCK.
 - HIGHLY WEATHER ROCK
- SCALE :- NOT TO SCALE.

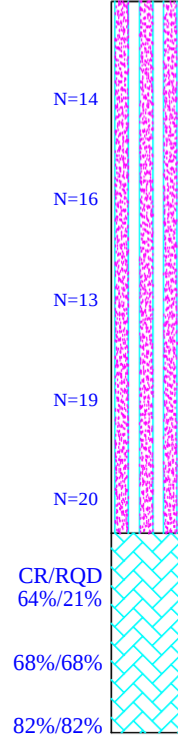
Depth Below
EGL



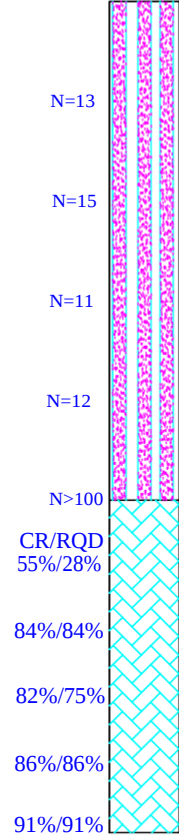
BH-P1
(CH. 20+515)



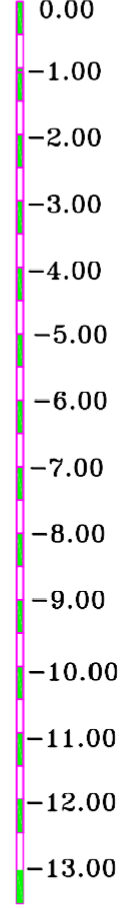
BH-P2
(CH. 20+610)



BH-A2
(CH. 20+740)



Depth Below
EGL



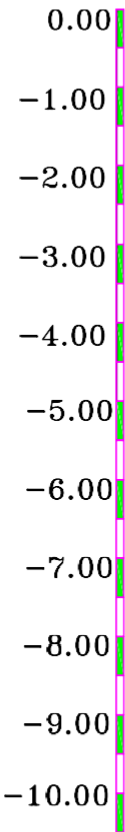
- LEGEND:**
- BORE HOLES.
 - SILTY CLAY(CL).
 - SILTY SAND(SM).
 - SOFT DISINTEGRATED ROCK.
 - HARD ROCK.

SCALE :- NOT TO SCALE.

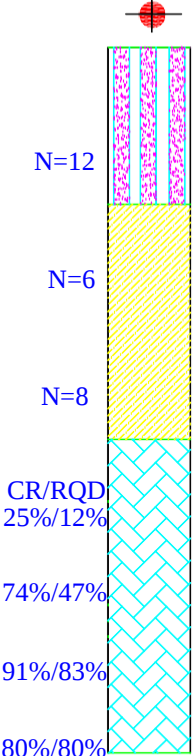
TITLE:
COMPREHENSIVE SUB SOIL PROFILE

PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED
CONSTRUCTION UPGRADATION TO 2/4 LANE NH-187 KALWAKURTHY IN
TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH
INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

Depth Below
EGL



BH-1
(CH. 20+965)



N=12

N=6

N=8

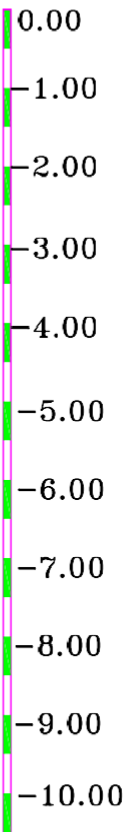
CR/RQD
25%/12%

74%/47%

91%/83%

80%/80%

Depth Below
EGL

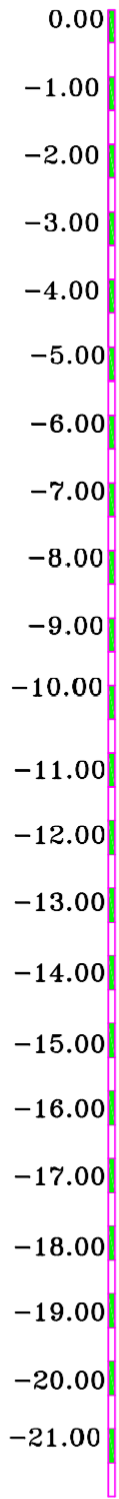


- LEGEND:
- BORE HOLES.
 - SILTY SAND.
 - SOFT DISINTEGRATED ROCK.
 - HARD ROCK.

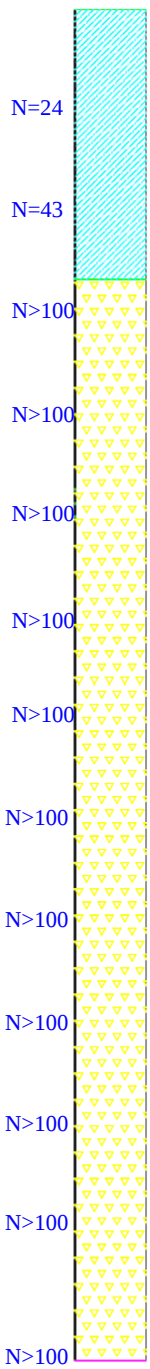
SCALE :- NOT TO SCALE.

CONSULTANTS:	CLIENT:	TITLE: COMPREHENSIVE SUB SOIL PROFILE	PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.
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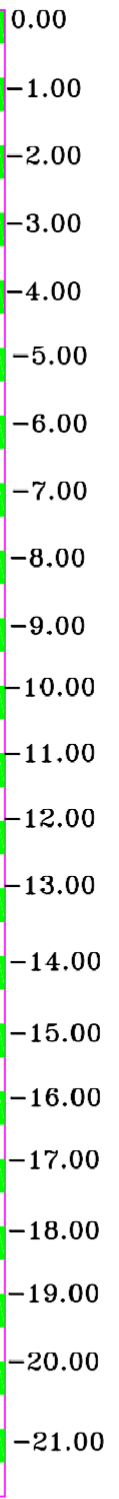
Depth Below
EGL



BH-1
(C.H. 22+715)



Depth Below
EGL



- LEGEND:
- BORE HOLES.
 - SILTY CLAY (CI).
 - SOFT DISINTEGRATED ROCK.
 - HIGHLY WEATHER ROCK

SCALE :- NOT TO SCALE.

TITLE:
COMPREHENSIVE SUB SOIL PROFILE

PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED
CONSTRUCTION UPGRADATION TO 2/4 LANE NH-187 KALWAKURTHY IN
TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH
INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

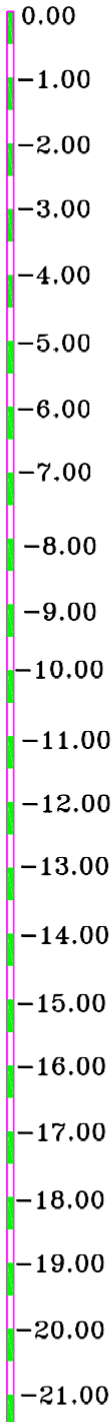
Depth Below
EGL



BH-1
(CH. 24+800)

N=28
N>100
N>100
N>100
N>100
N>100
N>100
N>100
N>100
N>100
N>100
N>100
N>100
N>100
N>100
N>100
N>100
N>100
N>100
N>100
N>100

Depth Below
EGL



- LEGEND:
- BORE HOLES.
 - SILTY CLAY(CL).
 - CLAYEY SAND (SC).
 - SOFT DISINTEGRATED ROCK.

SCALE :- NOT TO SCALE.

TITLE:	PROJECT:
COMPREHENSIVE SUB SOIL PROFILE	GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

CH-31+550

Depth Below
EGL

BH-1

BH-2

Depth Below
EGL

0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
-11.00
-12.00
-13.00
-14.00
-15.00
-16.00
-17.00
-18.00
-19.00
-20.00
-21.00
-22.00

N=7
N=10
N=14
N=43
N=48
N>100
N>100
N>100
N>100
CR/RQD
29%/25%
5%/Nil
9%/Nil
8%/Nil
5%/Nil
7%/Nil
9%/Nil

N=9
N=11
N=13
N=22
N=43
N>100
N>100
CR/RQD
5%/Nil
10%/Nil
8%/Nil
5%/Nil
11%/Nil
7%/Nil
5%/Nil
9%/Nil
19%/12%

0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
-11.00
-12.00
-13.00
-14.00
-15.00
-16.00
-17.00
-18.00
-19.00
-20.00
-21.00
-22.00

- LEGEND:
- BORE HOLES.
 - SILTY CLAY(CH).
 - SILTY SAND.
 - CLAYEY SAND (SC).
 - SILTY CLAY (CI).
 - SOFT DISINTEGRATED ROCK.
 - HIGHLY WEATHER ROCK
- SCALE :- NOT TO SCALE.

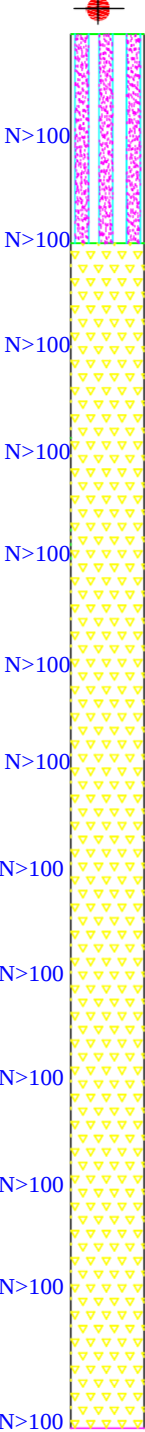
TITLE:
COMPREHENSIVE SUB SOIL PROFILE

PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED
CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN
TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH
INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

Depth Below
EGL

0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
-11.00
-12.00
-13.00
-14.00
-15.00
-16.00
-17.00
-18.00
-19.00
-20.00
-21.00

BH-1
(CH. 37+150)



Depth Below
EGL

0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
-11.00
-12.00
-13.00
-14.00
-15.00
-16.00
-17.00
-18.00
-19.00
-20.00
-21.00

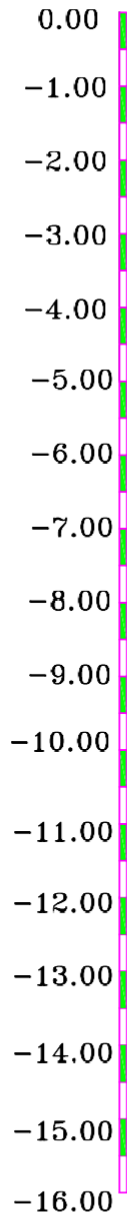
LEGEND:
 - BORE HOLES.
 - SILTY SAND.
 - SOFT DISINTEGRATED ROCK.

SCALE :- NOT TO SCALE.

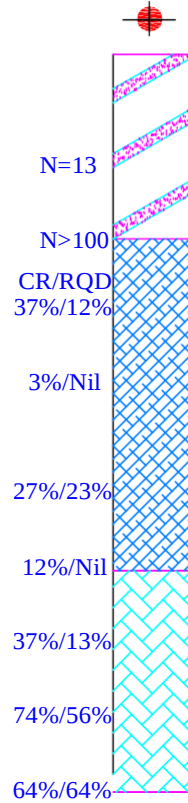
TITLE: COMPREHENSIVE SUB SOIL PROFILE	PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED
	CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

CH-37+550

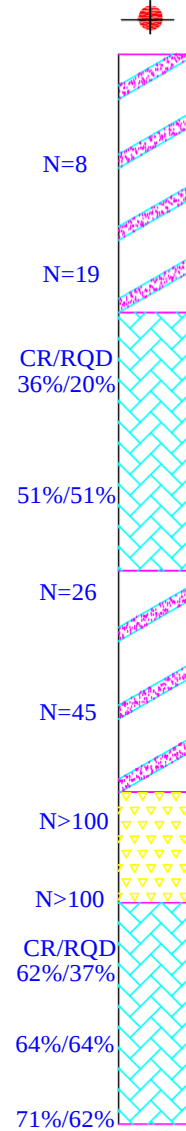
Depth Below
EGL



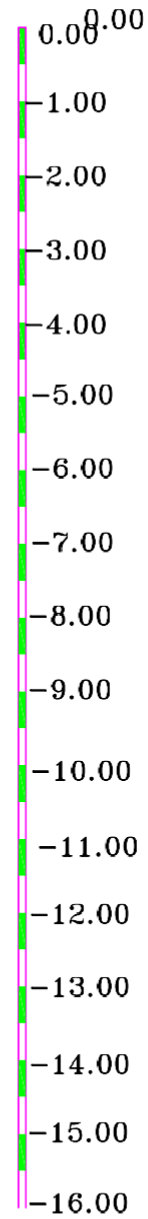
BH-1



BH-2



Depth Below
EGL



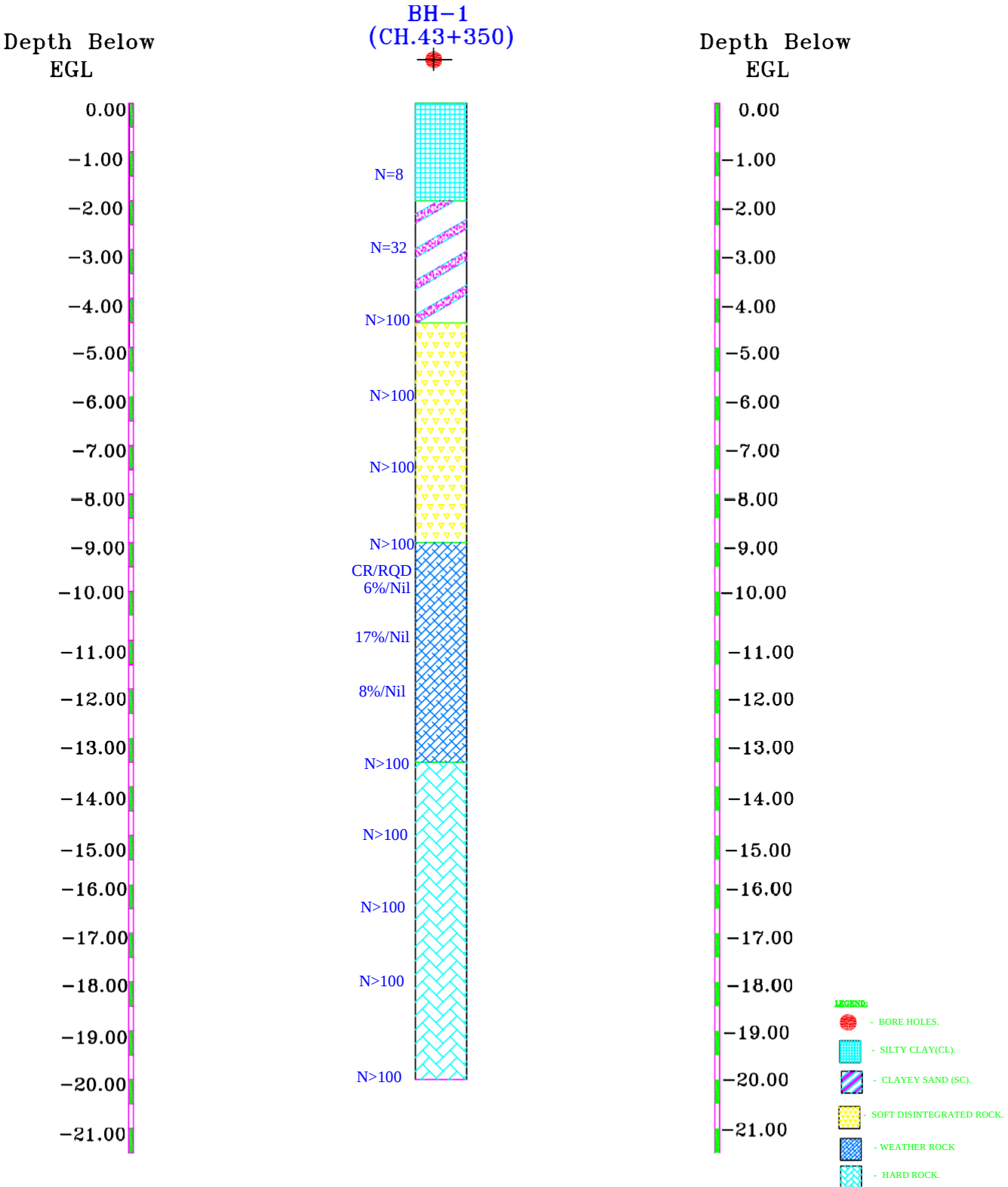
LEGEND:

- BORE HOLES.
- CLAYEY SAND (SC).
- SOFT DISINTEGRATED ROCK.
- HIGHLY WEATHER ROCK
- HARD ROCK.

SCALE :- NOT TO SCALE.

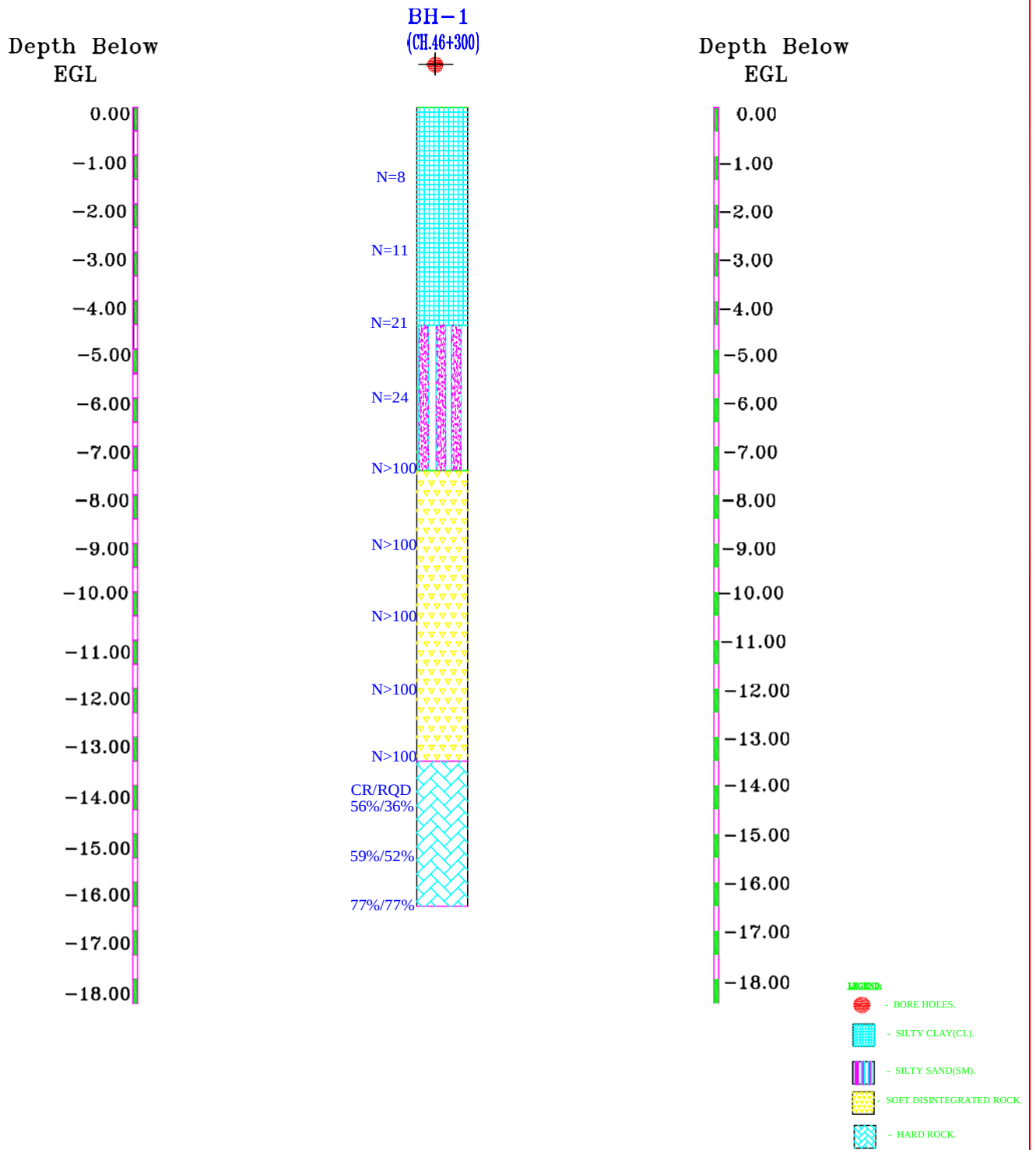
TITLE: COMPREHENSIVE SUB SOIL PROFILE

PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.



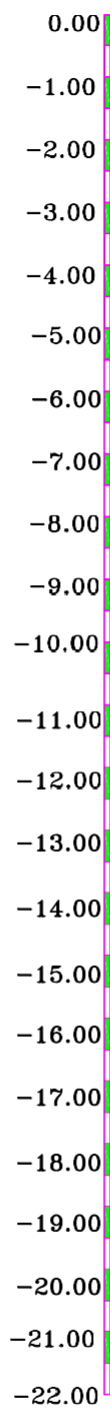
SCALE :- NOT TO SCALE.

TITLE:	PROJECT:
	COMPREHENSIVE SUB SOIL PROFILE
	GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.



SCALE :- NOT TO SCALE.

TITLE:	PROJECT:
COMPREHENSIVE SUB SOIL PROFILE	GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADEMENT TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

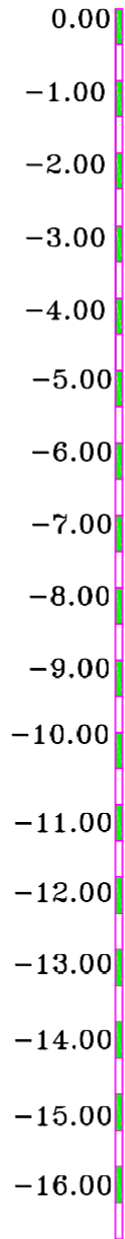


-  - BORE HOLES.
-  - CLAYEY SAND (SC).
-  - SILTY SAND(SM).
-  - SOFT DISINTEGRATED ROCK.

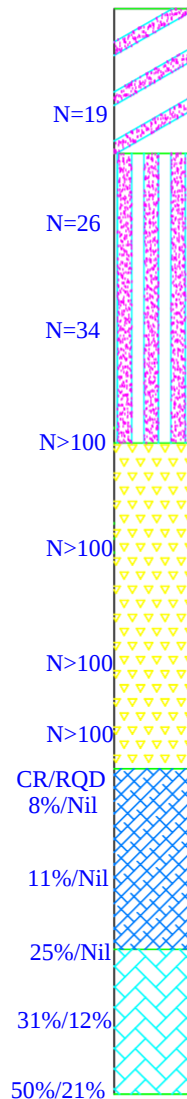
FILE: COMPREHENSIVE SUB SOIL PROFILE

PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED
CONSTRUCTION UPGRADEATION TO 2/4 LANE NH-167 KALWAKURTHY IN
TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH
INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

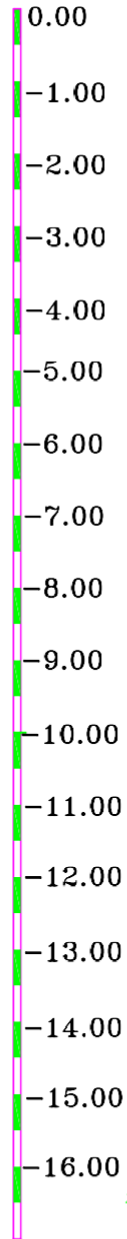
Depth Below
EGL



BH-1
(CH. 60+600)



Depth Below
EGL

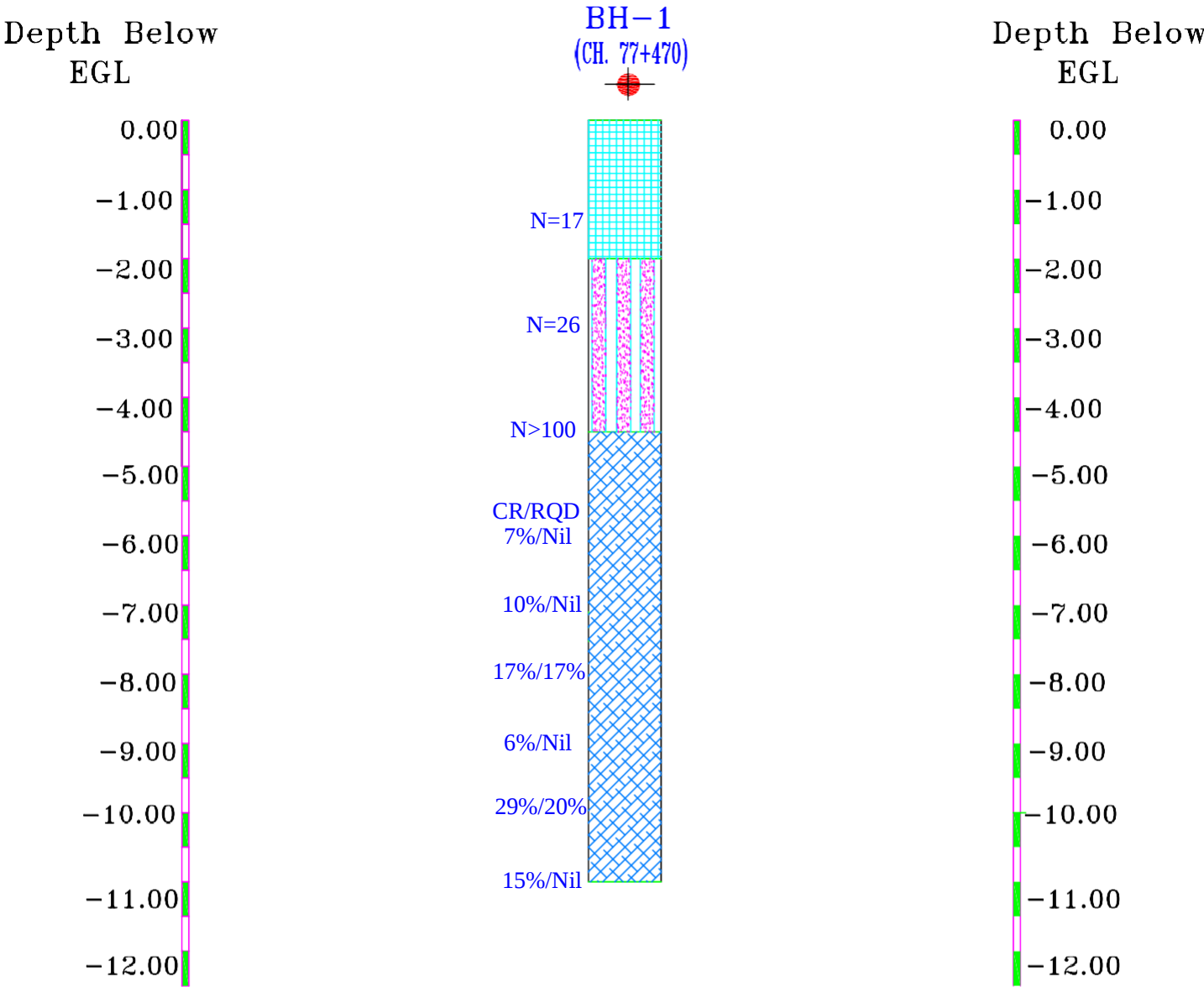


- LEGEND:
- BORE HOLES.
 - SILTY SAND(SM).
 - CLAYEY SAND (SC).
 - SOFT DISINTEGRATED ROCK.
 - WEATHER ROCK
 - HARD ROCK.

SCALE :- NOT TO SCALE.

TITLE:
COMPREHENSIVE SUB SOIL PROFILE

PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED
CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN
TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH
INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

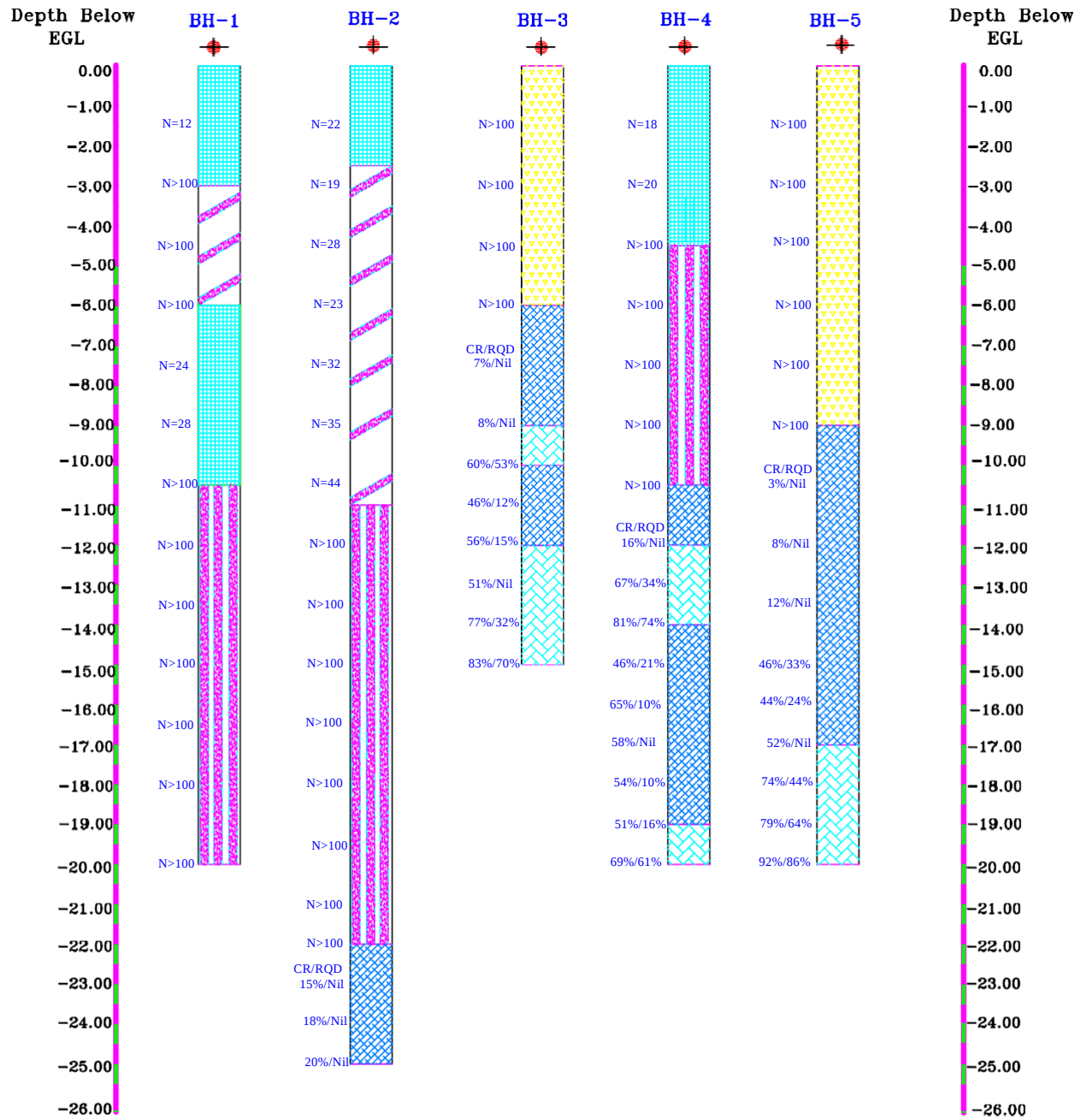


- LEGEND:
- BORE HOLES.
 - SILTY CLAY(CL).
 - SILTY SAND(SM).
 - WEATHER ROCK

SCALE :- NOT TO SCALE.

TITLE: COMPREHENSIVE SUB SOIL PROFILE	PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.
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CH.88+100



Note1: 1&2 TELANGANA SITE BORE HOLES.
Note2: 3,4&5 ANDHRA SITE BORE HOLES.

LEGEND:

-  - BORE HOLES.
-  - SILTY SAND (SM).
-  - CLAYEY SAND (SC).
-  - SILTY CLAY (CL).
-  - SOFT DISINTEGRATED ROCK.
-  - HIGHLY WEATHER ROCK
-  - HARD ROCK.

SCALE :- NOT TO SCALE.

TITLE:

COMPREHENSIVE SUB SOIL PROFILE

PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED
CONSTRUCTION UPGRADE/ADDITION TO 2/4 LANE NH-167 KALWAKURTHY IN
TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH
INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

Annexure – II

Field Bore Logs

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-1						
Boring Diameter : 150 mm									RL :						
Depth of GWT : 1.5m									Location/Chainage : 15+700 (MNB-3)						
Structure : RCC Structure									Date Commenced : 04.02.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 06.02.2022					Sheet 1 of 1	
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests		
	Depth (m)	Type	15	30	45	N									
1.00	1.50-1.95	SPT	3	5	6	11									
2.00															
3.00	3.00-3.45	SPT	4	7	10	17				Greyish clayey sand (SC)					
4.00															
5.00	4.50-4.95	SPT	6	8	12	20									
6.00															
6.00	6.00-6.25	SPT	30	50 blows for 10cm penetration						6.00		-6.00			
7.00	7.50-7.62	SPT	50 blows for 12cm penetration												
8.00															
9.00	9.00-9.10	SPT	50 blows for 10cm penetration												
10.00															
11.00	10.50-10.58	SPT	50 blows for 8cm penetration												
12.00															
13.00	12.00-12.07	SPT	50 blows for 7cm penetration												
14.00															
15.00	13.50-13.56	SPT	50 blows for 6cm penetration												
16.00															
17.00	15.00-15.09	SPT	50 blows for 9cm penetration												
18.00															
18.00	16.50-16.55	SPT	50 blows for 5cm penetration												
19.00															
20.00	18.00-18.03	SPT	50 blows for 3cm penetration						18.0		-18.00				
19.00															
20.00	18.00-19.00	Core					20%	Nil		Highly weathered rock					
20.00	19.00-20.00	Core					21%	Nil	20.00		-20.00				
										Borehole Terminated					
SPT : Standard Penetration Test										CR : Core Recovery					
UDS : Undistrubed Sample										RQD : Rock Quality Designation					
GWT : Ground Water Table										RP: Rate of Penetration					

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-A1						
Boring Diameter : 150 mm									RL :						
Depth of GWT : 1.8m									Location/Chainage : 20+430 (MJB-1)						
Structure : RCC Structure									Date Commenced : 26.01.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 28.01.2022					Sheet 1 of 1	
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests		
	Depth (m)	Type	15	30	45	N									
1.00	1.50-1.95	SPT	12	18	25	43			2.50	Greyish silty clay (CI)	-2.50				
2.00															
3.00	3.00-3.22	SPT	44	50 blows for 7cm penetration					Very dense moorum /Soft Disintegrated rock (SDR)	-3.50					
4.00	3.50-4.50	Core					73%	31%	Hard Rcock						
5.00	4.50-5.50	Core					80%	71%							
6.00	5.50-6.50	Core					81%	81%							
7.00	6.50-7.50	Core					88%	88%		7.50	-7.50				
8.00									Borehole Terminated						
9.00															
10.00															
11.00															
12.00															
13.00															
14.00															
15.00															
16.00															
17.00															
18.00															
SPT : Standard Penetration Test UDS : Undistrubed Sample GWT : Ground Water Table										CR : Core Recovery RQD : Rock Quality Designation RP: Rate of Penetration					

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna												
BOREHOLE RECORD														
Boring Method		: Rotary							Bore Hole No.		: BH-P1			
Boring Diameter		: 150 mm							RL		:			
Depth of GWT		: 0.5m							Location/Chainage		: 20+515 (MJB-1)			
Structure		: RCC Structure							Date Commenced		: 29.01.2022			
Boring Equipment		: Calyx / NX Drilling.							Date Completed		: 01.02.2022		Sheet 1 of 1	
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests	
	Depth (m)	Type	15	30	45	N								
1.00	0.30-1.30	Core					71%	63%	0.3	Soil	(0.30)			
2.00	1.30-2.30	Core					85%	76%		Hard Rock				
3.00	2.30-3.30	Core					50%	41%	3.30		-3.30			
4.00										Borehole Terminated				
5.00														
6.00														
7.00														
8.00														
9.00														
10.00														
11.00														
12.00														
13.00														
14.00														
15.00														
16.00														
17.00														
18.00														
SPT : Standard Penetration TestCR : Core Recovery														
UDS : Undisturbed SampleRQD : Rock Quality Designation														
GWT : Ground Water TableRP: Rate of Penetration														

Project Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD													
Boring Method : Rotary								Bore Hole No. : BH-P2					
Boring Diameter : 150 mm								RL :					
Depth of GWT : 1.7m								Location/Chainage : 20+610(MJB-1)					
Structure : RCC Structure								Date Commenced : 29.01.2022					
Boring Equipment : Calyx / NX Drilling.								Date Completed : 02.02.2022					
Sheet 1 of 1													
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests
	Depth (m)	Type	15	30	45	N							
1.00	1.50-1.95	SPT	5	6	8	14							
2.00													
3.00	3.00-3.45	SPT	4	7	9	16							
4.00													
5.00	4.50-4.95	SPT	5	6	7	13							
6.00													
7.00	6.00-6.45	SPT	7	9	10	19							
8.00													
9.00	7.50-7.95	SPT	6	8	12	20			8.0				
10.00													
11.00	8.00-9.00	Core					64%	21%		Hard Rock	-8.00		
	9.00-10.00	Core					68%	68%					
	10.00-11.00	Core					82%	82%	11.00				
12.00										Borehole Terminated			
13.00													
14.00													
15.00													
16.00													
17.00													
18.00													

SPT : Standard Penetration Test

UDS : Undisturbed Sample

GWT : Ground Water Table

CR : Core Recovery

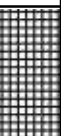
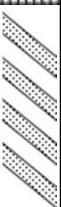
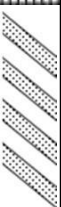
RQD : Rock Quality Designation

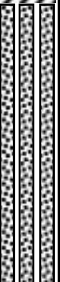
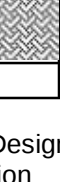
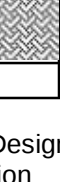
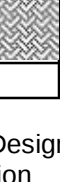
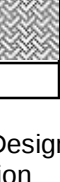
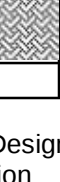
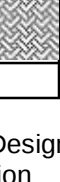
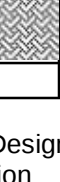
RP: Rate of Penetration

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna																		
BOREHOLE RECORD																				
Boring Method : Rotary									Bore Hole No. : BH-A2											
Boring Diameter : 150 mm									RL :											
Depth of GWT : 1.8m									Location/Chainage : 20+740(MJB-1)											
Structure : RCC Structure									Date Commenced : 26.01.2022											
Boring Equipment : Calyx / NX Drilling.									Date Completed : 28.01.2022											
Sheet 1 of 1																				
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests							
	Depth (m)	Type	15	30	45	N														
1.00	1.50-1.95	SPT	4	6	7	13			7.50	Fine to medium sand (SM)	-7.50									
2.00																				
3.00	3.00-3.45	SPT	6	6	9	15														
4.00																				
5.00	4.50-4.95	SPT	5	5	6	11														
6.00																				
7.00	6.00-6.45	SPT	5	6	6	12														
8.00																				
9.00	7.50-7.54	SPT	50 blows for 4cm penetration				55%	28%		Hard Rock	-12.50									
10.00	7.50-8.50	Core																		
11.00	8.50-9.50	Core																		
12.00	9.50-10.50	Core																		
13.00	10.50-11.50	Core																		
14.00	11.50-12.50	Core																		
15.00										Borehole Terminated										
16.00																				
17.00																				
18.00																				
SPT : Standard Penetration Test									CR : Core Recovery											
UDS : Undisturbed Sample									RQD : Rock Quality Designation											
GWT : Ground Water Table									RP: Rate of Penetration											

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna														
BOREHOLE RECORD																
Boring Method : Rotary									Bore Hole No. : BH-1							
Boring Diameter : 150 mm									RL :							
Depth of GWT : 2.6m									Location/Chainage : 20+965(MNB-4)							
Structure : RCC Structure									Date Commenced : 09.02.2022							
Boring Equipment : Calyx / NX Drilling.									Date Completed : 12.02.2022					Sheet 1 of 1		
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests			
	Depth (m)	Type	15	30	45	N										
1.00	1.50-1.95	SPT	4	6	6	12			2.00	Fine to medium sand (SM)	-2.00					
2.00										Greyish silty clay (CI)						
3.00	3.00-3.45	SPT	2	2	4	6										
4.00	4.50-4.95	SPT	2	3	5	8										
5.00	5.00-6.00	Core								9.00	Hard Rock			-5.00		
6.00							5.00-6.00	Core							25%	12%
7.00							6.00-7.00	Core							74%	47%
8.00							7.00-8.00	Core							91%	83%
9.00	8.00-9.00	Core					80%	80%							-9.00	
10.00									Borehole Terminated							
11.00																
12.00																
13.00																
14.00																
15.00																
16.00																
17.00																
18.00																
SPT : Standard Penetration Test UDS : Undisturbed Sample GWT : Ground Water Table													CR : Core Recovery RQD : Rock Quality Designation RP: Rate of Penetration			

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-1						
Boring Diameter : 150 mm									RL :						
Depth of GWT : 2.0m									Location/Chainage : 22+715(MNB-5)						
Structure : RCC Structure									Date Commenced : 06.02.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 09.02.2022					Sheet 1 of 1	
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests		
	Depth (m)	Type	15	30	45	N									
1.00	1.50-1.95	SPT	5	10	14	24			4.00	Reddish silty clay (CI)	-4.00				
2.00															
3.00	3.00-3.45	SPT	12	18	25	43									
4.00															
5.00	4.50-4.75	SPT	30	50 blows for 10cm penetration					Very dense moorum /Soft Disintegrated rock (SDR)						
6.00															
7.00	6.00-6.20	SPT	32	50 blows for 5cm penetration											
8.00															
9.00	7.50-7.62	SPT	50 blows for 12cm penetration												
10.00															
11.00	9.00-9.10	SPT	50 blows for 10cm penetration												
12.00															
13.00	10.50-10.58	SPT	50 blows for 8cm penetration												
14.00															
15.00	12.00-12.07	SPT	50 blows for 7cm penetration												
16.00															
17.00	13.50-13.55	SPT	50 blows for 5cm penetration												
18.00															
19.00	15.00-15.06	SPT	50 blows for 6cm penetration												
20.00															
21.00	16.50-16.53	SPT	50 blows for 4cm penetration												
22.00															
23.00	18.00-18.02	SPT	50 blows for 2cm penetration												
24.00															
25.00	20.00-20.01	SPT	50 blows for 1cm penetration												
26.00															
Borehole Terminated															
SPT : Standard Penetration Test										CR : Core Recovery					
UDS : Undisturbed Sample										RQD : Rock Quality Designation					
GWT : Ground Water Table										RP: Rate of Penetration					

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-1						
Boring Diameter : 150 mm									RL :						
Depth of GWT : 3.0m									Location/Chainage : 24+800 (MNB-6)						
Structure : RCC Structure									Date Commenced : 09.02.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 11.02.2022					Sheet 1 of 1	
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests		
	Depth (m)	Type	15	30	45	N									
1.00	1.50-1.95	SPT	10	13	15	28			2.00	Brownish silty clay (CL)	-2.00				
2.00															
3.00	3.00-3.43	SPT	20	35	50 blows for 13cm penetration										
4.00															
	4.50-4.73	SPT	26	50 blows for 8cm penetration					5.00	Reddish clayey sand (SC)	-5.00				
5.00															
6.00	6.00-6.13	SPT	50 blows for 13cm penetration												
7.00															
	7.50-7.61	SPT	50 blows for 11cm penetration												
8.00															
9.00	9.00-9.09	SPT	50 blows for 9cm penetration												
10.00															
	10.50-10.57	SPT	50 blows for 7cm penetration												
11.00															
12.00	12.00-12.08	SPT	50 blows for 8cm penetration												
13.00															
	13.50-13.60	SPT	50 blows for 10cm penetration												
14.00															
15.00	15.00-15.07	SPT	50 blows for 7cm penetration												
16.00															
	16.50-16.56	SPT	50 blows for 6cm penetration												
17.00															
18.00	18.00-18.04	SPT	50 blows for 4cm penetration												
19.00															
	20.00-20.2	SPT	50 blows for 2cm penetration						20.00	Very dense moorum /Soft Disintegrated rock (SDR)	-20.00				
										Borehole Terminated					
SPT : Standard Penetration Test									CR : Core Recovery						
UDS : Undistrubed Sample									RQD : Rock Quality Designation						
GWT : Ground Water Table									RP: Rate of Penetration						

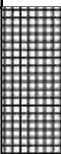
Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna											
BOREHOLE RECORD													
Boring Method : Rotary								Bore Hole No. : BH-1					
Boring Diameter : 150 mm								RL :					
Depth of GWT : 1.8m								Location/Chainage : 31+550 (MJB-2)					
Structure : RCC Structure								Date Commenced : 12.02.2022					
Boring Equipment : Calyx / NX Drilling.								Date Completed : 11.02.2022					
Sheet 1 of 1													
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests
	Depth (m)	Type	15	30	45	N							
1.00	1.50-1.95	SPT	3	3	4	7			3.00	Blackish silty clay (CH)	-3.00		
2.00													
3.00													
3.00	3.00-3.43	SPT	3	4	6	10			3.00				
4.00													
5.00													
4.00	4.50-4.95	SPT	4	7	7	14			7.00		-7.00		
5.00													
6.00													
6.00	6.00-6.45	SPT	10	20	23	43			7.00		-7.00		
7.00													
8.00													
7.00	7.50-7.95	SPT	14	20	28	48			9.00		-9.00		
8.00													
9.00													
9.00	9.00-9.10	SPT	50 blows for 10cm penetration						9.00		-9.00		
10.00													
11.00													
10.00	10.50-10.56	SPT	50 blows for 6cm penetration						13.00		-13.00		
11.00													
12.00													
12.00	12.00-12.04	SPT	50 blows for 4cm penetration						13.00		-13.00		
13.00													
14.00													
13.00	13.00-13.02	SPT	50 blows for 2cm penetration						13.00		-13.00		
14.00													
15.00													
14.00	13.00-14.00	Core					29%	25%					
15.00													
16.00													
15.00	14.00-15.00	Core					5%	Nil					
16.00													
17.00													
16.00	15.00-16.00	Core					9%	Nil					
17.00													
18.00													
17.00	16.00-17.00	Core					8%	Nil					
18.00													
19.00													
18.00	17.00-18.00	Core					5%	Nil					
19.00													
20.00													
19.00	18.00-19.00	Core					7%	Nil					
20.00													
20.00	19.00-20.00	Core					9%	Nil	20.00		-20.00		
										Borehole Terminated			
SPT : Standard Penetration Test										CR : Core Recovery			
UDS : Undisturbed Sample										RQD : Rock Quality Designation			
GWT : Ground Water Table										RP: Rate of Penetration			

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-2						
Boring Diameter : 150 mm									RL :						
Depth of GWT : 2.2m									Location/Chainage : 31+550(MJB-2)						
Structure : RCC Structure									Date Commenced : 13.02.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 15.02.2022					Sheet 1 of 1	
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests		
	Depth (m)	Type	15	30	45	N									
1.00	1.50-1.95	SPT	2	3	6	9			3.00	Blackish silty clay (CH)	-3.00				
2.00															
3.00	3.00-3.43	SPT	3	4	7	11									
4.00	4.50-4.95	SPT	4	5	8	13			6.5			Greyish silty clay (CI)		-6.50	
5.00															
6.00	6.00-6.45	SPT	8	10	12	22									
7.00	7.50-7.95	SPT	10	18	25	43			9.00			Greyish clayey sand (SC)		-9.00	
8.00															
9.00	9.00-9.27	SPT	30	50 blows for 12cm penetration											
10.00	10.50-10.60	SPT							11.0	Very dense moorum /Soft Disintegrated rock (SDR)				-11.00	
11.00															
12.00	11.00-12.00	Core					5%	Nil		Highly weathered rock					
13.00	12.00-13.00	Core					10%	Nil							
14.00	13.00-14.00	Core					8%	Nil							
15.00	14.00-15.00	Core					5%	Nil							
16.00	15.00-16.00	Core					11%	Nil							
17.00	16.00-17.00	Core					7%	Nil							
18.00	17.00-18.00	Core					5%	Nil							
19.00	18.00-19.00	Core					9%	Nil							
20.00	19.00-20.00	Core					19%	12%	20.00						-20.00
										Borehole Terminated					
SPT : Standard Penetration Test UDS : Undistrubed Sample GWT : Ground Water Table										CR : Core Recovery RQD : Rock Quality Designation RP: Rate of Penetration					

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-1						
Boring Diameter : 150 mm									RL :						
Depth of GWT : 1.5m									Location/Chainage : 37+150 (MNB-7)						
Structure : RCC Structure									Date Commenced : 15.02.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 17.02.2022					Sheet 1 of 1	
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests		
	Depth (m)	Type	15	30	45	N									
1.00	1.50-1.73	SPT	21	50 blows for 8cm penetration						Greyish silty sand (SM)					
2.00															
3.00	3.00-3.12	SPT	50 blows for 12cm penetration						3.00		-3.00				
4.00	4.50-4.60	SPT		50 blows for 10cm penetration											
5.00															
6.00	6.00-6.08	SPT	50 blows for 8cm penetration												
7.00	7.50-7.57	SPT		50 blows for 7cm penetration											
8.00															
9.00	9.00-9.06	SPT	50 blows for 6cm penetration												
10.00	10.50-10.59	SPT		50 blows for 9cm penetration											
11.00															
12.00	12.00-12.07	SPT	50 blows for 7cm penetration												
13.00	13.50-13.56	SPT		50 blows for 6cm penetration											
14.00															
15.00	15.00-15.05	SPT	50 blows for 5cm penetration												
16.00	16.50-16.53	SPT		50 blows for 3cm penetration											
17.00															
18.00	18.00-18.05	SPT	50 blows for 5cm penetration												
19.00															
	20.00-20.04	SPT	50 blows for 4cm penetration						20.00		-20.00				
										Borehole Terminated					
SPT : Standard Penetration Test UDS : Undistrubed Sample GWT : Ground Water Table									CR : Core Recovery RQD : Rock Quality Designation RP: Rate of Penetration						

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna											
BOREHOLE RECORD													
Boring Method : Rotary									Bore Hole No. : BH-1				
Boring Diameter : 150 mm									RL :				
Depth of GWT : 1.5m									Location/Chainage : 37+550(MNB-8)				
Structure : RCC Structure									Date Commenced : 19.02.2022				
Boring Equipment : Calyx / NX Drilling.									Date Completed : 21.02.2022				
Sheet 1 of 1													
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests
	Depth (m)	Type	15	30	45	N							
1.00	1.50-1.95	SPT	4	5	8	13			2.50	Greyish sandy clay (SC)	-2.50		
2.00													
3.00	2.50-2.64	SPT	50 blows for 14cm penetration							Weathered Rock	-7.00		
4.00	2.60-3.50	Core					37%	12%					
5.00	3.50-4.50	Core					3%	Nil					
6.00	4.50-6.00	Core					27%	23%					
7.00	6.00-7.00	Core					12%	Nil	7.00	Hard Rock	-10.00		
8.00	7.00-8.00	Core					37%	13%					
9.00	8.00-9.00	Core					74%	56%		Borehole Terminated			
10.00	9.00-10.00	Core					64%	64%	10.00				
11.00										Borehole Terminated			
12.00													
13.00													
14.00													
15.00													
16.00													
17.00													
18.00													
19.00													
20.00													
SPT : Standard Penetration Test UDS : Undisturbed Sample GWT : Ground Water Table													

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna											
BOREHOLE RECORD													
Boring Method : Rotary								Bore Hole No. : BH-2					
Boring Diameter : 150 mm								RL :					
Depth of GWT : 1.2m								Location/Chainage : 37+550(MNB-8)					
Structure : RCC Structure								Date Commenced : 17.02.2022					
Boring Equipment : Calyx / NX Drilling.								Date Completed : 20.02.2022					
Sheet 1 of 1													
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests
	Depth (m)	Type	15	30	45	N							
1.00	1.50-1.95	SPT	3	4	4	8			3.5	Greyish sandy clay (SC)	-3.50		
2.00													
3.00	3.00-3.45	SPT	7	9	10	19							
4.00	3.50-4.50	Core					36%	20%		Hard rock (Boulder)			
5.00													
6.00	4.50-6.00	Core					51%	51%					
7.00	7.50-7.95	SPT	10	12	14	26			7.00	Greyish sandy clay (SC)	-7.00		
8.00													
9.00	9.00-9.45	SPT	14	20	25	45							
10.00	10.50-10.75	SPT	38	50 blows for 10cm penetration					10.00	Very dense moorum /Soft Disintegrated rock (SDR)	-10.00		
11.00													
12.00	11.50-11.58	SPT	50 blows for 10cm penetration						11.5		-11.50		
13.00	11.50-12.50	Core					62%	37%		Hard Rock			
14.00	12.50-13.50	Core					64%	64%					
15.00	13.50-14.50	Core					71%	62%	14.50		-14.50		
16.00										Borehole Terminated			
17.00													
18.00													
19.00													
20.00													
SPT : Standard Penetration Test UDS : Undistrubed Sample GWT : Ground Water Table										CR : Core Recovery RQD : Rock Quality Designation RP: Rate of Penetration			

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna											
BOREHOLE RECORD													
Boring Method : Rotary									Bore Hole No. : BH-1				
Boring Diameter : 150 mm									RL :				
Depth of GWT : 1.6m									Location/Chainage : 43+350(MNB-11)				
Structure : RCC Structure									Date Commenced : 24.02.2022				
Boring Equipment : Calyx / NX Drilling.									Date Completed : 25.02.2022				
Sheet 1 of 1													
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests
	Depth (m)	Type	15	30	45	N							
1.00	1.50-1.95	SPT	3	4	4	8			2.00	Greyish silty clayeysand (CL)	-2.00		
2.00													
3.00	3.00-3.45	SPT	10	14	18	32				Clayey sand (SC)			
4.00	4.50-4.77	SPT	35	50 blows for 12cm penetration					4.50		-4.50		
5.00													
6.00	6.00-6.10	SPT	50 blows for 10cm penetration							Very dense moorum /Soft Disintegrated rock (SDR)	-9.00		
7.00	7.50-7.58	SPT	50 blows for 8cm penetration										
8.00	9.00-9.06	SPT	50 blows for 6cm penetration						9.00		-9.00		
9.00													
10.00	9.00-10.00	Core					6%	Nil		Weathered Rock	-13.5		
11.00	10.00-11.00	Core					17%	Nil					
12.00	11.00-12.00	Core					8%	Nil					
13.00	13.50-13.56	SPT	50 blows for 6cm penetration						13.5		-13.5		
14.00													
15.00	15.00-15.02	SPT	50 blows for 2cm penetration							Very dense moorum /Soft Disintegrated rock (SDR)	-20.0		
16.00	16.50-16.51	SPT	50 blows for 1cm penetration										
17.00	18.00-18.03	SPT	50 blows for 3cm penetration										
18.00	18.00-18.03	SPT	50 blows for 3cm penetration										
19.00	19.00-19.05	SPT	50 blows for 5cm penetration										
20.00	20.00-20.02	SPT	50 blows for 2cm penetration						20.00		-20.0		
										Borehole Terminated			
SPT : Standard Penetration Test													
CR : Core Recovery													
UDS : Undistrubed Sample													
RQD : Rock Quality Designation													
GWT : Ground Water Table													
RP: Rate of Penetration													

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD														
Boring Method : Rotary									Bore Hole No. : BH-1					
Boring Diameter : 150 mm									RL :					
Depth of GWT : 1.4m									Location/Chainage : 46+300(MNB-13)					
Structure : RCC Structure									Date Commenced : 21.02.2022					
Boring Equipment : Calyx / NX Drilling.									Date Completed : 23.02.2022					
Sheet 1 of 1														
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests	
	Depth (m)	Type	15	30	45	N								
1.00	1.50-1.95	SPT	2	3	5	8				Greyish silty clayeysand (CL)				
2.00														
3.00	3.00-3.45	SPT	4	5	6	11								
4.00														
5.00	4.50-4.95	SPT	6	9	12	21			4.50		-4.50			
6.00														
7.00	6.00-6.45	SPT	8	11	13	24				Fine to medium sand (SM)				
8.00														
10.00	7.50-7.77	SPT	30	50 blows for 12cm penetration						7.50		-7.50		
9.00														
11.00	9.00-9.10	SPT	50 blows for 10cm penetration							Very dense moorum /Soft Disintegrated rock (SDR)				
12.00														
13.00	10.50-10.58	SPT	50 blows for 8cm penetration											
14.00														
16.00	12.00-12.06	SPT	50 blows for 6cm penetration											
17.00														
18.00	13.50-13.55	SPT	50 blows for 5cm penetration						13.5		-13.5			
19.00														
21.00	13.50-14.50	Core					56%	36%	Hard Rock					
22.00	14.50-15.50	Core					59%	52%						
23.00	15.50-16.50	Core					77%	77%						
25.00									16.50	Borehole Terminated				
26.00														

SPT : Standard Penetration Test

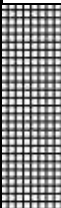
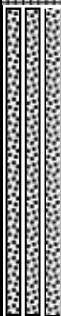
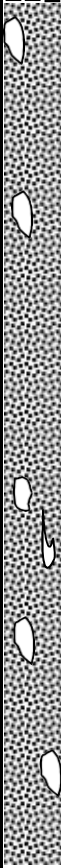
UDS : Undistrubed Sample

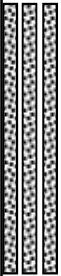
GWT : Ground Water Table

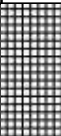
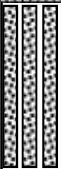
CR : Core Recovery

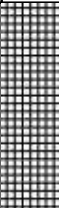
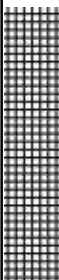
RQD : Rock Quality Designation

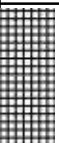
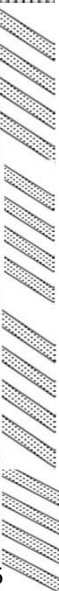
RP: Rate of Penetration

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna																
BOREHOLE RECORD																		
Boring Method : Rotary									Bore Hole No. : BH-1									
Boring Diameter : 150 mm									RL :									
Depth of GWT : 2.5m									Location/Chainage : 52+505(MNB-15)									
Structure : RCC Structure									Date Commenced : 26.02.2022									
Boring Equipment : Calyx / NX Drilling.									Date Completed : 01.03.2022									
Sheet 1 of 1																		
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests					
	Depth (m)	Type	15	30	45	N												
1.00	1.50-1.95	SPT	5	6	6	12			3.5	Greyish clayeysand (SC)	-3.50							
2.00																		
3.00	3.00-3.45	SPT	6	7	9	16												
4.00	4.50-4.95	SPT	10	14	20	34												
5.00																		
6.00	6.00-6.25	SPT	34	50 blows for 10cm penetration				6.5	Fine to medium sand with gravel (SM)	-6.50								
7.00	7.50-7.61	SPT	50 blows for 11cm penetration															
8.00	9.00-9.08	SPT	50 blows for 8cm penetration						Very dense moorum /Soft Disintegrated rock (SDR)									
9.00																		
10.00	10.50-10.56	SPT	50 blows for 6cm penetration															
11.00	12.00-12.07	SPT	50 blows for 7cm penetration															
12.00																		
13.00	13.50-13.54	SPT	50 blows for 4cm penetration															
14.00	15.00-15.03	SPT	50 blows for 3cm penetration															
15.00																		
16.00	16.50-16.55	SPT	50 blows for 5cm penetration															
17.00	18.00-18.04	SPT	50 blows for 4cm penetration															
18.00																		
19.00	20.00-20.02	SPT	50 blows for 2cm penetration															
20.00																		
			(Small core pieces)									Borehole Terminated						
SPT : Standard Penetration Test										CR : Core Recovery								
UDS : Undistrubed Sample										RQD : Rock Quality Designation								
GWT : Ground Water Table										RP: Rate of Penetration								

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-1						
Boring Diameter : 150 mm									RL :						
Depth of GWT : 2.2m									Location/Chainage : 60+600(MNB-18)						
Structure : RCC Structure									Date Commenced : 01.03.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 03.03.2022					Sheet 1 of 1	
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests		
	Depth (m)	Type	15	30	45	N									
1.00	1.50-1.95	SPT	7	9	10	19			2.00	Greyish clayey sand (SC)	0.00				
2.00															
3.00	3.00-3.45	SPT	10	11	15	26									
4.00	4.50-4.95	SPT	13	16	18	34									
5.00	6.00-6.27	SPT	35	50 blows for 12cm penetration					6.00	Fine to medium sand(SM)					
6.00															
7.00	7.50-7.60	SPT	50 blows for 10cm penetration												
8.00	9.00-9.08	SPT		50 blows for 8cm penetration					10.50		Very dense moorum /Soft Disintegrated rock (SDR)				
9.00															
10.00	10.00-10.06	SPT	50 blows for 6cm penetration												
11.00	10.00-11.00	Core					8%	Nil	13.00	Weathered Rock		-10.50			
12.00	11.00-12.00	Core					11%	Nil							
13.00	12.00-13.00	Core					25%	Nil							
14.00	13.00-14.00	Core					31%	21%							
15.00	14.00-15.00	Core					50%	21%	15.00	Hard Rock	-13.00				
16.00										Borehole Terminated					
17.00															
18.00															
SPT : Standard Penetration Test UDS : Undistrubed Sample GWT : Ground Water Table										CR : Core Recovery RQD : Rock Quality Designation RP: Rate of Penetration					

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-1						
Boring Diameter : 150 mm									RL :						
Depth of GWT : 1.5m									Location/Chainage : 77+470(MNB-33)						
Structure : RCC Structure									Date Commenced : 04.03.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 04.03.2022					Sheet 1 of 1	
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests		
	Depth (m)	Type	15	30	45	N									
1.00	1.50-1.95	SPT	5	8	9	17			2.00	Greyish silty clayeysand (CL)					
2.00										Fine to medium sand(SM)					
3.00	3.00-3.45	SPT	10	12	14	26	4.50	Weathered Rock	-4.50						
4.00	4.50-4.76	SPT	15	50 blc ws for 11cm penetration											
5.00	4.50-6.00	Core								7%	Nil				
6.00												6.00-7.00	Core		
7.00	7.00-8.00	Core					17%	17%	11.00		-11.00				
8.00	8.00-9.00	Core					6%	Nil							
9.00	9.00-10.00	Core					29%	20%							
10.00	10.00-11.00	Core					15%	Nil							
11.00	10.00-11.00	Core					15%	Nil	11.00						
12.00										Borehole Terminated					
13.00															
14.00															
15.00															
16.00															
17.00															
18.00															
18.00															
SPT : Standard Penetration Test UDS : Undisturbed Sample GWT : Ground Water Table									CR : Core Recovery RQD : Rock Quality Designation RP: Rate of Penetration						

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna												
BOREHOLE RECORD													
Boring Method : Rotary									Bore Hole No. : BH-1				
Boring Diameter : 150 mm									RL :319.385				
Depth of GWT : Not met									Location/Chainage : 88+100 (MJB-3) TS side				
Structure : RCC Structure									Date Commenced : 27.01.2022				
Boring Equipment : Calyx / NX Drilling.									Date Completed : 01.03.2022				
Sheet 1 of 1													
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests
	Depth (m)	Type	15	30	45	N							
1.00	1.50-1.95	SPT	4	6	6	12			3.00	Silty clay (CL)	316.385		
2.00													
3.00													
4.00	4.50-4.77	SPT	30	50 blows for 12cm penetration						6.00	313.385		
5.00													
6.00													
7.00	7.50-7.95	SPT	7	10	14	24			10.50	Silty clay with gravel (CL)	308.885		
8.00													
9.00													
10.00	10.50-10.76	SPT	45	50 blows for 11cm penetration						20.00	299.385		
11.00													
12.00													
13.00	13.50-13.77	SPT	48	50 blows for 12cm penetration									
14.00													
15.00													
16.00	15.00-15.38	SPT	38	45	50 blows for 8cm penetration								
17.00													
18.00													
19.00	16.50-16.86	SPT	15	30	50 blows for 6cm penetration								
20.00													
	18.00-18.22	SPT	18	50 blows for 7cm penetration									
	20.00-20.05	SPT	50 blows for 5cm penetration										
									Borehole Terminated				
SPT : Standard Penetration Test									CR : Core Recovery				
UDS : Undistrubed Sample									RQD : Rock Quality Designation				
GWT : Ground Water Table									RP: Rate of Penetration				

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-2						
Boring Diameter : 150 mm									RL :296.895						
Depth of GWT : 2.9m									Location/Chainage : 88+100(MJB-3) TS side						
Structure : RCC Structure									Date Commenced : 02.03.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 06.03.2022					Sheet 1 of 1	
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests		
	Depth (m)	Type	15	30	45	N									
1.00	1.50-1.95	SPT	6	9	13	22			2.50	Silty clay (CL)	294.395				
2.00															
3.00	3.00-3.45	SPT	5	8	11	19			11.00	Clayey sand with gravel (SC)					
4.00	4.50-4.95	SPT	9	12	16	28									
5.00	6.00-6.45	SPT	4	9	14	23									
6.00	7.50-7.95	SPT	11	14	18	32									
7.00	9.00-9.45	SPT	10	16	19	35									
8.00	10.50-10.95	SPT	14	20	24	44									
9.00	12.00-12.27	SPT	16	50 blows for 6cm penetration							285.895				
10.00	13.50-13.75	SPT	30	50 blows for 10cm penetration											
11.00	15.00-15.08	SPT	50 blows for 8cm penetration												
12.00	16.50-16.56	SPT	50 blows for 6cm penetration												
13.00															
14.00															
15.00	18.00-18.07	SPT	50 blows for 7cm penetration												
16.00															
17.00															
18.00															
SPT : Standard Penetration Test										CR : Core Recovery					
UDS : Undisturbed Sample										RQD : Rock Quality Designation					
GWT : Ground Water Table										RP: Rate of Penetration					

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-2						
Boring Diameter : 150 mm									RL :296.895						
Depth of GWT : 2.9m									Location/Chainage : 88+100(MJB-3) TS side						
Structure : RCC Structure									Date Commenced : 02.03.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 06.03.2022					Sheet 1 of 1	
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests		
	Depth (m)	Type	15	30	45	N									
19.00	19.50-19.55	SPT	50 blows for 5cm penetration						22.00	Very dense silty sand with gravel (SM)	274.895				
20.00															
21.00	21.00-21.03	SPT	50 blows for 3cm penetration												
22.00	22.00-22.02	SPT	50 blows for 2cm penetration												
23.00	22.00-23.00	Core					15%	Nil		Weathered Rock	271.895				
24.00	23.00-24.00	Core					18%	Nil							
25.00	24.00-25.00	Core					20%	Nil							
26.00										Borehole Terminated					
27.00															
28.00															
29.00															
30.00															
31.00															
32.00															
33.00															
34.00															
35.00															
36.00															
SPT : Standard Penetration Test UDS : Undisturbed Sample GWT : Ground Water Table									CR : Core Recovery RQD : Rock Quality Designation RP: Rate of Penetration						

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-3						
Boring Diameter : 150 mm									RL :288.828						
Depth of GWT : Not met									Location/Chainage : 88+100 (MJB-3) AP side						
Structure : RCC Structure									Date Commenced : 20.01.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 25.01.2022					Sheet 1 of 1	
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests		
	Depth (m)	Type	15	30	45	N									
1.00	1.50-1.77	SPT	35	50 blows for 12cm penetration											
2.00															
3.00	3.00-3.09	SPT	50 blows for 9cm penetration												
4.00															
5.00	4.50-4.58	SPT	50 blows for 8cm penetration												
6.00															
6.00	6.00-6.03	SPT	50 blows for 3cm penetration						6.00		282.828				
7.00															
8.00	6.00-7.50	Core					7%	Nil							
9.00															
10.00	7.50-9.00	Core					8%	Nil	9.00		279.828				
11.00															
12.00	9.00-10.00	Core					60%	53%							
13.00															
14.00	10.00-11.00	Core					46%	12%	10.0		278.828				
15.00															
16.00	11.00-12.00	Core					56%	15%							
17.00															
18.00	12.00-13.00	Core					51%	Nil	12.00		276.828				
19.00															
20.00	13.00-14.00	Core					77%	32%							
21.00															
22.00	14.00-15.00	Core					83%	70%	15.00		273.828				
23.00															
24.00										Borehole Terminated					
25.00															
26.00															
27.00															
28.00															
29.00															
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99.00															
100.00															
SPT : Standard Penetration Test UDS : Undistrubed Sample GWT : Ground Water Table										CR : Core Recovery RQD : Rock Quality Designation RP: Rate of Penetration					

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna											
BOREHOLE RECORD													
Boring Method : Rotary									Bore Hole No. : BH-5				
Boring Diameter : 150 mm									RL :254.594				
Depth of GWT : 3.8m									Location/Chainage : 88+100 (MJB-3) AP side				
Structure : RCC Structure									Date Commenced : 12.01.2022				
Boring Equipment : Calyx / NX Drilling.									Date Completed : 16.01.2022				
Sheet 1 of 1													
Depth (m)	Sample / In-situ Tests		SPT 'N' Value				CR	RQD	Depth (BGL) (m)	Description	RL (m)	Log	Remarks / Other Tests
	Depth (m)	Type	15	30	45	N							
1.00	1.50-1.58	SPT	50 blows for 8cm penetration										
2.00													
3.00	3.00-3.07	SPT	50 blows for 7cm penetration										
4.00													
5.00	4.50-4.55	SPT	50 blows for 5cm penetration										
6.00													
7.00	6.00-6.04	SPT	50 blows for 4cm penetration										
8.00													
9.00	7.50-7.53	SPT	50 blows for 3cm penetration										
10.00													
11.00	9.00-9.02	SPT	50 blows for 2cm penetration						9.00		245.594		
12.00													
13.00	9.50-10.50	Core	Small core piece				3%	Nil					
14.00													
15.00	10.50-12.00	Core	Small core piece				8%	Nil					
16.00													
17.00	12.00-13.50	Core					12%	Nil					
18.00													
19.00	13.50-15.00	Core					46%	33%					
20.00													
21.00	15.00-16.00	Core					44%	24%					
22.00													
23.00	16.00-17.00	Core					52%	Nil	17.0		237.594		
24.00													
25.00	17.00-18.00	Core					74%	44%					
26.00													
27.00	18.00-19.00	Core					79%	64%					
28.00													
29.00	19.00-20.00	Core					92%	86%	20.00		234.594		
30.00													
										Borehole Terminated			
SPT : Standard Penetration Test										CR : Core Recovery			
UDS : Undistrubed Sample										RQD : Rock Quality Designation			
GWT : Ground Water Table										RP: Rate of Penetration			

Annexure – III

Laboratory Test Results

Project: Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna																					
Laboratory Test Results																					
Structure / Location	Borehole	Depth (m)	SPT "N"	Type of sample	Soil Description	IS Classification	NMC (%)	Atterberg's Limits		Grain Size Distribution (%)				Specific gravity	Density (kN/m³)		Shear Test *			Rock Test	
										Gravel	Sand	Silt & Clay			Bulk	Dry	Test	C (kN/m²)	f'	UCS (Mpa)	Point load Index (MPa)
								w _L	w _p			M	C								
Test Methods					IS :1498		IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)				IS: 2720 (Part-3)	SP: 36 (Part -2)		IS: 2720 (Part-10)			IS: 9143	IS: 8764
MNB -1 (CH 10+300)	BH-1	1.5	33	SPT	Reddish fine to medium sand with gravel	SM	10.2			8	70	22			18.4	16.7	DS	7.6	34		
		3.0	>100	SPT				Non Plastic		7	74	19									
		13.0-14.0	-	Core	Weathered Rock		-														3.7
		19.0-20.0	-	Core			-														10.6
MNB 3 (CH 15+700)	BH-1	1.5	11	SPT	Clayey sand	SC				12	42	46									
		3.0	17	SPT				30	18	9	48	43									
		4.5	20	SPT			14.3			10	51	39		2.71	18.9	16.5	DS	11	36		
		18.0-19.0	-	Core	Weathered Rock		-														2.8
MNB 3 (CH)	BH-2	1.5	4	SPT	Brownish silty clay	CI		37	21	6	42	52									
		3.0	14	SPT	Fine to medium sand	SM	9.3	Non Plastic		11	65	24			17.8	16.3	DS	5	32		
MJB 1 (CH 20+430)	BH-A1	1.5	43	SPT	Greyish silty clay	CI				3	44	53									
		4.5-5.5	-	Core	Hard Rcock	-													38.5		
		6.5-7.5	-	Core		-													46.2		
MJB 1 (20+515)	BH-P1	1.3-2.3	-	Core	Hard Rock	-													37.4		
		2.3-3.3	-	Core		-													43.8		
MJB 1 (CH)	BH-P2	1.5	14	SPT	Fine to medium sand	SM	10.5			7	67	26									
		3.0	16	SPT				Non Plastic		5	71	24									
		4.5	13	SPT						4	69	27									

Project:		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna																			
Laboratory Test Results																					
Structure / Location	Borehole	Depth (m)	SPT "N"	Type of sample	Soil Description	IS Classification	NMC (%)	Atterberg's Limits		Grain Size Distribution (%)			Specific gravity	Density (kN/m³)		Shear Test *			Rock Test		
								w _L	w _P	Gravel	Sand	Silt & Clay		Bulk	Dry	Test	C (kN/m²)	f'	UCS (Mpa)	Point load Index (MPa)	
												M									C
Test Methods					IS :1498		IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)			IS: 2720 (Part-3)	SP: 36 (Part -2)		IS: 2720 (Part-10)			IS: 9143	IS: 8764	
MJB 1 (CH 20+610)	BH-P2	6.0	19	SPT	Fine to medium sand	SM	11.5	Non Plastic		8	72	20			18.4	16.5	DS	2	33		
		7.5	20	SPT						10	68	22									
		9.0-10.0	-	Core	Hard Rcok	-														47.3	
		10.0-11.0	-	Core		-														45.2	
MJB 1 (CH 20+740)	BH-A2	1.5	13	SPT	Fine to medium sand	SM	9.8			8	69	23									
		3.0	15	SPT				Non Plastic		10	71	19									
		4.5	11	SPT			10			9	70	21			18.1	16.4	DS	7	30		
		6.0	12	SPT						11	67	22									
		8.5-9.5	-	Core	Hard Rock	-														39.5	
		10.5-11.5	-	Core		-														46.0	
		11.5-12.5	-	Core		-														65.7	
MNB 4 (CH.20+965)	BH-1	1.5	12	SPT	Fine to medium sand	SM	9.3	Non Plastic		13	62	25		2.72							
		3.0	6	SPT	Greyish silty clay	CI				5	44	51									
		4.5	8	SPT				32	21	7	40	53									
		7.0-8.0	-	Core	Hard Rock	-														47.1	
		8.0-9.0	-	Core		-														56.3	
MNB 5 (22+715)	BH-1	1.5	24	SPT	Reddish silty clay	CI				8	38	54									
		3.0	43	SPT				28	17	6	36	58									

Project:			Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna																		
Laboratory Test Results																					
Structure / Location	Borehole	Depth (m)	SPT "N"	Type of sample	Soil Description	IS Classification	NMC (%)	Atterberg's Limits		Grain Size Distribution (%)			Specific gravity	Density (kN/m³)		Shear Test *			Rock Test		
								w _L	w _P	Gravel	Sand	Silt & Clay		Bulk	Dry	Test	C (kN/m²)	f'	UCS (Mpa)	Point load Index (MPa)	
												M									C
Test Methods					IS :1498		IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)			IS: 2720 (Part-3)	SP: 36 (Part -2)		IS: 2720 (Part-10)			IS: 9143	IS: 8764	
MNB 6 (24+800)	BH-1	1.5	28	SPT	Brownish silty clay	CL				1	33	66									
		3.0	>100	SPT	Reddish clayey sand	SC	10.7			7	48	45		18.9	17.1	DS	14	35			
MJB 2 (CH.31+550)	BH-1	1.5	7	SPT	Blackish silty clay	CH				5	17	78									
		3.0	10	SPT				56	33	3	21	76									
		4.5	14	SPT	Silty fine sand	SM	9.8			8	65	27		18.2	16.6	DS	9	30			
		6.0	43	SPT				Non Plastic		10	66	24									
		7.5	48	SPT	Greyish clayey sand	SC				8	45	47									
		13.0-14.0	-	Core	Weathered Rock	WR	-														2.4
MJB 2 (CH.31+550)	BH-2	1.5	9	SPT	Blackish silty clay	CH				2	25	73									
		3.0	11	SPT				51	35	1	28	71									
		4.5	13	SPT	Greyish silty clay	CI				5	45	50									
		6.0	22	SPT				31	22	8	43	49									
		7.5	43	SPT	Greyish clayey sand	SC	13.2			11	53	36		18.7	16.5	DS	18	34			
		19.0-20.0	-	Core	Highly weathered rock	WR	-														3.7
MNB 7 (37+150)	BH-1	1.5	>100	SPT	Greyish silty sand	SM	8.7			9	67	24									
		3.0	>100	SPT				Non Plastic		11	68	21									

Project:		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna																			
Laboratory Test Results																					
Structure / Location	Borehole	Depth (m)	SPT "N"	Type of sample	Soil Description	IS Classification	NMC (%)	Atterberg's Limits		Grain Size Distribution (%)			Specific gravity	Density (kN/m³)		Shear Test *			Rock Test		
								w _L	w _P	Gravel	Sand	Silt & Clay		Bulk	Dry	Test	C (kN/m²)	f _v	UCS (Mpa)	Point load Index (MPa)	
												M									C
Test Methods					IS :1498		IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)			IS: 2720 (Part-3)	SP: 36 (Part -2)		IS: 2720 (Part-10)			IS: 9143	IS: 8764	
MNB 8 (CH.37+550)	BH-1	1.5	13	SPT	Greyish sandy clay	SC	12.1			10	44	46									
		4.5-6.0	-	Core	Weathered Rock																
		8.0-9.0	-	Core	Hard Rock		-													42.5	
		9.0-10.0	-	Core			-													65.3	
MNB 8 (CH.37+550)	BH-2	1.5	8	SPT	Greyish sandy clay	SC				11	45	44									
		3.0	19	SPT			11.5			8	50	42			17.9	16.1	DS	25	31		
		7.5	26	SPT				31	20	12	49	39									
		9.0	45	SPT						10	50	40									
		4.5-6.0	-	Core	Hard rock	-													23.4		
		12.5-13.5	-	Core		-													32.8		
		13.5-14.5	-	Core		-													69.5		
MNB 11 (CH.43+350)	BH-1	1.5	8	SPT	Greyish silty clayeysand	CL				1	37	62									
		3.0	32	SPT				33	22	3	33	64									
		4.5	>100	SPT	Clayey sand	SC				9	45	46									
MNB 13 (CH.46+300)	BH-1	1.5	8	SPT	Greyish silty clayeysand	CL	12.5			1	34	65									
		3.0	11	SPT				32	20	3	30	67									
		4.5	21	SPT						2	29	69									
		6.0	24	SPT	Fine to medium sand	SM	11	Non Plastic		11	68	21			17.5	15.7	DS	6	32		

Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna																					
Laboratory Test Results																					
Structure / Location	Borehole	Depth (m)	SPT "N"	Type of sample	Soil Description	IS Classification	NMC (%)	Atterberg's Limits		Grain Size Distribution (%)			Specific gravity	Density (kN/m³)		Shear Test *			Rock Test		
								w _L	w _P	Gravel	Sand	Silt & Clay		Bulk	Dry	Test	C (kN/m²)	f'	UCS (Mpa)	Point load Index (MPa)	
Test Methods					IS :1498		IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)			IS: 2720 (Part-3)	SP: 36 (Part -2)		IS: 2720 (Part-10)			IS: 9143	IS: 8764	
MNB 13 (CH.46+300)	BH-1	14.5-15.5	-	Core	Hard Rock	-														36.2	
		15.5-16.5	-	Core		-														60.3	
MNB 15 (CH.52+505)	BH-1	1.5	12	SPT	Greyish clayeysand	SC				11	53	36									
		3.0	16	SPT	Fine to medium sand with gravel	SM	8.5			2	74	24									
		4.5	34	SPT				Non Plastic		1	77	22									
MNB 18 (CH.60+600)	BH-1	1.5	19	SPT	Greyish clayey sand	SC				8	45	47									
		3.0	26	SPT	Fine to medium sand	SM				9	70	21									
		4.5	34	SPT			9.7	Non Plastic		6	72	22		18.5	16.9	DS	11	34			
		13.0-14.0	-	Core	Hard Rock	-														30.5	
		14.0-15.0	-	Core		-														58.4	
MNB33 (CH.77+470)	BH-1	1.5	17	SPT	Greyish silty clayeysand	SC				11	53	36									
		3.0	26	SPT	Fine to medium sand	SM	8.6	Non Plastic		12	64	24		18.3	16.9	DS	8	32			
		9.0-10.0	-	Core	Weathered Rock	-															6.9
Note: SPT - Standard Penetration Test, NMC- Natural Moisture Content, WL- Liquid Limit, WP- Plastic limit, M- Silt, C- Clay, *- Direct shear test on remoulded samples																					

Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna																					
Laboratory Test Results																					
Structure / Location	Borehole	Depth (m)	SPT "N"	Type of sample	Soil Description	IS Classification	NMC (%)	Atterberg's Limits		Grain Size Distribution (%)			Specific gravity	Density (kN/m³)		Shear Test *			Rock Test		
								w _L	w _P	Gravel	Sand	Silt & Clay		Bulk	Dry	Test	C (kN/m²)	f'	UCS (Mpa)	Point load Index (MPa)	
												M									C
Test Methods					IS :1498		IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)			IS: 2720 (Part-3)	SP: 36 (Part -2)		IS: 2720 (Part-10)			IS: 9143	IS: 8764	
MJB 3 (CH.88+100)	BH-1	1.5	12	SPT	Silty clay	CL		34	19	3	28	69	2.69								
		3.0	>100	SPT	Clayey sand	SC				9	48	43									
		7.5	24	SPT	Silty clay with gravel	CL	8.7			1	35	64									
		9.0	28	SPT				31	20	2	30	68									
MJB 3 (CH.88+100)	BH-2	1.5	22	SPT	Silty clay	CL				4	26	70									
		3.0	19	SPT	Clayey sand with gravel	SC	10.1			10	47	43		18.1	16.4	DS	16	32			
		4.5	28	SPT				28	17	7	51	42									
		6.0	23	SPT						12	48	40									
		7.5	32	SPT			10.8			9	52	39									
		9.0	35	SPT				26	15	13	50	37		18.1	16.3	DS	10	34			
		10.5	44	SPT						11	53	36									
MJB 3 (CH.88+100)	BH-3	9.0-10.0	-	Core	Hard Rock		-												32.9		
		13.0-14.0	-	Core			-												47.6		
		14.0-15.0	-	Core			-												70.5		
MJB 3 (CH.88+100)	BH-4	1.5	18	SPT	Silty clay	CL	10.6			1	30	69									
		3.0	20	SPT			34	20	2	27	71										
		12.0-13.0	-	Core	Hard Rock	-												37.5			
		13.0-14.0	-	Core		-												39.3			

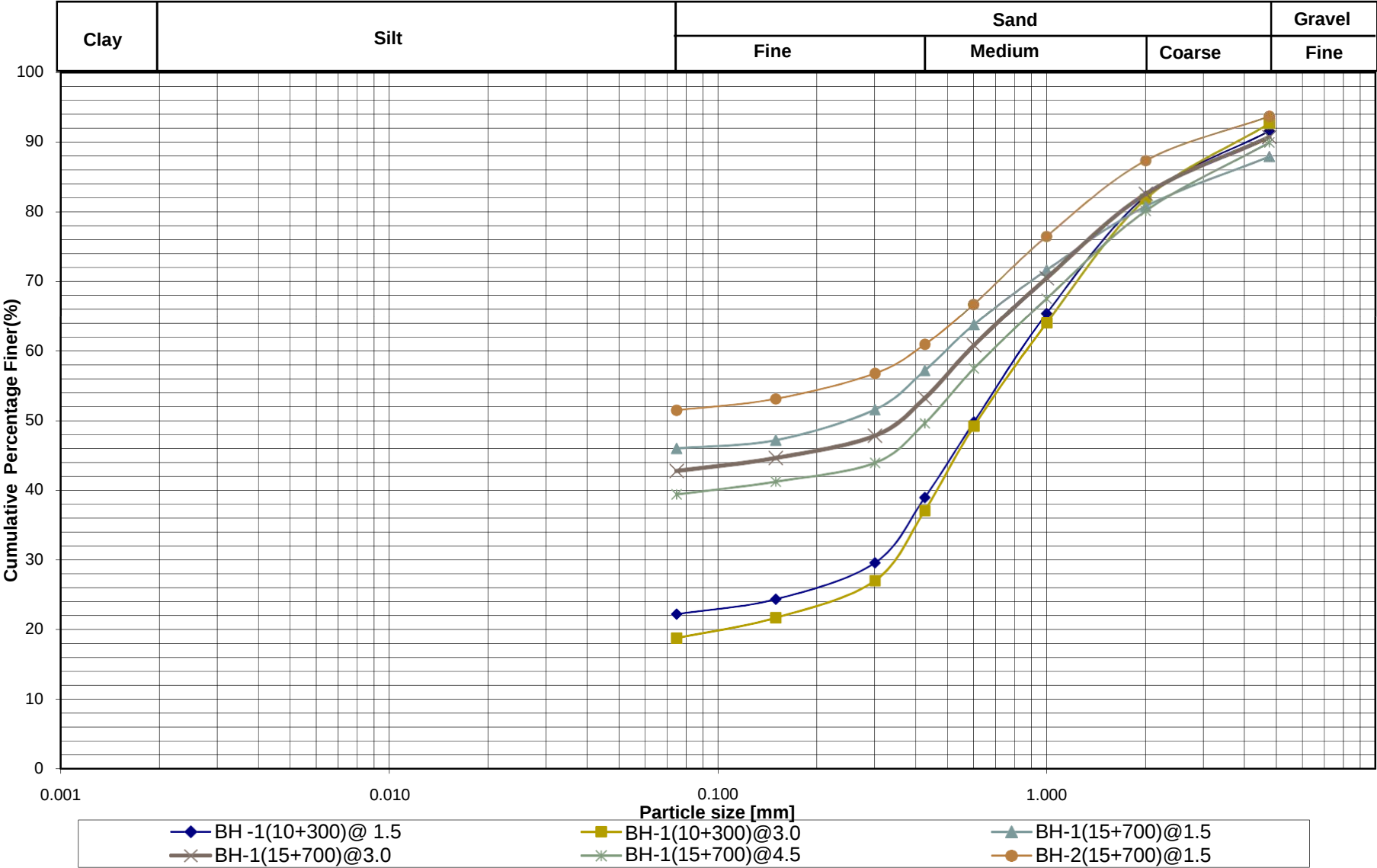
Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna																					
Laboratory Test Results																					
Structure / Location	Borehole	Depth (m)	SPT "N"	Type of sample	Soil Description	IS Classification	NMC (%)	Atterberg's Limits		Grain Size Distribution (%)			Specific gravity	Density (kN/m³)		Shear Test *			Rock Test		
								w _L	w _P	Gravel	Sand	Silt & Clay		Bulk	Dry	Test	C (kN/m²)	f'	UCS (Mpa)	Point load Index (MPa)	
												M									C
Test Methods					IS :1498		IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)			IS: 2720 (Part-3)	SP: 36 (Part -2)		IS: 2720 (Part-10)			IS: 9143	IS: 8764	
MJB 3 (CH.88+100)	BH-5	17.0-18.0	-	Core	Hard Rock	-											65.8				
		18.0-19.0	-	Core		-											77.5				
		19.0-20.0	-	Core		-											98.2				
Note:		SPT - Standard Penetration Test, NMC- Natural Moisture Content, WL- Liquid Limit, WP- Plastic limit, M- Silt, C- Clay, *- Direct shear test on remoulded samples																			

GRAINSIZE ANALYSIS

Project

Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in
Telangana and connecting with NH-40 near Nabbayal in Andhra Pradesh. Including
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Grain Size Distribution Curves

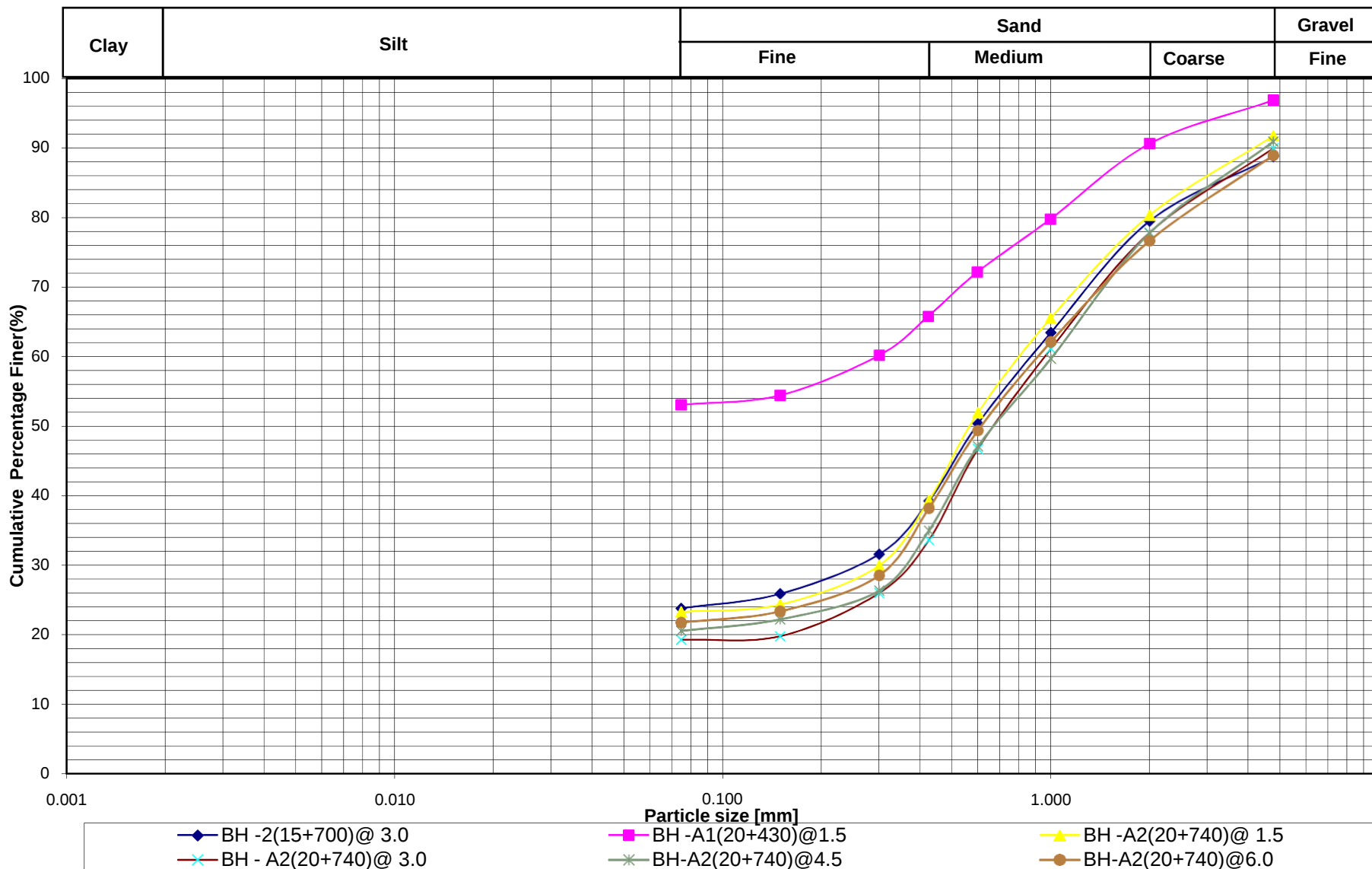


GRAINSIZE ANALYSIS

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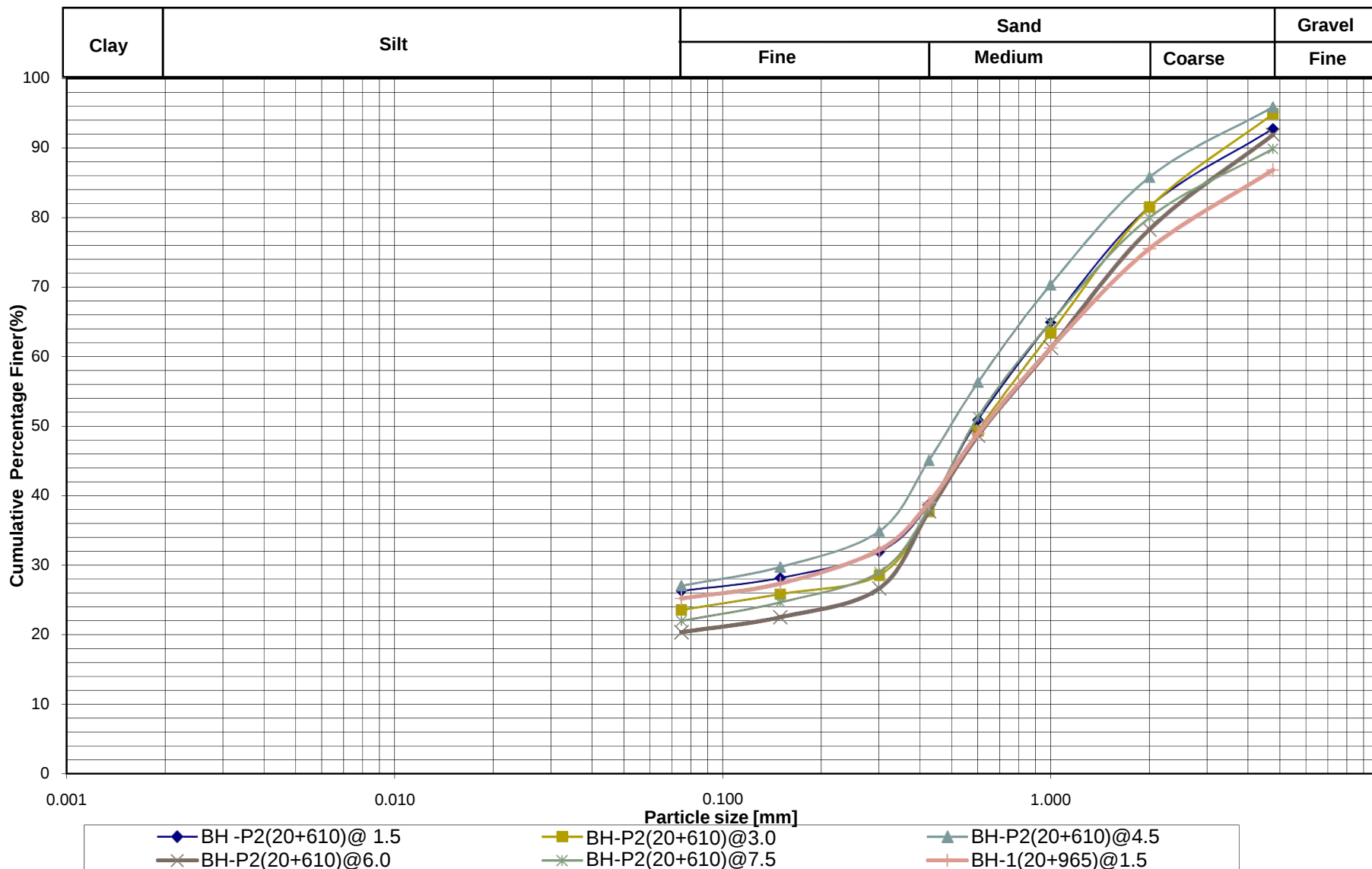


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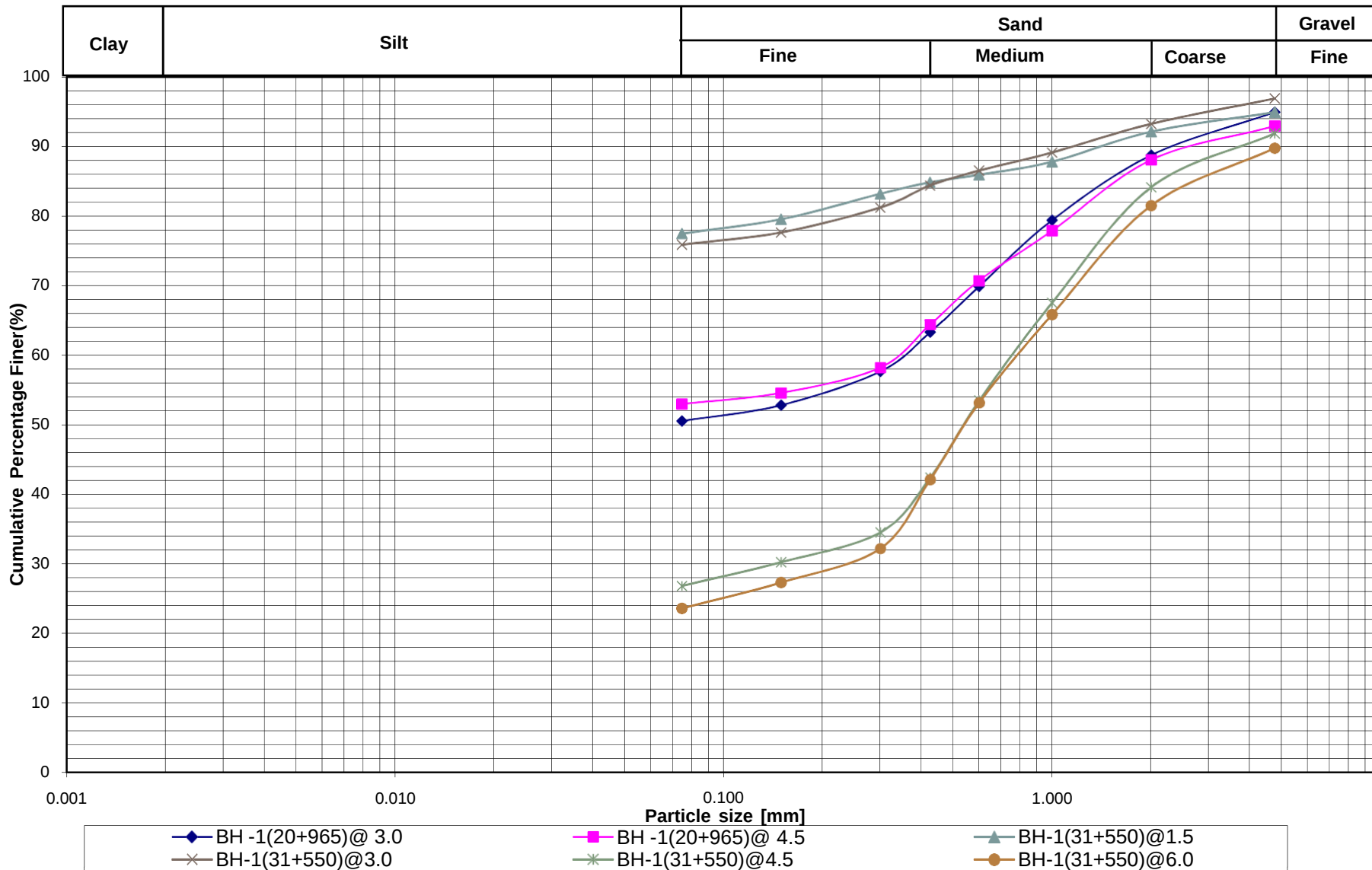
Grain Size Distribution Curves



GRAINSIZE ANALYSIS

Project
Telangana and connecting with NH-40 near Nabbdyal in Andhra Pradesh. Including
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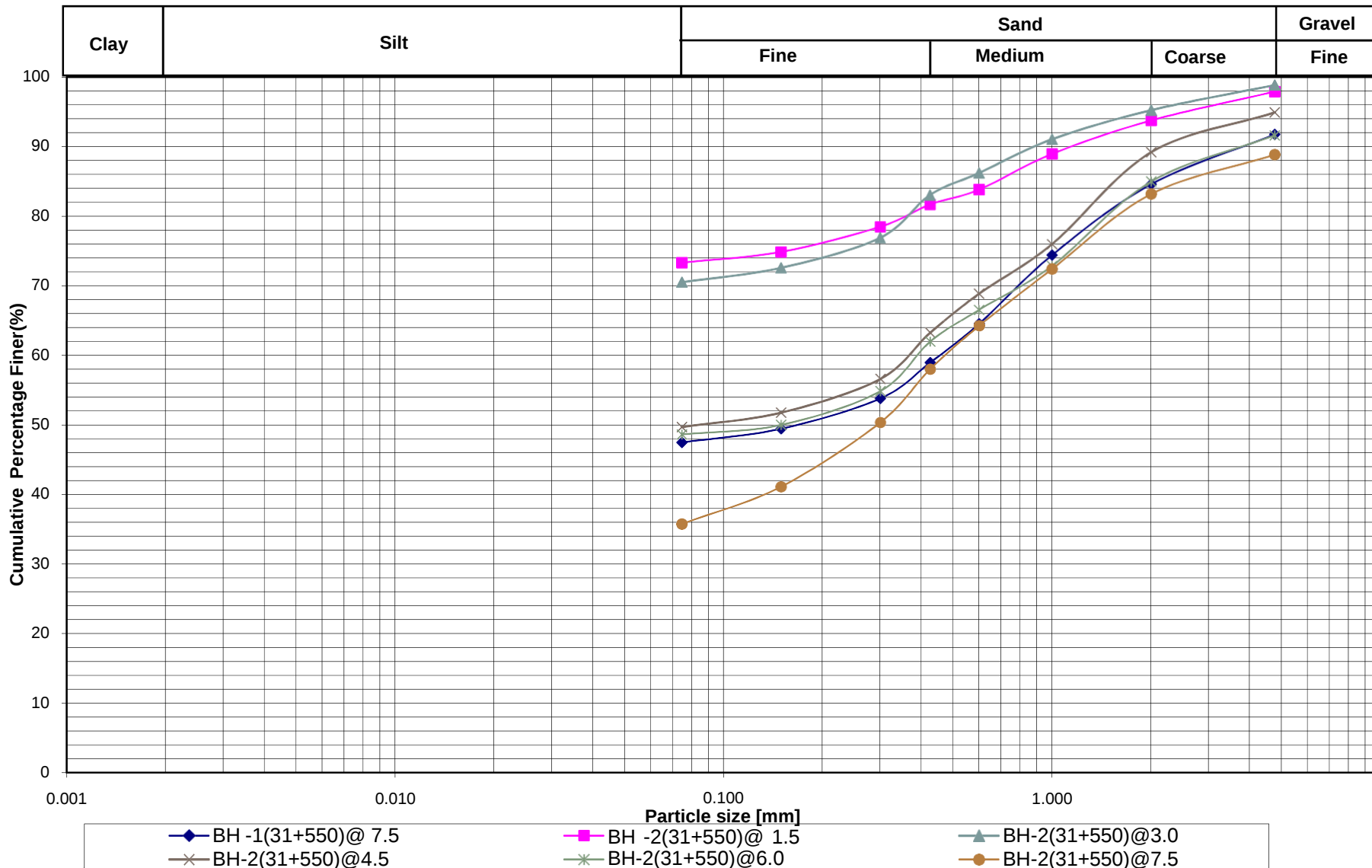


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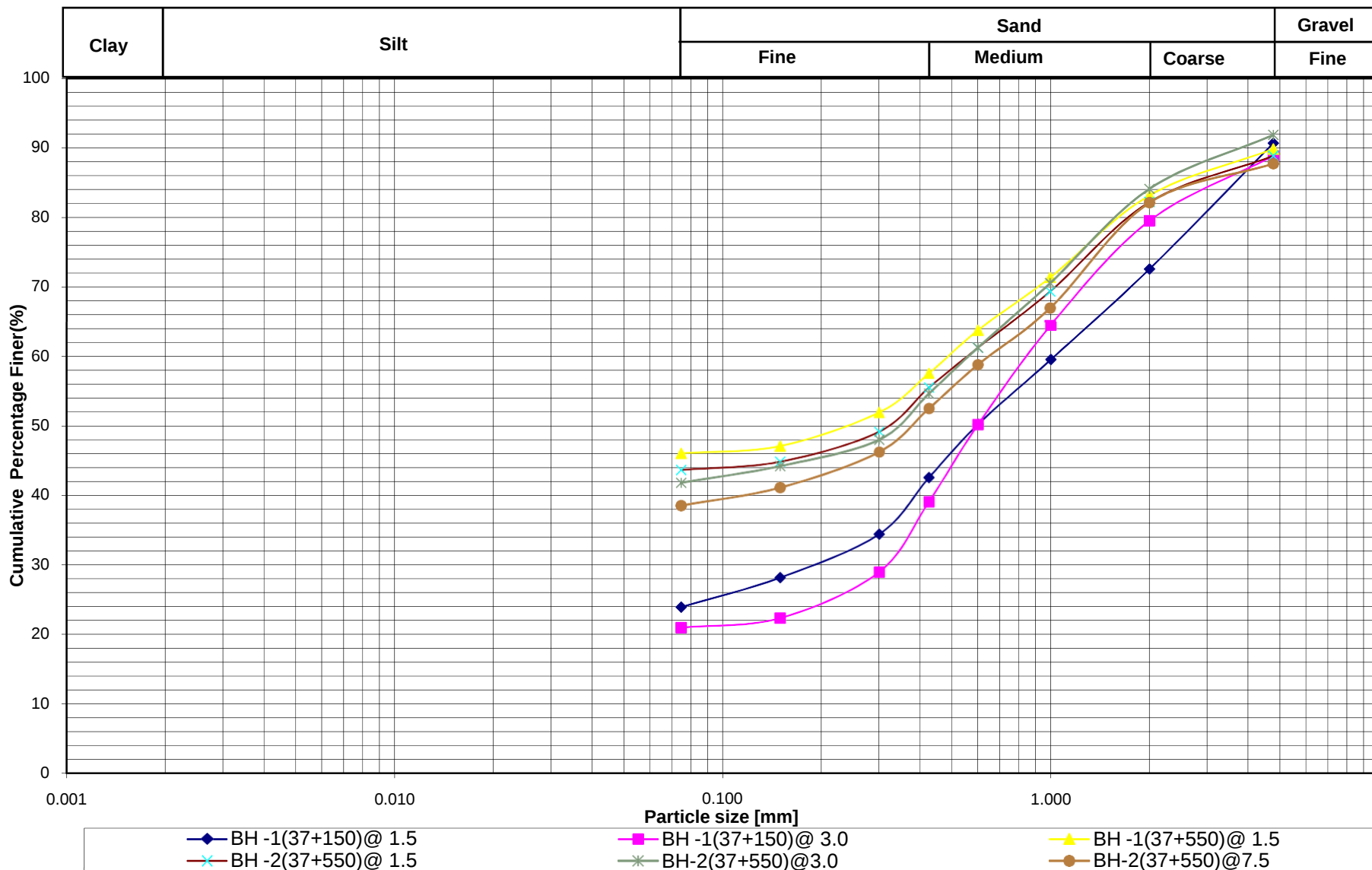


GRAINSIZE ANALYSIS

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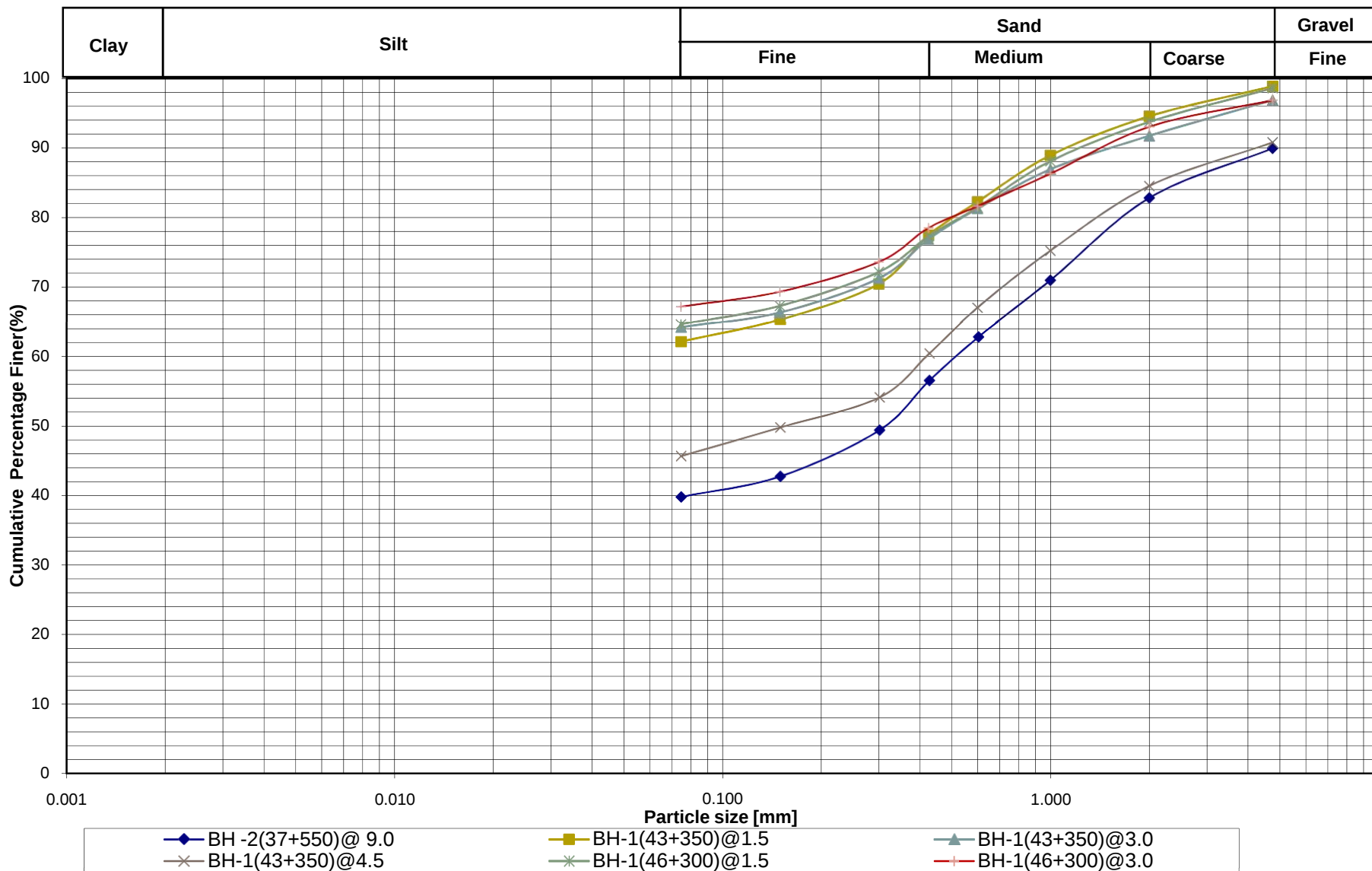


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Grain Size Distribution Curves

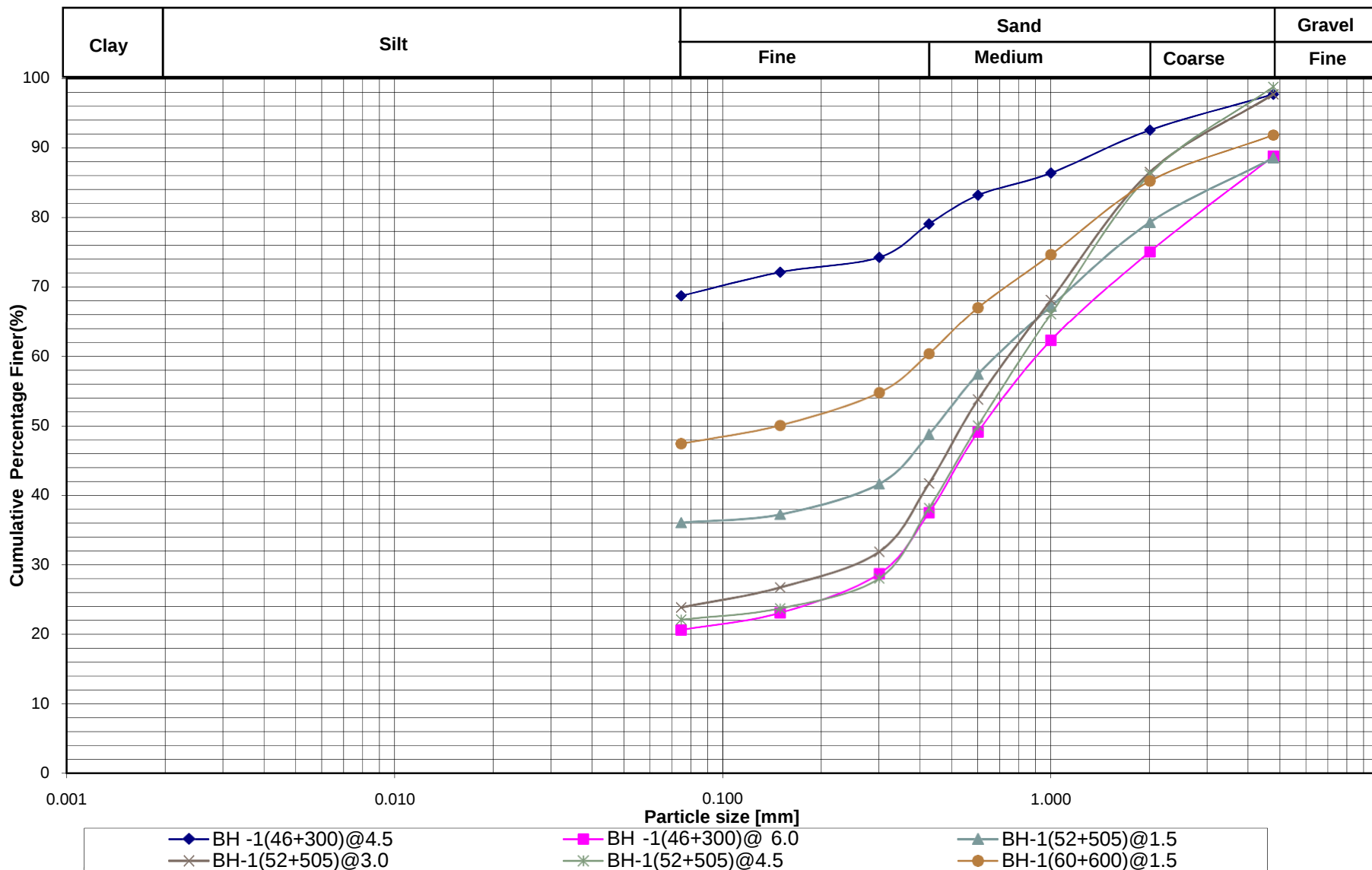


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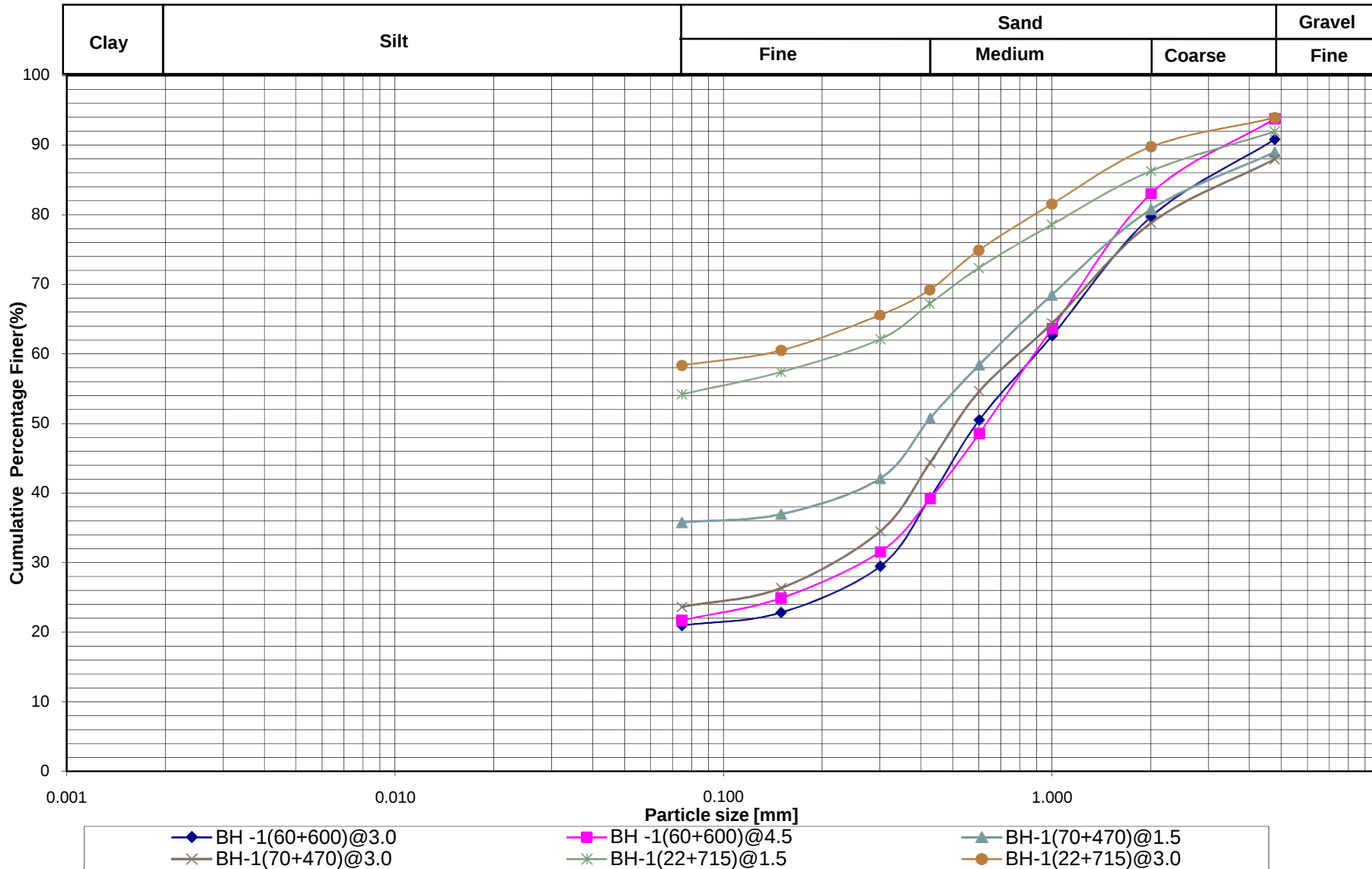


GRAINSIZE ANALYSIS

Project

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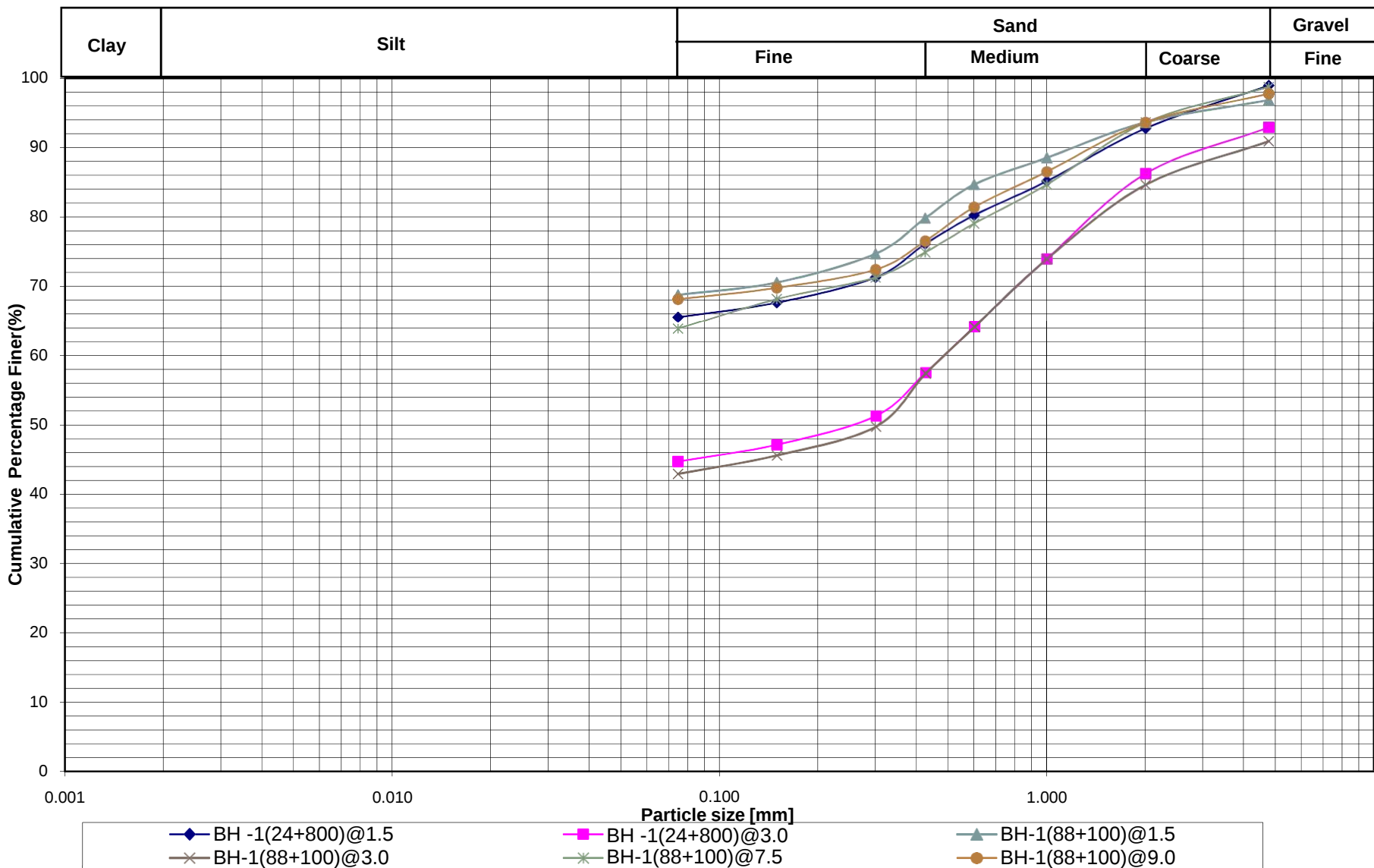
Grain Size Distribution Curves



GRAINSIZE ANALYSIS

Project
 Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in
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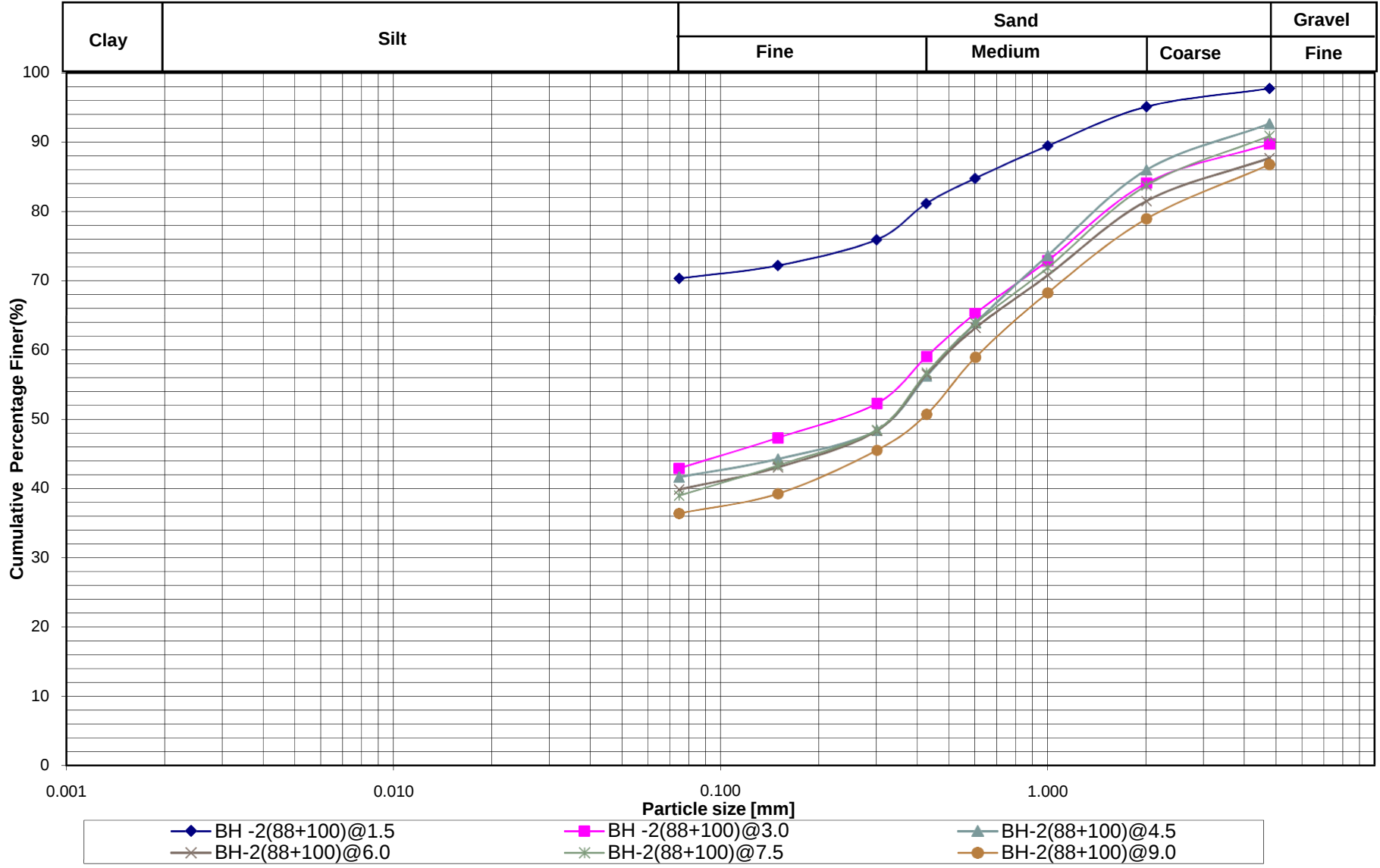
Grain Size Distribution Curves



GRAINSIZE ANALYSIS

Project
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Grain Size Distribution Curves

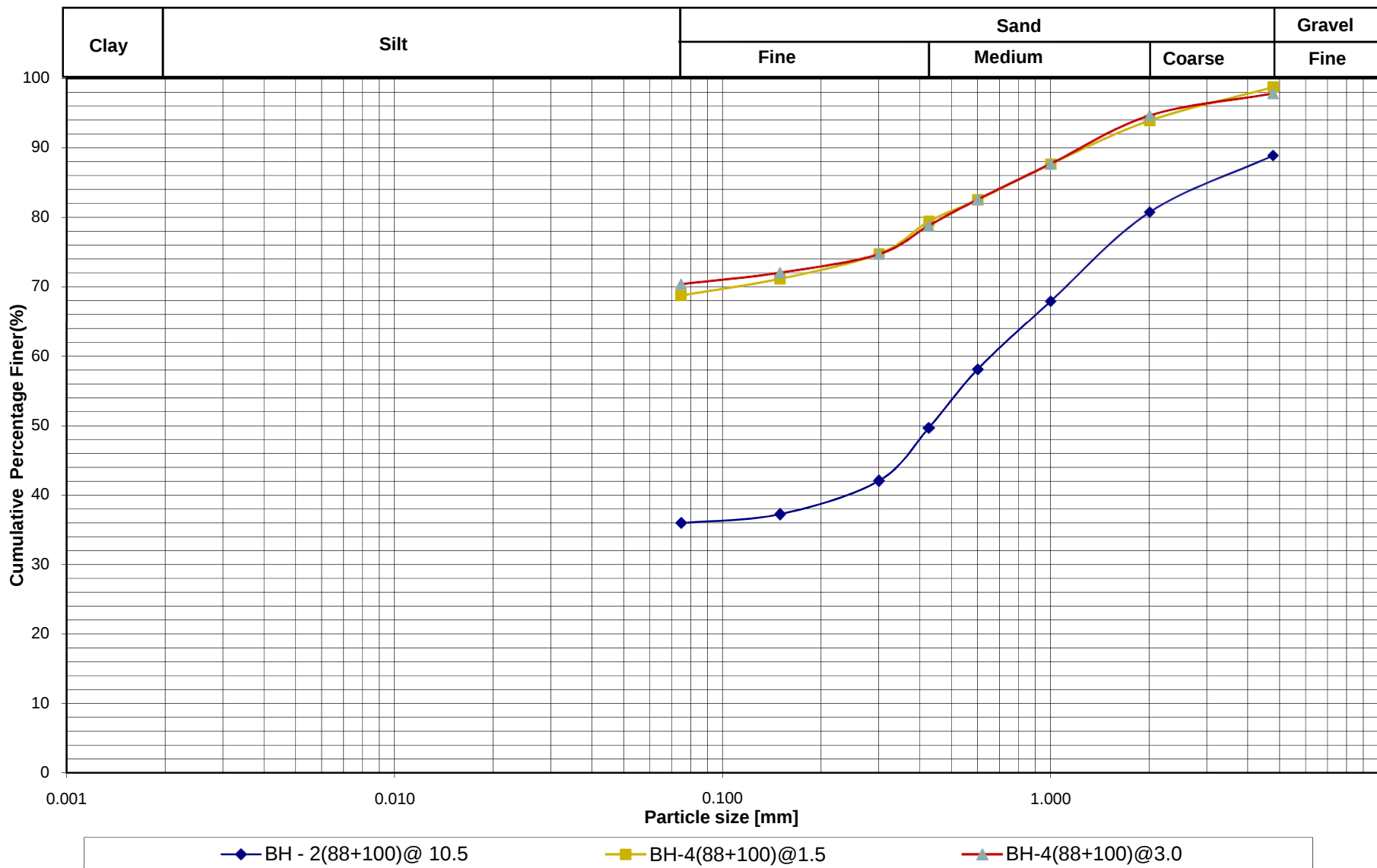


GRAINSIZE ANALYSIS

Project

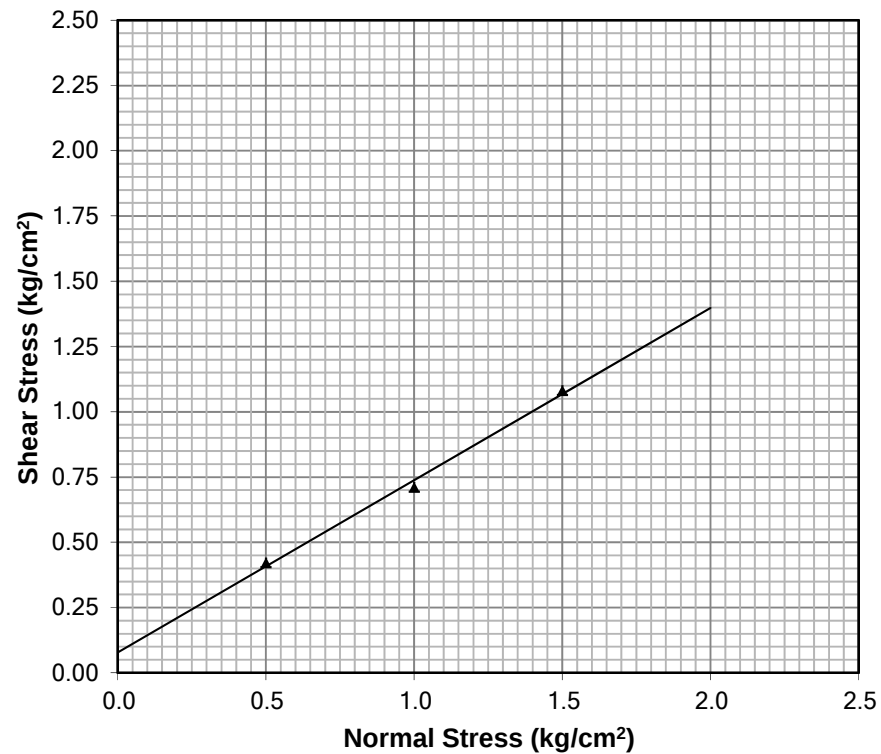
Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in
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four lane Major Bridge across river Krishna

Grain Size Distribution Curves



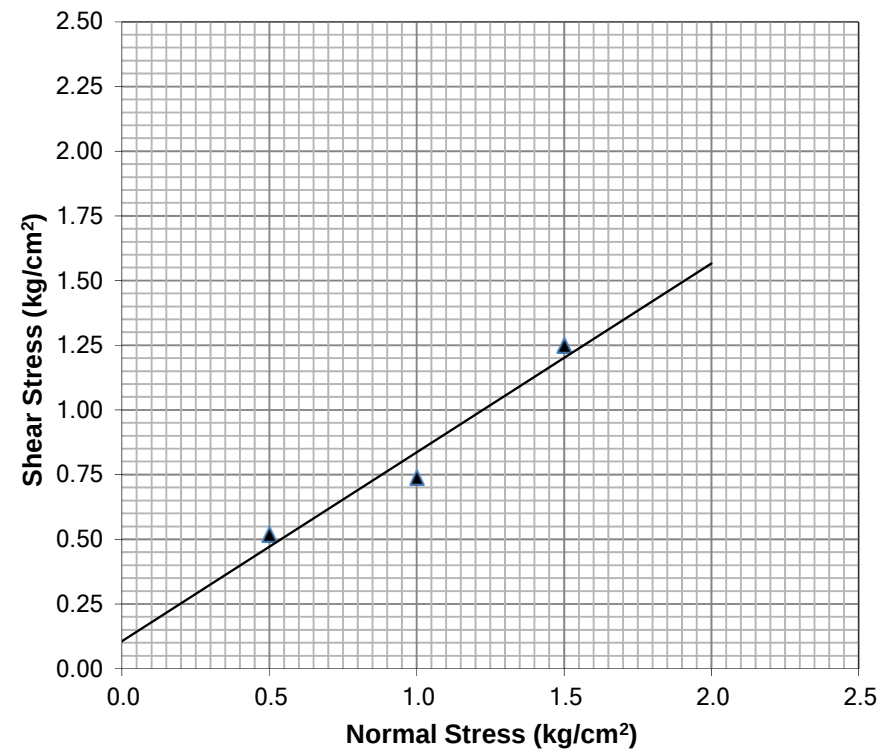
Project : Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna

Direct Shear Test



Test Results

Location	CH 1+300 : BH-01 (MNB-1)		
Depth (m)	1.5m	Cohesion (kg/cm²)	0.076
Type of Sample	DS	Angle of internal friction(f)	34

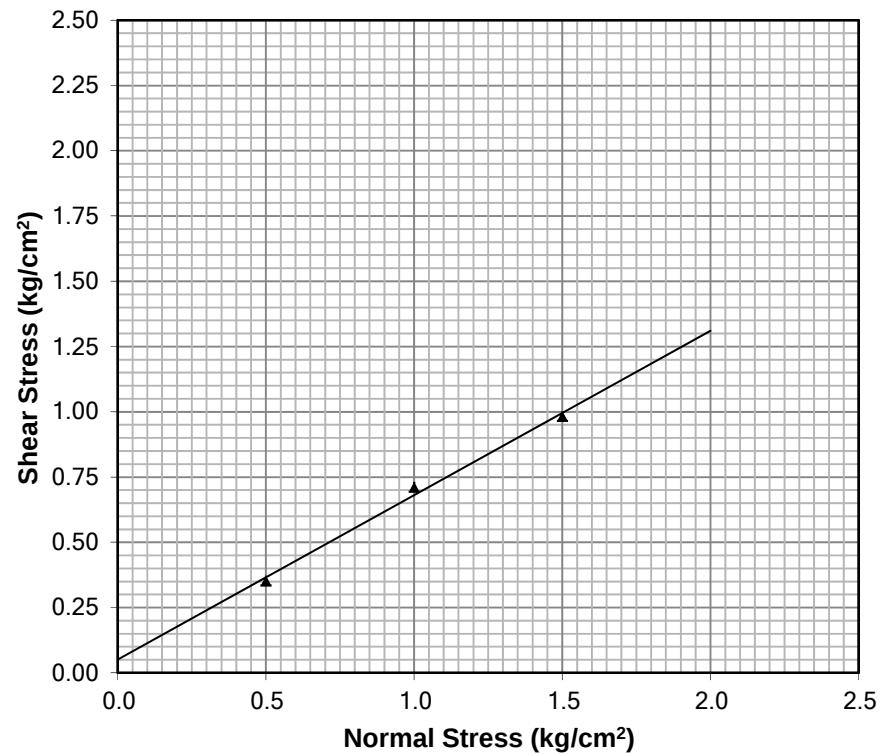


Test Results

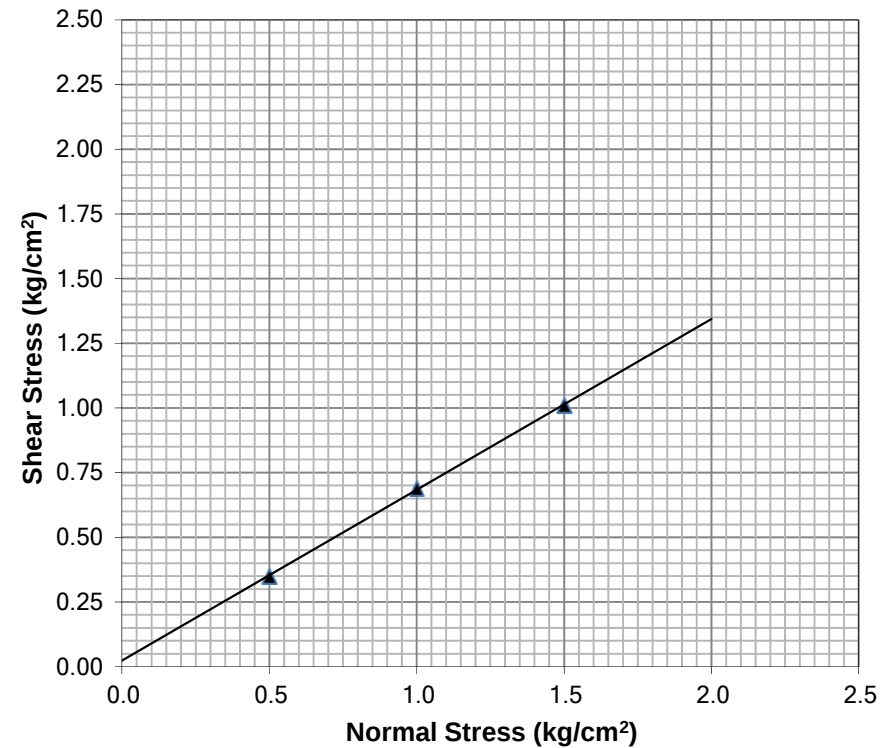
Location	CH 15+700 BH-01 (MNB-3)		
Depth (m)	4.5m	Cohesion (kg/cm²)	0.11
Type of Sample	DS	Angle of internal friction(f)	36

Project : Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna

Direct Shear Test



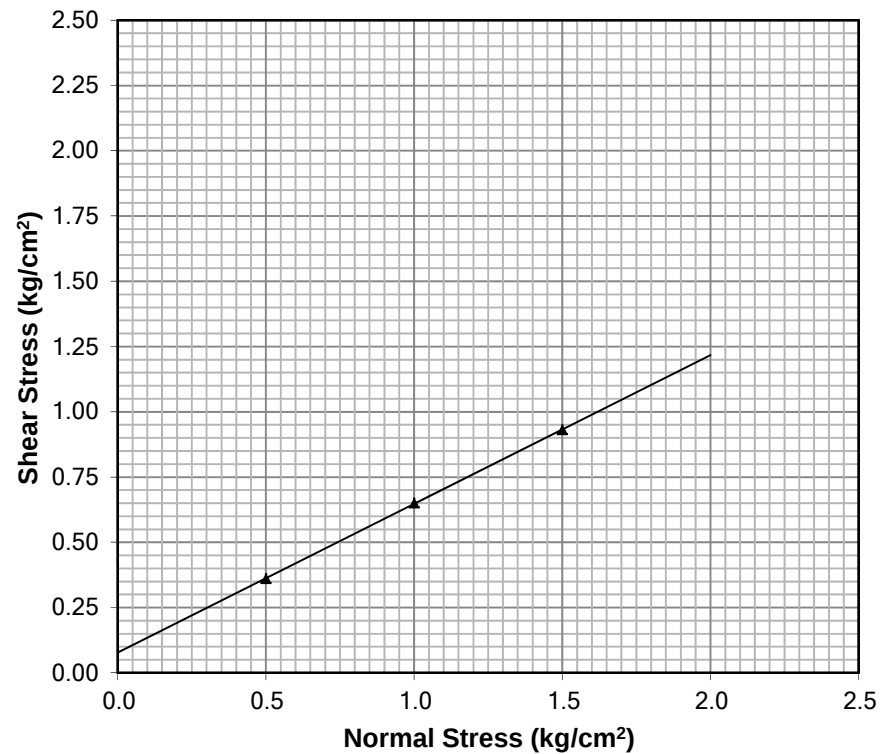
Test Results			
Location	CH 15+700 BH-1 MNB-3		
Depth (m)	3.0m	Cohesion (kg/cm²)	0.05
Type of Sample	DS	Angle of internal friction(f)	32



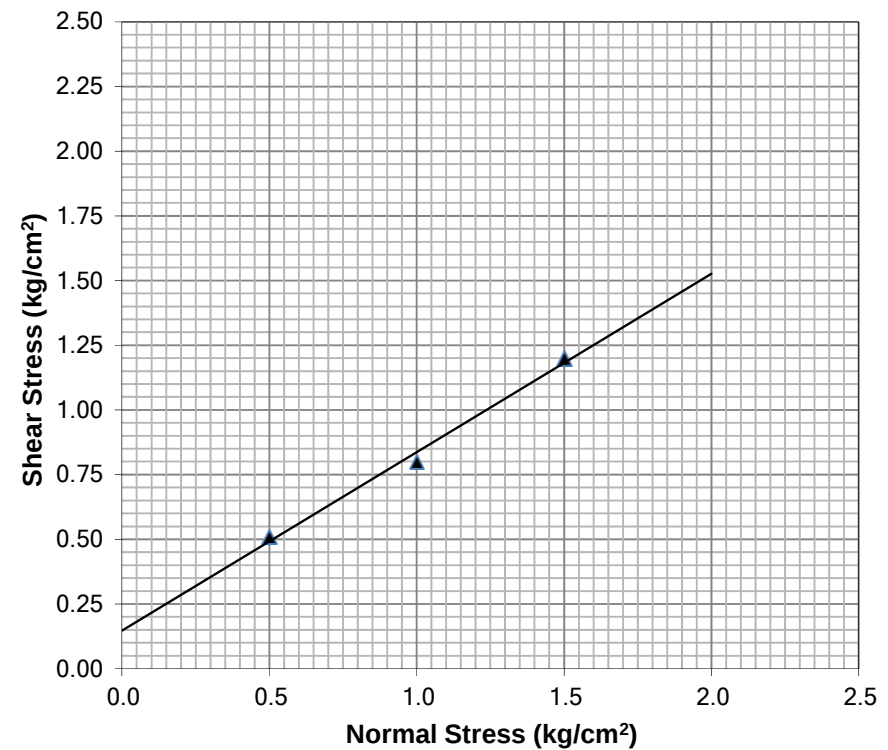
Test Results			
Location	CH 20+610 BH-P2 MJB-1		
Depth (m)	6.0m	Cohesion (kg/cm²)	0.020
Type of Sample	DS	Angle of internal friction(f)	33

Project : Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna

Direct Shear Test



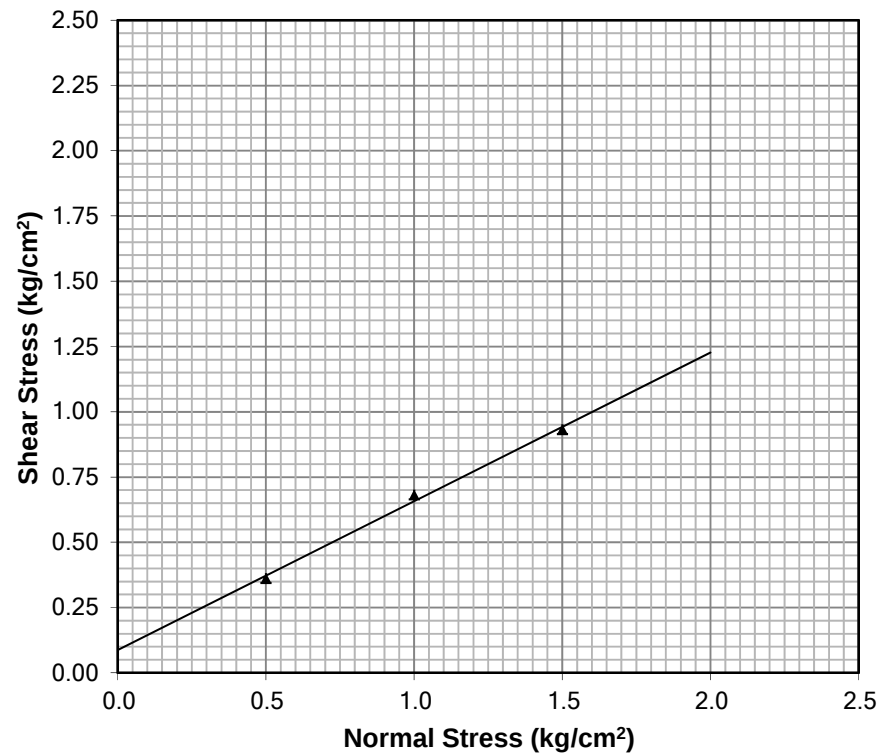
Test Results			
Location	CH 20+610 BH-A2 MJB-1		
Depth (m)	4.5m	Cohesion (kg/cm²)	0.07
Type of Sample	DS	Angle of internal friction(f)	30



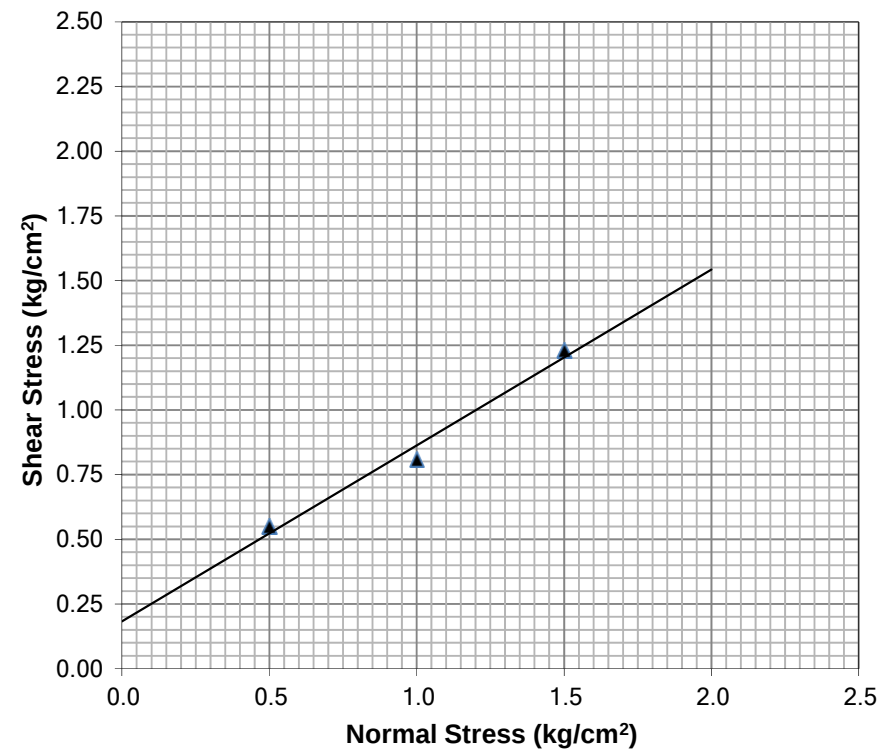
Test Results			
Location	CH 24+800 BH-1 MNB-6		
Depth (m)	3.0m	Cohesion (kg/cm²)	0.140
Type of Sample	DS	Angle of internal friction(f)	35

Project : Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna

Direct Shear Test



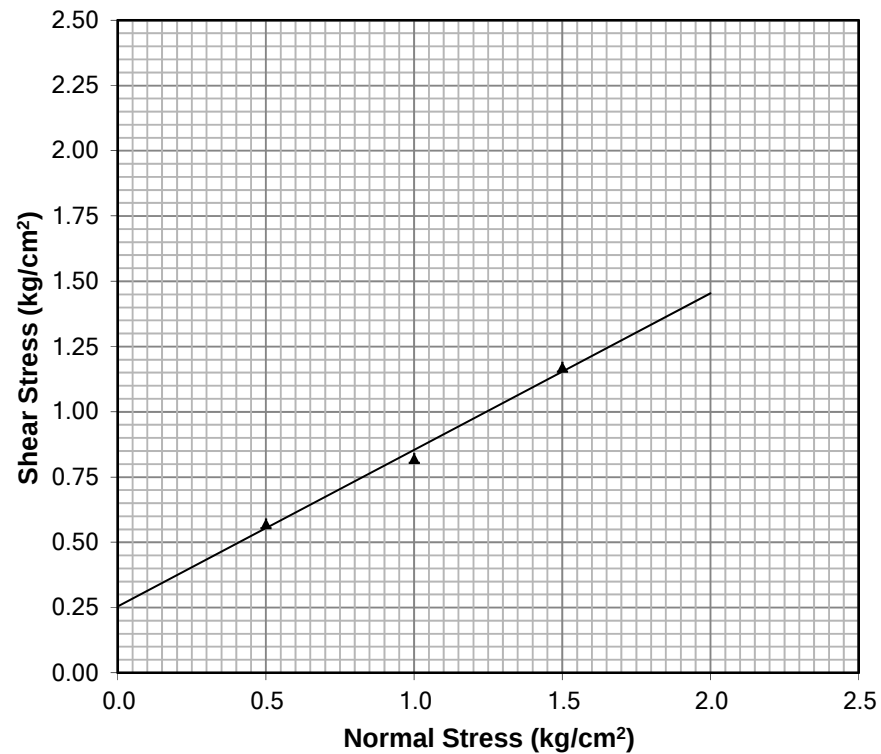
Test Results			
Location	CH 31+550 BH-1 MJB-2		
Depth (m)	4.5m	Cohesion (kg/cm²)	0.09
Type of Sample	DS	Angle of internal friction(f)	30



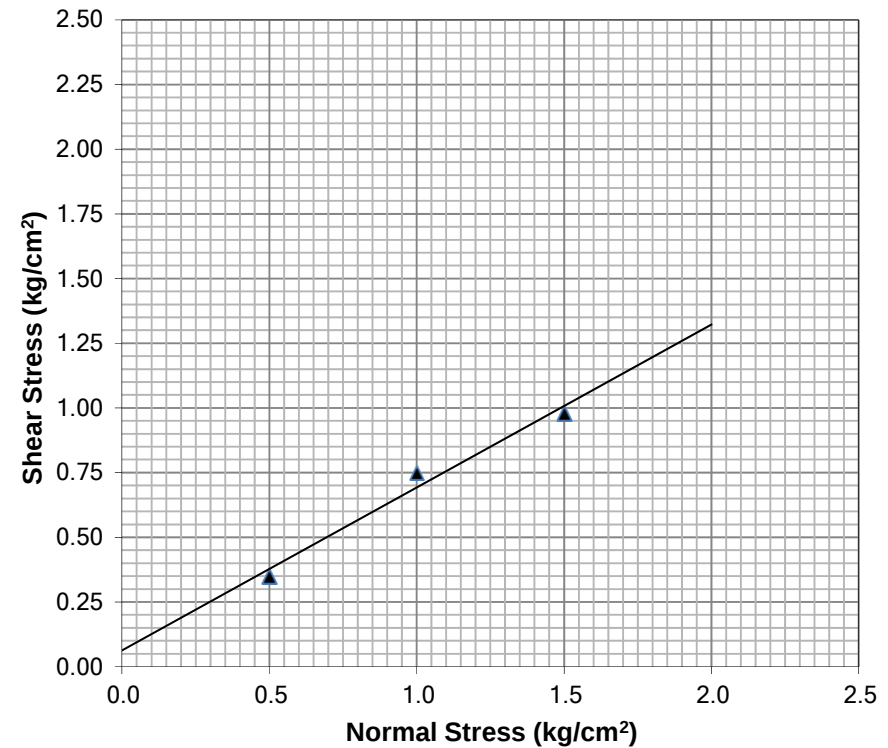
Test Results			
Location	CH 31+550 BH-2 MJB-2		
Depth (m)	7.5m	Cohesion (kg/cm²)	0.180
Type of Sample	DS	Angle of internal friction(f)	34

Project : Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna

Direct Shear Test



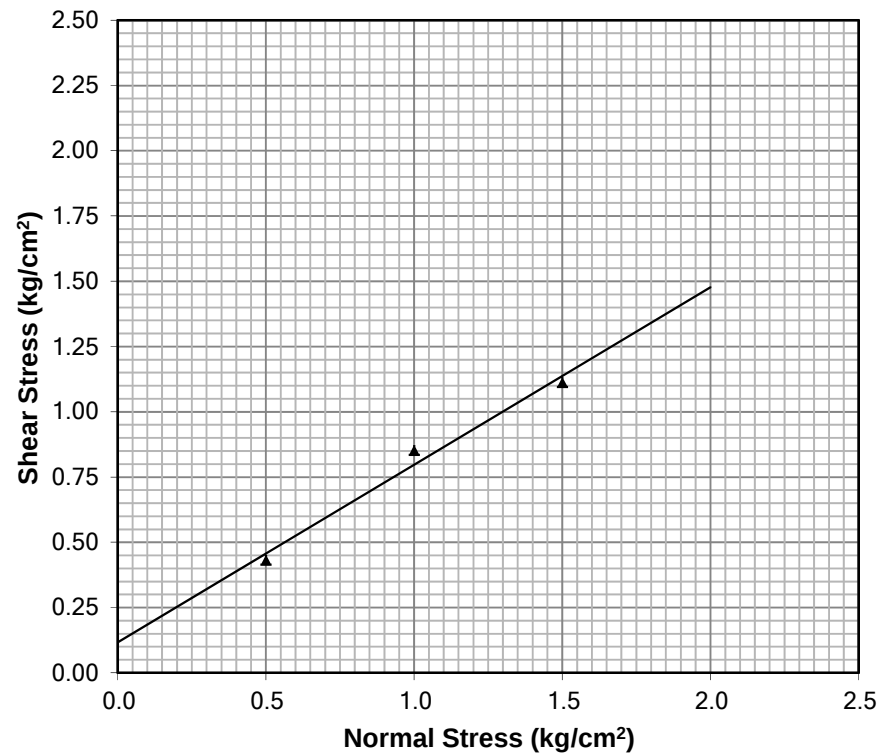
Test Results			
Location	CH 37+550 BH-2 MNB-8		
Depth (m)	3.0m	Cohesion (kg/cm²)	0.25
Type of Sample	DS	Angle of internal friction(f)	31



Test Results			
Location	CH 46+300 BH-1 MNB-13		
Depth (m)	6.0m	Cohesion (kg/cm²)	0.060
Type of Sample	DS	Angle of internal friction(f)	32

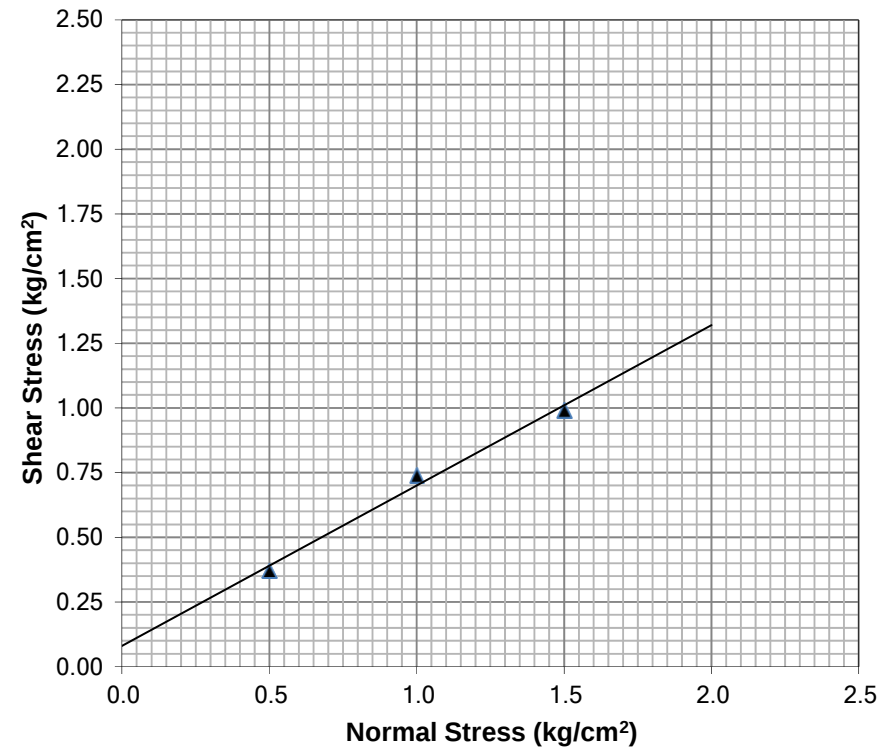
Project : Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna

Direct Shear Test



Test Results

Location	CH 60+600 BH-1 MNB-18		
Depth (m)	4.5m	Cohesion (kg/cm²)	0.11
Type of Sample	DS	Angle of internal friction(f)	34

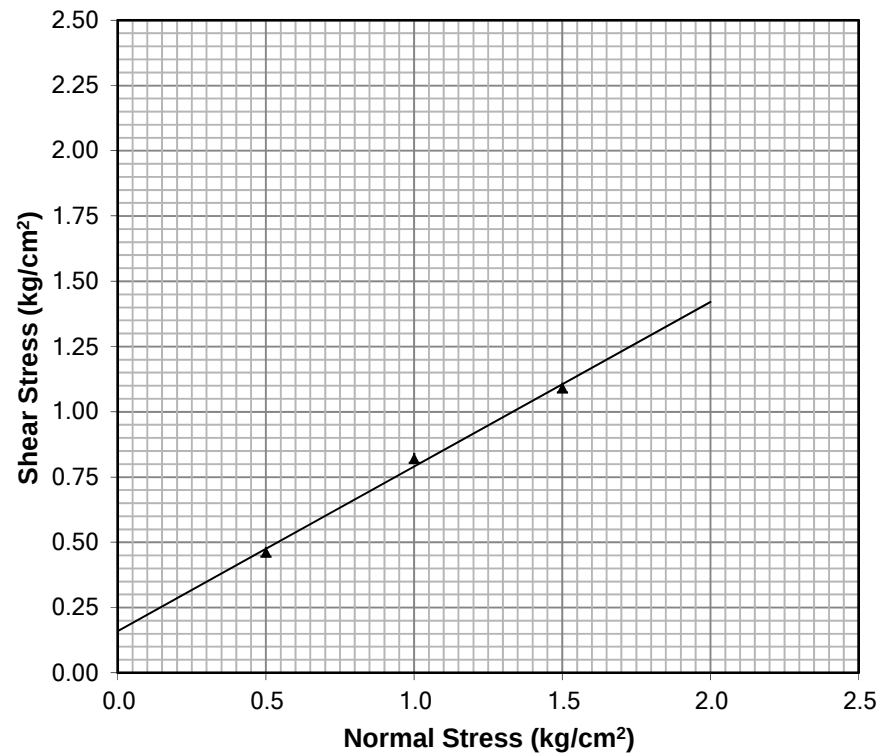


Test Results

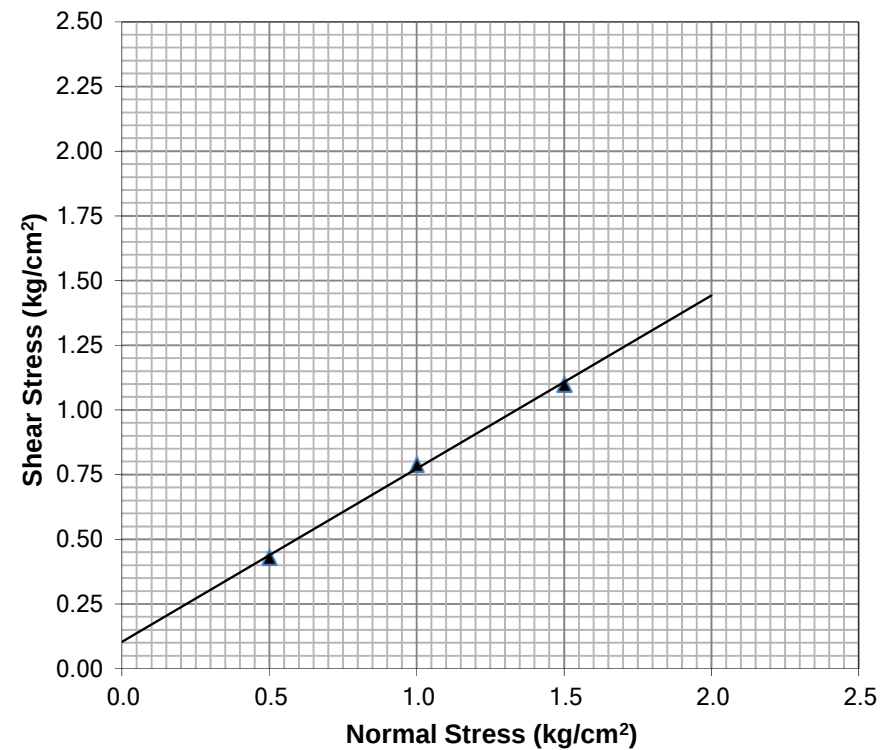
Location	CH 77+470 BH-1 MNB-33		
Depth (m)	3.0m	Cohesion (kg/cm²)	0.080
Type of Sample	DS	Angle of internal friction(f)	32

Project : Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna

Direct Shear Test



Test Results			
Location	CH 88+100 BH-2 MJB-3		
Depth (m)	3.0m	Cohesion (kg/cm²)	0.16
Type of Sample	DS	Angle of internal friction(f)	32



Test Results			
Location	CH 88+100 BH-2 MJB-3		
Depth (m)	9.0m	Cohesion (kg/cm²)	0.100
Type of Sample	DS	Angle of internal friction(f)	34

Annexure – IV

Safe Bearing Capacity Calculations

Annexure – V
Site Photographs

Bearing Capacity Based on Shear Criteria

(Based on IS: 6403-1981)

Ref BH-1(37+150)

Type of soil at founding level	=	Clayey sand
Ground water table location (Dw)	=	0 m
Unit weight of soil (γ)	=	1.8 t/m ³
Submerged unit of soil (γ')	=	0.8 t/m ³
Type of footing :	=	Square footing
Width of footing (B)	=	1.5 m
Length of footing(L)	=	1.5 m
Depth of footing from bed level (D _f)	=	3.0 m
Average Corrected 'N' value at base of footing	=	>100
Angle of internal friction (ϕ)	=	33 deg.
Cohesion (C)	=	0 t/m ²
If ϕ value is in between local & general shear failure. As per IS: 6403 - 1981 the SBC value is to be interpolated between		
ϕ	=	35 deg (for general shear failure)
ϕ	=	29 deg (for local shear failure)

A) Local shear failure :

$\phi' = \tan^{-1} (0.67 \tan \phi)$	=	20 deg.
Cohesion (C)	=	0 t/m ²
Bearing capacity factors		
N _c '	=	14.00
N _q '	=	6.00
N _{γ} '	=	5.00
Shape factors :		
S _c	=	1.30
S _q	=	1.20
S _{γ}	=	0.80
Inclination factors :		
i _c = i _q = i _{γ} = 1		
Depth factors :		
D _c	=	1.57
D _q	=	1.29
d _{γ}	=	1.29
Effective overburden pressure (q)	=	2.4 t/m ²
Factor of safety (F.S)	=	2.5

Ultimate bearing capacity (UBC)

$$UBC = C' * N_c' * S_c * d_c * i_c + q * (N_q' - 1) * S_q * d_q * i_q + 0.5 * B * \gamma' * N_{\gamma}' * S_{\gamma} * d_{\gamma} * i_{\gamma} * w$$

Where w = Water table correction factor

$$w = 0.5$$

Bearing Capacity Based on Shear Criteria

(Based on IS: 6403-1981)

$$\text{Ultimate bearing capacity (Local)} = 22.0 \text{ t/m}^2$$

Safe bearing capacity as per shear criteria,

$$(\text{SBC}) \text{ Local} = \text{UBC}/\text{F.S} = 8.8 \text{ t/m}^2$$

B) General Shear Failure :

$$\phi = 36 \text{ deg.}$$

$$\text{Cohesion (C)} = 0 \text{ t/m}^2$$

Bearing capacity factors

$$N_c = 51.00$$

$$N_q = 38.00$$

$$N_\gamma = 57.00$$

Depth factors

$$d_c = 1.79$$

$$d_q = 1.39$$

$$d_\gamma = 1.39$$

$$\text{Over burden pressure (q} = \gamma' * D_f) = 2.4 \text{ t/m}^2$$

$$\text{Factor of safety (F.S)} = 2.5$$

Ultimate bearing capacity (UBC)

$$\text{UBC} = C * N_c * S_c * d_c * i_c + q * (N_q - 1) * S_q * d_q * i_q + 0.5 * B * \gamma * N_\gamma * S_\gamma * d_\gamma * i_\gamma * w$$

$$= 190.9 \text{ t/m}^2$$

$$(\text{SBC})_{\text{general}} = \text{UBC}/\text{F.S} = 76.4 \text{ t/m}^2$$

From above Local & General shear failures the SBC for actual case can be calculated as follows

$$\text{Actual SBC} = (\text{SBC})_{\text{local}} + \{[(\text{SBC})_{\text{general}} - (\text{SBC})_{\text{local}}] / (36-29)\} * (\phi - 29)$$

Therefore,

$$\text{Actual SBC} = 54 \text{ t/m}^2$$

$$\text{Recommended SBC} = 40 \text{ t/m}^2$$

$$= 400 \text{ kN/m}^2$$

BEARING CAPACITY BASED ON SETTLEMENT CRITERIA
(Based on IS: 8009 (Part-1)-1976)

Type of foundation = Square footing

Unit weight of soil (g) = 1.8 t/m³

Width of foundation (B) = 1.5 m

Length of foundation (L) = 1.5 m

Depth of foundation from NGL (D_f) = 3.0 m

Bearing pressure at founding level (q) = 40 t/m²

Depth of pressure bulb (1.50*B) H = 2.3 m

Bearing capacity Based on Settlement

Immediate settlement S_i = $pB\{(1-\mu^2) / E_s\} I$

where E_s = Elastic modulus of sand
B = Width of foundation
p = Bearing pressure
I = Influence factor
 μ = Poissons ratio

Type of soil = SDR

Depth of layer (H) = 2.3 m

Increase in pressure p = 40.0 t/m²

μ = 0.35

I = 0.95

E_s = 8000 t/m² (based on shultz & Muhs curves)

settlement of layer = 6.3 mm

Depth correction factor = 0.66 (as per Fig.12 of IS:8009-pt1)

Rigidity factor = 0.8 (as per clause 9.5.2 of IS 8009-pt1)

Corrected settlement = 3.3 mm



Bearing Capacity Based on Shear Criteria

(Based on IS: 6403-1981)

Ref BH-1(15+700)

Type of soil at founding level	=	Clayey sand
Ground water table location (Dw)	=	0 m
Unit weight of soil (γ)	=	1.8 t/m ³
Submerged unit of soil (γ')	=	0.8 t/m ³
Type of footing :	=	Square footing
Width of footing (B)	=	1.5 m
Length of footing(L)	=	1.5 m
Depth of footing from bed level (D _f)	=	3.0 m
Average Corrected 'N' value at base of footing	=	17
Angle of internal friction (ϕ)	=	31 deg.
Cohesion (C)	=	0 t/m ²
If ϕ value is in between local & general shear failure. As per IS: 6403 - 1981 the SBC value is to be interpolated between		
ϕ	=	35 deg (for general shear failure)
ϕ	=	29 deg (for local shear failure)

A) Local shear failure :

$\phi' = \tan^{-1} (0.67 \tan \phi)$	=	20 deg.
Cohesion (C)	=	0 t/m ²
Bearing capacity factors		
N _c '	=	14.00
N _q '	=	6.00
N _{γ} '	=	5.00
Shape factors :		
S _c	=	1.30
S _q	=	1.20
S _{γ}	=	0.80
Inclination factors :		
i _c = i _q = i _{γ} = 1		
Depth factors :		
d _c	=	1.57
d _q	=	1.29
d _{γ}	=	1.29
Effective overburden pressure (q)	=	2.4 t/m ²
Factor of safety (F.S)	=	2.5

Ultimate bearing capacity (UBC)

$$UBC = C' * N_c' * S_c * d_c * i_c + q * (N_q' - 1) * S_q * d_q * i_q + 0.5 * B * \gamma' * N_{\gamma}' * S_{\gamma} * d_{\gamma} * i_{\gamma} * w$$

Where w = Water table correction factor

$$w = 0.5$$

Bearing Capacity Based on Shear Criteria

(Based on IS: 6403-1981)

Ultimate bearing capacity (Local) = 22.0 t/m²

Safe bearing capacity as per shear criteria,

(SBC) Local = UBC/F.S = 8.8 t/m²

B) General Shear Failure :

ϕ = 36 deg.

Cohesion (C) = 0 t/m²

Bearing capacity factors

N_c = 51.00

N_q = 38.00

N_γ = 57.00

Depth factors

d_c = 1.79

d_q = 1.39

d_γ = 1.39

Over burden pressure ($q = \gamma' * D_f$) = 2.4 t/m²

Factor of safety (F.S) = 2.5

Ultimate bearing capacity (UBC)

$UBC = C * N_c * S_c * d_c * i_c + q * (N_q - 1) * S_q * d_q * i_q + 0.5 * B * \gamma * N_{\gamma} * S_{\gamma} * d_{\gamma} * i_{\gamma} * w$

= 190.9 t/m²

(SBC)_{general} = UBC/F.S = 76.4 t/m²

From above Local & General shear failures the SBC for actual case can be calculated as follows

Actual SBC = (SBC)_{local} + {[(SBC)_{general} - (SBC)_{local}] / (36-29)} * (ϕ - 29)

Therefore,

Actual SBC = 31 t/m²

Recommended SBC = 25 t/m²

= 250 kN/m²

BEARING CAPACITY BASED ON SETTLEMENT CRITERIA
(Based on IS: 8009 (Part-1)-1976)

Type of foundation = Square footing

Unit weight of soil (g) = 1.8 t/m³

Width of foundation (B) = 1.5 m

Length of foundation (L) = 1.5 m

Depth of foundation from NGL (D_f) = 3.0 m

Bearing pressure at founding level (q) = 25 t/m²

Depth of pressure bulb (1.50*B) H = 2.3 m

Bearing capacity Based on Settlement

Immediate settlement S_i = $pB\{(1-\mu^2) / E_s\} I$

where E_s = Elastic modulus of sand
B = Width of foundation
p = Bearing pressure
I = Influence factor
 μ = Poissons ratio

Type of soil = Clayey sand

Depth of layer (H) = 2.3 m

Increase in pressure p = 25.0 t/m²

μ = 0.35

I = 0.95

E_s = 4180 t/m² (based on shultz & Muhs curves)

settlement of layer = 7.5 mm

Depth correction factor = 0.66 (as per Fig.12 of IS:8009-pt1)

Rigidity factor = 0.8 (as per clause 9.5.2 of IS 8009-pt1)

Corrected settlement = 3.9 mm

PILE LOAD CARRYING CAPACITY AS PER IRC:78-2000

(Notification no 68 / Section-9 – Appendix-5)

1.0 GENERAL & PILE DATA:

Structure / Location	=	MJB-3 @ CH 88+100 - TS side
Type of Pile	=	Bored cast in situ pile
Borehole considered for design	=	BH-2
Diameter of pile	=	1.5 m
Pile cutoff level (considered)	=	2.0 m below EGL
Length of socket (3D)	=	4.5 m
Total length of pile from EGL	=	28.5 m
Pile tip below pile cutoff level	=	26.5 m
Pile terminated in	=	Weathered
Code of Practice	=	IRC:78 Notification 68 (Method-2)

2.0 SOIL PROFILE:

Based on the soil data furnished in geotechnical investigation report following design parameters arrived

Layer (m)		Soil classification	Design parameters
0.00	2.50	Silty clay (CL)	$C = 11 \text{ t/m}^2$ $g, \text{ t/m}^3 = 1.8$ $N_{\text{avg}} = 22$
2.50	11.00	Clayey sand (SC)	$f = 34$ $g, \text{ t/m}^3 = 1.8$ $N_{\text{avg}} = 30$
11.00	22.00	Dense moorum (SM)	$f = 36$ $g, \text{ t/m}^3 = 1.8$ $N_{\text{avg}} > 100$
22.00	25.00	Weathered Rock	$\text{UCS} = 3.3 \text{ Mpa}^*$ $N_{\text{avg}} = 300$

Note: UCS values are calculated from SPT'N' as per IRC 78 Amendment No-68 Method-2

3.0 PILE VERTICAL CAPACITY:

3.1 End bearing Resistance:

End Bearing resistance (R_e),	=	$C_{ub} * N_c * A_b$
Average shear strength of rock below pile tip		
	$C_{ub} =$	3.0 Mpa
		300 t/m^2
Bearing capacity factor	$N_c =$	9.00
Cross sectional area at base of the pile	=	1.767 m^2
Ultimate end bearing	=	4771 t
FOS for end bearing resistance	=	3
Safe end bearing capacity	=	1590 t
Maximum allowable end bearing pressure	=	5 Mpa
		500 t/m^2
Allowable end bearing capacity	=	884 T

PILE LOAD CARRYING CAPACITY AS PER IRC:78-2000

(Notofication no 68 / Section-9 – Appendix-5)

3.2 Skin Friction Resistance:

Ultimate side socket shear (R_{af}),	=	$A_s * C_{us}$	
Ultimate shear strength along the socket	=	3.00	Mpa
length		300	t/m ²
Characteristic compressive strength of concrete			
concrete (F_{ck})	=	M35	
Limiting value of socket shear resistance	=	3.0	Mpa
	=	300	t/m ²
Effective length of socket ($L_{se} = L_s - 0.3$)	=	4.2	m
Surface area of the pile	=	$\pi() * 1.5 * 4.2$	
	=	19.79	m ²
Ultimate side socket shear (R_{af}),	=	5938	t
FOS for friction resistance	=	6	(as per IRC78 Notification68)
Allowable capacity due to side socket shea	=	990	t

3.3 Load carrying capacity of pile

	=	$R_e + R_{sf}$	
		1873	t
Self weight of pile (W_p)	=	$Y_{sub,concrete} * \pi() / 4 * D^2 * L_{pile}$	
		70	t
Safe vertical load capacity of pile	=	1803	t

4.0 PILE UPLIFT CAPACITY:

Uplift capacity of pile, P	=	$(2/3 Q_f) / 2.5 + \text{self weight of pile}$	
	=	1653.6	t

PILE LOAD CARRYING CAPACITY AS PER IRC:78-2000

(Notification no 68 / Section-9 – Appendix-5)

1.0 GENERAL & PILE DATA:

Structure / Location	=	MJB-3 @ CH 88+100 - AP side
Type of Pile	=	Bored cast in situ pile
Borehole considered for design	=	BH-4
Diameter of pile	=	1.5 m
Pile cutoff level (considered)	=	2.0 m below EGL
Length of socket (3D)	=	4.5 m
Total length of pile from EGL	=	18.5 m
Pile tip below pile cutoff level	=	16.5 m
Pile terminated in	=	Weathered
Code of Practice	=	IRC:78 Notification 68 (Method-2)

2.0 SOIL PROFILE:

Based on the soil data furnished in geotechnical investigation report following design parameters arrived

Layer (m)		Soil classification	Design parameters
0.00	4.50	Silty clay (CL)	$C = 9.5 \text{ t/m}^2$ $g, \text{ t/m}^3 = 1.8$ $N_{avg} = 19$
4.50	10.50	Dense moorum (SM)	$f = 36$ $g, \text{ t/m}^3 = 1.8$ $N_{avg} > 100$
10.50	12.00	Weathered Rock	$UCS = 3.3 \text{ Mpa}^*$ $N_{avg} = 300$
12.00	14.00	Hard rock	$UCS = 5.5 \text{ Mpa}^*$ $N_{avg} > 300$
12.00	19.00	Weathered Rock	$UCS = 3.3 \text{ Mpa}^*$ $N_{avg} = 300$
19.00	20.00	Hard rock	$UCS = 5.5 \text{ Mpa}^*$ $N_{avg} > 300$

Note: UCS values are calculated from SPT'N' as per IRC 78 Amendment No-68 Method-2

3.0 PILE VERTICAL CAPACITY:

3.1 End bearing Resistance:

End Bearing resistance (R_e),	=	$C_{ub} * N_c * A_b$
Average shear strength of rock below pile tip		
	C_{ub}	= 3.0 Mpa
		= 300 t/m^2
Bearing capacity factor	N_c	= 9.00
Cross sectional area at base of the pile	=	1.767 m^2
Ultimate end bearing	=	4771 t
FOS for end bearing resistance	=	3
Safe end bearing capacity	=	1590 t
Maximum allowable end bearing pressure	=	5 Mpa
		500 t/m^2
Allowable end bearing capacity	=	884 T

PILE LOAD CARRYING CAPACITY AS PER IRC:78-2000

(Notofication no 68 / Section-9 – Appendix-5)

3.2 Skin Friction Resistance:

Ultimate side socket shear (R_{af}),	=	$A_s * C_{us}$	
Ultimate shear strength along the socket	=	3.00	Mpa
length		300	t/m ²
Characteristic compressive strength of concrete			
concrete (F_{ck})	=	M35	
Limiting value of socket shear resistance	=	3.0	Mpa
	=	300	t/m ²
Effective length of socket ($L_{se} = L_s - 0.3$)	=	4.2	m
Surface area of the pile	=	$\pi() * 1.5 * 4.2$	
	=	19.79	m ²
Ultimate side socket shear (R_{af}),	=	5938	t
FOS for friction resistance	=	6	(as per IRC78 Notification68)
Allowable capacity due to side socket shea	=	990	t

3.3 Load carrying capacity of pile

	=	$R_e + R_{sf}$	
		1873	t
Self weight of pile (W_p)	=	$Y_{sub,concrete} * \pi() / 4 * D^2 * L_{pile}$	
		44	t
Safe vertical load capacity of pile	=	1829	t

4.0 PILE UPLIFT CAPACITY:

Uplift capacity of pile, P	=	$(2/3 Q_f) / 2.5 + \text{self weight of pile}$	
	=	1627.1	t

BORED CAST IN - SITU PILE CAPACITY CALCULATIONS

Lateral Load Capacity of Pile

(As per IS : 2911(Part1/Section2):2010, Second Revision and IRC:78)

1.0 Pile Data:

Ref BH-2

Type of pile	=	Bored cast in situ pile
Diameter of pile (D)	=	150 cm
Pile cut-off level	=	2 m
Length of pile below pile cut-off level	=	26.5 m
Grade of Concrete (M)	f_{ck} M	= 35
Grade of steel ,	f_y	= 415
Concrete Elastic Modulus,	E	= $5000 (f_{ck})^{1/2}$ 29580 N/mm ²
Pile Modulus of Elasticity (E)		295804 kg/cm ²
Moment of inertia of pile (I)	=	24850489 cm ⁴

2.0 Soil Parameters

Soil Type	=	Sand
Average SPT"N" value	=	30
Angle of shearing resistance (ϕ)	=	33 deg
Soil condition w.r.t GWT (submerged/Dry)	=	Submerged

3.0 Determination of Lateral Load Capacity

Modulus of subgrade reaction (h_h)	=	0.22 kg/cm ³	
Stiffness factor for chosive soil, T	=	506.74 cm	
$T = (E * I / h_h)^{1/5}$	=		
Free length of pile above ground (L1)	=	0 cm	
For fixed head pile, $L_f = 2.15 * T$	=	1089.49 cm	
Pile head deflection at pile cut-off leve (d)	=	1.5 cm	(1% of pile dia)
Leteral Load Capacity for fixed head pile (Qh)	=	$12 y E I / (L1+Lf)^3$	
	=	102316.7 kg	
	=	102.3 MT	

Project

Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration at BH-1 @10+300



Geotechnical Exploration at BH-1@15+700

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration at BH-2 @15+700



Geotechnical Exploration at BH-A1@20+430

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration at BH-P1@20+515



Geotechnical Exploration at BH-P2@20+610

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration at BH-A2@20+740



Geotechnical Exploration at BH-1@20+965

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration at BH-1@22+715



Geotechnical Exploration at BH-1@24+800

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration at BH-1@31+550



Geotechnical Exploration at BH-2@31+550

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration at BH-1@37+550



Geotechnical Exploration at BH-2@37+550

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration at BH-1@37+150



Geotechnical Exploration at BH-1@43+350

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration at BH-1@46+300



Geotechnical Exploration at BH-1@52+505

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration at BH-1@60+600



Geotechnical Exploration at BH-1@77+470

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration at BH-1@60+600



Geotechnical Exploration at BH-1@77+480

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration at BH-3@88+100



Geotechnical Exploration at BH-4@88+100

Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration at BH-5@88+100



Project

Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration - Core Box BH-1@10+300



Geotechnical Exploration - Core Box BH-1@15+700



Geotechnical Exploration - Core Box BH-A1@20+430

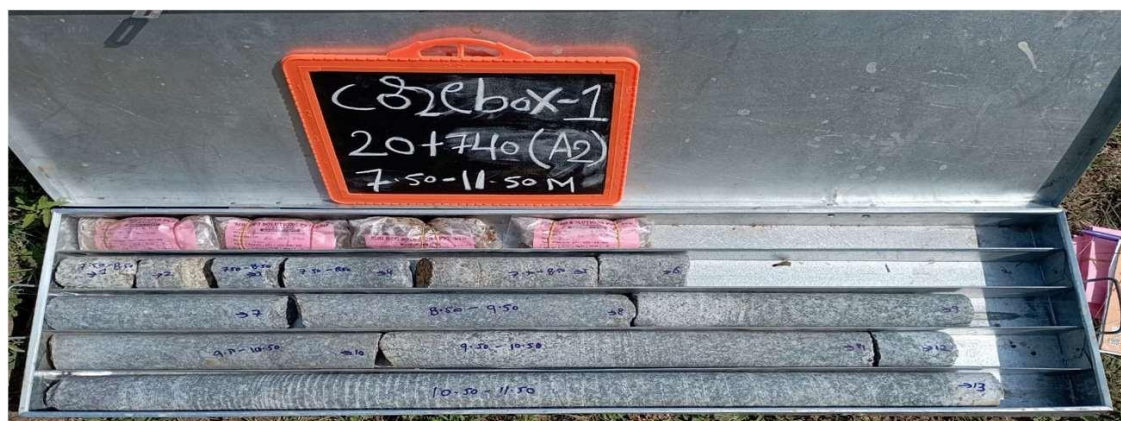


Geotechnical Exploration - Core Box BH-P1@20+515

	
Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration - Core Box BH-P2@20+610



Geotechnical Exploration - Core Box BH-A2@20+740



Geotechnical Exploration - Core Box BH-1@20+965



Geotechnical Exploration - Core Box BH-1@31+550



Project

Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration - Core Box BH-2@31+550



Geotechnical Exploration - Core Box BH-1@37+550



Geotechnical Exploration - Core Box BH-2@37+550



Geotechnical Exploration - Core Box BH-1@46+300

	
Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna



Geotechnical Exploration - Core Box BH-1@60+600



Geotechnical Exploration - Core Box BH-3@88+100



Geotechnical Exploration - Core Box BH-3@88+100



Geotechnical Exploration - Core Box BH-4@88+100

Client :							
Independent Engineer :							
Project Name :	Project Management Consultancy for Up-Gradation to 2/4 Lane with Paved Shoulders Configuration of Newly Declared NH 167k Starting from it's Junction with NH-167 near Kalwakurthy connecting Nagarkurnool, Kollapur, Rampur in The State of Telangana, Mandugula, Sivapuram, Karivena and terminating at it's Junction with NH 40 Near Nandyal in the State of Andhra Pradesh for A length of 185.90 Kms (Approx.) Including Four Lane Major Bridge Across River Krishna.						
Report Title :	Geotechnical Investigation Report for MNB & MJB between Mandugula and junction with NH 40 near Nandyal in Andhra Pradesh						
Report No:							
Revision Details:					Revision No:		R0
R0	14.04.2022	Initial Submission					
Rev.	Date	Details	Init.	Sign.	Init.	Sign.	Init. Sign.
			Prepared		Checked		Approved
			BAS		VSR		CSB

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Annexure

Annexure - I	:	Comprehensive Sub Surface Profile
Annexure - II	:	Field Bore Log
Annexure - III	:	Laboratory Test Results
Annexure - IV	:	Safe Bearing Capacity Calculations
Annexure - V	:	Site Photographs

1 INTRODUCTION

_____ has awarded the work of conducting Geotechnical investigation for the proposed construction Minor Bridge (MNB) and Major Bridges (MJB) for up-gradation of NH 167k starting it's junction with NH-167 near Kalwakurthy connecting Nagarkurnool, Kollapur, Rampur in Telangana stage and Mandugula, Sivapuram, Karivena and terminating at junction with NH -40 near Nandyal in Andhra Pradesh state project to M/s Siri Geo Solutions Pvt Ltd., Hyderabad.

Objective of the geotechnical investigation is to ascertain sub-soil parameters for appropriate design of the foundation system.

This report covers the scope of geotechnical investigation from MNB & MJB between Mandugula and junction with NH 40 near Nandyal in Andhra Pradesh.

2 SCOPE OF WORK

The scope of work is to make specified number of standard geotechnical boreholes for the proposed construction of MNB & MJB as per the specifications and direction given by the client.

The detailed scope of work includes the following

-  Making thirty four standard geotechnical boreholes at twenty six structures proposed structure location.
-  Drilling through soil and rock strata as per client directions.
-  Conducting standard penetration test at 1.5m depth intervals below proposed foundation level.
-  Collecting disturbed and undisturbed soil samples.
-  Conducting relevant field and laboratory tests.
-  Submitting comprehensive geotechnical report which covering all field works, laboratory test results and recommendations for the foundation system

3 FIELD WORK

Field investigations were carried out during the month of February and March 2022. Brief methodologies of boring and other field works are given below.

3.1 Soil Boring

Exploratory boreholes of 150mm diameter were drilled in soil strata by rotary drilling machine with bentonite circulation technique. The description of sub soil stratum with SPT 'N' values at regular intervals and ground water table was recorded in the bore logs and presented in Annexure -II.

3.2 Rock Drilling

Drilling in rock was resorted to in boreholes after encountering 'Refusal' condition. Standard rotary drilling machine, driven by diesel-operated engine and fitted with diamond bits of 'NX' size with single tube core barrel was used in drilling through rock strata with conventional water circulation technique. Standard Penetration Tests were conducted in drill holes at no appreciable core recovery was possible. Core recovery (CR) and Rock Quality Designation (RQD) percentage were measured and recorded in drill-logs. Rock core samples were preserved sequentially in wooden core boxes.

Details of boreholes, depth of exploration and ground levels are presented in the table below.

SI No.	Structure	Location CH	BH No.	Depth Explored (m)	Ground water table *
1	MNB 34	98+290	BH-1	7.0	Not met
2	MNB 35	99+590	BH-1	9.0	Not met
3	MNB36	101+500	BH-1	6.5	4.8m
4	MNB 37	-	BH-1	6.0	Not met
5	MNB 38	-	BH-1	10.0	Not met
6	MNB 39	-	BH-1	8.0	4.1m
7	MNB 40	-	BH-1	7.0	5.0m
8	MNB41	109+550	BH-1	9.0	5.0m
9	MNB 42	109+650	BH-1	9.5	Not met
10	MNB 43	112+620	BH-1	6.5	Not met
11			BH-2	8.0	Not met
12	MNB 44	116+775	BH-1	8.0	5.0m

SI No.	Structure	Location CH	BH No.	Depth Explored (m)	Ground water table *
13	MNB 45	119+300	BH-1	12.0	Not met
14	MNB 46	119+400	BH-1	9.0	5.0m
15	MNB 47	119+500	BH-1	13.0	4.9m
16	MNB 48	135+200	BH-1	4.0	Not met
17			BH-2	4.5	Not met
18	MJB4	143+300	BH-1	7.0	Not met
19			BH-2	5.0	Not met
20			BH-3	9.0	Not met
21	MNB49	145+450	BH-1	6.0	4.0m
22	MNB50	151+250	BH-1	9.0	3.6m
23	MNB51	153+750	BH-1	15.0	3.0m
24			BH-2	14.5	3.0m
25	MNB52	155+690	BH-1	9.0	3.2m
26	MNB53	156+080	BH-1	10.0	3.6m
27	MNB54	161+100	BH-1	7.0	4.0m
28	MNB55	164+575	BH-1	10.0	3.1m
29	MNB56	167+050	BH-1	9.0	3.8m
30			BH-2	9.0	3.5m
31	MNB57	168+500	BH-1	7.0	3.8m
32			BH-2	8.0	3.8m
33	ROB	170+550	BH-1	14.0	4.5m
34			BH-2	10.0	5.0m

Note: * water level in borehole at the time of investigation

3.3 Sampling

Disturbed soil samples were collected from SPT spoon collected at representative depth during boring and subsequently sent to laboratory for visual examination and laboratory tests.

3.4 Standard Penetration Test

In all boreholes, standard penetration tests were conducted at 1.5m intervals for full depth of the borehole or change in strata as per Indian Standard, IS:2131-1981 and split spoon sampler used conformed to the Indian Standard, IS:9640-1980. These tests were performed by driving the sampler with 63.5kg hammer falling from a height of 75cm. Number of blows required to effect each 15cm penetration is recorded. The first 15cm penetration is considered to be the seating drive. The sum of the total blows required for a second and

third 15cm (total 30cm) penetration is termed the penetration resistance SPT' N' value and the same is reported. Filed SPT 'N' values is given in bore logs in Annexure-II.

4 LABORATORY TESTS

Laboratory tests were carried out on soil samples as per the relevant Indian Standard Specifications. Details of various tests conducted are presented below.

A) Tests on soil samples:

The following tests have been performed for soil samples:

-  Grain size analysis tests as per IS:2720 (Part -4)
-  Atterberg's limits-liquid limit and plastic limit as per IS: 2720 (Part-5)
-  Specific Gravity tests as per IS:2720 (Part -3)
-  Director Shear test as per IS: 2720 (Part-13)

On sandy samples grain size distribution analysis test were conducted using both dry and wet sieve analysis techniques. These tests are completed primarily to classify and to find out the gradation characteristics.

In general on clayey samples Atterberg's Limit tests are conducted to derive the engineering characteristic.

B) Tests on rock samples

Rock samples were inspected by engineering geologist and selected core samples were tested.

The following test has been performed for rock samples:

- a) Unconfined Compressive Strength as per IS:9143
- b) Point load index as per IS : 8764

Laboratory test results of soil and rock results are given in Annexure -III.

5 SUBSOIL CONDITION

Thirty four boreholes were drilled for twenty six structures in the section. These boreholes were terminated as directed by the client. Details of the SPT“N” values conducted at various depths are presented in individual bore logs with IS classification in Annexure-II.

Structure	Location CH	BH No.	Stratum From - to (m)	Type of soil / stratum
MNB 1	98+290	BH-1	0.0 - 3.0	Brownish silty clay (CL)
			3.0 – 7.0	Hard Rock
MNB 1	99+590	BH-1	0.0-3.0	Brownish silty clay(CL)
			3.0-5.0	Very dense moorum /SDR
			5.0-9.0	Hard Rock
MNB 3	101+500	BH-1	0.0 – 2.5	Brownish silty clay(CL)
			2.5 -6.5	Hard Rock
MNB-37	-	BH-1	0.0-1.5	Brownish clayey sand(SC)
			1.5-3.0	Weathered / Fractured rock
			3.0-6.0	Hard Rock
MNB-38	-	BH-1	0.0-2.5	Brownish silty clay(CL)
			2.5-5.0	Brownish silty clayey sand(SC)
			5.0-7.0	Weathered / Fractured rock
			7.0-10.0	Hard rock
MNB-39	-	BH-1	0.0-3.0	Brownish silty clay
			3.0-5.0	Weathered / Fractured rock
			5.0-8.0	Hard rock
MNB-40	-	BH-1	0.0 -3.0	Silty clay (CL)
			3.0 -7.0	Hard rock
MNB 41	109+550	BH-1	0.0 -2.0	greyish brown silty clay(CL)
			2.0 – 4.0	Greyish clay with sand(SC)
			4.0 – 6.0	Weathered / Fractured rock
			6.0 – 9.0	Hard Rock
MNB 42	109+650	BH-1	0.0 -2.0	Brownish silty clay(CL)
			2.0 – 4.5	Brownish clay with sand(SC)
			4.5 – 6.5	Weathered / Fractured rock
			6.5 – 9.5	Hard Rock
MNB 43	112+620	BH-1	0.0 -2.5	Brownish silty clay(CL)
			2.5 -6.5	Hard Rock
		BH-2	0.0 -3.0	Brownish silty clay(CL)
			3.0 -8.0	Hard rock

Geotechnical Investigation Report for MNB & MJB between Mandugula and junction with NH 40 near Nandyal in Andhra Pradesh

Structure	Location CH	BH No.	Stratum From - to (m)	Type of soil / stratum
MNB 44	116+775	BH-1	0.0 - 3.0	Brownish silty clay
			3.0 -5.0	Weathered / Fractured rock
			5.0 - 8.0	Hard rock
MNB 45	119+300	BH-1	0.0 – 3.5	Brownish silty clay(CL)
			3.5 – 8.0	Brownish clayey sand (SC)
			8.0 – 12.0	Hard rock
MNB 46	119+400	BH-1	0.0 – 5.0	Brownish silty clayey sand (SC)
			5.0 -9.0	Hard rock
MNB 47	119+500	BH-1	0.0 – 2.0	Brownish silty clay(CL)
			2.0 – 9.0	Brownish silty clayey sand (SC)
MNB 47	119+500	BH-1	9.0-13.0	Hard Rock
MNB 48	135+220	BH-1	0.0-1.0	Top soil
			1.0-4.0	Weathered / Fractured rock
		BH-2	0.0 -1.0	Top soil
			1.0 -4.5	Weathered / Fractured rock
MJB4	143+300	BH-1	0.0-5.0	Hard Rock
		BH-2	0.0-3.5	Brownish silty clay (CL)
			3.5-7.0	Hard rock
		BH-3	0.0-2.0	Brownish silty clay (CL)
			2.0-4.0	Brownish silty clayey sand(SC)
			4.0-9.0	Hard rock
MNB 49	145+450	BH-1	0.0-2.0	Brownish silty clayey sand (SC)
			2.0-6.0	Hard rock
MNB 50	151+250	BH-1	0.0 -4.5	Very dense moorum /SDR
			4.5 -9.0	Hard rock
MNB 51	153+750	BH-1	0.0 -4.5	Greyish brown silty clay (CL)
			4.5 -10.5	Brownish clayey sand (SC)
			10.5 -15.0	Hard rock
		BH-2	0.0-3.0	Brownish silty clay (CL)
			3.0-8.5	Brownish clayey sand (SC)
			8.5-10.5	Very dense moorum / SDR
			10.5-14.5	Hard rock
MNB 52	155+690	BH-1	0.0-2.0	Brownish silty clay(CL)
			2.0-4.5	Brownish clayey sand (SC)
			4.5-7.0	Weathered / Fractured rock
			7.0-9.0	Hard rock

Structure	Location CH	BH No.	Stratum From - to (m)	Type of soil / stratum
MNB 53	156+080	BH-1	0.0-5.0	Brownish sandy silty clay (CL)
			5.0-6.0	Boulder
			6.0-10.0	Hard rock
MNB54	161+100	BH-1	0.0-3.0	Brownish sandy silty clay (CL)
			3.0-7.0	Hard rock
MNB55	164+575	BH-1	0.0-3.0	Brownish silty clayey sand (SC)
			3.0-6.0	Weathered / Fractured rock
			6.0-10.0	Hard Rock
MNB56	167+050	BH-1	0.0-3.5	Greyish silty clay (CL)
			3.5-5.0	Greyish clayey sand (SC)
			5.0-7.0	Weathered / Fractured rock
			7.0-9.0	Hard rock
		BH-2	0.0-3.5	Greyish silty clay (CL)
			3.5-5.0	Greyish silty clayey sand (SC)
MNB57	168+500	BH-1	5.0-9.0	Hard Rock
			0.0-3.0	Brownish silty clay (CL)
		BH-2	3.0-7.0	Hard rock
			0.0-3.0	Brownish silty clay (CL)
			3.0-6.0	Weathered / Fractured rock
ROB	170+550	BH-1	6.0-8.0	Hard rock
			0.0-2.0	Brownish silty clay (CL)
			2.0-12.0	Weathered / Fractured rock
		BH-2	12.0-14.0	Hard rock
			0.0-2.0	Brownish silty clay (CL)
			2.0-7.0	Weathered / Fractured rock
			7.0-10.0	Hard rock

Comprehensive sub soil profiles are shown in Annexure -I.

6 ENGINEERING APPRAISAL

General Discussion

As per the field and laboratory test results the sub soil stratum for each bridge is presented in comprehensive sub soil profile. Considering the incidence of structural load and natural soil below the existing ground level isolated foundation is preferable for this structure.

A. Shallow Foundation

Foundation Analysis

The safe bearing capacity is arrived based on the shear failure criteria and settlement criteria. The estimated safe bearing capacity is calculated as per IS: 6403-1981 code and IS: 8009 (Part-1)-1976 with available soil profile.

A properly designed foundation has to satisfy two limit states.

- 1) Limit state of collapse (ie., Shear strength)
- 2) Limit state of serviceability (ie., Settlement)

Shear Criteria

The first criterion is depending on shear strength. The calculations are based on "TERZAGHI" bearing capacity equation as recommended by IS:6403 (with factor of Safety 2.5) which takes care of L/B ratio (shape), foundation depth etc., along with other parameters.

The intensity of loading at the base of the foundation, which would cause shear failure of the soil support, is termed as ultimate bearing capacity (UBC).

The following equation is used to calculate ultimate bearing capacity,

$$Net\ UBC = C * N_c * S_c * d_c + q * (N_q - 1) * S_q * d_q + 0.5 * B * \gamma * N_\gamma * S_\gamma * d_\gamma * W'$$

Safe bearing capacity (SBC) is the maximum intensity of loading that the foundation will safely carry without the risk of shear failure of soil irrespective of any settlement that may occur. Safe bearing capacity can be obtained by dividing the UBC with suitable factor of safety (2.5).

$$SBC = UBC / 2.5$$

Settlement Criteria:

The intensity of loading that will cause a permissible settlement or specified settlement of the structure is termed as allowable bearing pressure.

The elastic settlement of granular soil and consolidated settlement of cohesive soils are calculated using SPT 'N' values and laboratory test results. Settlement is predicted using IS: 8009 (part-1)-1976.

B. Pile Foundation

The bearing capacity of pile is arrived based on the static approach. Separate evaluation of shaft friction and end bearing forms the basis of this approach. Safe bearing capacities of piles are calculated for 1000mm and 1200 mm dia bored cast-in-situ piles considering pile socketing as 3D into weathered rock, where D is diameter of the pile. The estimated pile capacities are as per IS code with available soil data and depth at which weathered rock layer is recorded in the boreholes. The actual capacities are to be arrived from pile load tests. Lateral load capacities are estimated based on allowable lateral deflection of 1% of pile diameter.

1) Piles in Weathered Rock: (Method-2)

Ultimate bearing capacity (Q_u) of pile in granular soils is given by the following formula.

$$Q_u = R_e + R_{af} = c_{ub} \cdot N_c \cdot A_b + c_{us} A_s$$

$$Q_{allow} = R_e/3 + R_{af}/6$$

Where:

Q_u - Ultimate capacity of pile

Q_{allow} - Allowable capacity of pile

A_b - Cross sectional area of pile toe

A_s - Surface area of socket

C_{ud} - Average shear strength below base of pile for the depth twice the diameter / least lateral dimension of pile

γ - Effective unit weight of soil at pile toe

C_{us} - Ultimate shear strength along socket length

Discussions on strength parameters

All the strength properties are verified and corroborated based on well-known correlations between SPT values and strength parameters.

Relative density (D_r) and angle of shearing resistance (ϕ) are obtained based on penetration test data and based on the laboratory results on remoulded disturbed samples from non-cohesive soils. IS 6403: 1981 gives the correlation between corrected SPT values 'N' and ϕ .

Depth of foundation for river bridges:

Depth of foundation for the river bridges is mainly depends on scour depth. The minimum depth of foundation should be provided as per IRC 78-2000 clause 705. The silt factor and scour depths are calculated as per IRC 78-2000 and IRC 5-1998.

Form the grain size analysis weighted mean particle diameter and silt factors are tabulated below;

Sl No.	Type of Structure	Chainage	Average Particle Diameter (d_m)	Silt factor $=1.76$ $(d_m)^{1/2}$
1	MNB 34	98+290	0.48	1.21
2	MNB 35	99+590	0.53	1.28
3	MNB36	101+500	0.68	1.45
4	MNB 37	-	0.95	1.71
5	MNB 38	-	0.71	1.48
6	MNB 39	-	0.45	1.18
7	MNB 40	-	0.46	1.19
8	MNB-41	109+550	0.68	1.45
9	MNB-42	109+650	0.67	1.44
10	MNB-43	112+620	0.51	1.26
11	MNB-44	116+775	0.47	1.20
12	MNB-45	119+300	0.73	1.50
13	MNB-46	119+400	0.97	1.73
14	MNB-47	119+500	0.70	1.47
15	MJB 2	143+300	0.54	1.29
17	MNB-51	153+750	0.81	1.58
18	MNB-52	155+690	0.71	1.48
19	MNB-53	156+080	0.52	1.27
20	MNB-54	161+100	0.62	1.38
21	MNB-55	164+575	0.53	1.28
22	MNB-56	167+050	0.66	1.43

Sl No.	Type of Structure	Chainage	Average Particle Diameter (d_m)	Silt factor $=1.76 (d_m)^{1/2}$
23	MNB-57	168+500	0.62	1.39
24	ROB	170+550	0.55	1.31

A typical calculation for estimating the bearing capacity of shallow foundation and pile capacity are given in annexure- IV.

7 RECOMMENDATION

Based on the field and laboratory tests the following recommendations are given

- Open foundations are recommended in the form of isolated footing
- The recommended safe bearing capacity and depth of foundation is tabulated below.

Chainag & Structure		Foundation Location	Proposed Foundation level from EGL	Net safe bearing capacity(KN/Sq.m)	Founding strata
MNB -34	98+290	Abutment & Pier	3.5	600	Rock (Shale)
MNB -35	99+590	Abutment & Pier	3.5	450	SDR
MNB -36	101+500	Abutment & Pier	3.0	500	Rock (Shale)
MNB -37	-	Abutment & Pier	2.5	500	Rock (Shale)
+MNB -38	-	Abutment & Pier	2.5	250	Clayey sand
			5.5	500	Rock (Shale)
MNB -39	-	Abutment & Pier	3.5	500	Rock (Shale)
MNB -40	-	Abutment & Pier	3.5	500	Rock (Shale)
MNB -41	109+550	Abutment & Pier	2.5	250	Clayey sand
			4.5	500	Rock (Shale)
+MNB -42	109+650	Abutment & Pier	2.5	250	Clayey sand
			5.0	500	Rock (Shale)
MNB -43	112+620	Abutment & Pier	3.5	500	Rock (Shale)
MNB -44	116+775	Abutment & Pier	3.5	500	Rock (Shale)
+MNB -45	119+300	Abutment & Pier	4.0	250	Clayey sand
			8.5	500	Rock (Shale)
+MNB -46	119+400	Abutment & Pier	3.5	250	Clayey sand
			5.5	600	Rock (Shale)
+MNB -47	119+500	Abutment & Pier	3.5	250	Clayey sand
			9.5	500	Rock (Shale)
MNB -48	135+200	Abutment & Pier	1.5	500	Rock (Shale)
MJB -4	143+300	Abutment & Pier	4.5	600	Rock (Shale)