

Chainag & Structure		Foundation Location	Proposed Foundation level from EGL	Net safe bearing capacity(KN/Sq.m)	Founding strata
MNB -49	145+450	Abutment & Pier	3.0	500	Rock (Shale)
+MNB -50	151+250	Abutment & Pier	2.5	450	SDR
			5.0	500	Rock (Shale)
+MNB -51	153+750	Abutment & Pier	5.0	300	Clayey sand
+MNB-52	155+690	Abutment & Pier	3.0	250	Clayey sand
			5.5	500	Rock (Shale)
+MNB -53	156+080	Abutment & Pier	5.5	450	SDR
MNB -54	161+100	Abutment & Pier	3.5	500	Rock (Shale)
MNB -55	164+575	Abutment & Pier	3.5	500	Rock (Shale)
MNB -56	167+050	Abutment & Pier	4.0	250	Clayey sand
MNB -57	168+500	Abutment & Pier	3.5	500	Rock (Shale)
ROB	170+550	Abutment & Pier	3.0	500	Rock (Shale)

Note: + for the foundation depth more than 5m, alternatively pile foundations are recommended.

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.

Alternatively pile foundations are recommended for the following structures. The recommended pile capacity are tabulated below

Pile Capacity Recommendations									
BH. No.	Dia of pile (M)	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
MNB 38	1.0	8.0	6.0	5000	3500	300	410000	30000	WR
	1.2	8.6	6.6	8000	5000	450	660000	37500	WR
	1.5	9.5	7.5	12500	8500	750	1040000	50000	WR

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

Pile Capacity Recommendations									
BH. No.	Dia of pile (M)	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
MNB 42	1.0	7.5	5.5	5000	3500	250	410000	25000	WR
	1.2	8.1	6.1	8000	5000	400	660000	33000	WR
	1.5	9.0	7.0	12500	8500	650	1040000	43000	WR
MNB 45	1.0	11.0	9.0	5000	3500	250	410000	25000	WR
	1.2	11.6	9.6	8000	5000	400	660000	33000	WR
	1.5	12.5	10.5	12500	8500	650	1040000	43000	WR
MNB 46	1.0	8.0	6.0	5000	3500	250	410000	25000	WR
	1.2	8.6	6.6	8000	5000	400	660000	33000	WR
	1.5	9.5	7.5	12500	8500	650	1040000	43000	WR
MNB 47	1.0	12.0	10.0	5000	3500	250	410000	25000	WR
	1.2	12.6	10.6	8000	5000	400	660000	33000	WR
	1.5	13.5	11.5	12500	8500	650	1040000	43000	WR
MNB 50	1.0	7.5	5.5	5000	3500	250	410000	25000	WR
	1.2	8.1	6.1	8000	5000	400	660000	33000	WR
	1.5	9.0	7.0	12500	8500	650	1040000	43000	WR
MNB 51	1.0	13.5	11.5	5000	3500	250	410000	25000	WR
	1.2	14.1	12.1	8000	5000	400	660000	33000	WR
	1.5	15.0	13.0	12500	8500	650	1040000	43000	WR
MNB 52	1.0	7.5	5.5	5000	3500	250	410000	25000	WR
	1.2	8.1	6.1	8000	5000	400	660000	33000	WR
	1.5	9.0	7.0	12500	8500	650	1040000	43000	WR
MNB 53	1.0	9.0	7.0	5000	3500	250	410000	25000	WR
	1.2	9.6	7.6	8000	5000	400	660000	33000	WR
	1.5	10.5	8.5	12500	8500	650	1040000	43000	WR

Note : Weathered rock WR (SPT>100 or RQD nil) stratum, Length of socket is about 3D

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 Reddy
Geotech Engineer



Annexure – I

Comprehensive Sub Soil Profile

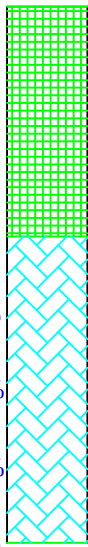
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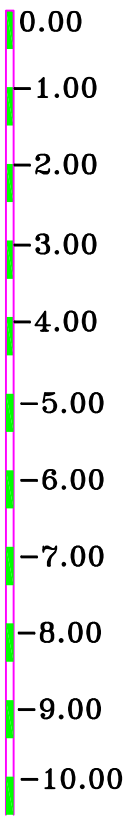
BH-1
(CH. 98+290)



N=12
N>100
CR/RQD
56%/10%
74%/38%
72%/52%
86%/86%



Depth Below
EGL

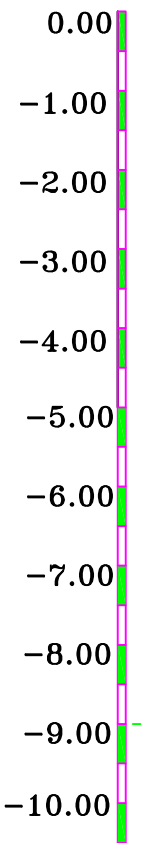


- LEGEND:
- BORE HOLES.
 - SILTY CLAY(CL).
 - HARD ROCK.

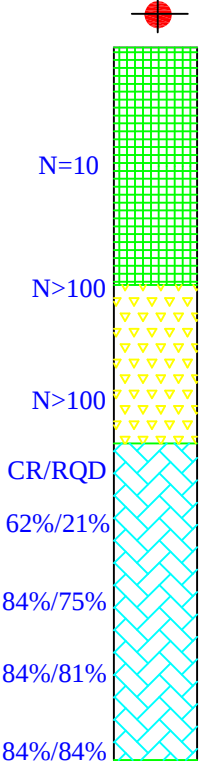
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TITLE	PROJECT:
COMPREHENSIVE SUB SOIL PROFILE	GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER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

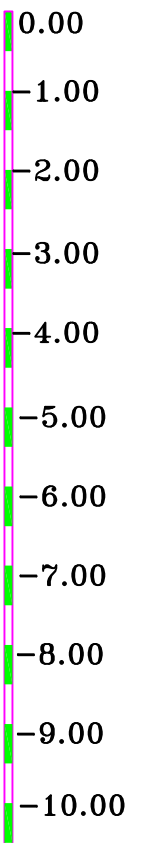
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EGL



BH-1
(CH.99+590)



Depth Below
EGL

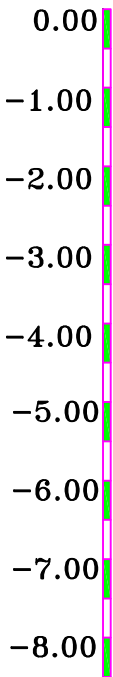


- LEGEND:
- BORE HOLES.
 - SILTY CLAY(CL).
 - SOFT DISINTEGRATED ROCK.
 - HARD ROCK.

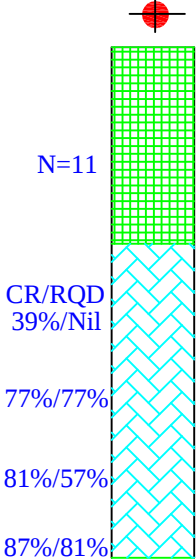
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TITLE:	PROJECT:
COMPREHENSIVE SUB SOIL PROFILE	GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER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

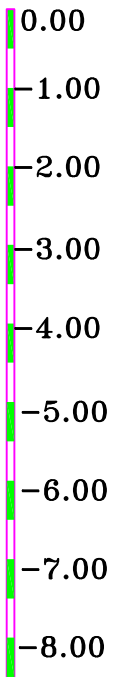
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BH-1
(CH. 101+500)



Depth Below
EGL

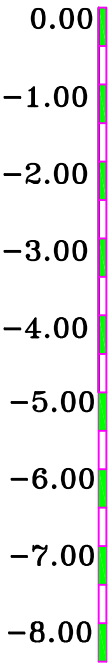


- LEGEND:
- BORE HOLES.
 - SILTY CLAY(CL).
 - HARD ROCK.

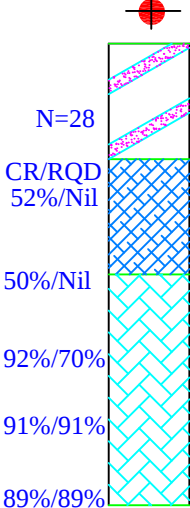
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COMPREHENSIVE SUB SOIL PROFILE	GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

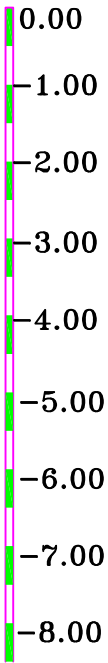
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BH-1
(MNB-37)



Depth Below
EGL

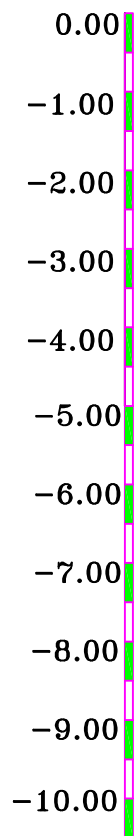


- LEGEND:
- BORE HOLES.
 - CLAYEY SAND (SC).
 - WEATHER ROCK/FRACTURED
 - HARD ROCK.

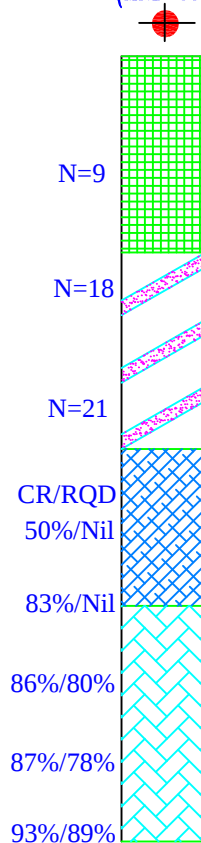
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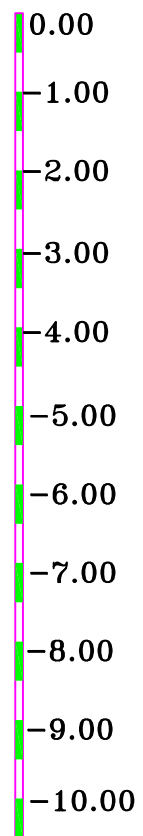
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BH-1
(MNB-38)



Depth Below
EGL



LEGEND:

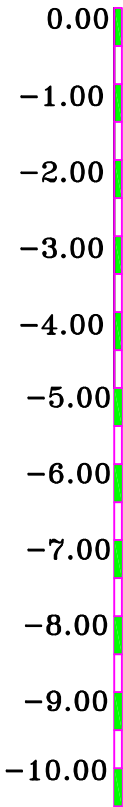
- BORE HOLES.
- SILTY CLAY (CL).
- CLAYEY SAND (SC).
- WEATHER ROCK/FRACTURED
- HARD ROCK.

SCALE :- NOT TO SCALE.

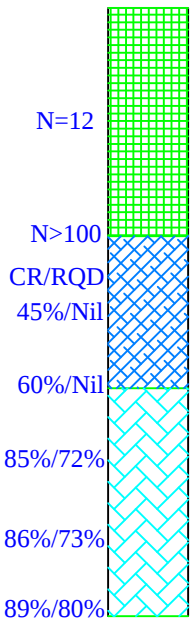
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COMPREHENSIVE SUB SOIL PROFILE

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.

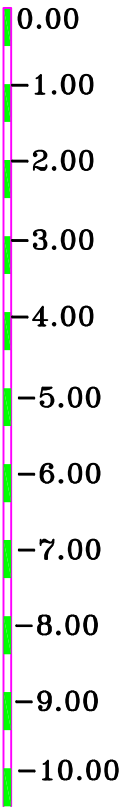
Depth Below
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BH-1
(MNB-39)



Depth Below
EGL



- LEGEND:
- BORE HOLES.
 - SILTY CLAY(CL).
 - WEATHER ROCK/FRACTURED
 - HARD ROCK.

SCALE :- NOT TO SCALE.

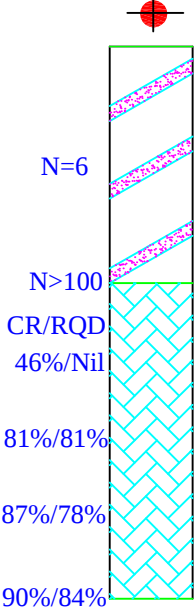
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COMPREHENSIVE SUB SOIL PROFILE

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.

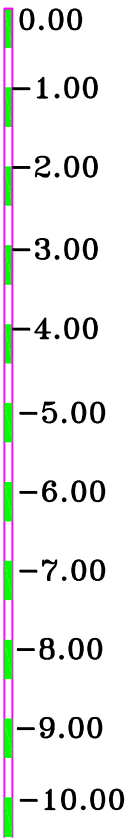
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BH-1
(MNB-40)



Depth Below
EGL

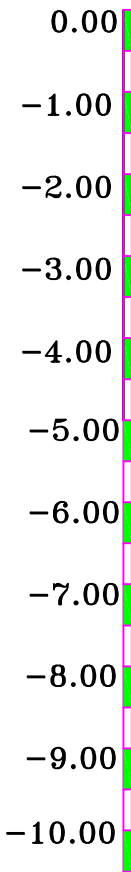


- LEGEND:
- BORE HOLES.
 - SILTY CLAY(CL).
 - HARD ROCK.

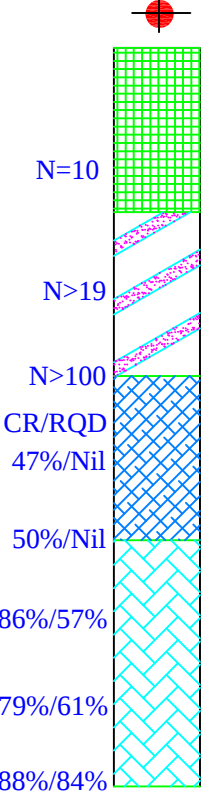
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COMPREHENSIVE SUB SOIL PROFILE	GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADE TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

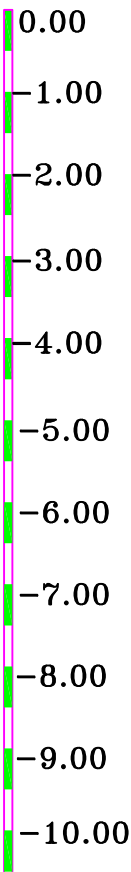
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BH- 1
(CH.109+550)



Depth Below
EGL

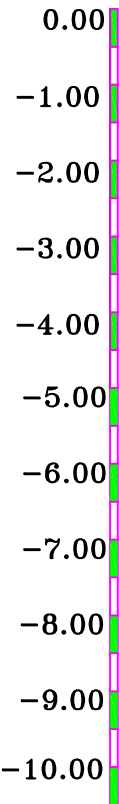


- LEGEND:
- BORE HOLES.
 - SILTY CLAY(CL).
 - CLAYEY SAND (SC).
 - WEATHER ROCK/FRACTURED
 - HARD ROCK.

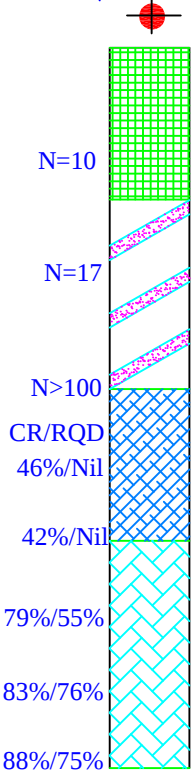
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TITLE:	PROJECT:
COMPREHENSIVE SUB SOIL PROFILE	GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER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

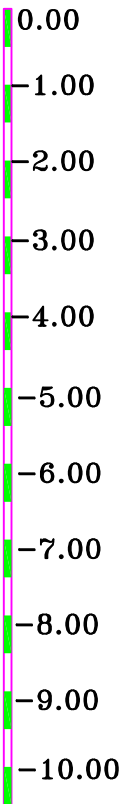
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BH-1
(CH.109+650)



Depth Below
EGL

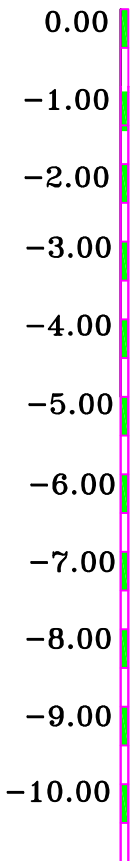


- LEGEND:
- BORE HOLES.
 - SILTY CLAY(CL).
 - CLAYEY SAND (SC).
 - WEATHER ROCK/FRACTURED
 - HARD ROCK.

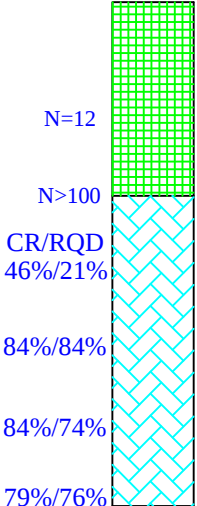
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TITLE:	PROJECT:
COMPREHENSIVE SUB SOIL PROFILE	GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADEATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS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

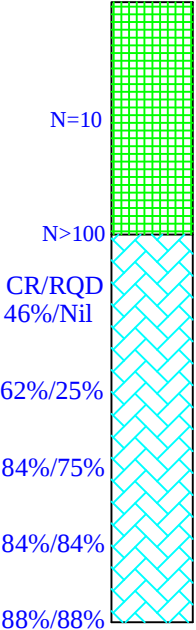
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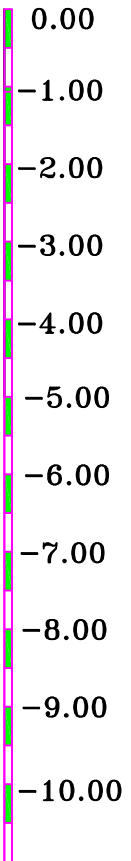
BH-1
(CH. 112+620)



BH-2
(CH.112+620)



Depth Below
EGL

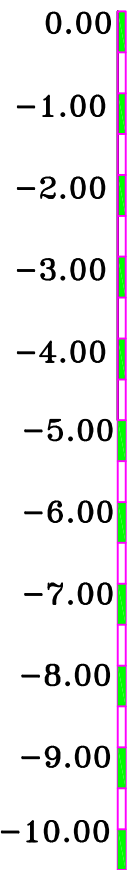


- LEGEND:**
- BORE HOLES.
 - SILTY CLAY(CL).
 - HARD ROCK.

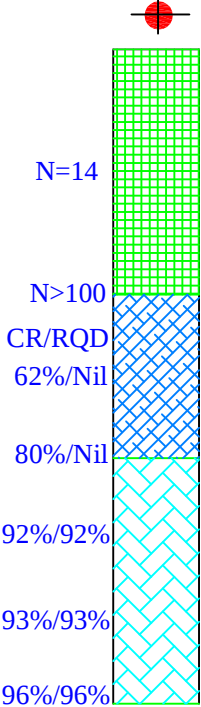
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TITLE: COMPREHENSIVE SUB SOIL PROFILE	PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER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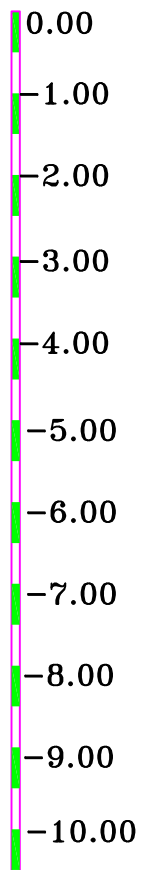
Depth Below
EGL



BH-1
(CH.116+775)



Depth Below
EGL

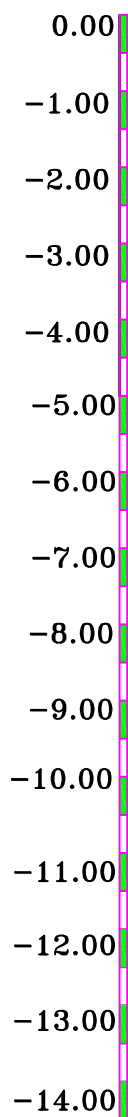


- LEGEND:
- BORE HOLES.
 - SILTY CLAY (CL).
 - WEATHERED ROCK/FRACTURED
 - HARD ROCK.

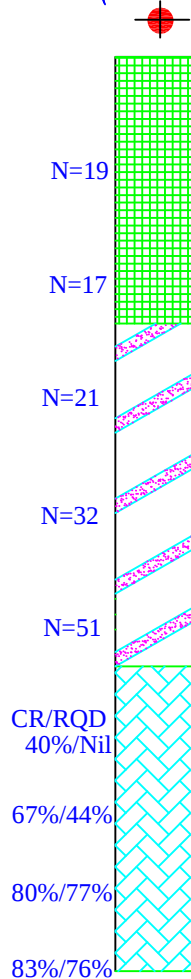
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TITLE:	PROJECT:
COMPREHENSIVE SUB SOIL PROFILE	GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADE TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER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

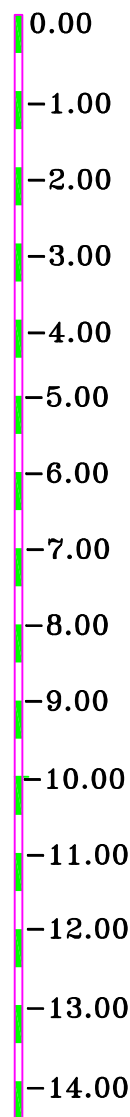
Depth Below
EGL



BH-1
(CH.119+300)



Depth Below
EGL



LEGEND:

- BORE HOLES.
- SILTY CLAY(CL).
- CLAYEY SAND (SC).
- HARD ROCK.

SCALE :- NOT TO SCALE.

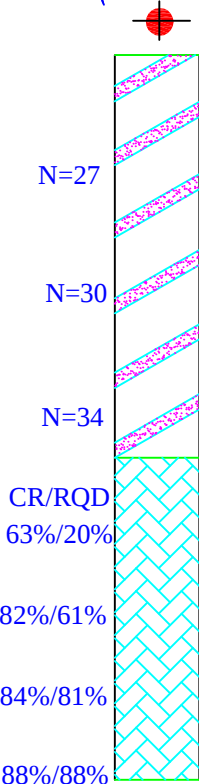
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COMPREHENSIVE SUB SOIL PROFILE

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.

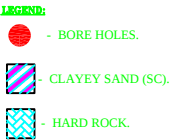
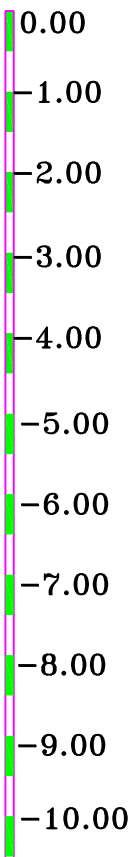
Depth Below
EGL



BH-1
(CH.119+400)



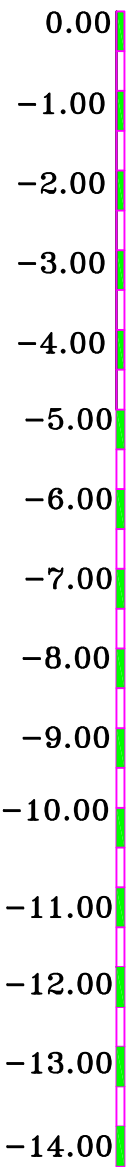
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EGL



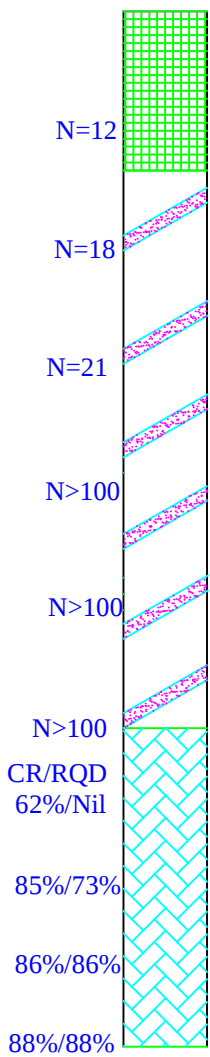
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TITLE: COMPREHENSIVE SUB SOIL PROFILE	PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER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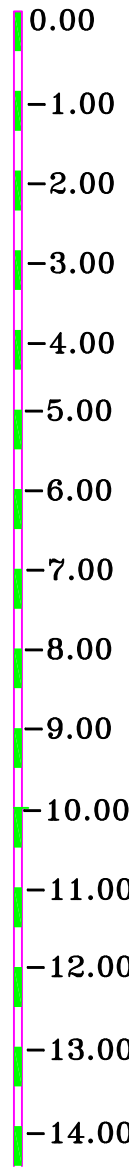
Depth Below
EGL



BH-1
(CH.119+500)



Depth Below
EGL



- LEGEND:
- BORE HOLES.
 - CLAYEY SAND (SC).
 - HARD ROCK.

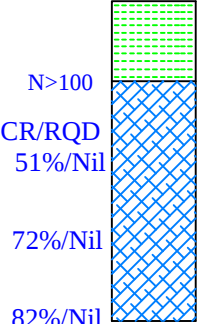
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TITLE: COMPREHENSIVE SUB SOIL PROFILE	PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED CONSTRUCTION UPGRADATION TO 2/4 LANE NH-167 KALWAKURTHY IN TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.
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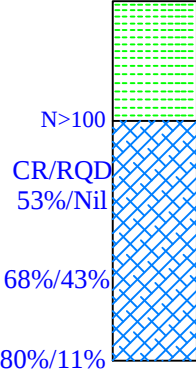
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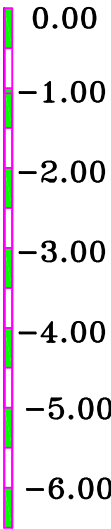
BH-1
(CH. 135+220)



BH-2
(CH.135+220)



Depth Below
EGL



LEGEND:

- BORE HOLES.

- WEATHER ROCK/FRACTURED

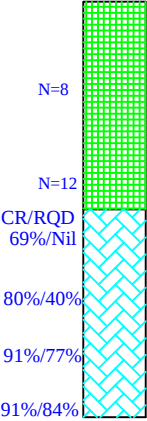
SCALE :- NOT TO SCALE.

TITLE:	PROJECT:
COMPREHENSIVE SUB SOIL PROFILE	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.

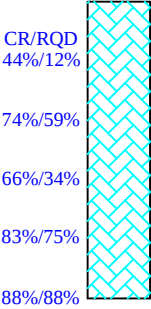
Depth Below
EGL



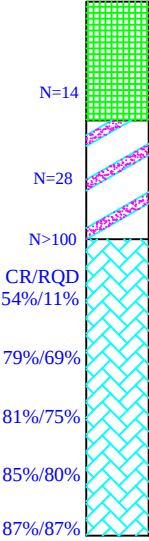
BH-1
(CH. 143+300)



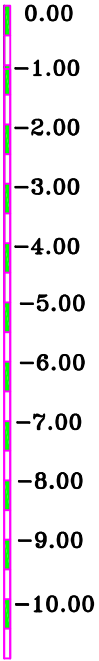
BH-2
(CH.143+300)



BH-3
(CH.143+300)



Depth Below
EGL

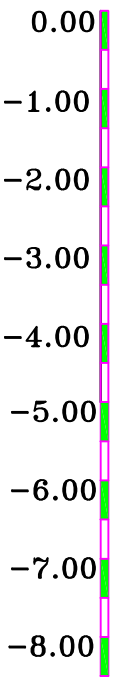


- LEGEND:
- BORE HOLES.
 - SILTY CLAY (CL).
 - CLAYEY SAND (SC).
 - HARD ROCK.

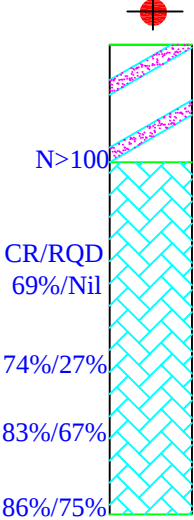
SCALE :- NOT TO SCALE.

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.
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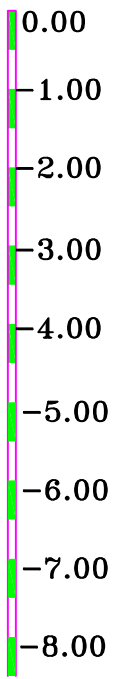
Depth Below
EGL



BH-1
(145+450)



Depth Below
EGL

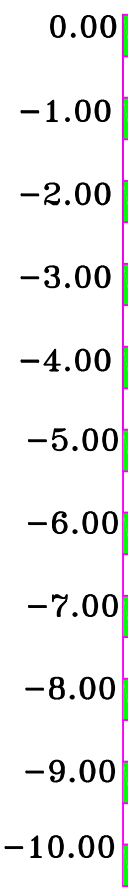


- LEGEND:
- BORE HOLES.
 - CLAYEY SAND (SC).
 - HARD ROCK.

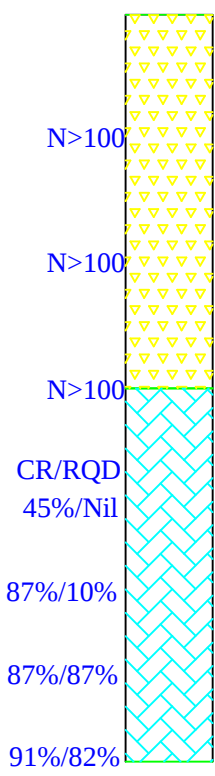
SCALE :- NOT TO SCALE.

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.

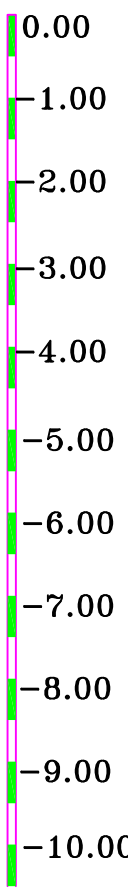
Depth Below
EGL



BH-1
(CH.151+250)



Depth Below
EGL



- LEGEND:
- BORE HOLES.
 - 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-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-153+750

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

N=9

N=10

N=20

N=23

N=29

N=51

N>100

CR/RQD
44%/Nil

85%/80%

90%/87%

92%/88%

N=7

N=17

N=20

N=23

N=30

N>100

N>100

CR/RQD
49%/Nil

76%/71%

84%/78%

87%/64%

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

LEGEND:

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

SCALE :- NOT TO SCALE.

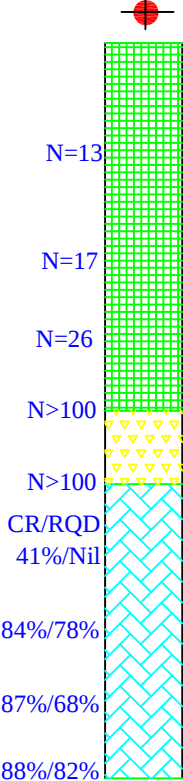
TITLE:
COMPREHENSIVE SUB SOIL PROFILE

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

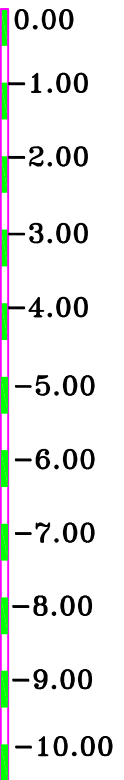
Depth Below
EGL



BH-1
(CH.156+080)



Depth Below
EGL

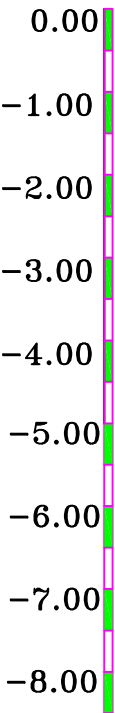


- LEGEND:
- BORE HOLES.
 - SILTY CLAY(CL).
 - SOFT DISINTEGRATED ROCK.
 - HARD ROCK.

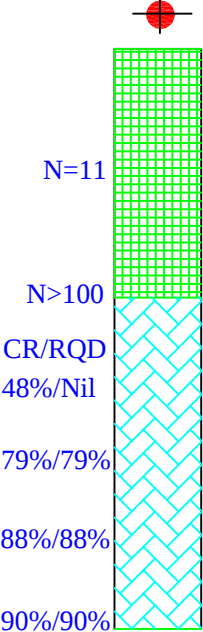
SCALE :- NOT TO SCALE.

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.

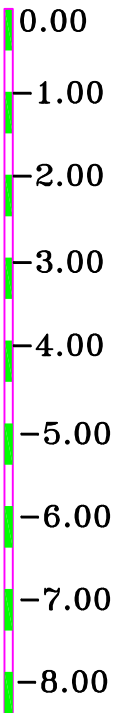
Depth Below
EGL



BH-1
(161+100)



Depth Below
EGL



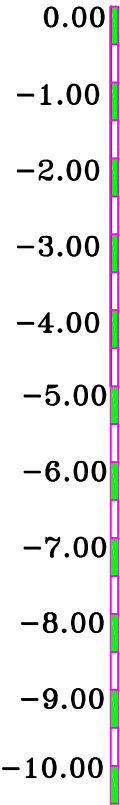
- LEGEND:
- BORE HOLES.
 - SILTY CLAY(CL).
 - HARD ROCK.

SCALE :- NOT TO SCALE.

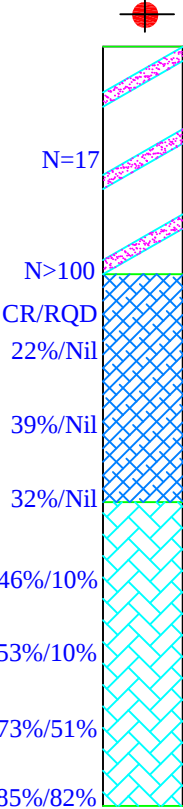
TITLE:
COMPREHENSIVE SUB SOIL PROFILE

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.

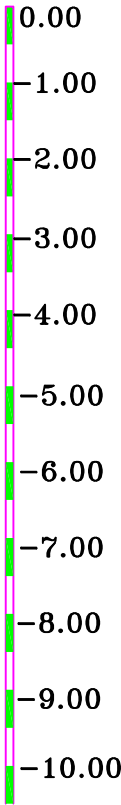
Depth Below
EGL



BH-1
(CH.164+575)



Depth Below
EGL



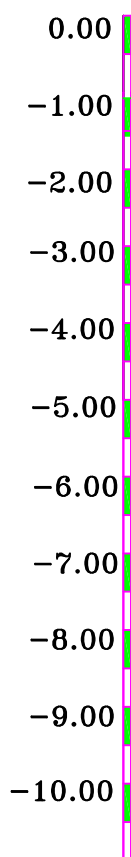
- LEGEND:
- - BORE HOLES.
 - ▨ - CLAYEY SAND (SC).
 - ▩ - WEATHER ROCK/FRACTURED
 - ▧ - HARD ROCK.

SCALE :- NOT TO SCALE.

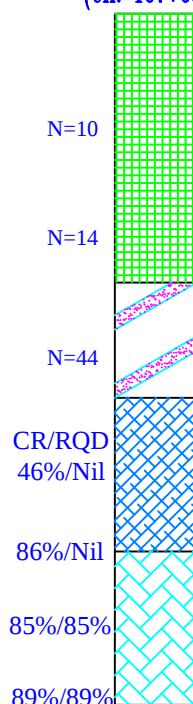
TITLE:
COMPREHENSIVE SUB SOIL PROFILE

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.

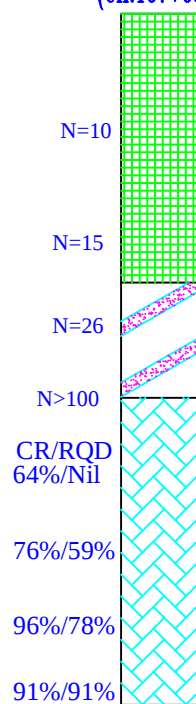
Depth Below
EGL



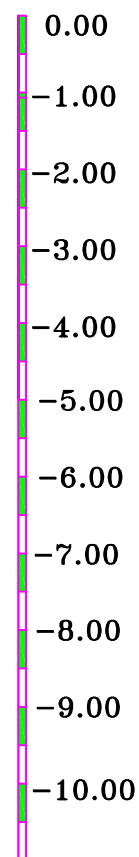
BH-1
(CH. 167+050)



BH-2
(CH.167+050)



Depth Below
EGL



LEGEND:

- - BORE HOLES.
- ▨ CLAYEY SAND (SC).
- ▤ WEATHER ROCK/FRACTURED
- ▧ - HARD ROCK.

SCALE :- NOT TO SCALE.

TITLE:
COMPREHENSIVE SUB SOIL PROFILE

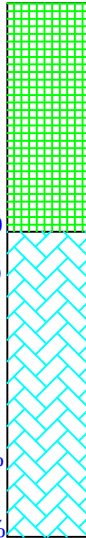
PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED
CONSTRUCTION UPGRADEATION TO 2/4 LANE NH-167 KALWAKURTHY IN
TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH
INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

Depth Below
EGL



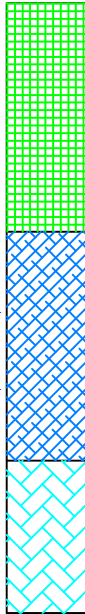
BH-1
(CH. 168+500)

N=17
N>100
CR/RQD
29%/Nil
61%/25%
76%/62%
81%/77%

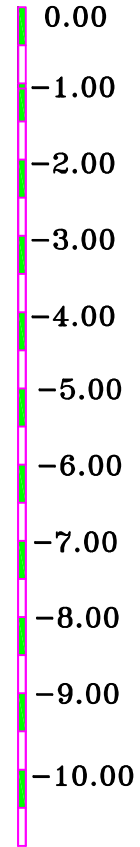


BH-2
(CH.168+500)

N=10
N>100
CR/RQD
35%/Nil
34%/Nil
67%/Nil
76%/65%
89%/72%



Depth Below
EGL



LEGEND:

- - BORE HOLES.
- - SILTY CLAY(CL).
- - WEATHER ROCK/FRACTURED
- - HARD ROCK.

SCALE :- NOT TO SCALE.

TITLE:
COMPREHENSIVE SUB SOIL PROFILE

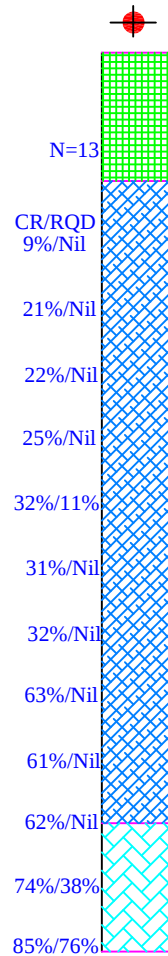
PROJECT: GEOTECHNICAL INVESTIGATION FOR PROPOSED
CONSTRUCTION UPGRADEATION TO 2/4 LANE NH-187 KALWAKURTHY IN
TELANGANA AND CONNECTING WITH NEAR NANDYAL IN ANDHRA PRADESH
INCLUDING FOUR LANE MAJOR BRIDGE ACROSS RIVER KRISHNA.

CH-170+550

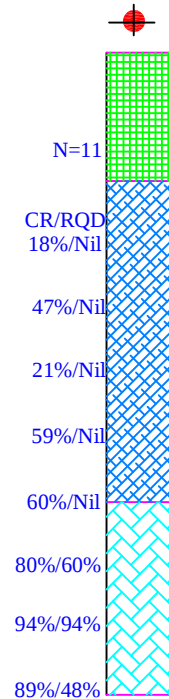
Depth Below
EGL



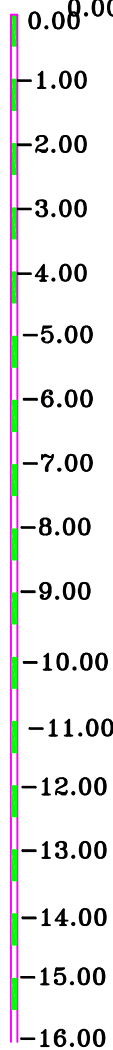
BH-1



BH-2



Depth Below
EGL



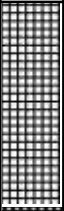
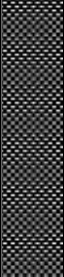
- LEGEND:
- BORE HOLES.
 - SILTY CLAY(CL).
 - WEATHER ROCK/FRACTURED
 - HARD ROCK.

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.

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 : Not met								Location/Chainage : 98+290 (MNB-34)					
Structure : RCC Structure								Date Commenced : 06.03.2022					
Boring Equipment : Calyx / NX Drilling.								Date Completed : 07.03.2022					
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				Brownish silty clay (CL)	-3.00		
2.00													
3.00	3.00-3.11	SPT	50 blows for 11cm penetration						3.00				
4.00	3.00-4.00	Core					56%	10%		Hard Rock (Formation of fine grained SHALE)			
5.00	4.00-5.00	Core					74%	38%					
6.00	5.00-6.00	Core					72%	52%					
7.00	6.00-7.00	Core					86%	86%	7.00				
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 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 : Not met									Location/Chainage : 99+590 (MNB-35)						
Structure : RCC Structure									Date Commenced : 07.03.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 08.03.2022					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	3	4	6	10				Brownish silty clay(CL)					
2.00															
3.00	3.00-3.40	SPT	10	22	50 blows for 10cm penetration				3.0	Very dense moorum /SDR	-3.00				
4.00	4.50-4.59	SPT	50 blows for 9cm penetration						5.00		-5.00				
5.00	5.00-6.00	Core					62%	21%		Hard Rock (Formation of fine grained SHALE)					
6.00	6.00-7.00	Core					84%	75%							
7.00	7.00-8.00	Core					84%	81%							
8.00	8.00-9.00	Core					84%	84%	9.00					-9.00	
9.00										Borehole Terminated					
10.00															
11.00															
12.00															
13.00															
14.00															
15.00															
16.00															
17.00															
18.00															
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 : 4.8m									Location/Chainage : 101+500 (MNB-36)				
Structure : RCC Structure									Date Commenced : 09.03.2022				
Boring Equipment : Calyx / NX Drilling.									Date Completed : 10.03.2022				
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	3	4	7	11			2.50	Brownish silty clay(CL)	-2.50		
2.00													
3.00	1.50-2.50	SPT	50 blows for 5cm penetration							Hard Rock (Formation of fine grained SHALE)			
4.00	2.50-3.50	Core					39%	Nil					
5.00	3.50-4.50	Core					77%	77%					
6.00	4.50-5.50	Core					81%	57%					
7.00	5.50-6.50	Core					87%	81%	6.50				
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 : Undisturbed Sample

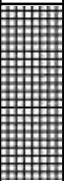
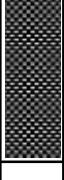
GWT : Ground Water Table

CR : Core Recovery

RQD : Rock Quality Designation

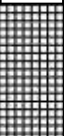
RP: Rate of Penetration

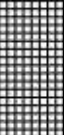
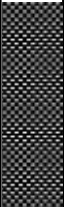
Project Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD													
Boring Method : Rotary								Bore Hole No. : BH-1					
Boring Diameter : 150 mm								RL :					
Depth of GWT : Not met								Location/Chainage : (MNB-37)					
Structure : RCC Structure								Date Commenced : 11.03.2022					
Boring Equipment : Calyx / NX Drilling.								Date Completed : 12.03.2022					
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	1.00-1.45	SPT	8	10	18	28			1.50	Brownish clayey sand (SC)	-1.50		
2.00	1.50-2.00	Core					52%	Nil		Weathered / Fractured rock			
3.00	2.00-3.00	Core					50%	Nil	3.00			-3.00	
4.00	3.00-4.00	Core					92%	70%					
5.00	4.00-5.00	Core					91%	91%					
6.00	5.00-6.00	Core					89%	89%	6.00	Hard Rock (Formation of fine grained SHALE)	-6.00		
7.00										Borehole Terminated			
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 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 : Not met									Location/Chainage : (MNB-38)				
Structure : RCC Structure									Date Commenced : 13.03.2022				
Boring Equipment : Calyx / NX Drilling.									Date Completed : 14.03.2022				
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	3	4	5	9			2.50	Brownish silty clay(CL)	-2.50		
2.00													
3.00	3.00-3.45	SPT	8	8	10	18				Brownish silty clayey sand (SC)			
4.00													
5.00	4.50-4.95	SPT	8	9	12	21			5.00		-5.00		
6.00													
7.00	5.00-6.00	Core					50%	Nil	7.00	Weathered / Fractured rock	-7.00		
8.00	6.00-7.00	Core					83%	Nil					
9.00	7.00-8.00	Core					86%	80%		Hard rock (Formation of fine grained SHALE)			
10.00	8.00-9.00	Core					87%	78%					
10.00	9.00-10.00	Core					93%	89%	10.00		-10.00		
										Borehole Terminated			
11.00													
12.00													
13.00													
14.00													
15.00													
16.00													
17.00													
18.00													
SPT : Standard Penetration Test									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 : 4.1m								Location/Chainage : (MNB-39)					
Structure : RCC Structure								Date Commenced : 14.03.2022					
Boring Equipment : Calyx / NX Drilling.								Date Completed : 14.03.2022 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	3	5	7	12				Brownish silty clay (CL)			
2.00													
3.00	3.00-3.25	SPT	31	50 blows for 10cm penetration						3.00		-3.00	
4.00	3.00-4.00	Core					45%	Nil		Weathered / Fractured rock			
5.00	4.00-5.00	Core					60%	Nil	5.00			-5.00	
6.00	5.00-6.00	Core					85%	72%		Hard rock (Formation of fine grained SHALE)			
7.00	6.00-7.00	Core					86%	73%					
8.00	7.00-8.00	Core					89%	80%	8.00				-8.00
9.00										Borehole Terminated			
10.00													
11.00													
12.00													
13.00													
14.00													
15.00													
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 : 5.0m									Location/Chainage : (MNB-40)						
Structure : RCC Structure									Date Commenced : 15.03.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 16.03.2022					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	2	3	3	6			3.00	Silty clay with sand(SC)	-3.00				
2.00															
3.00	3.00-3.25	SPT	20	50 blows for 10cm penetration						Hard rock (Formation of fine grained SHALE)					
4.00	3.00-4.00	Core					46%	Nil							
5.00	4.00-5.00	Core					81%	81%							
6.00	5.00-6.00	Core					87%	78%							
7.00	6.00-7.00	Core					90%	84%	7.00						
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 : 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 : 5.0m									Location/Chainage : 109+550 (MNB-41)						
Structure : RCC Structure									Date Commenced : 16.03.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 17.03.2022					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	3	4	6	10			2.0	greyish brown silty clay (CL)	-2.00				
2.00										Greyish clay with sand(SC)					
3.00	3.00-3.45	SPT	6	8	11	19			4.0	Weathered / Fractured rock	-4.00				
4.00	4.00-4.08	SPT	50 blows for 8cm penetration												
5.00	4.00-5.00	Core					47%	Nil	6.00	Hard Rock (Formation of fine grained SHALE)	-6.00				
6.00	5.00-6.00	Core					50%	Nil							
7.00	6.00-7.00	Core					86%	57%							
8.00	7.00-8.00	Core					79%	61%							
9.00	8.00-9.00	Core					88%	84%	9.00		-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									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 : Not met								Location/Chainage : 109+650 (MNB-42)					
Structure : RCC Structure								Date Commenced : 17.03.2022					
Boring Equipment : Calyx / NX Drilling.								Date Completed : 18.03.2022					
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	4	7	11			2.00	Brownish silty clay (CL)	-2.00		
2.00													
3.00	3.00-3.45	SPT	4	7	10	17			4.50	Brownish clay with sand(SC)	-4.50		
4.00													
5.00	4.50-4.61	SPT	50 blows for 11cm penetration						4.50		-4.50		
6.00	4.50-5.50	Core					46%	Nil	6.50	Weathered / Fractured rock	-6.50		
7.00	5.50-6.50	Core					42%	Nil					
8.00	6.50-7.50	Core					79%	55%		Hard Rock (Formation of fine grained SHALE)			
9.00	7.50-8.50	Core					83%	76%					
10.00	8.50-9.50	Core					88%	75%	9.50		-9.50		
10.00										Borehole Terminated			
11.00													
12.00													
13.00													
14.00													
15.00													
16.00													
17.00													
18.00													

SPT : Standard Penetration Test

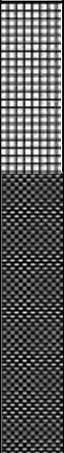
UDS : Undisturbed Sample

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 : Not met									Location/Chainage : 112+620 (MNB-43)				
Structure : RCC Structure									Date Commenced : 12.03.2022				
Boring Equipment : Calyx / NX Drilling.									Date Completed : 13.03.2022				
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	5	7	12			2.50	Brownish silty clay (CL)	-2.50		
2.00													
3.00	2.50-2.62	SPT	50 blows for 12cm penetration							Hard rock (Formation of fine grained SHALE)			
4.00	2.50-3.50	Core					46%	21%					
5.00	3.50-4.50	Core					84%	84%					
6.00	4.50-5.50	Core					84%	74%					
7.00	5.50-6.50	Core					79%	76%					
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 : Undisturbed Sample

GWT : Ground Water Table

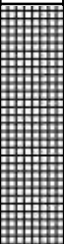
CR : Core Recovery

RQD : Rock Quality Designation

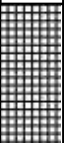
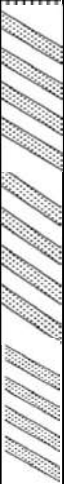
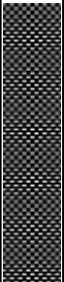
RP: Rate of Penetration

Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyaal 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 : Not met								Location/Chainage : 112+620 (MNB-43)					
Structure : RCC Structure								Date Commenced : 12.03.2022					
Boring Equipment : Calyx / NX Drilling.								Date Completed : 13.03.2022					
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	2	4	6	10				Brownish silty clay (CL)			
2.00													
3.00	3.00-3.25	SPT	10	50 blows for 10cm penetration					3.00		-3.00		
4.00	3.00-4.00	Core					46%	Nil		Hard rock (Formation of fine grained SHALE)			
5.00	4.00-5.00	Core					62%	25%					
6.00	5.00-6.00	Core					84%	75%					
7.00	6.00-7.00	Core					84%	84%					
8.00	7.00-8.00	Core					88%	88%	8.00		-8.00		
9.00										Borehole Terminated			
10.00													
11.00													
12.00													
13.00													
14.00													
15.00													
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 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 : 5m									Location/Chainage : 116+775 (MNB-44)						
Structure : RCC Structure									Date Commenced : 15.03.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 16.03.2022					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	8	14				Brownish silty clay (CL)					
2.00															
3.00	3.00-3.25	SPT	21	50 blows for 10cm penetration					3.00		-3.00				
4.00	3.00-4.00	Core					62%	Nil		Weathered / Fractured rock	-5.00				
5.00	4.00-5.00	Core					80%	Nil	5.00						
6.00	5.00-6.00	Core					92%	92%		Hard rock (Formation of fine grained SHALE)					
7.00	6.00-7.00	Core					93%	93%							
8.00	7.00-8.00	Core					96%	96%	8.00		-8.00				
9.00										Borehole Terminated					
10.00															
11.00															
12.00															
13.00															
14.00															
15.00															
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 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 : Not met									Location/Chainage : 119+300 (MNB-45)																	
Structure : RCC Structure									Date Commenced : 14.03.2022																	
Boring Equipment : Calyx / NX Drilling.									Date Completed : 15.03.2022					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	11	19			3.5	Brownish silty clay (CL)	-3.50															
2.00																										
3.00	3.00-3.45	SPT	4	7	10	17																				
4.00																										
5.00	4.50-4.95	SPT	6	9	12	21																				
6.00																										
7.00	6.00-6.45	SPT	10	14	18	32																				
8.00																										
9.00	7.50-7.95	SPT	13	22	29	51		8.00	Brownish clayey sand (SC)	-8.00																
10.00																										
11.00	8.00-9.00	Core					40%	Nil																		
12.00																										
13.00	9.00-10.00	Core					67%	44%																		
14.00																										
15.00	10.00-11.00	Core					80%	77%																		
16.00																										
17.00	11.00-12.00	Core					83%	76%		12.00				-12.00												
18.00																										
13.00										Borehole Terminated																
14.00																										
15.00																										
16.00																										
17.00																										
18.00																										
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 : 5m								Location/Chainage : 119+400 (MNB-46)					
Structure : RCC Structure								Date Commenced : 16.03.2022					
Boring Equipment : Calyx / NX Drilling.								Date Completed : 17.03.2022					
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	8	12	15	27			5.00	Brownish silty clayey sand (SC)	-5.00		
2.00													
3.00													
4.00													
5.00	4.50-4.95	SPT	9	15	19	34				Hard rock (Formation of fine grained SHALE)			
6.00													
7.00													
8.00													
9.00	8.00-9.00	Core					88%	88%	9.00		-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													

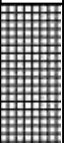
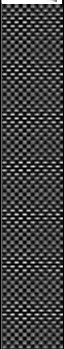
Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-1						
Boring Diameter : 150 mm									RL :						
Depth of GWT : 4.9m									Location/Chainage : 119+500 (MNB-47)						
Structure : RCC Structure									Date Commenced : 16.03.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 17.03.2022					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	3	5	7	12			2.00	Brownish silty clay(CL)	-2.00				
2.00															
3.00	3.00-3.45	SPT	6	8	10	18				Brownish silty clayey sand (SC)					
4.00	4.50-4.95	SPT	6	10	11	21									
5.00															
6.00	6.00-6.25	SPT	21	50 blows 10cm penetration											
7.00	7.50-7.58	SPT	50 blows 8cm penetration												
8.00										Hard Rock (Formation of fine grained SHALE)	-9.00				
9.00	9.00-9.05	SPT	50 blows 5cm penetration						9.00						
10.00	9.00-10.00	Core					62%	Nil							
11.00	10.00-11.00	Core					85%	73%							
12.00	11.00-12.00	Core					86%	86%							
13.00	12.00-13.00	Core					88%	88%	13.00		-13.00				
14.00										Borehole Terminated					
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		: Not met						Location/Chainage : 135+220 (MNB-48)					
Structure		: RCC Structure						Date Commenced : 21.02.2022					
Boring Equipment		: Calyx / NX Drilling.						Date Completed		: 22.02.2022		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	1.00-1.05	SPT	50 blows 5cm penetration						1.00	Top soil			
2.00	1.00-2.00	Core					51%	Nil	Weathered / Fractured rock				
3.00	2.00-3.00	Core					72%	Nil					
4.00	3.00-4.00	Core					82%	Nil		4.00		-4.00	
5.00									Borehole Terminated				
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 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 : Not met								Location/Chainage : 135+220 (MNB-48)					
Structure : RCC Structure								Date Commenced : 19.02.2022					
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	1.00-1.04	SPT	50 blows 4cm penetration						1.00	Top soil	-1.00		
2.00	1.50-2.50	Core				53%	Nil		Weathered / Fractured rock (Formation of fine grained SHALE)				
3.00													
4.00													
4.00	2.50-3.50	Core				68%	43%						
4.00	3.50-4.50	Core				80%	11%	4.50		-4.50			
5.00	Borehole Terminated												
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 Test UDS : Undisturbed Sample GWT : Ground Water Table													
CR : Core Recovery RQD : Rock Quality Designation RP: Rate of Penetration													

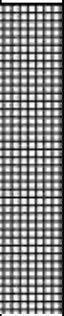
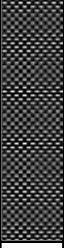
Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyaal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-1						
Boring Diameter : 150 mm									RL :						
Depth of GWT : Not met									Location/Chainage : 143+300 (MJB-4)						
Structure : RCC Structure									Date Commenced : 14.02.2022						
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	3	3	5	8			3.50	Brownish silty clay (CL)	-3.50				
2.00															
3.00	3.00-3.45	SPT	4	6	6	12				Hard rock (Formation of fine grained SHALE)					
4.00	3.50-4.00	Core					69%	Nil							
5.00	4.00-5.00	Core					80%	40%							
6.00	5.00-6.00	Core					91%	77%							
7.00	6.00-7.00	Core					91%	84%	7.00		-7.00				
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									CR : Core Recovery						
UDS : Undisturbed Sample									RQD : Rock Quality Designation						
GWT : Ground Water Table									RP: Rate of Penetration						

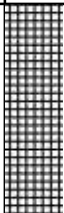
Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna											
BOREHOLE RECORD													
Boring Method : Rotary								Bore Hole No. : BH-2					
Boring Diameter : 150 mm								RL :					
Depth of GWT : Not met								Location/Chainage : 143+300 (MJB-4)					
Structure : RCC Structure								Date Commenced : 11.02.2022					
Boring Equipment : Calyx / NX Drilling.								Date Completed : 13.02.2022 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	0.00-1.00	Core					44%	12%		Hard rock (Formation of fine grained SHALE)			
2.00	1.00-2.00	Core					74%	59%					
3.00	2.00-3.00	Core					66%	34%					
4.00	3.00-4.00	Core					83%	75%					
5.00	4.00-5.00	Core					88%	88%	5.00				
6.00										Borehole Terminated			
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 Test										CR : Core Recovery			
UDS : Undisturbed Sample										RQD : Rock Quality Designation			
GWT : Ground Water Table										RP: Rate of Penetration			

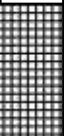
Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna											
BOREHOLE RECORD													
Boring Method : Rotary									Bore Hole No. : BH-3				
Boring Diameter : 150 mm									RL :				
Depth of GWT : Not met									Location/Chainage : 143+300 (MJB-4)				
Structure : RCC Structure									Date Commenced : 16.02.2022				
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	1.50-1.95	SPT	4	6	8	14			2.00	Brownish silty clay (CL)	-2.00		
2.00													
3.00	3.00-3.45	SPT	10	14	14	28			4.00	Brownish silty clayey sand(SC)	-4.00		
4.00	4.00-4.04	SPT	50 blows 4cm penetration										
5.00	4.00-5.00	Core					54%	11%		Hard rock (Formation of fine grained SHALE)			
6.00	5.00-6.00	Core					79%	69%					
7.00	6.00-7.00	Core					81%	75%					
8.00	7.00-8.00	Core					85%	80%					
9.00	8.00-9.00	Core					87%	87%	9.00	-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									CR : Core Recovery				
UDS : Undisturbed Sample									RQD : Rock Quality Designation				
GWT : Ground Water Table									RP: Rate of Penetration				

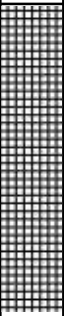
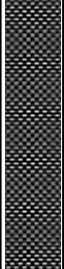
Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna											
BOREHOLE RECORD													
Boring Method : Rotary									Bore Hole No. : BH-1				
Boring Diameter : 150 mm									RL :				
Depth of GWT : 4.0m									Location/Chainage : 145+450 (MNB-49)				
Structure : RCC Structure									Date Commenced : 19.03.2022				
Boring Equipment : Calyx / NX Drilling.									Date Completed : 20.03.2022				
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	1.50-1.75	SPT	24	50 blows 10cm penetration					2.00	Brownish silty clayey sand (SC)	-2.00		
2.00													
3.00	2.00-3.00	Core					69%	Nil		Hard rock (Formation of fine grained SHALE)			
4.00	3.00-4.00	Core					74%	27%					
5.00	4.00-5.00	Core					83%	67%					
6.00	5.00-6.00	Core					86%	75%	6.00		-6.00		
7.00										Borehole Terminated			
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 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 : 3.6m								Location/Chainage : 151+250 (MNB-50)					
Structure : RCC Structure								Date Commenced : 19.03.2022					
Boring Equipment : Calyx / NX Drilling.								Date Completed : 20.03.2022 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	1.50-1.76	SPT	24	50 blows for 11cm penetration						Very dense moorum /SDR	-4.50		
2.00													
3.00	3.00-3.10	SPT	50 blows for 10cm penetration										
4.00	4.50-4.58	SPT	50 blows for 8cm penetration					4.50					
5.00													
6.00	5.00-6.00	Core					45%	Nil	Hard rock (Formation of fine grained SHALE)				
7.00	6.00-7.00	Core					87%	10%					
8.00	7.00-8.00	Core					87%	87%					
9.00	8.00-9.00	Core					91%	82%					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 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 : 153+750 (MNB-51)											
Structure : RCC Structure									Date Commenced : 22.03.2022											
Boring Equipment : Calyx / NX Drilling.									Date Completed : 23.03.2022											
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	3	4	5	9			4.50	Greyish brown silty clay (CL)	-4.50									
2.00																				
3.00	3.00-3.45	SPT	4	5	5	10														
4.00	4.50-4.95	SPT	7	9	11	20														
5.00																				
6.00	6.00-6.45	SPT	9	10	13	23			Brownish clayey sand (SC)	-10.50										
7.00	7.50-7.95	SPT	10	13	16	29														
8.00																				
9.00	9.00-9.45	SPT	14	19	32	51														
10.00	10.50-10.60	SPT	50 blows for 10cm penetration																	
11.00																				
12.00	11.00-12.00	Core					44%	Nil	10.5		Hard rock (Formation of fine grained SHALE)									
13.00	12.00-13.00	Core					85%	80%												
14.00	13.00-14.00	Core					90%	87%												
15.00	14.00-15.00	Core					92%	88%	15.00	-15.00										
16.00										Borehole Terminated										
17.00																				
18.00																				
18.00																				
SPT : Standard Penetration Test									CR : Core Recovery											
UDS : Undisturbed Sample									RQD : Rock Quality Designation											
GWT : Ground Water Table									RP: Rate of Penetration											

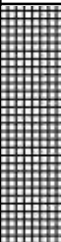
Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna											
BOREHOLE RECORD													
Boring Method : Rotary									Bore Hole No. : BH-2				
Boring Diameter : 150 mm									RL :				
Depth of GWT : 3.0m									Location/Chainage : 153+750 (MNB-51)				
Structure : RCC Structure									Date Commenced : 19.03.2022				
Boring Equipment : Calyx / NX Drilling.									Date Completed : 20.03.2022				
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	3	3	4	7			3.00	Brownish silty clay (CL)	-3.00		
2.00													
3.00	3.00-3.45	SPT	4	6	11	17			8.50	Brownish clayey sand (SC)	-8.5		
4.00													
5.00	4.50-4.95	SPT	7	8	11	19			10.50	Very dense moorum / SDR	-10.5		
6.00													
7.00	6.00-6.45	SPT	7	12	14	26			14.50	Hard rock (Formation of fine grained SHALE)	-14.50		
8.00													
9.00	7.50-7.95	SPT	11	13	17	30							
10.00	9.00-9.26	SPT	18	50 blows for 11cm penetration									
11.00	10.50-10.58	SPT	50 blows for 8cm penetration										
12.00	10.50-11.50	Core					49%	Nil					
13.00	11.50-12.50	Core					76%	71%					
14.00	12.50-13.50	Core					84%	78%					
15.00	13.50-14.50	Core					87%	64%	14.50				
16.00										Borehole Terminated			
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			

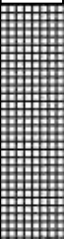
Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna												
BOREHOLE RECORD														
Boring Method : Rotary									Bore Hole No. : BH-1					
Boring Diameter : 150 mm									RL :					
Depth of GWT : 3.2m									Location/Chainage : 155+690 (MNB-52)					
Structure : RCC Structure									Date Commenced : 21.03.2022					
Boring Equipment : Calyx / NX Drilling.									Date Completed : 22.03.2022				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	3	4	6	10			2.00	Brownish silty clay(CL)	-2.00			
2.00										Brownish clayey sand (SC)				
3.00	3.00-3.45	SPT	8	11	14	25			4.50		-4.50			
4.00	4.50-4.76	SPT	31	50 blows for 11cm penetration						Weathered / Fractured rock				
5.00														
6.00	5.00-6.00	Core					57%	Nil	7.00	Hard rock (Formation of fine grained SHALE)	-7.00			
7.00	6.00-7.00	Core					73%	Nil						
8.00	7.00-8.00	Core					85%	77%						
9.00	8.00-9.00	Core					87%	87%	9.00		-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									CR : Core Recovery					
UDS : Undisturbed Sample									RQD : Rock Quality Designation					
GWT : Ground Water Table									RP: Rate of Penetration					

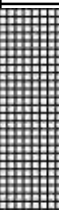
Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna												
BOREHOLE RECORD														
Boring Method : Rotary									Bore Hole No. : BH-1					
Boring Diameter : 150 mm									RL :					
Depth of GWT : 3.6m									Location/Chainage : 156+080 (MNB-53)					
Structure : RCC Structure									Date Commenced : 22.03.2022					
Boring Equipment : Calyx / NX Drilling.									Date Completed : 23.03.2022					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	7	13			5.00	Brownish sandy silty clay (CL)	-5.00			
2.00														
3.00	3.00-3.45	SPT	6	6	11	17								
4.00	4.00-4.45	SPT	10	11	15	26								
5.00	5.00-5.10	SPT	50 blows for 10cm penetration						6.00	Boulder	-6.00			
6.00	6.00-6.07	SPT	50 blows for 7cm penetration											
7.00	6.00-7.00	Core					41%	Nil	10.00	Hard rock (Formation of fine grained SHALE)	-10.00			
8.00	7.00-8.00	Core					84%	78%						
9.00	8.00-9.00	Core					87%	68%						
10.00	9.00-10.00	Core					88%	82%						
										Borehole Terminated				
11.00														
12.00														
13.00														
14.00														
15.00														
16.00														
17.00														
18.00														
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 : 4.0m								Location/Chainage : 161+100 (MNB-54)					
Structure : RCC Structure								Date Commenced : 21.03.2022					
Boring Equipment : Calyx / NX Drilling.								Date Completed : 22.03.2022 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	5	6	11				brownish sandy silty clay (CL)			
2.00													
3.00	3.00-3.22	SPT	24	50 blows for 12cm penetration						3.00		-3.00	
4.00	3.00-4.00	Core					48%	Nil		Hard rock (Formation of fine grained SHALE)			
5.00	4.00-5.00	Core					79%	79%					
6.00	5.00-6.00	Core					88%	88%					
7.00	6.00-7.00	Core					90%	90%	7.00		-7.00		
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 CR : Core Recovery UDS : Undisturbed Sample RQD : Rock Quality Designation GWT : Ground Water Table RP: Rate of Penetration													

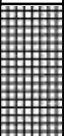
Project		Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna													
BOREHOLE RECORD															
Boring Method : Rotary									Bore Hole No. : BH-1						
Boring Diameter : 150 mm									RL :						
Depth of GWT : 3.1m									Location/Chainage : 164+575 (MNB-55)						
Structure : RCC Structure									Date Commenced : 23.03.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 24.03.2022					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	7	10	17				Brownish silty clayey sand (SC)					
2.00															
3.00	3.00-3.22	SPT	14	50 blows for 12cm penetration					3.00		-3.00				
4.00	3.00-4.00	Core					22%	Nil		Weathered / Fractured rock					
5.00	4.00-5.00	Core					39%	Nil			6.00	-6.00			
6.00	5.00-6.00	Core					32%	Nil							
7.00	6.00-7.00	Core					46%	10%		Hard rock (Formation of fine grained SHALE)					
8.00	7.00-8.00	Core					53%	10%							
9.00	8.00-9.00	Core					73%	51%							
10.00	9.00-10.00	Core					85%	82%	10.00						
										Borehole Terminated					
11.00															
12.00															
13.00															
14.00															
15.00															
16.00															
17.00															
18.00															
SPT : Standard Penetration Test									CR : Core Recovery						
UDS : Undistrubed Sample									RQD : Rock Quality Designation						
GWT : Ground Water Table									RP: Rate of Penetration						

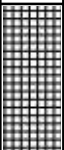
Project	Geotechnical Investigation for up gradation to 2/4 lane NH-167 Kalwalkurthy in Telangana and : connecting with NH-40 near Nabdyal in Andhra Pradesh. Including four lane Major Bridge across river Krishna												
BOREHOLE RECORD													
Boring Method : Rotary									Bore Hole No. : BH-1				
Boring Diameter : 150 mm									RL :				
Depth of GWT : 3.8m									Location/Chainage : 167+050 (MNB-56)				
Structure : RCC Structure									Date Commenced : 23.03.2022				
Boring Equipment : Calyx / NX Drilling.									Date Completed : 24.03.2022				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	3	4	6	10			3.5	Greyish silty clay (CL)	-3.50		
2.00													
3.00	3.00-3.45	SPT	4	7	7	14			5.00	Greyish clayey sand (SC)	-5.00		
4.00													
5.00	4.50-4.95	SPT	10	20	24	44	46%	Nil	7.00	Weathered / Fractured rock	-7.00		
6.00													
7.00	5.00-6.00	Core					86%	Nil	9.00	Hard rock (Formation of fine grained SHALE)	-9.00		
8.00													
9.00	6.00-7.00	Core					85%	85%					
	7.00-8.00	Core					89%	89%					
	8.00-9.00	Core											
10.00	Borehole Terminated												
11.00													
12.00													
13.00													
14.00													
15.00													
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 :						
Depth of GWT : 3.5m									Location/Chainage : 167+050 (MNB-56)						
Structure : RCC Structure									Date Commenced : 25.03.2022						
Boring Equipment : Calyx / NX Drilling.									Date Completed : 26.03.2022					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	3	4	7	11			3.5	Greyish silty clay (CL)	-3.50				
2.00															
3.00	3.00-3.45	SPT	4	6	9	15									
4.00	4.00-4.45	SPT	10	12	14	26									
5.00	5.00-5.11	SPT	50 blows for 11cm penetration						5.0	Greyish silty clayey sand (SC)	-5.00				
6.00	5.00-6.00	Core					64%	Nil		Hard rock (Formation of fine grained SHALE)					
7.00	6.00-7.00	Core					76%	59%							
8.00	7.00-8.00	Core					96%	78%							
9.00	8.00-9.00	Core					91%	91%	9.00		-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										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 : 3.8m									Location/Chainage : 168+500(MNB-57)				
Structure : RCC Structure									Date Commenced : 24.03.2022				
Boring Equipment : Calyx / NX Drilling.									Date Completed : 25.03.2022				
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			3.00	Brownish silty clay (CL)	-3.00		
2.00													
3.00	3.00-3.26	SPT	20	50 blows for 11cm penetration									
4.00	3.00-4.00	Core					29%	Nil		Hard rock (Formation of fine grained SHALE)			
5.00	4.00-5.00	Core					61%	25%					
6.00	5.00-6.00	Core					76%	62%					
7.00	6.00-7.00	Core					81%	77%	7.00				
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									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 : 3.8m									Location/Chainage : 168+500(MNB-57)				
Structure : RCC Structure									Date Commenced : 23.03.2022				
Boring Equipment : Calyx / NX Drilling.									Date Completed : 24.03.2022				
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	3	4	6	10				Brownish silty clay (CL)			
2.00													
3.00	3.00-3.25	SPT	30	50 blows for 10cm penetration					3.00		-3.00		
4.00	3.00-4.00	Core					35%	Nil		Weathered / Fractured rock			
5.00	4.00-5.00	Core					34%	Nil					
6.00	5.00-6.00	Core					67%	Nil	6.00		-6.00		
7.00	6.00-7.00	Core					76%	65%		Hard rock (Formation of fine grained SHALE)			
8.00	7.00-8.00	Core					89%	72%	8.00		-8.00		
9.00										Borehole Terminated			
10.00													
11.00													
12.00													
13.00													
14.00													
15.00													
16.00													
17.00													
18.00													
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 : 4.1m									Location/Chainage : 170+550(ROB)				
Structure : RCC Structure									Date Commenced : 25.03.2022				
Boring Equipment : Calyx / NX Drilling.									Date Completed : 28.03.2022				
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	7	13			2.00	Brownish silty clay (CL)	-2.00		
2.00													
3.00	2.00-3.00	Core					9%	Nil		Weathered / Fractured rock (Formation of fine grained SHALE)			
4.00	3.00-4.00	Core					21%	Nil					
5.00	4.00-5.00	Core					22%	Nil					
6.00	5.00-6.00	Core					25%	Nil					
7.00	6.00-7.00	Core					32%	11%					
8.00	7.00-8.00	Core					31%	Nil					
9.00	8.00-9.00	Core					32%	Nil					
10.00	9.00-10.00	Core					63%	Nil					
11.00	10.00-11.00	Core					61%	Nil					
12.00	11.00-12.00	Core					62%	Nil	12.00				
13.00	12.00-13.00	Core					74%	38%		Hard rock (Formation of fine grained SHALE)	-14.00		
14.00	13.00-14.00	Core					85%	76%	14.00				
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-2					
Boring Diameter : 150 mm									RL :					
Depth of GWT : 5.0m									Location/Chainage : 170+550(ROB)					
Structure : RCC Structure									Date Commenced : 26.03.2022					
Boring Equipment : Calyx / NX Drilling.									Date Completed : 29.03.2022					
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	3	5	6	11			2.00	Brownish silty clay (CL)	-2.00			
2.00														
3.00	2.00-3.00	Core					18%	Nil	7.00	Weathered / Fractured rock (Formation of fine grained SHALE)	-7.00			
4.00	3.00-4.00	Core					47%	Nil						
5.00	4.00-5.00	Core					21%	Nil						
6.00	5.00-6.00	Core					59%	Nil						
7.00	6.00-7.00	Core					60%	Nil						
8.00	7.00-8.00	Core					80%	60%	10.00	Hard rock (Formation of fine grained SHALE)	-10.00			
9.00	8.00-9.00	Core					94%	94%						
10.00	9.00-10.00	Core					89%	48%						
										Borehole Terminated				
11.00														
12.00														
13.00														
14.00														
15.00														
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					

Annexure – III

Laboratory Test Results

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 (%)			Density (kN/m ³)		Shear Test *			Rock Test			
										Gravel	Sand	Silt & Clay									
								w _L	w _P			M	C	Bulk	Dry	Test	C (kN/m ²)	φ'	UCS (Mpa)	Point load Index (MPa)	
Test Methods					IS :1498		IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)			SP: 36 (Part -2)		IS: 2720 (Part-10)			IS: 9143	IS: 8764		
MNB -34 (CH 98+290)	BH-1	1.5	12	SPT	Brownish silty clay	CL	12.8	28	16	0	42	58									
		4.0-5.0	-	Core	Rock (SHALE formation)															21.5	
		6.0-7.0	-	Core																24.3	
MNB 35 (CH 99+590)	BH-1	1.5	10	SPT	Brownish silty clay	CL		30	21	0	45	55									
		6.0-7.0	-	Core	Rock (SHALE formation)															26.1	
		8.0-9.0	-	Core																28.4	
MNB -36 (CH 101+500)	BH-1	1.5	11	SPT	Brownish silty clay	CL	16.5	32	19	3	44	53									
		3.5-4.5	-	Core	Rock (SHALE formation)															32.6	
		4.5-5.5	-	Core																30.9	
MNB -37	BH-1	1.5	28	SPT	Brownish clayey sand	SC	10			7	48	45		18.2	16.50	DS	17	32			
		3.0-4.0	-	Core	Rock (SHALE formation)															29.4	
		4.0-5.0	-	Core																33.8	
MNB -38	BH-1	1.5	9	SPT	Brownish silty clay	CL	10.5	31	22	0	47	53									
		3.0	18	SPT	Brownish silty clayey sand	SC				3	55	42									
		4.5	21	SPT				9.4			5	49	46		18.0	16.45	DS	17	31		
		8.0-9.0	-	Core	Rock (SHALE formation)															36.7	
		9.0-10.0	-	Core																32.9	
MNB 39	BH-1	1.5	12	SPT	Brownish silty clay	CL	10.2	34	24	0	42	58									
		6.0-7.0	-	Core	Rock (SHALE formation)															35.1	
		7.0-8.0	-	Core																37.4	

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 (%)			Density (kN/m ³)		Shear Test *			Rock Test		
										Gravel	Sand	Silt & Clay								
								w _L	w _P			M	C	Bulk	Dry	Test	C (kN/m ²)	φ'	UCS (Mpa)	Point load Index (MPa)
Test Methods					IS :1498		IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)			SP: 36 (Part -2)		IS: 2720 (Part-10)			IS: 9143	IS: 8764	
MNB-40	BH-1	1.5	6	SPT	Silty clay with sand	SC	10.5	22	14	6	57	37								
		4.0-5.0	-	Core	Rock (SHALE formation)														39.8	
		6.0-7.0	-	Core															36.2	
MNB 41 (CH.109+550)	BH-1	1.5	10	SPT	Brownish silty clay	CL		33	23	0	38	62								
		3.0	19	SPT	Brownish silty clayey sand	SC	15.3			5	57	38		17.8	15.44	DS	13	30		
		6.0-7.0	-	Core	Rock (SHALE formation)														30.5	
		7.0-8.0	-	Core															32.9	
MNB 42 (CH.109+650)	BH-1	1.5	11	SPT	Brownish silty clay	CL		34	27	1	39	60								
		3.0	17	SPT	Brownish silty clayey sand	SC	11.8			7	50	43		17.5	15.65	DS	12	30		
		7.5-8.5		Core	Rock (SHALE formation)														26.8	
		8.5-9.5		Core															37.0	
MNB 43 (CH.112+620)	BH-1	1.5	12	SPT	Brownish silty clay	CL	10.9			0	44	56								
		3.5-4.5	-	Core	Rock (SHALE formation)														35.9	
		5.5-6.5	-	Core															40.2	
MNB 43 (CH.112+620)	BH-1	1.5	10	SPT	Brownish silty clay	CL				0	47	53								
		5.0-6.0	-	Core	Rock (SHALE formation)														33.6	
		6.0-7.0	-	Core															36.2	
MNB 44 (116+775)	BH-1	1.5	14	SPT	Brownish silty clay	CL				0	45	55								
		5.0-6.0	-	Core	Rock (SHALE formation)														41.0	
		6.0-7.0	-	Core															39.7	

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 (%)			Density (kN/m ³)		Shear Test *			Rock Test		
								w _L	w _P	Gravel	Sand	Silt & Clay		Bulk	Dry	Test	C (kN/m ²)	φ'	UCS (Mpa)	Point load Index (MPa)
												M	C							
Test Methods					IS :1498	IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)			SP: 36 (Part -2)		IS: 2720 (Part-10)			IS: 9143	IS: 8764		
MNB 45 (CH.119+300)	BH-1	1.5	19	SPT	Brownish silty clay	CL	9.8			0	49	51								
		3.0	17	SPT				29	18	0	43	57								
		4.5	21	SPT			Brownish clayey sand	SC	10.5			5	50	45	18.2	16.5	DS	11	34	
		6.0	32	SPT		22			14	7	52	41								
		7.5	51	SPT						8	45	47								
		9.0-10.0	-	Core	Rock (SHALE formation)														26.5	
		10.0-11.0	-	Core															30.1	
MNB 46 (CH.119+400)	BH-2	1.5	27	SPT	Brownish silty clayey sand	SC	11.5			8	48	44								
		3.0	30	SPT				31	20	10	50	40	17.9	16.1	DS	15	32			
		4.5	34	SPT						9	49	42								
		7.0-8.0	-	Core	Rock (SHALE formation)														36.8	
		8.0-9.0	-	Core															40.0	
MNB 47 (CH 119+500)	BH-1	1.5	12	SPT	Brownish silty clay	CL	8.7			0	41	59								
		3.0	18	SPT	Brownish silty clayey sand	SC				3	54	43								
		4.5	21	SPT			10.5	25	16	5	55	40	18.1	16.4	DS	11	32			
		11.0-12.0	-	Core	Rock (SHALE formation)														35.2	
		12.0-13.0	-	Core															39.0	
MNB 48 (CH.135+220)	BH-1	2.0-3.0	-	Core	Fractured Rock (SHALE formation)															0.65
		3.0-4.0	-	Core																0.52
	BH-2	2.5-3.5	-	Core	Fractured Rock (SHALE formation)														23.5	
		3.5-4.5	-	Core																1.12

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 (%)			Density (kN/m ³)		Shear Test *			Rock Test			
								w _L	w _P	Gravel	Sand	Silt & Clay		Bulk	Dry	Test	C (kN/m ²)	φ'	UCS (Mpa)	Point load Index (MPa)	
												M	C								
Test Methods					IS :1498		IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)			SP: 36 (Part -2)		IS: 2720 (Part-10)			IS: 9143	IS: 8764		
MJB 4 (CH.143+300)	BH-1	1.5	8	SPT	Brownish silty clay	CL				1	44	55									
		3.0	12	SPT			10.8	32	24	0	42	58		17.9	16.2	DS	25	31			
		5.0-6.0	-	Core	Rock (SHALE formation)	-														33.8	
		6.0-7.0	-	Core		-														37.2	
	BH-2	2.0-3.0	-	Core	Rock (SHALE formation)	-														36.8	
		4.0-5.0	-	Core		-														40.2	
	BH-3	1.5	14	SPT	Brownish silty clay	CL				0	40	60									
		3.0	28	SPT	Brownish silty clayey sand	SC	8.5	22	13	2	55	43		1.84	1.70	DS	10	32			
		6.0-7.0	-	Core	Rock (SHALE formation)	-														39.0	
		7.0-8.0	-	Core		-														41.5	
MNM-49 (CH.145+450)	BH-1	3.0-4.0	-	Core	Rock (SHALE formation)	-															1.2
		4.0-5.0	-	Core		-														27.6	
MNB-50 (CH.151+250)	BH-1	7.0-8.0	-	Core	Rock (SHALE formation)	-														35.0	
		8.0-9.0	-	Core		-														39.1	
MNB 51 (CH.153+750)	BH-1	1.5	9	SPT	Greyish brown silty clay	CL				1	37	62									
		3.0	10	SPT				33	25	3	33	64									
		4.5	20	SPT	Brownish clayey sand	SC				10	47	43									
		6.0	23	SPT			11.3			7	51	42									
		7.5	29	SPT				26	15	8	48	44									
		9.0	51	SPT				6.5			9	53	38		18.5	17.4	DS	11	34		
		13.0-14.0	-	Core	Rock (SHALE formation)	-														32.8	
		14.0-15.0	-	Core		-														40.6	

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 (%)			Density (kN/m ³)		Shear Test *			Rock Test		
								w _L	w _P	Gravel	Sand	Silt & Clay		Bulk	Dry	Test	C (kN/m ²)	φ'	UCS (Mpa)	Point load Index (MPa)
												M	C							
Test Methods					IS :1498		IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)			SP: 36 (Part -2)		IS: 2720 (Part-10)			IS: 9143	IS: 8764	
MNB 51 (CH.153+750)	BH-2	1.5	7	SPT	Brownish silty clay	CL	9.6	34	19	1	34	65								
		3.0	17	SPT	Brownish clayey sand	SC				11	45	44								
		4.5	19	SPT						8	50	42		17.6	15.9	DS	24	30		
		6.0	26	SPT				30	19	10	47	43								
		7.5	30	SPT						7	53	40								
		12.5-13.5	-	Core	Rock (SHALE formation)														35.8	
		13.5-14.5	-	Core															39.0	
MNB 52 (CH.155+690)	BH-1	1.5	10	SPT	Brownish silty clay	CL				0	39	61								
		3.0	25	SPT	Brownish clayey sand	SC		28	17	10	44	46								
		7.0-8.0	-	Core	Rock (SHALE formation)														32.6	
		8.0-9.0	-	Core															37.2	
MNB53 (CH.156+080)	BH-1	1.5	13	SPT	Brownish sandy silty clay	CL				1	40	59								
		3.0	17	SPT						0	38	62								
		4.5	26	SPT				33	20	3	37	60								
		8.0-9.0	-	Core	Rock (SHALE formation)														26.8	
		9.0-10.0	-	Core															33.4	
MNB54 (CH.161+100)	BH-1	1.5	11	SPT	Brownish sandy silty clay	CL				2	46	52								
		5.0-6.0	-	Core	Rock (SHALE formation)														36.2	
		6.0-7.0	-	Core															40.1	
MNB55 (CH.164+575)	BH-1	1.5	17	SPT	Brownish silty clayey sand	SC				3	34	63								
		8.0-9.0	-	Core	Rock (SHALE formation)														29.5	
		9.0-10.0	-	Core															31.4	

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 (%)			Density (kN/m³)		Shear Test *			Rock Test		
										Gravel	Sand	Silt & Clay								
								w _L	w _P			M	C	Bulk	Dry	Test	C (kN/m²)	φ'	UCS (Mpa)	Point load Index (MPa)
Test Methods					IS :1498		IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)										
MNB56 (CH.167+050)	BH-1	1.5	10	SPT	Greyish silty clay	CL				1	39	60								
		3.0	14	SPT				34	23	3	34	63								
		4.5	44	SPT	Greyish silty clayey sand	SC	10			6	50	44		18.9	17.2	DS	15	34		
		7.0-8.0	-	Core	Rock (SHALE formation)													33.5		
		8.0-9.0	-	Core														37.2		
MNB56 (CH.167+050)	BH-2	1.5	10	SPT	Greyish silty clay	CL				2	42	56								
		3.0	15	SPT				31	19	3	45	52								
		4.5	26	SPT	Greyish clayey sand	SC				1	51	48								
		6.0-7.0	-	Core	Rock (SHALE formation)													35.8		
		8.0-9.0	-	Core														40.6		
MNB57 (CH.168+500)	BH-1	1.5	17	SPT	Brownish silty clay	CL				5	38	57								
		5.0-6.0	-	Core	Rock (SHALE formation)													36.1		
		6.0-7.0	-	Core														37.5		
MNB57 (CH.168+500)	BH-2	1.5	10	SPT	Brownish silty clay	CL				4	36	60								
		6.0-7.0	-	Core	Rock (SHALE formation)													33.5		
		7.0-8.0	-	Core														39.4		
ROB (CH.170+550)	BH-1	1.5	13	SPT	Brownish silty clay	CL				2	39	59								
		12.0-13.0	-	Core	Rock (SHALE formation)													30.6		
		13.0-14.0	-	Core														32.7		

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 (%)				Density (kN/m³)		Shear Test *			Rock Test	
										Gravel	Sand	Silt & Clay								
								w _L	w _P			M	C	Bulk	Dry	Test	C (kN/m²)	φ'	UCS (Mpa)	Point load Index (MPa)
Test Methods					IS :1498		IS: 2720 (Part-2)	IS: 2720 (Part-5)		IS: 2720 (Part-4)				SP: 36 (Part -2)		IS: 2720 (Part-10)			IS: 9143	IS: 8764
ROB (CH.170+550)	BH-2	1.5	11	SPT	Brownish silty clay	CL		31	22	1	44	55								
		8.0-9.0	-	Core	Rock (SHALE formation)	-													36.5	
		9.0-10.0	-	Core		-													39.1	
Note: SPT - Standard Penetration Test, NMC- Natural Moisture Content, WL- Liquid Limit, WP- Plastic limit, M- Silt, C- Clay,																				

Annexure – IV

Safe Bearing Capacity Calculations

SIRI GEOSOLUTIONS PVT LTD

Civil & Geotechnical Engineering Services

Bearing Capacity Based on Shear Criteria

(Based on IS: 6403-1981)

MNB-35

Type of soil at founding level	=	SDR	
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)	=	2.0 m	(below scour level)
Average Corrected 'N' value at base of footing	=	>100	
Angle of internal friction (ϕ)	=	36 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	=	36 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	=	1.38
d _q	=	1.19
d _{γ}	=	1.19
Effective overburden pressure (q)	=	1.6 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)

$$\text{Ultimate bearing capacity (Local)} = 15.0 \text{ t/m}^2$$

Safe bearing capacity as per shear criteria,

$$(\text{SBC}) \text{ Local} = \text{UBC}/\text{F.S} = 6 \text{ t/m}^2$$

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

$$d_c = 1.52$$

$$d_q = 1.26$$

$$d_\gamma = 1.26$$

$$\text{Over burden pressure (q} = \gamma' * D_f) = 1.6 \text{ t/m}^2$$

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

Ultimate bearing capacity (UBC)

$$\begin{aligned} \text{UBC} &= C * N_c * S_c * d_c * i_c + q * (N_q - 1) * S_q * d_q * i_q + 0.5 * B * \gamma * N_\gamma * S_\gamma * d_\gamma * i_\gamma * w \\ &= 128.3 \text{ t/m}^2 \end{aligned}$$

$$(\text{SBC})_{\text{general}} = \text{UBC}/\text{F.S} = 51.3 \text{ t/m}^2$$

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,

$$\text{Actual SBC} = 51 \text{ t/m}^2$$

$$\text{Recommended SBC} = 45 \text{ t/m}^2$$

BEARING CAPACITY BASED ON SETTLEMENT CRITERIA

(Based on IS: 8009 (Part-1)-1976)

Type of foundation = Square footing

Unit weight of soil (γ) = 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) = 2.0 m

Bearing pressure at founding level (q) = 45 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 = 45.0 t/m²

μ = 0.35

I = 0.95

E_s = 8000 t/m²

settlement of layer = 7.0 mm

Depth correction factor = 0.68 (as per Fig.12 of IS:8009-pt1)

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

Corrected settlement = 3.8 mm

Bearing Capacity Based on Shear Criteria
(Based on IS: 6403-1981)

Ref MNB-52

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)	=	2.0 m
Average Corrected 'N' value at base of footing	=	25
Angle of internal friction (ϕ)	=	32 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	=	36 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	=	1.38
d _q	=	1.19
d _γ	=	1.19
Effective overburden pressure (q)	=	1.6 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 SETTLEMENT CRITERIA

(Based on IS: 8009 (Part-1)-1976)

Type of foundation = Square footing

Unit weight of soil (γ) = 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) = 2.0 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 = 5500 t/m²

settlement of layer = 5.7 mm

Depth correction factor = 0.68 (as per Fig.12 of IS:8009-pt1)

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

Corrected settlement = 3.1 mm

Bearing Capacity Based on Shear Criteria

(Based on IS: 6403-1981)

$$\text{Ultimate bearing capacity (Local)} = 15.0 \text{ t/m}^2$$

Safe bearing capacity as per shear criteria,

$$(\text{SBC}) \text{ Local} = \text{UBC}/\text{F.S} = 6 \text{ t/m}^2$$

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

$$d_c = 1.52$$

$$d_q = 1.26$$

$$d_\gamma = 1.26$$

$$\text{Over burden pressure (q} = \gamma' * D_f) = 1.6 \text{ t/m}^2$$

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

Ultimate bearing capacity (UBC)

$$\begin{aligned} \text{UBC} &= C * N_c * S_c * d_c * i_c + q * (N_q - 1) * S_q * d_q * i_q + 0.5 * B * \gamma * N_\gamma * S_\gamma * d_\gamma * i_\gamma * w \\ &= 128.3 \text{ t/m}^2 \end{aligned}$$

$$(\text{SBC})_{\text{general}} = \text{UBC}/\text{F.S} = 51.3 \text{ t/m}^2$$

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,

$$\text{Actual SBC} = 25 \text{ t/m}^2$$

$$\text{Recommended SBC} = 25 \text{ t/m}^2$$

Net safe bearing pressure based on core strength as per IS: 12070 – 1987

Net safe bearing pressure (q_s)	:	$q_c \times N_j$
Unconfined compressive strength of rock (q_c)	:	14.3 MPa (lab results MNB-48)
Spacing of discontinuities of rock (N_j)	:	0.1
(as per table 4.0 of IS:12070-1987 for 30cm to 100cm spacing of discontinuities)		

Net safe bearing pressure (q_s)	:	14.3x 0.1
	:	1.43 MPa
	:	143t/m ²

Factor of safety for submerged conditions and slope

Submerged condition	:	0.5
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(as per IS: 12070 – 1987 clause 9.2 (i) for submerged condition under water table)

Factor of safety for slope	:	0.75
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Net safe bearing pressure (q_s)	:	143 x 0.5 x 0.75
	:	53.62t/m ²

However recommended Net Safe Bearing Pressure	:	50 t/m²
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PILE LOAD CARRYING CAPACITY AS PER IRC:78-2000

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

1.0 GENERAL & PILE DATA:

Structure / Location	=	MNB-38 @ CH - AP side
Type of Pile	=	Bored cast in situ pile
Borehole considered for design	=	BH-1
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	=	9.5 m
Pile tip below pile cutoff level	=	7.5 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)	$C = 3.5 \text{ t/m}^2$	$\gamma, \text{ t/m}^3 = 1.8$	$N_{\text{avg}} = 9$
2.50	5.00	Clayey sand (SC)	$\phi = 32$	$\gamma, \text{ t/m}^3 = 1.8$	$N_{\text{avg}} = 19$
5.00	7.00	Weathered Rock	$\text{UCS} = 2.5 \text{ Mpa}^*$		$N_{\text{avg}} = 300$
7.00	10.00	Hard rock	$\text{UCS} = 4.5 \text{ Mpa}^*$		$N_{\text{avg}} > 300$

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		
	$C_{ub} =$	2.0 Mpa
	=	200 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	=	3181 t
FOS for end bearing resistance	=	3
Safe end bearing capacity	=	1060 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	=	2.00	Mpa
length		200	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}),	=	3958	t
FOS for friction resistance	=	6	(as per IRC78 Notification68)
Allowable capacity due to side socket shea	=	660	t

3.3 Load carrying capacity of pile

	=	$R_e + R_{sf}$	
		1543	t
Self weight of pile (W_p)	=	$Y_{sub,concrete} * \pi()/4 * D^2 * L_{pile}$	
		20	t
Safe vertical load capacity of pile	=	1523	t

4.0 PILE UPLIFT CAPACITY:

Uplift capacity of pile, P	=	$(2/3 Q_f) / 2.5 + \text{self weight of pile}$	
	=	1075.5	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 : MNB-38

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	=	7.5 m
Grade of Concrete (M)	f_{ck} M	= 35
Grade of steel ,	f_y	= 500
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	=	Clay
Average SPT"N" value	=	-
Chesion of soil (C)	=	0.8 kg/cm ²
Unconfined compressive strenght of soil	=	1.6 kg/cm ²
Soil condition w.r.t GWT (submerged/Dry)	=	Submerged

3.0 Determination of Lateral Load Capacity

Modulus of subgrade reaction (k_1)	=	2.88 kg/cm ³
Modulus of horizontal subgrade reaction	=	0.384 kg/cm ³
$k=k_1*0.3/1.5*B$		
Stiffiness factor for chosive soil, R	=	597.69 cm
$R= (E * I / B * K_2)^{1/4}$		
Free length of pile above ground (L1)	=	0 cm
For fixed head pile, $L_f = 1.91 * R$	=	1147.57 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)	=	$12 y E I / (L1+Lf)^3$
	=	87552.88 kg
	=	87.6 MT

Annexure – V

Site Photographs

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 @98+290



Geotechnical Exploration at BH-1@99+590

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 at BH-1 @101+500



Geotechnical Exploration at BH-1@109+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@109+650



Geotechnical Exploration at BH-1@112+620

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@112+620



Geotechnical Exploration at BH-1@116+775

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 at BH-1@119+300



Geotechnical Exploration at BH-1@119+400

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@119+500



Geotechnical Exploration at BH-1@135+220

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@135+220



Geotechnical Exploration at BH-1@143+300

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@143+300



Geotechnical Exploration at BH-3@143+300

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@145+450



Geotechnical Exploration at BH-1@151+250

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 at BH-1@153+750



Geotechnical Exploration at BH-2@153+750

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 at BH-1@155+690



Geotechnical Exploration at BH-1@156+080

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@161+100



Geotechnical Exploration at BH-1@164+575

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 at BH-1@167+050



Geotechnical Exploration at BH-2@167+050

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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



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Geotechnical Exploration at BH-2@168+500

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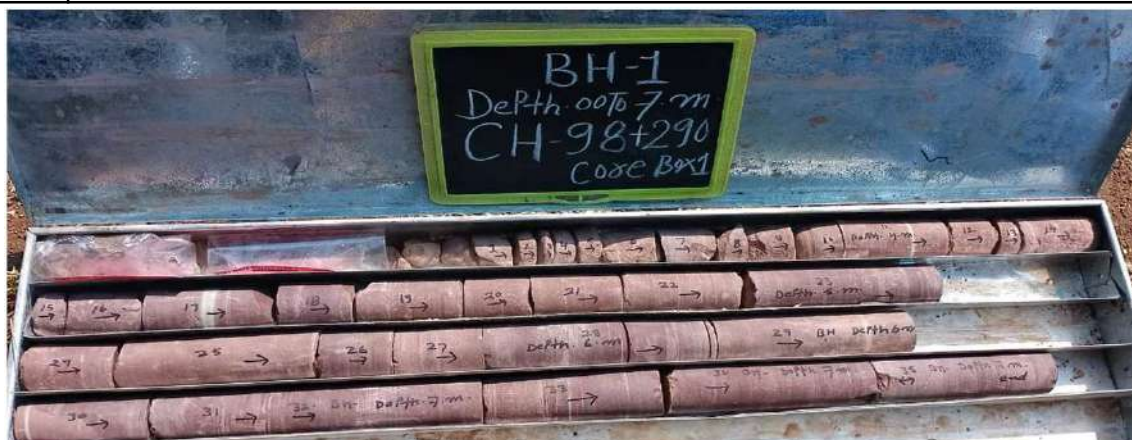
Geotechnical Exploration at BH-1@170+550



Geotechnical Exploration at BH-2@170+550

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Geotechnical Exploration - Core Box BH-1@MNB-38



Geotechnical Exploration - Core Box BH-1@MNB-39



Geotechnical Exploration - Core Box BH-1@MNB40

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Geotechnical Exploration - Core Box BH-1@112+620



Geotechnical Exploration - Core Box BH-2@112+620



Geotechnical Exploration - Core Box BH-1@116+775

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Geotechnical Exploration - Core Box BH-1@119+300



Geotechnical Exploration - Core Box BH-1@119+400



Geotechnical Exploration - Core Box BH-1@119+500



Geotechnical Exploration - Core Box BH-1@135+220

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Geotechnical Exploration - Core Box BH-2@135+220



Geotechnical Exploration - Core Box BH-1@143+300



Geotechnical Exploration - Core Box BH-2@143+300



Geotechnical Exploration - Core Box BH-3@143+300

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Geotechnical Exploration - Core Box BH-1@145+450



Geotechnical Exploration - Core Box BH-1@151+250



Geotechnical Exploration - Core Box BH-1@153+750



Geotechnical Exploration - Core Box BH-2@153+750

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Geotechnical Exploration - Core Box BH-1@155+690



Geotechnical Exploration - Core Box BH-1@156+080



Geotechnical Exploration - Core Box BH-1@161+100



Geotechnical Exploration - Core Box -1@164+575

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Geotechnical Exploration - Core Box BH-2@164+575



Geotechnical Exploration - Core Box BH-1@167+050



Geotechnical Exploration - Core Box BH-2@167+050



Geotechnical Exploration - Core Box BH-1@168+500

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Geotechnical Exploration - Core Box BH-2@168+500



Geotechnical Exploration - Core Box-1@170+550



Geotechnical Exploration - Core Box-2@170+550



Geotechnical Exploration - Core Box-BH-2@170+550

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Geotechnical Exploration - Core Box BH-1@99+590

**REPORT
ON
SEISMIC REFRACTION SURVEY
FOR
PROPOSED CONSTRUCTION OF
ICONIC KRISHNA RIVER BRIDGE
NEAR KALWAKURTHY.
IN
TELANGANA STATE.**

**CLIENT: ROADS & BUILDINGS DEPARTMENT NH
CIRCLE, MINISTRY OF ROAD TRANSPORT AND
HIGHWAYS (MORTH)**

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1.0 INTRODUCTION

The Geophysical Investigations comprising of Seismic Refraction Survey for ICONIC bridge project at Kollapur to Sangameshwar ,Telangana and Andra Pradesh border has been recently completed

The object of the investigation was to assess the stratifications for earthwork cutting locations for pavement construction and pier location p1 and p2 of proposed iconic cable stay bridge. The work of carrying out seismic refraction survey and marine investigations was awarded to M/s Renuka Consultants. The field data acquisition was carried out during 30th May to 5th June 2022. Present report summarizes scope and method of Investigations at the proposed chainages. This is summarized in relevant sections.

2.0 SCOPE OF WORK

The work of Seismic Refraction for chainage between km 79,000 to km 97,530 have been carried out to understand the near surface & sub-surface formation along the alignment with a view to assess the feasibility of the proposed alignment and to highlight various geotechnical problems likely to be encountered.

3.0 SITE CONDITIONS AND ACCESSIBILITY

The alignment passes through hilly terrain with thick vegetation cover/dense forest and marked the outcrops at few locations. The area along the alignment is accessible through foot tracks only. The survey were carried out at following locations.

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Table 1 Details of seismic line spread

Location	Chainage (m)		Length (m)	Spread	Remarks (Depth of cutting from NGL)
	From	To			
Telangana side	80600	80715	115	Line 1	20 m cutting
	81540	81655	115	Line 2	13 m cutting
	81850	81965	115	Line 6	19.5 m cutting
	83880	83995	115	Line 3	19 m cutting
	84010	84125	115	Line 4	19 m cutting
	84200	84315	115	Line 5	19 m cutting
	86190	86305	115	Line 7	19 m cutting
	86330	86445	115	Line 8	19 m cutting
	86700	86815	115	Line 9	23 m cutting
	86840	86955	115	Line 10	23 m cutting
	87050	87165	115	Line 11	23 m cutting
Telangana side	Pier 1 Across line 87658 (Marine)		115	Line 16	Pier 1
Andra Pradesh side	Pier 2 Across line 88138		115	Line 15	Pier 2
Andra Pradesh side	88810	88925	115	Line 12	17 m cutting
	89600	89715	115	Line 14	23 m cutting
	90150	90265	115	Line 13	16 m cutting

4.0 OBJECTIVE AND METHODOLOGY OF INVESTIGATION

The present report summarizes the results of seismic refraction survey study around the area of proposed selected survey line for mapping of subsurface stratigraphy between chainage 79+000 Km – 97+530 Km. The object of the investigations was to obtain the quantitative knowledge of the overburden material and depth to firm rock with its condition for geotechnical assessment of the proposed line in the alignment.

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Total 14 nos. of Seismic spreads (locations) have been assessed for alignment located in the cutting section in order to understand the properties. And two surveys are planned to be carried out at pier locations of proposed iconic bridge pier 1 at Telangana side and pier 2 at Andhra Pradesh side.

The planned contribution of geophysical investigations was to measure seismic velocities to map the overburden, weathered and hard rock interface with its thickness. The seismic data is of good quality and provided a detail insight about the overburden and basement rock condition. In general, two-layer models have been established based on acquired seismic data. Compressional (P) wave velocities were measured to know the rock mass conditions of basement layer with thickness of different layer of subsurface.

Generally this survey are conducted to ascertain the depth of overburden comprise of slope debris under saturated and un-saturated condition along with rock slumps, weathered rock layer and depth of bedrock along with its condition. The objective of the survey is to assess seismic velocity with thickness of geological “layers” observed at the site e.g.

- Mapping of subsurface stratigraphy
- Overburden Material (slope debris & rock slumps)
- Weathered rock mass
- To map the subsurface layer with variation in seismic velocity and thickness also delineation of overburden, weathered jointed and fresh bedrock conditions along the profile.

The outcome of geophysical surveys is based on the acquired seismic data at site. The interpretations of the seismic sections have been correlated with geomorphological conditions namely.

4.1 Basic Principle of Seismic Refraction method

Seismic refraction survey is one of the important tools in the family of exploration geophysics. Seismic investigations utilize the fact that elastic waves (also called seismic waves) travel with different velocities in different formations. By generating seismic waves at a point and observing the time of arrival of these waves at a number

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of other points on the ground surface, it is possible to determine the velocity distribution and locate the subsurface interfaces where the waves are reflected or refracted. The underlying theory of seismic refraction survey is that whenever a seismic wave travel in the boundary separating two media, energy is partly reflected and partly refracted. Hence, by choosing the refracted arrivals alone, we can relate the delay in the arrival times of refracted seismic waves at different locations to a lateral or transverse variation in the velocity of different subsurface layers.

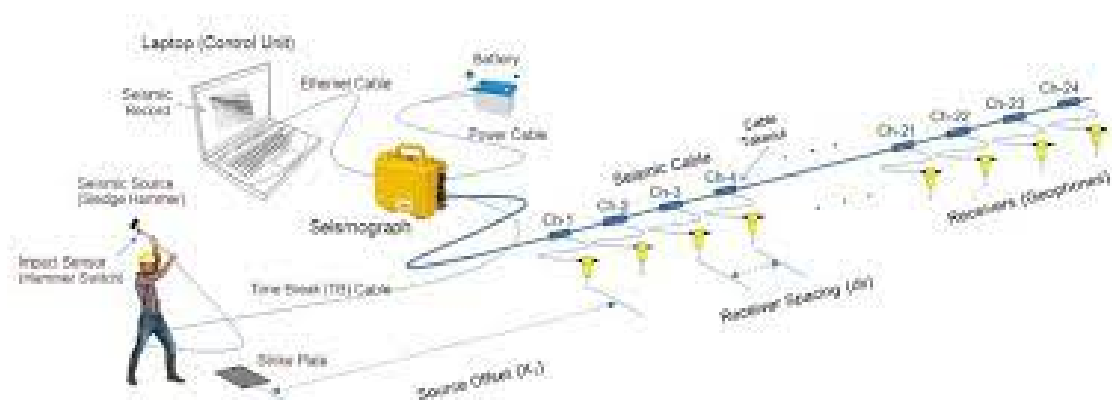


Figure 1 Theory of seismic refraction survey

Normally, seismic wave velocities increase with depth, and hence travel-time plot of arrival of seismic waves in an array of sensors (geophones) spread linearly will show the presence of various layers based on the slope of different segment of the first arrival time plot. Seismic waves travel through material medium and is recorded by an array of sensors spread along the profile line. From the record of the first arrival time in different sensors from which the velocity of the two layers involved in the refraction as well as the depth to this refracting layer are determined.

Seismic (P-Wave) velocities of materials are related to the strength properties and the degree of weathering and joint sets available in-situ. This defines rocks in various sub-categories such as Hard, Weathered and Soft in terms of range of P-wave velocities in them. Therefore, a comprehensive knowledge of the seismic velocities in different medium is the basis of the interpretation of seismic survey data. In fact, the entire stratigraphy of the area as deciphered from the seismic refraction survey is a velocity imaging of the area. Later this variation in velocity is correlated to the local geology and by using standard table of seismic wave velocities in different geologic medium in

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dry and wet conditions, as shown in Figure-2 or with a prior information of rock types (local geology) or based on laboratory investigations of the core samples.

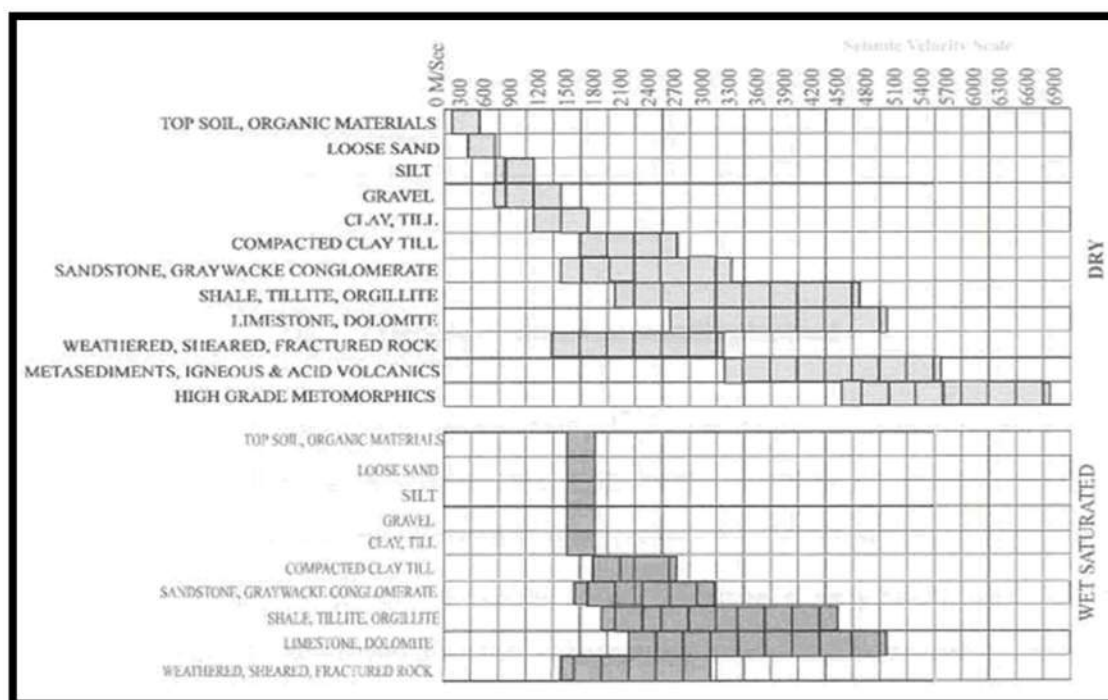


Figure 2 Seismic wave velocity in different geological materials

4.2 Methodology

The Seismic refraction survey was conducted on the given selected proposed chainage site. Seismic refraction survey has been carried out in the project area to determine:

- Overburden and bed rock configuration & its characteristic
- Thickness of the overburden
- Compressional (P) wave velocity for overburden and bed rock

The equipment used in the survey was GEOMETRICS, Geode 24 - Channel digital seismograph of Geometrics Inc. USA. This is a high-resolution digital seismograph with facility of data stacking, frequency filtering and various other digital signal-processing capabilities available on-line for optional selection of data acquisition parameters. Twenty-Four channels with 4.5 Hz vertical geophones at 5m interval were used for each seismic survey line of 115m spread length as per site condition. The

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geophones were connected to the acquisition unit through specially provided multiple take-out cables.

Seven numbers of shots have been carried out in each seismic spread, two far shot in either end of the spread, five shots between Geophone (1-2),(6-7), (12-13), (18-19) & (23-24) with the use of hammer as seismic source. The field set-up of the present seismic refraction survey made by using the following parameters:

- Data acquisition unit : Geometrics Geode
- No. of channels : 24
- Source type used : Hammer
- Trigger mode : Seismic starter
- Channel spacing : 5 m
- Sampling interval : 250 msec.
- No. of stacks : 5-20 (As per site condition)
- Recording format : SEG 2
- Operating software : Seismoduler
- Display type : Monochrome in wiggle or other formats
- Data processing : Seis-Imager-2D

4.3 Data processing & Interpretation

The seismic data acquired in the field was of good quality. Thus the seismic data has been checked for initial velocity & depth to bedrock through inbuilt SIPQC software in the seismograph. However, final processing of SEG-2 data has been done through SEISIMAGER software, which is having different module like PICKWIN, PLOTREFA etc. Picking of first arrival has been done precisely through PICKWIN and after gathering all shots in a spread, initial velocity & depth model has been calculated by using delay time method. The initial model has been further refined by inversion technique with the help of PLOTREFA software. In the inversion techniques an initial model is given for which the computer arrives at the theoretical model and compare with the initial field model then it takes the difference between the computed and the field model and assign the new model for reducing the difference (error). It again computes a new theoretical model, compare with the field

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model, and sets another new model to reduce the difference (error). The process of iteration goes on till the error is minimized and finally displays the model.

The seismic sections thus obtained were interpreted in terms of geological cross sections along each seismic line. The interpretation of the seismic data is presented in the form of seismic sections along each line have been shown in figures with interpretation tables.

Seismic wave velocity in soil and rock is dependent on the soil type and its condition, for rocks degree of weathering, jointing, fracturing etc., are important.

For subsurface stratification through seismic velocities, the available information and the subsurface velocities of different geological materials under unsaturated & saturated conditions as mentioned in figure 2 have been used. Based on the observed velocities in the surveyed area, the following subsurface stratification has been made as shown in table -1:

Table 2 Classification of Subsurface Strata in Terms of Seismic wave velocity

Seismic velocity (m/sec)	Inferred Lithology
300- 1000	The overburden is mainly composed of granular loose soils with Boulders and Cobbles
1000 - 2000	Composed of completely weathered disintegrated rock converted to residual soil formation.
>2000 – 4000 and Above	Highly weathered to unweathered Compact Fine grained pinkish Sedimentary formation Metamorphised to Quarzitic Rock formation.

Seismic sections give the detail insight information about the subsurface stratigraphy in terms of their seismic velocities, which are directly related to the quality and the strength of the medium. These layers might not reflect a change in the geologic medium or a change in subsurface rock type; nevertheless, they represent a significant change in the engineering properties of the rock mass. Seismic velocities in the rock mass can be correlated to other engineering properties by specific empirical relationship.

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4.4 DISCUSSION OF RESULTS

4.4.1 Seismic spread(line) Information

Seismic Refraction profiles were acquired at proposed alignment between chainage (79+000 Km – 97+530 Km) of Telangana –Andra Pradesh town new Embankment and pier section, during the month of June 2022. The details of seismic lines are placed in Table-1.

4.5 Corelation to Engineering Properties of rock mass

Based on the seismic velocity, rock mass classification as per Barton's 'Q' values has been attempted for stability of excavation of Pier. The empirical relations used for calculation of the parameters are referred as under:

1. Rock Quality $Q = 10^{\left(\frac{V_p - 3500}{1000}\right)}$ (Barton's et al. 1993)
2. $RMR = 15 \log Q + 50$ (Barton's et al. 1995)
3. Rock mass strength $\sigma_c = (0.035 * V_p - 31.5)$ (Linear regression equation by Freyberg, 1972)

The rock mass is classified as per both Q-system (Barton et al., 1974) and RMR System (Barton et al., 1995/9). On the basis of seismic velocity (V_p) and "Q" value of different layers, an overall appraisal of the rock mass strength (σ_c), RMR, have been assessed

4.6 Interpretation of seismic sections

Along the Embankment and pier, of Telangana to Andra Pradesh section, the result of the Seismic refraction survey brought out the different surface and subsurface stratification having variation of seismic velocities with depth.

Cutting locations:-

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The overburden is mainly composed of granular loose soils with boulders and cobbles. with velocity ranges 300 – 600 m/s.

Similarly the second layer shall be composed of completely weathered disintegrated rock residual soil formation. velocity 600 – 1000 m/s . and moderately disintegrated metamorphic rock formation in velocity ranges 1000 – 2500 m/s .

Estimation of Engineering properties based on seismic velocity

Pier Location (P1)

First layer indicates the presence of loose overburden soil strata with boulders velocity 300- 1200 m/s. upto 5.00m below NGL

Second layer is followed by highly weathered to Metamorphic hard rock formation velocity ranges between 1200 – 4200 m/s.

Rock Quality of Pier location $Q = 0 - 7$

RMR Value of Rock strata = 62.67

Rock mass strength = 115.50 MPa

Pier Location (P2)

First layer Indicates shallow presence loose overburden soils with cobbles and boulders with velocity ranges 300 – 1300 m/s ,

Second layer is followed with compact fine grained pinkish sedimentary formation Metamorphic to Quarzitic rock formation velocity ranges between 1300 – 4100 m/s.

The Properties of rock mass calculated using above references

Rock Quality of Pier location $Q = 0 - 7$

RMR Value of Rock strata = 62.67

Rock mass strength = 112.0 MPa

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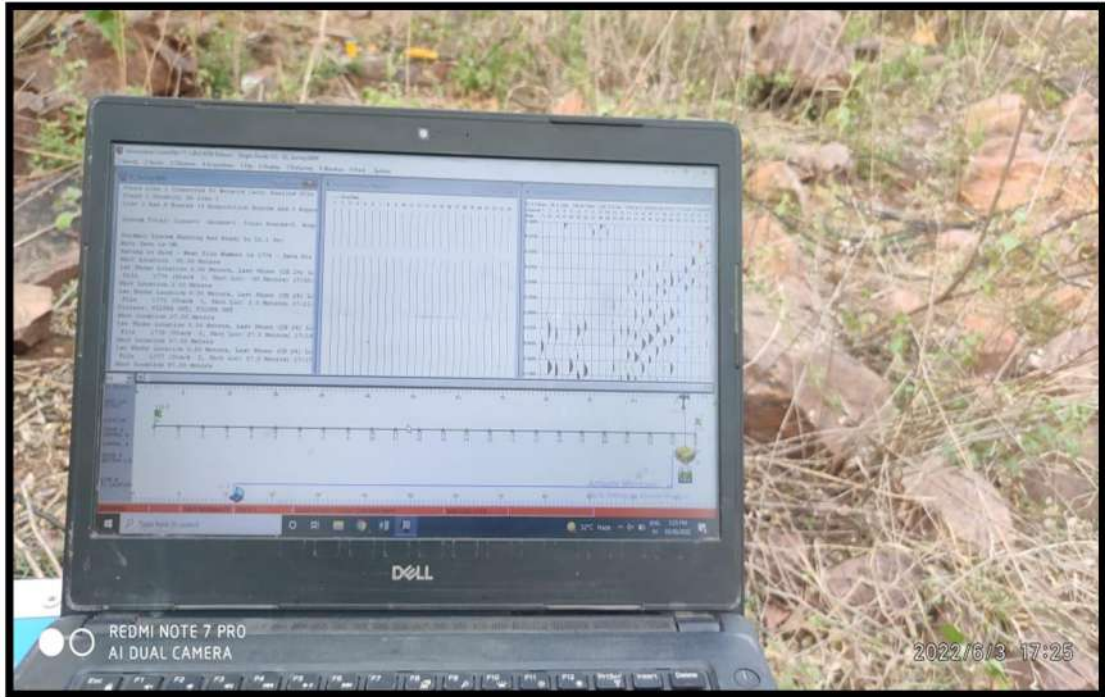


Figure 3 Signal quality during field acquisition



Figure 4 field data acquisition setup.

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Figure 5 lying of cables at pier 2 location



Figure 6 Jungle cutting & lying of cables

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4.6.1 Seismic section along alignment chainages

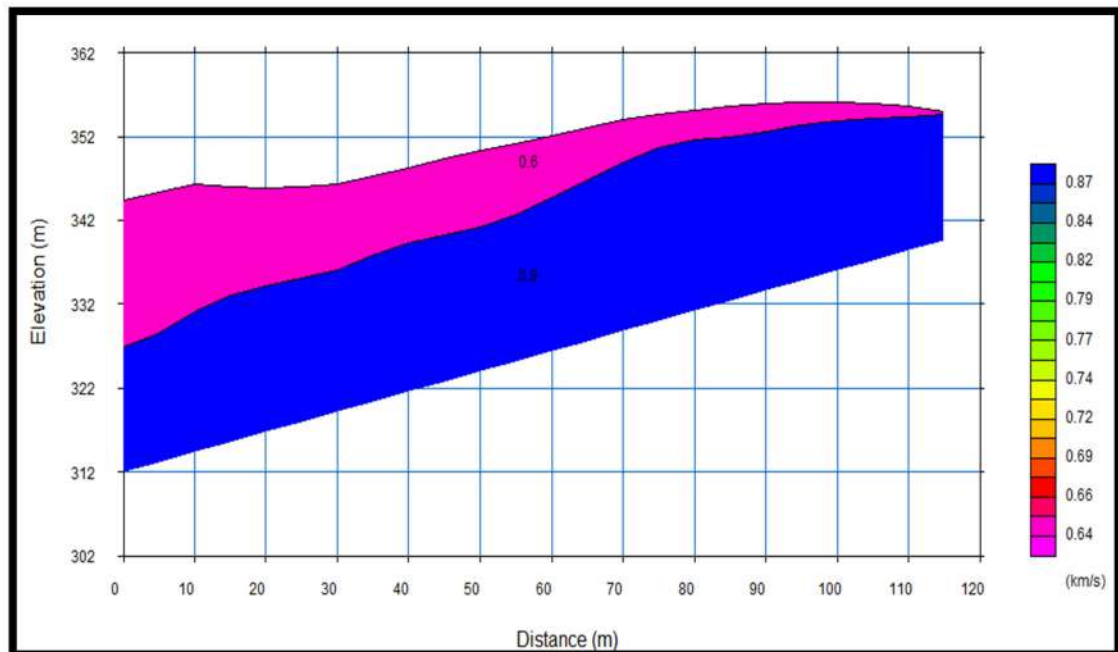


Figure 7: SRT Section of Chainage 80600 – 80715 m

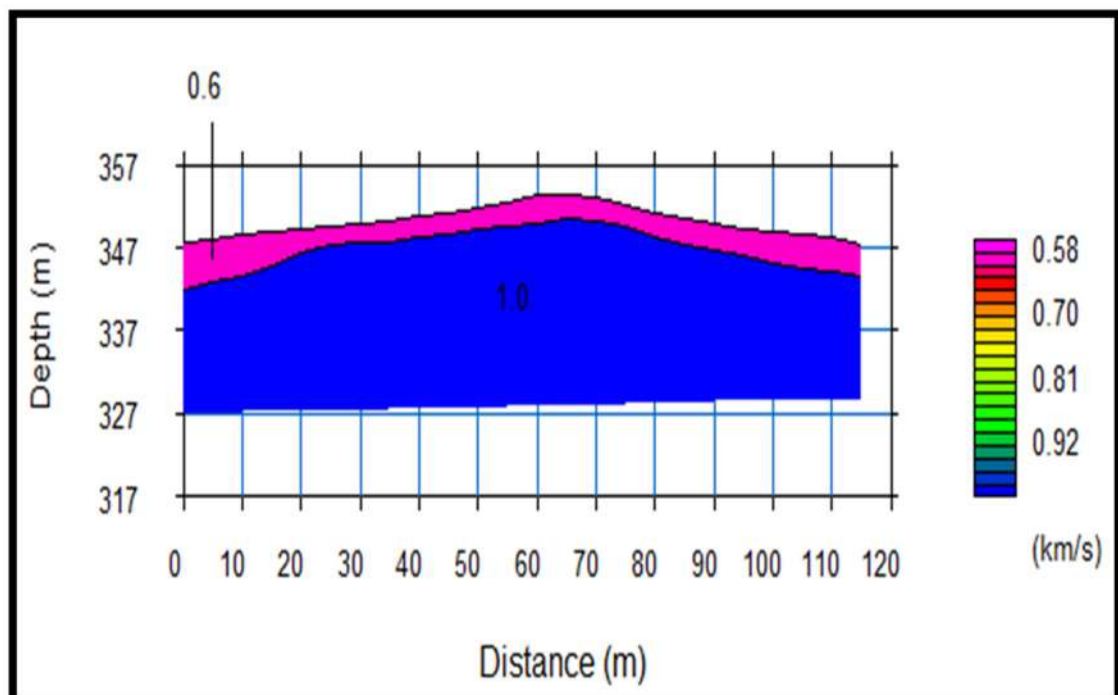


Figure 8: SRT Section of Chainage 81540 – 81655 m

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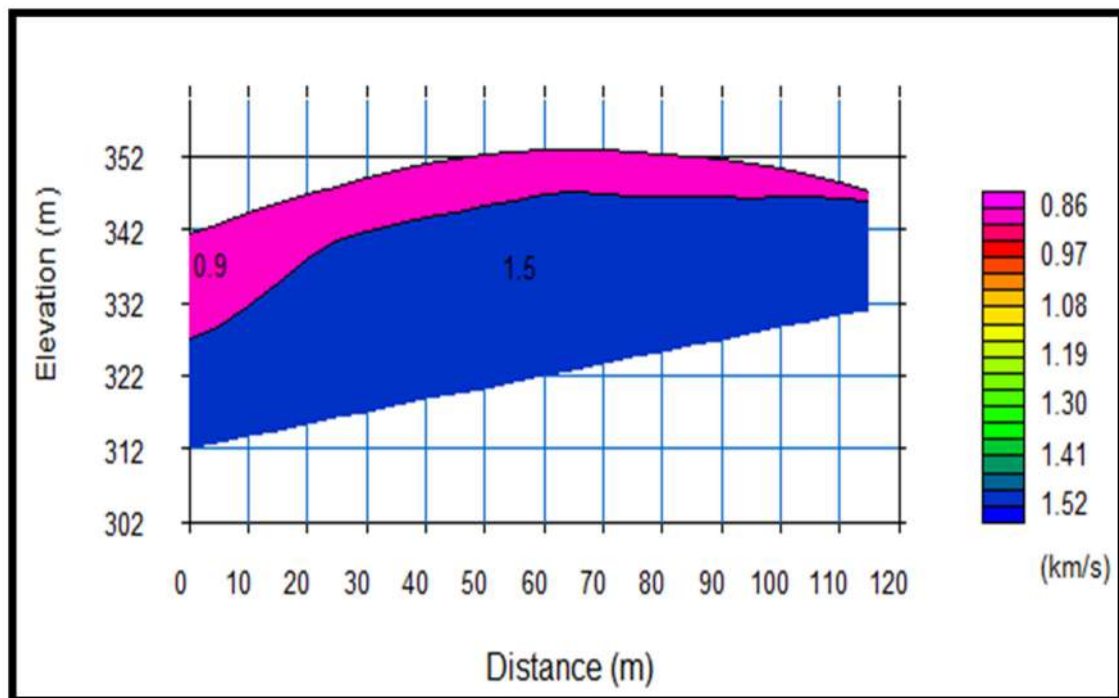


Figure 9: SRT Section of Chainage 81850 – 81965 m

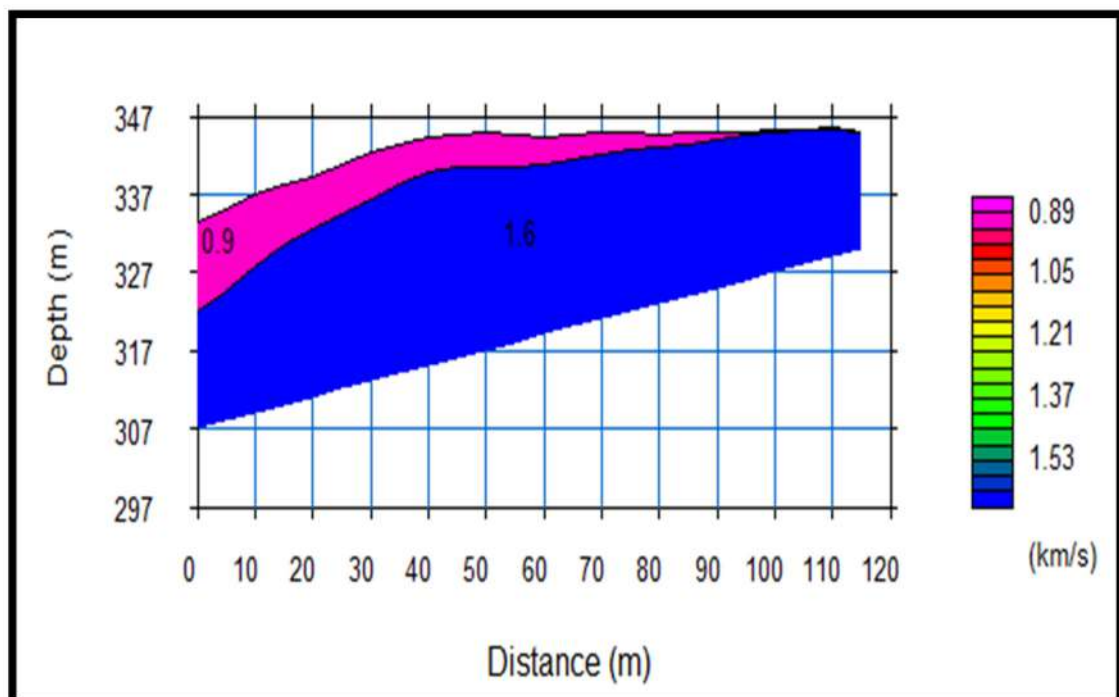


Figure 10: SRT Section of Chainage 83880 – 83995 m

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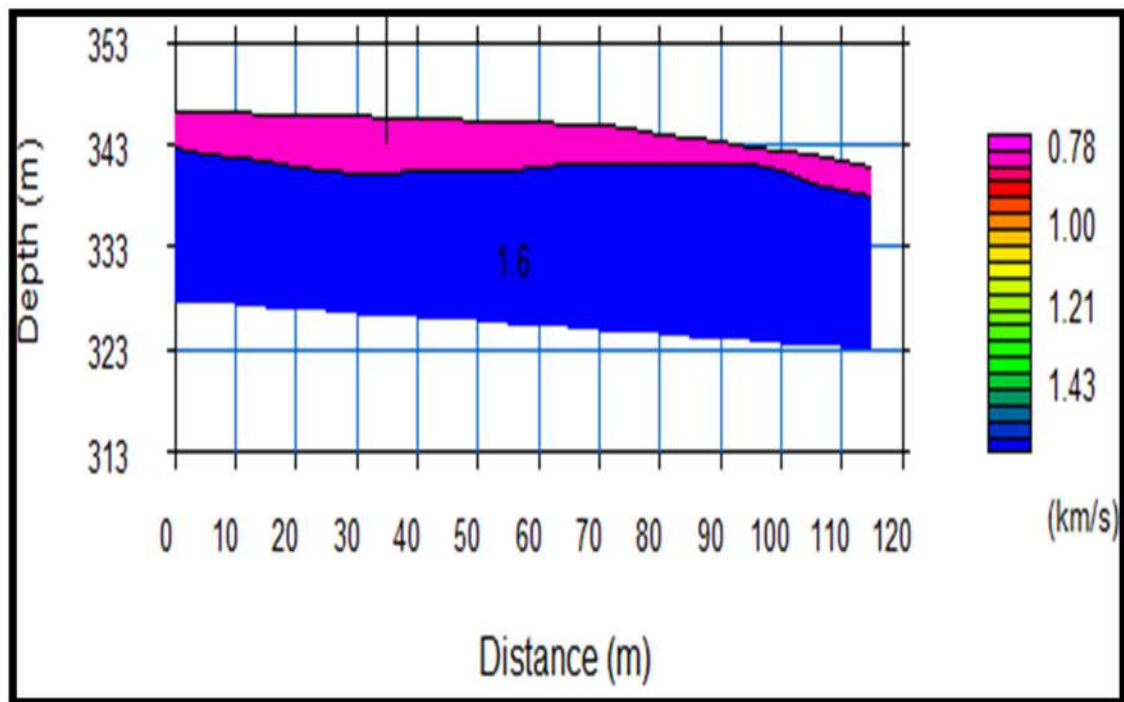


Figure 11: SRT Section of Chainage 84010 – 84125 m

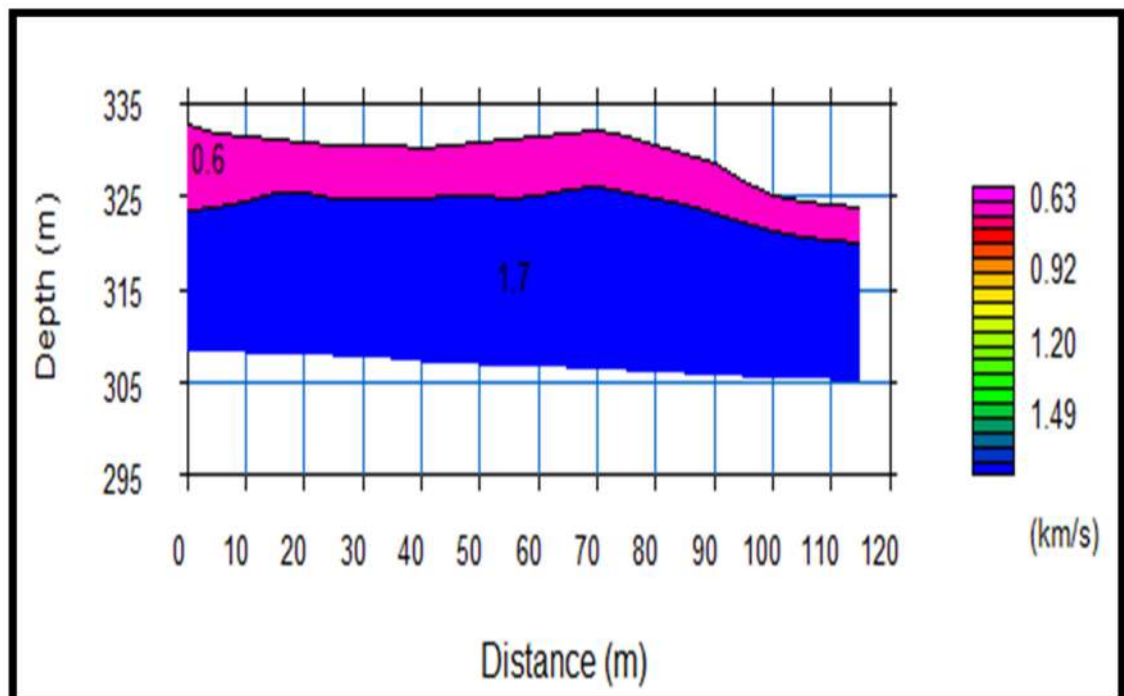


Figure 12: SRT Section of Chainage 84200 – 84315 m

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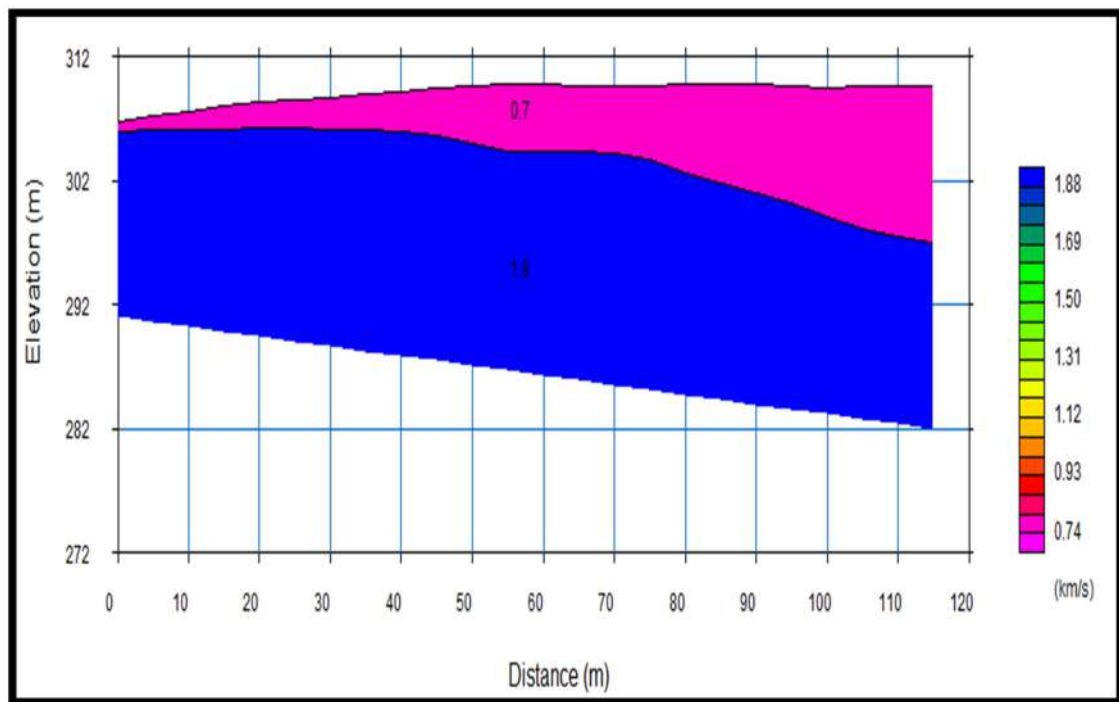


Figure 13: SRT Section of Chainage 86190 – 86305 m

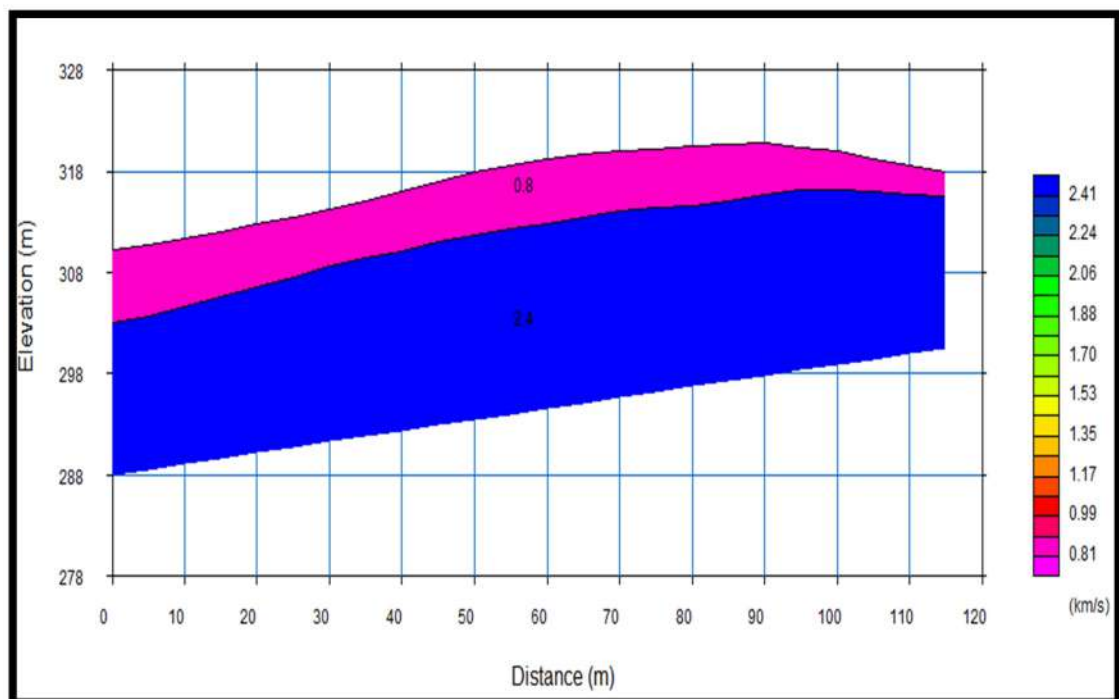


Figure 14: SRT Section of Chainage 86330 – 86445 m

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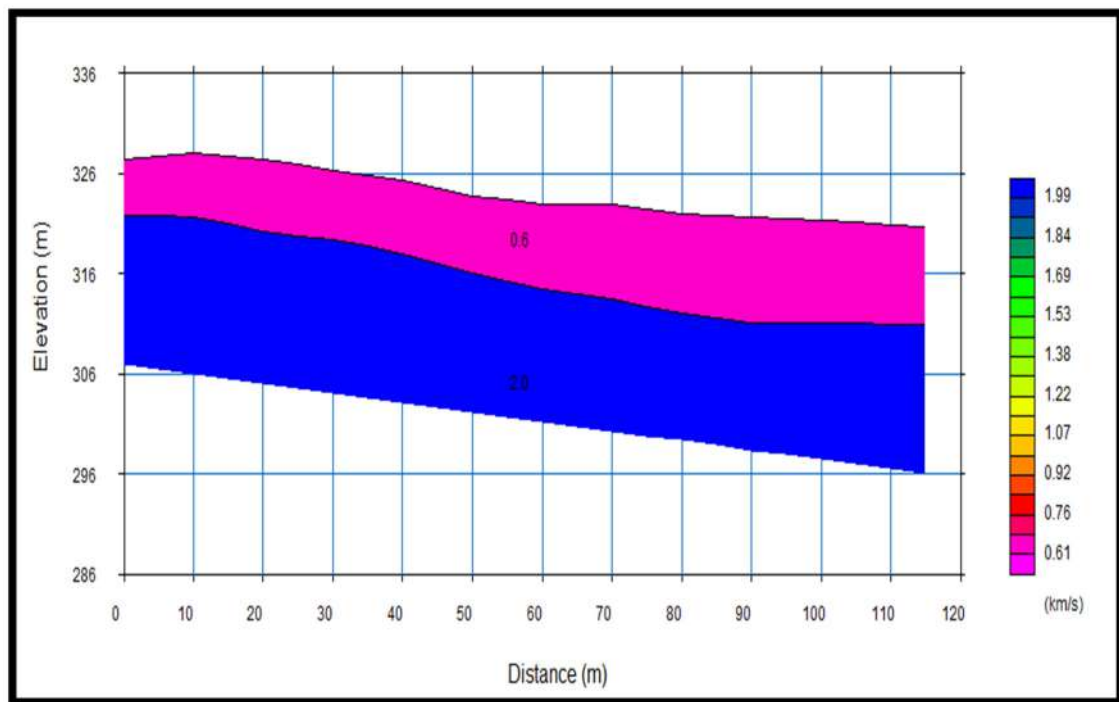


Figure 15: SRT Section of Chainage 86700 – 86815 m

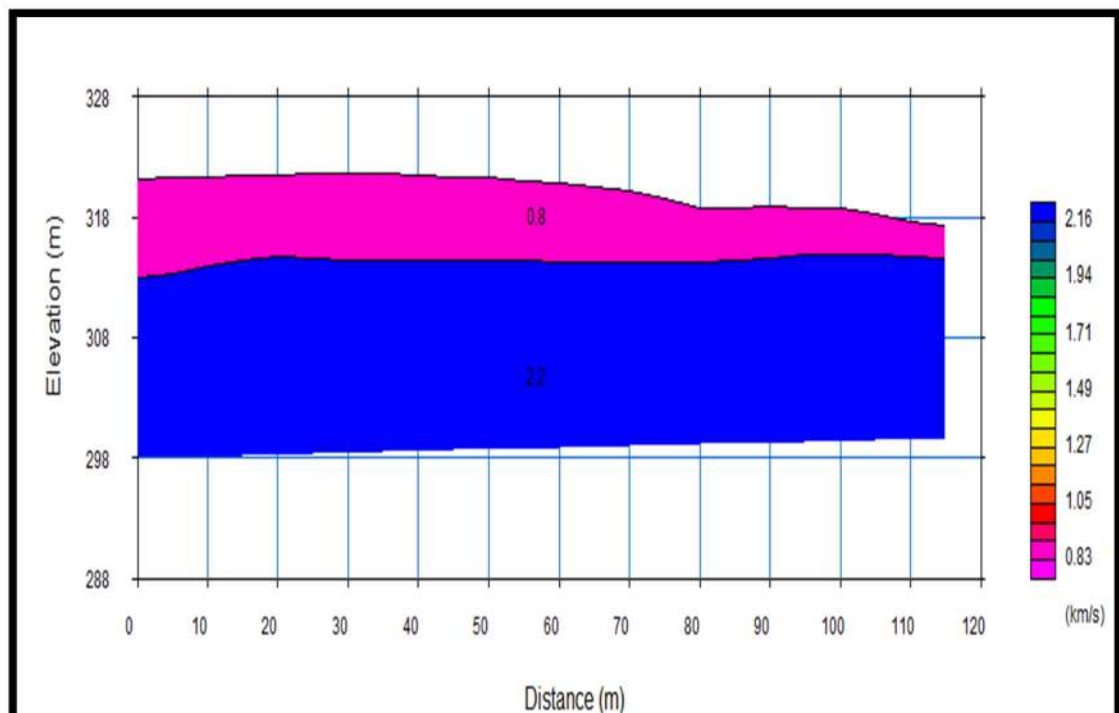


Figure 16: SRT Section of Chainage 86840 – 86955

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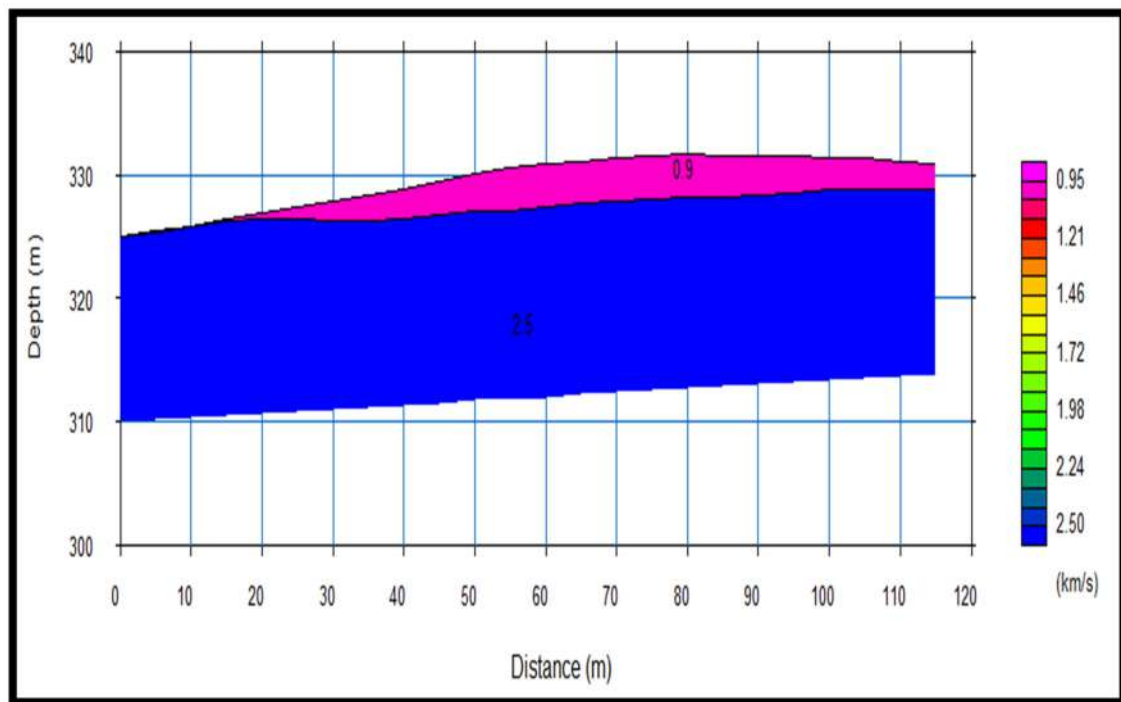


Figure 17 SRT Section of Chainage 87050 – 87165 m

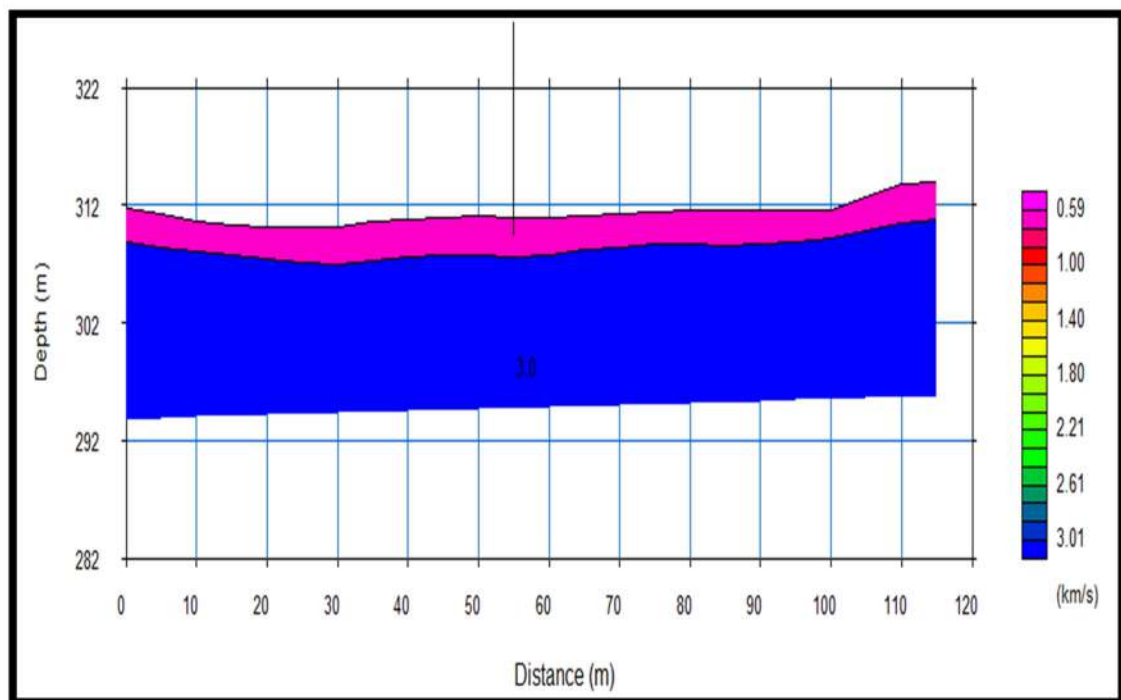


Figure 18 SRT Section of Chainage 88810 – 88925 m

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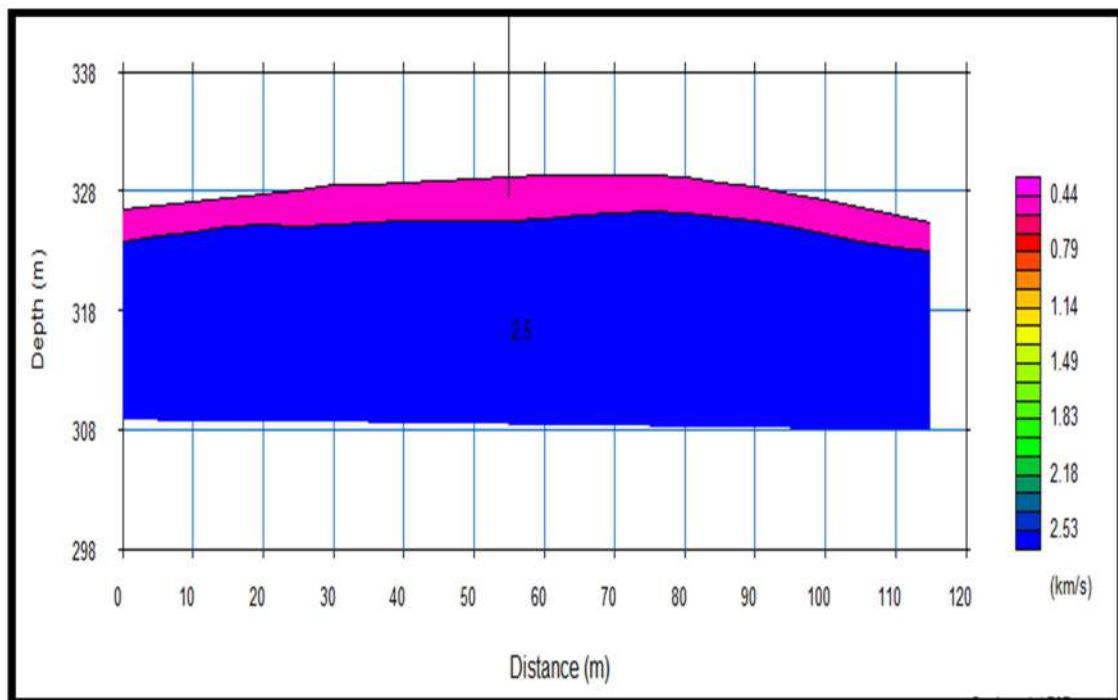


Figure 19 SRT Section of Chainage 89600 – 89715 m

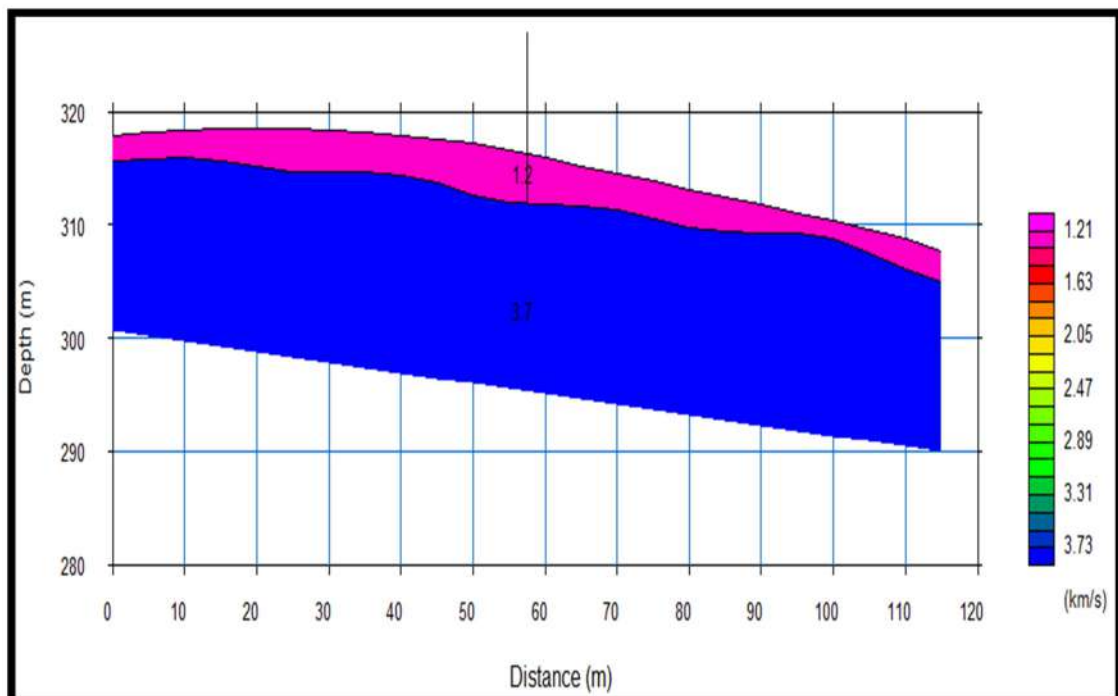


Figure 20 SRT Section of Chainage 90150– 90265 m

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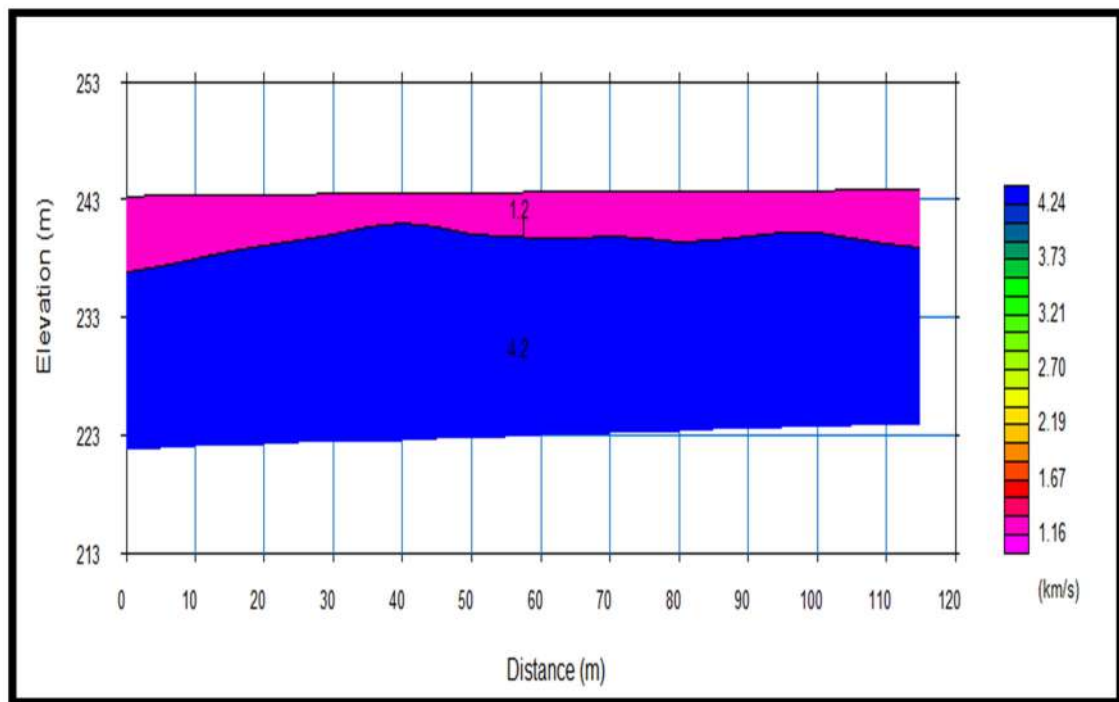


Figure 21 SRT Section of Pier 1

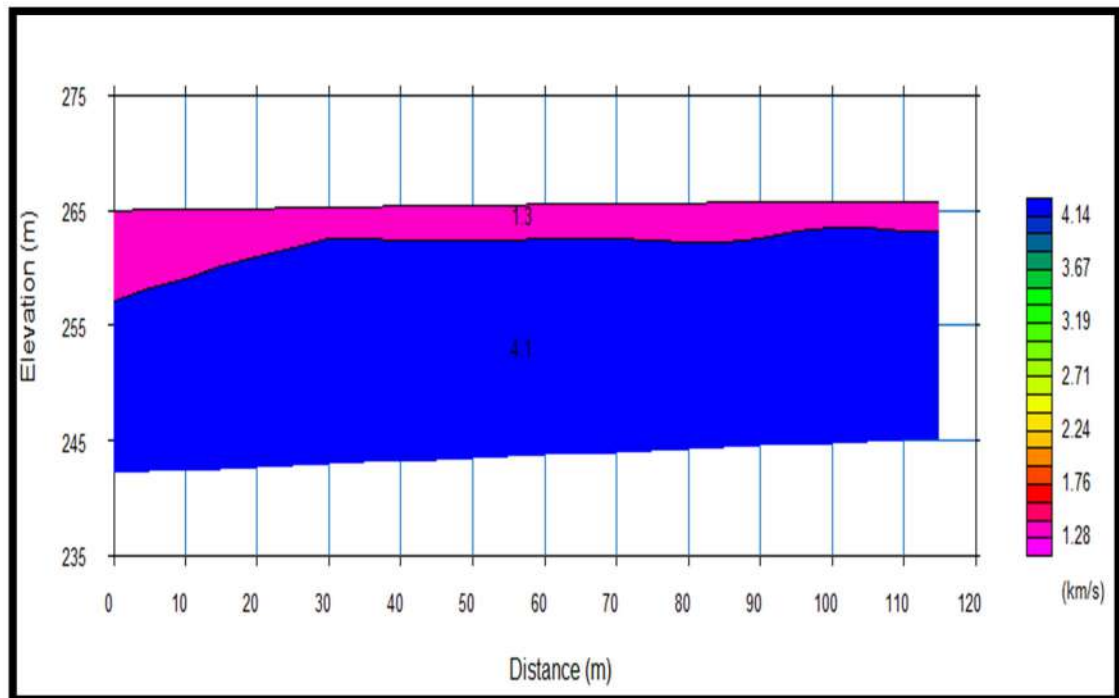


Figure 22 SRT Section of Pier 2

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5.0 CONCLUSIONS AND RECOMMENDATIONS:

5.1 Cable Stay Bridge Locations

PIER 1 & PIER 2

- Based on seismic velocities profiles, the rock formations are encountered at 4.50 to 5.5m below existing GL.
- As per seismic wave velocity, the RMR calculated for is varying from 13.50 to 62.67.
- As per Engineering properties of rock quality 0 – 7 and Rock Mass strength 75 to 115.5 MPa.

6.0 REFERENCES:

- Seismic Refraction and Exploration for Engineering Site Investigations, By Bruce. B. Redpath, NTIS.
- Seisimager Manual - 2D.
- IS 15681(2006) -Geological exploration by Geophysical Method (Seismic Refraction Method)



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