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JOB NO.G4.237: S.I. PROPOSED CHODAN - SALVADOR-DO-MUNDO BRIDGE AT SALVADOR-DO-MUNDO, GOA JUL '13

REPORT

SOIL INVESTIGATION FOR CONSTRUCTION OF BRIDGE OVER MAPUSA RIVER CONNECTING CHODAN & SALVADOR-DO-MUNDO

**PREPARED FOR
MADHAV KAMAT & ASSOCIATES
JULIETA BUILDING
SWATANTRYA PATH
VASCO-DA-GAMA, GOA.**



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1. SCOPE OF WORK

The Government of Goa has proposed to construct a bridge across the Mapusa river to connect Chorao with Salvador-do-Mundo. Hence, it was decided to do Geotechnical Investigation.

Site is located on left bank of Mapusa river on Madel side, Chorao on d/s of existing jetty in paddy field. Borehole location is at approximately at 2m away from HTL.

The purpose of this investigation was to know the founding strata for designing foundation.

The soil Investigation consisted of drilling one borehole on Chorao bank including sampling, conducting the necessary field and laboratory tests and submitting a comprehensive engineering report with recommendations for type of foundation.

The site location plan is placed at fig. no.1.

2. DRILLING & FIELD TESTS

Drilling was done by power operated rotary drilling rig with tungsten carbide bit. Depth of borehole was about 32.33m below existing ground level. Water was circulated by pressure pump. 100mm dia. / NX size casing was used in the drill hole to prevent collapse.

Undisturbed samples were collected depending upon the nature of strata metwith. Standard penetration tests were conducted at regular intervals. Soil samples from the split spoon were collected in plastic bags as representative disturbed samples for visual classification. Site layout plan showing borehole location is placed at fig. no.2. Borehole log in standard proforma giving strata & samples collected is placed at fig. no.3.

Standard penetraiaon test results are compiled separately in a tabular proforma and are placed at fig. no.4.

Undisturbed samples were tested in our soil laboratory at Panaji.



3. LABORATORY TESTS

Laboratory tests were conducted on undisturbed soil samples and the data is compiled in a tabular proforma placed at fig. no.5. The soil samples were tested for general identification of samples and also for shear strength.

4. SOIL / ROCK PROFILE

The soil / rock profile as revealed by one borehole shows the following sequence of stratas metwith (Refer fig. no.3):

- a) Whitish, brownish silty clay (paddy field). Thickness of this strata is about 0.5m.
- b) Redish brown stiff lateritic clayey silt with gravels. Thickness of this strata is about 3.0m & SPT-N is varying from 11 to 20.
- c) Redish, brownish, whitish (bauxite) very stiff lateritic clayey silt with gravels. Thickness of this strata is about 4.0m and SPT-N is varying from 29 to 45
- d) Pinkish, yellowish, very stiff phyllitic clayey silt (derived from highly weathered rock). Thickness of this strata is about 14.6m and SPT-N is varying from 26 to >50.
- e) **Hard rock:** Ash grey hard argillite rock with inclined joints partly weathered at top yielding poor recovery. Exact thickness of this strata is not known due to termination of borehole depth in this strata. Rock is softer than concrete.

5. FOUNDATION RECOMMENDATIONS

5.1 Depth of scour/erosion

The bridge is located over Mapusa river having strata of clayey silt with gravels. On such strata, the scour / erosion may be due to floods. It is very difficult to work out such scour / erosion depth as no formula is applicable. Scour / erosion may be taken upto 3.5m till upper lateritic strata or can be taken as per existing similar structure in the near vicinity.

5.2 Type of foundation

Since strata upto 3.5m or so can scour during floods. **Open foundation and raft foundations are not recommended.**



6.3 Bored cast insitu RCC pile foundation

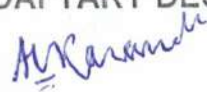
- 1) The pile can be considered as frictional end bearing on argillite rock available at a depth of about 22.5m below existing GL with insitu lateritic strata above.
- 2) The underlying rock is hard argillite which shows inclined joints.
- 3) The total rock quality designation (RQD) is very poor.
- 4) The minimum crushing strength of soaked rock is 130.01 kg/sq.cm. Adopting factor of safety = 10, allowable bearing capacity of rock = 13.0 kg/sq.cm.
- 5) The allowable end bearing capacity for bored cast insitu RCC piles will be limited to the permissible working stress in the concrete pile shaft with suitable factor of safety and should be suitably modified to allow for code requirement for long length of piles.
- 6) The piles will have to be chiseled and socketed in hard rock for a depth of 2.0m to 2.5m to get full load carrying capacity as rock is soft and to get bond between rock and concrete.
- 7) The allowable load carrying capacity of different diameters of bored cast-in-situ RCC piles for M30 grade of concrete & having socket length of 2000mm to 2500mm is as under:

Sr.No.	Pile diameter (mm)	Pile length (m)	Allowable load carrying capacity of pile (MT)
1	1000	25	384.0
2	1200	25	502.0

The above allowable load carrying capacities should be suitably modified for long length of piles depending on the end conditions.

- 8) Since the piles will be resting and socketed into hard rock, there will be no settlements of piles.
- 9) The site lies in an area of Mapusa river, precautions may be taken against corrosion of steel and concrete.
- 10) The applicable code for design and construction is IS:2911 (Part I/Sec.2) - 1979 : Bored cast insitu piles.

For DAFTARY DESCON ENGINEERING PVT. LTD.


A. V. Karandikar
Manager



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ANNEXURES



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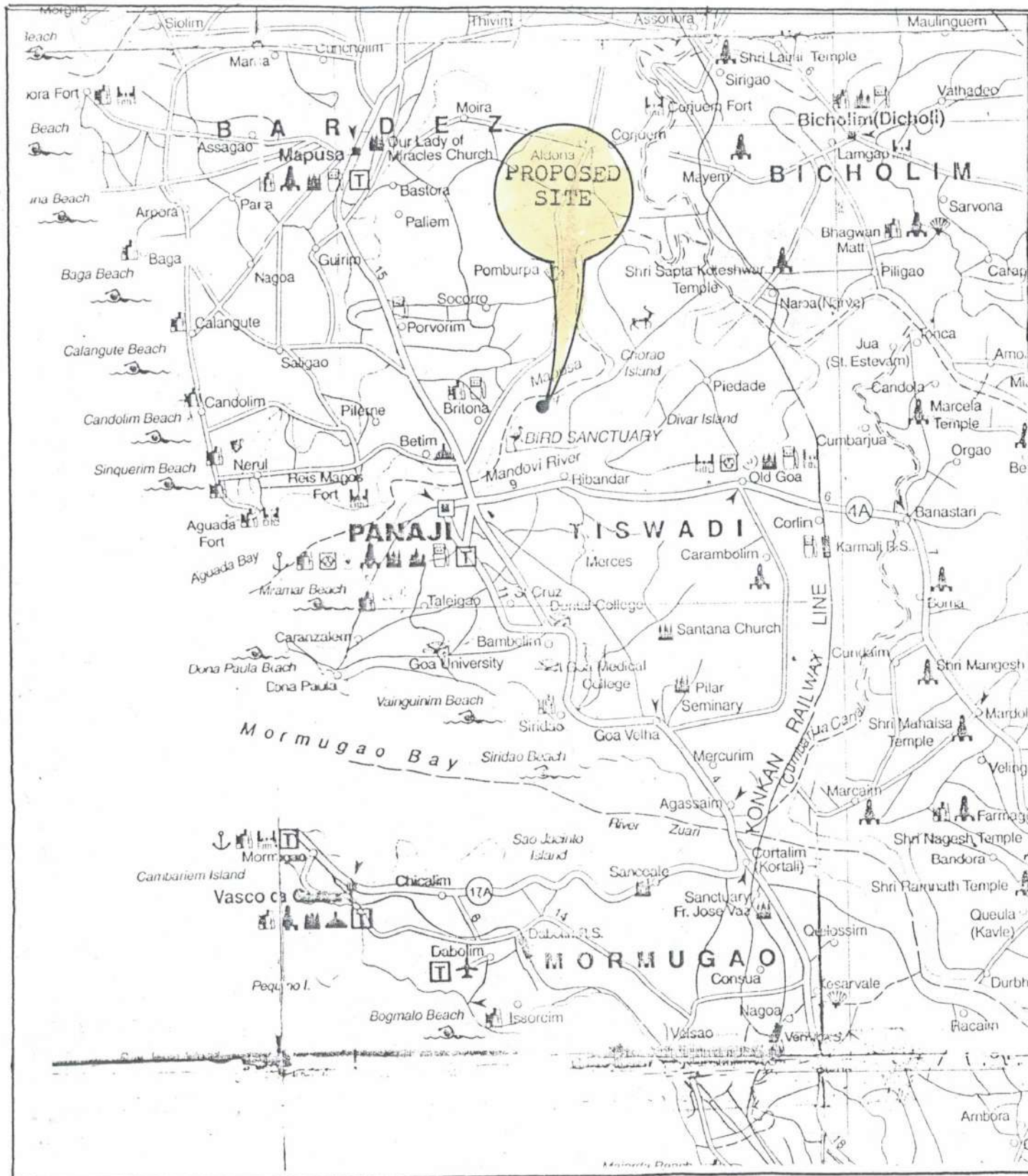


FIG. NO.1: GENERAL SITE LOCATION PLAN

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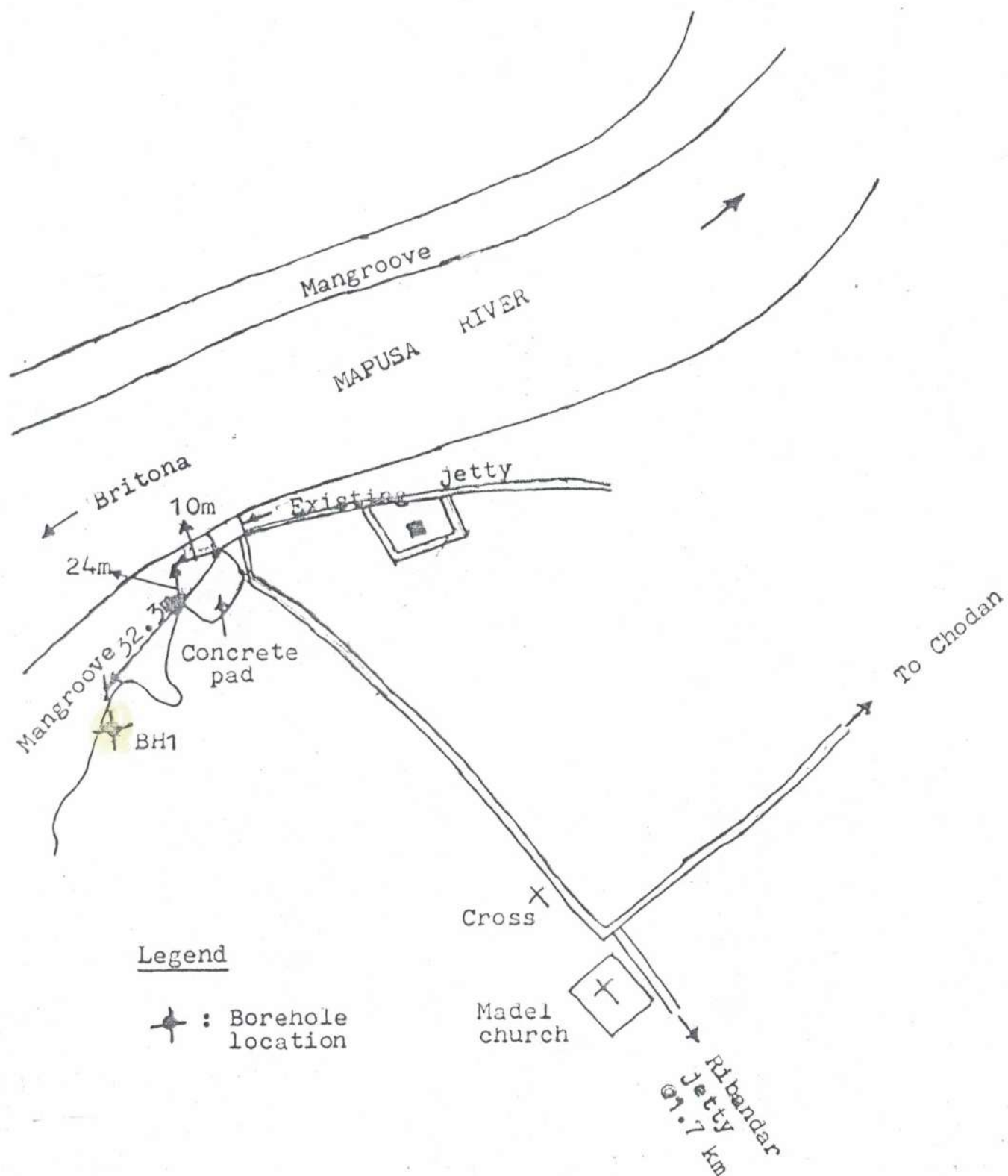


FIG NO.2: SITE LAYOUT PLAN SHOWING BOREHOLE LOCATION (NTS)

FIG NO.3 : BOREHOLE LOG NO.1

Date Of Start : 24/05/2013 Rotary Drilling : TC & diamond bit
Date Of Completion : 05/06/2008 Dia. Of Casing : 100mm / NX
Borehole Coords : Refer site layout plan Dia. Of Core : NX
Ground level : --

Profile	Depth below GL (m)	Description	SPT N	Samples				Remarks
				No.	Type	Depth (m)		
						From	To	
xx		Whitish, brownish silty clay (paddy field)						
			11	01	DP	01.00	01.45	
xx			15	02	DW	02.00	02.45	DP sample slipped
	2.5	Redish brown stiff lateritic clayey silt with gravels.	20	03	DP	03.02	03.47	
xx			29	04	DP	04.00	04.45	
	5.0	Redish, brownish, whitish (bauxite) very stiff lateritic clayey silt with gravels.	33	05	DP	05.00	05.45	
xx			47	06	UD	05.50	05.80	
				07	DP	06.00	06.45	
xx	7.5		45	08	DP	07.50	07.95	
				09	UD	08.26	08.56	
xx								
	10.0		26	10	DP	10.20	10.65	
xx				11	UD	11.00	11.30	
		Pinkish, yellowish, very stiff phyllitic clayey silt.	31	12	DP	12.07	12.52	
xx	12.5							
xx			35	13	DP	14.50	14.95	
	15.0		>50	14	DP	15.01	15.46	
xx								

LEGEND

DP : Sample From SPT Tube
DW : Wash Sample

UD : Undisturbed Sample
CB : Core Barrel Sample

FIG NO.3 : BOREHOLE LOG NO.1 (CONTD.)

Date Of Start : 24/05/2013 Rotary Drilling : TC & diamond bit
Date Of Completion : 05/06/2008 Dia. Of Casing : 100mm / NX
Borehole Coords : Refer site layout plan Dia. Of Core : NX
Ground level : --

Profile	Depth below GL (m)	Description	SPT N	Samples				Remarks
				No.	Type	Depth (m)		
						From	To	
		Pinkish, yellowish, very stiff phyllitic clayey silt.	>50	15	DP	16.02	16.30	
	17.5							
			>50	16	DP	18.00	18.45	
				17	CB	18.60	19.00	
		Quartz vein		18	DW	19.00	19.10	UD sample slipped
	20.0	Brownish, greyish, very stiff clayey silt (derived from highly weathered rock)						
			>50	19	DP	21.60	21.69	
				20-21	CB	22.10	23.61	
	22.5							
				22-25	CB	23.61	25.26	
	25.0	ROCK		26-45	CB	25.26	26.74	
		Ash grey hard argillite rock with inclined joints.						
		Partly weathered at top yielding poor recovery.		46-52	CB	26.74	28.37	
	27.5							
				53-55	CB	28.37	29.88	
				56-63	CB	29.88	31.51	
	30.0							

LEGEND

DP : Sample From SPT Tube
DW : Wash Sample

UD : Undisturbed Sample
CB : Core Barrel Sample

FIG NO.3 : BOREHOLE LOG NO.1 (CONTD.)

Date Of Start : 24/05/2013 Rotary Drilling : TC & diamond bit
Date Of Completion : 05/06/2008 Dia. Of Casing : 100mm / NX
Borehole Coords : Refer site layout plan Dia. Of Core : NX
Ground level : --

Profile	Depth below GL (m)	Description	SPT N	Samples			Remarks	
				No.	Type	Depth (m)		
						From		To
		ROCK						
		Ash grey hard argillite rock with inclined joints. Partly weathered at top yielding poor recovery.		64-70	CB	31.51	32.33	
	32.5							
	35.0							
	37.5							
	40.0							
	42.5							
	45.0							
BOREHOLE DEPTH BELOW EXISTING GL = 32.33M								

LEGEND

DP : Sample From SPT Tube UD : Undisturbed Sample
DW : Wash Sample CB : Core Barrel Sample

FIG NO.4: STANDARD PENETRATION TEST RESULTS

SR. NO.	BH. NO.	DEPTH (M) BELOW GL		PENETRATION (CM)	CORRESPONDING NO. OF BLOWS	SPT N	REMARKS
		FROM	TO				
01	1	01.00	01.45	15	03		
				15	04		
				15	07	11	
02	1	02.00	02.45	15	10		
				15	08		
				15	07	15	
03	1	03.02	03.47	15	14		
				15	09		
				15	11	20	
04	1	04.00	04.45	15	07		
				15	11		
				15	18	29	
05	1	05.00	05.45	15	12		
				15	16		
				15	17	33	
06	1	06.00	06.45	15	15		
				15	20		
				15	27	47	
07	1	07.50	07.95	15	10		
				15	20		
				15	25	45	
08	1	10.20	10.65	15	05		
				15	11		
				15	15	26	
09	1	12.07	12.52	15	04		
				15	06		
				15	25	31	
10	1	14.50	14.95	15	05		
				15	15		
				15	20	35	
11	1	15.01	15.46	15	15		
				15	31		
				15	30	>50	
12	1	16.02	16.30	15	26		
				13	50	>50	Rebound from 3 rd blow.
13	1	18.00	18.45	15	10		
				15	21		
				15	34	>50	
14	1	21.60	21.69	09	50	>50	Rebound from 15 th blow.

FIG NO.5 : ROCK CORE RECOVERY DETAILS

BH. NO.	SAMPLE NO.		DEPTH (M)		DRILLING RUN (M)	CORE RECOVERED (M)	CORE RECOVERED (%)	R.Q.D.	R.Q.D. (%)
	FROM	TO	FROM	TO					
1	20	21	22.10	23.61	1.51	0.33	21.85	Nil	Nil
1	22	25	23.61	25.26	1.65	0.50	30.30	Nil	Nil
1	26	45	25.26	26.74	1.48	1.18	79.72	0.10	6.75
1	46	52	26.74	28.37	1.63	0.93	57.05	0.33	20.24
1	53	55	28.37	29.88	1.51	0.41	27.15	Nil	Nil
1	56	63	29.88	31.51	1.64	1.08	66.00	0.25	15
1	64	70	31.51	32.33	0.82	0.60	73.00	Nil	Nil

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FIG. NO.6: TABLE OF LABORATORY TEST RESULTS

Sr.N o.	Borehole	Depth		Field density & moisture content			Atterberg Limits			Mechanical analysis				Specific gravity	Box shear (consolidated)		Unconfined compression	Consolidation		
		From	To	Bulk density gm/cc	Dry density gm/cc	Moisture content %	L.L.	P.L.	P.I.	Gravel above 4.76mm %	Sand 0.076mm to 4.76mm %	Silt 002 to 0.075mm %	Clay below 002mm %		Cq	Øq Deg.		Pressure range kg/cm ²	Coeff. of compressibility cm ² /kg	
1	1	5.50	5.80	2.09	1.72	21.5	--	--	--	--	--	--	--	--	750	25.0	3440	--	--	--
2	1	8.26	8.56	2.02	1.60	26.2	--	--	--	--	--	--	--	--	1000	26.0	5010	--	--	--
3	1	11.00	11.30	2.18	1.59	37.0	--	--	--	--	--	--	--	--	0	29.0	5800	--	--	--
4	1	15.01	15.31	2.15	1.60	34.4	--	--	--	--	--	--	--	--	0	31.0	5000	--	--	--

Note: Shear tests are done on remoulded samples at their respective field density & NMC.

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Sr. No.	BH. No.	Sample No.		Depth Below GL		Dia. (D)	Length (L)	Rock Crushing Results (Soaked)		
		From	To	From	To			Load Applied	Actual Crushing Strength	Corrected Crushing Strength (Kg/cm ²)
				(m)	(m)	(cm)	(cm)	(Kg.)	(Kg/cm ²)	
1	1	64.00	64.70	31.51	32.33	5.4	7.2	3200	139.80	130.01

FIG. NO.7 : ROCK CORE CRUSHING STRENGTH TEST RESULT (SOAKED)