

# Geotechnical Investigation Report for Extension of Q2-Q3 Berth at Mattancheery Wharf - Kerala

## Geotechnical Consultant



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## Geotechnical Investigation Report - BH 01 & BH 02

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Description	Prepared by	Reviewed by	Approved by
Geotechnical investigation Report- (01 BHs)			
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### Client:

Cochin Port Authority  
Willingdon Island,  
Cochin – 682 009,  
Kerala (India).



### Client Consultant:

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## Document History

This document has been issued and amended as follows:

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## Acronyms and Abbreviations

The following acronyms and abbreviations are used throughout this document:

Abbreviation	Definition
BDL	Below Detection Limit
BH	Bore Hole
Cc	Compression Index
CR	Core Recovery
Cu	Consolidated Undrained
DL	Detection Limit
DS	Disturbed Sample
FSI	Free Swell Index
IS	Indian Standards
NP	Non Plastic
RA	Reaffirmed
RQD	Rock Quality Designation
SPT	Standard Penetration Test
UCC	Unconfined Compression
UCS	Unconfined Compressive Strength
UDS	Undisturbed Sample
UU	Unconsolidated Undrained
WS	Washing Sample
WT	Water Table

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## 1.0 Introduction

M/S.MYRTLE PROJECT AND CONSULTANCY PVT LTD., had been awarded the work for - Geotechnical Investigation Report for Extension of Q2-Q3 Berth at Mattancheery Wharf - Kerala . This report is based on two boreholes with field test results.

## 2.0 Scope of work

- a. Drilling boreholes by Rotary drilling maximum upto 41.5m as per IS: 1892 – 1979 of practice and at locations as directed by client.
- b. Conducting Standard Penetration tests in the bore holes at regular intervals of 1.5m or change in stratum as per IS: 2131-1981.
- c. Collecting undisturbed soil samples in thin walled tube sampler as per IS: 2132 – 1986 at regular interval or as directed by the Engineer-in-Charge.
- d. Collecting core samples from the bore holes as per IS: 4078 – 1980 and recording Rock Quality Designation (RQD) and Core recovery (CR).
- e. Recording of water table level in the bore holes after drilling.
- f. Conducting laboratory tests on relevant Soil /Rock samples as per IS Code specifications.
- g. Conducting Chemical tests on Soil & Water Samples.
- h. Soil classification was carried out in accordance with IS: 1498-1970 & for rock weathering was classified in accordance with IS: 4464-1985.
- i. Preparation of report summarizing the details of soil classification, analysis of test data, type of foundation etc.

## 3.0 Overview

### 3.1 Methodology of Field investigation

#### 3.1.1. Boring

Boreholes were drilled by Rotary drilling upto 41.5m depth. In refusal strata, drilling was resorted by Nx size double tube core barrel with diamond bits as per IS : 1892 - 1979 of practice and as directed by Engineer-in-charge. The details of Borehole drilled, depth of the borehole, depth of water table and road level are as given in Table : 4.1.

#### 3.1.2. Standard Penetration test

Rotary Calyx Rig was used to conduct SPT at field. In accordance with IS: 2131-1981,SPT was conducted at every change of stratum or at intervals of not more than 1.5 m depth whichever occurs earlier. It was done by connecting the split spoon sampler to SPT rod and driving it upto 45 cm using a 63.5 kg hammer falling freely from a height of 75 cm.The number of blows required to penetrate the initial 15 cm of the split spoon was ignored for seating the sampler due to possible presence of loose materials or cutting from the drilling operation. The cumulative number of blows required to penetrate the balance 30 cm out of 45 cm was termed as the SPT or N values.

#### 3.1.3. Disturbed & Undisturbed samples

i) Conducting Standard Penetration Test at 1.5m intervals, disturbed soil samples were collected using a split spoon sampler.

ii) Undisturbed soil samples were collected in soil layers wherever possible by using thin walled sampling tube and mentioned in the respective bore logs.

### 3.1.4. Rock Coring

Tungsten Carbide (TC) / Diamond bits were used to drill through weathered rock / hard rock stratum. Recovered cores were measured and percentages of CR and RQD has been calculated as per below:

$$\%CR = \left[ \frac{\text{Length of core}}{\text{Length of run}} \right] * 100$$

$$\%RQD = \left[ \frac{\text{Length of core in pieces of 10cm \& above}}{\text{Length of run}} \right] * 100$$

### 3.1.5. Ground Water table

Water table in each borehole was noted by allowing the water table level to stabilize for minimum 24 hrs. This can be noticed after the completion of drilling activity in each borehole. The depth of water level below EGL is noted in respective bore logs.

### 3.1.6. Backfilling of boreholes

All boreholes were backfilled in proper way after the termination of each boreholes. (as directed by Engineer incharge)

## 3.2 Laboratory Test

The following tests were performed in Laboratory on soil, rock & water samples collected from field.

### 3.2.1. For Soil

- Grain Size Analysis- IS 2720 (Part 4) : 1985
- Hydrometer analysis - IS 2720 (Part 4) : 1985
- Bulk & Dry Density - IS 2720 (Part 29) : 1975
- Natural Moisture Content - IS 2720 (Part 2) : 1973
- Specific Gravity - IS 2720 (Part 3) : 1980
- Liquid limit & Plastic limit – IS 2720 (Part 5): 1985
- Shrinkage Limit– IS 2720 (Part 6): 1972
- Free swell Index– IS 2720 (Part 40): 1977
- Swell Pressure Test– IS 2720 (Part 41): 1977
- Direct Shear - IS 2720 (Part 13) : 1986
- Triaxial Compressive strength test (UU) - IS 2720 (Part 11) : 1993

#### i) Grain Size & Hydrometer Analysis - IS 2720 (Part 4): 1985

Grain Size & Hydrometer Analysis was determined from the various UD & DS soil samples collected in boreholes. Based on the proportion of the different soil constituents, the soil can be classified.

#### ii) Bulk & Dry Density - IS 2720 (Part 29) : 1975

Density was determined from the various soil samples collected in required depth. It is defined as mass per unit volume of soil. It is expressed in kg per cubic meter.

**iv) Natural Moisture Content - IS 2720 (Part 2) : 1973**

Moisture content was determined from the various soil samples collected in required depth. It is the ratio of weight of water to the weight of the solids in a given mass of soil. This ratio is usually expressed as percentage.

**v) Specific Gravity - IS 2720 (Part 3) : 1980**

Specific gravity of soil was determined for the required soil samples collected. It is defined as the ratio of unit weight of solid particles to the unit weight of water.

**vi) Direct Shear - IS 2720 (Part 13) : 1986**

Specific gravity of soil was determined for the required soil samples collected. It is defined as the ratio of unit weight of solid particles to the unit weight of water.

**vii) Liquid limit & Plastic limit – IS 2720 (Part 5): 1985**

The Liquid & Plastic limit values of the cohesive layers were determined from the Clay samples collected. The Liquid Limit is the moisture content at which a fine-grained soil can no longer flows like a liquid. The Plastic Limit is the moisture content at which a fine-grained soil can no longer be remolded without cracking.

**viii) Shrinkage limit – IS 2720 (Part 5): 1985**

The Shrinkage limit values were determined from the various clay & silt samples collected. It is defined as the moisture content at which no further volume decrease occurs, but where the degree of saturation is still essentially 100 %.

**ix) Free Swell Index -IS 2720 (Part 40) : 1977**

Free Swell Index values of the cohesive layers were determined from the Clay samples collected. It is the increase in volume of a soil, without any external constraints, on submergence in water.

**X) Swell Pressure Test : IS 2720 (Part 41): 1977**

The pressure which the expansive soil exerts, when it is not allowed to swell or the volume change of the soil is arrested, is known as swelling pressure of soil.

**Xi) Triaxial test -IS 2720 (Part 11) : 1993**

A triaxial test involves confining a cylindrical soil specimen in a pressurised cell to simulate a stress condition and then shearing to failure, in order to determine the shear strength properties of the sample.

**Xii) Consolidation -IS 2720 (Part 15) : 1986**

Consolidation test is used to determine the rate and magnitude of soil consolidation when the soil is restrained laterally and loaded axially. The Consolidation test is also referred to as Standard Oedometer test or One-dimensional compression test.

### 3.2.2. For Rock

#### Physical tests on Rock core samples:

The following tests were performed on selected rock core samples conforming to IS (relevant parts):

- Unconfined compressive strength - IS 9143 : 1979
- Point Load Index - IS 8764: 1998

#### i) Unconfined Compressive Strength IS 9143 : 1979

The unconfined compression test of rock samples were determined for various samples collected. It is used to derive the Unconfined Compressive Strength (UCS) of a rock specimen when load applied in one direction.

#### ii) Point Load Index - IS 8764: 1998

Point Load Index test of rock samples were determined for various samples collected at required depths. This test consists of the application of load between two points to the fragment of rock. This is a measurement of tensile strength.

### 3.2.3. Chemical Analysis for soil and water

- For soil (pH Value, Sulphates and Chlorides).
- For water (pH Value, Sulphates and Chlorides).

## 3.3 Geological Conditions

- |                              |   |  |
|------------------------------|---|--|
| a. Flood history             | : | On Dec,2019 Heavy Rain occurred in Kochi District. |
| b. Earthquake history        | : | On Nov,2021 Earthquake occurred in Kochi District. |
| c. Earthquake zone           | : | III  |
| d. Water bodies near by site | : | Big river @ 10.0m,Sea @ 1.5km                      |

## 4.0 Field data:

For Geotechnical Investigation report – 2 Boreholes were drilled as directed by Engineer incharge.

Borehole No.	Date of Test	Co-ordinates	Borehole Termination Depth (m)	Water table (Below Ground Level) (m)
BH-01	02-03-2026 to 05-03-2026	N - 1101126.00 E - 638777.00	41.5m	4.0 m
BH-02	19-02-2026 to 01-03-2026	N - 1101011.00 E - 638818.00	41.5m	4.5 m

*\*Note: Seasonal and annual fluctuations in ground water levels can be expected at different depths.*

## 4.1 Sub soil profile

Based on Borehole information, sub surface soil profile for the Geotechnical Investigation Report for Extension of Q2-Q3 Berth at Mattancheery Wharf - Kerala is given below

BH NO.	Depth (m)		Type of Soil
	From	To	
BH-01	0.0	6.0	Brown colored Sandy CLAY(CL)
	6.0	16.5	Black colored Silty CLAY(CL)
	16.5	19.5	Yellow and Brown colored Silty SAND(SM)
	19.5	21.0	Yellow colored Clayey SILT(ML)
	21.0	24.0	Grey colored Silty CLAY(CL)
	24.0	27.0	Brown and Black colored Silty SAND mixed with Clay(SM)
	27.0	31.5	Brown and Yellow colored Silty CLAY(CL)
	31.5	36.0	Black colored Silty CLAY(CL)
	36.0	40.0	Black colored Sandy CLAY(CL)
BH-02	40.0	41.5	Brown and Black colored Coarse SAND(SP)
	0.0	1.5	Black Colored Sandy CLAY (CL)
	1.5	21.0	Black Colored Silty CLAY (CL)
	21.0	28.5	Brown and Yellow Colored Silty CLAY (CL)
	28.5	33.5	Brown and Grey Colored Silty CLAY (CL)
	33.5	40.0	Brown and Red Colored Sandy SILT mixed with Clay (ML)
40.0	41.5	Yellow Colored Silty SAND mixed with Clay (SM)	

# Annexure I

## (Borelog Figures)

**BORE LOG AND CORE LOG SHEET**



**Geotechnical Investigation Report for Extension of Q2-Q3 Berth at Mattancherry Wharf-Kerala**

**MPAC PVT. LTD.**

<b>BH.NO:</b>	<b>1</b>		
DEPTH OF WATER TABLE :	4.0M	BORE HOLE DIAMETER:	150mm/75mm
LAND MARK DETAILS :	Mattancherry Wharf,Willingdon Island,Kochi Port-BH1	DATE OF START & FINISH :	02-03-2026 to 05-03-2026
BORE HOLE TERMINATION:	41.5M	LADTITUDE & LONGITUDE :	N - 1101126.00 E - 638777.00

From	To	Thickness of Layer (m)	Type	Description	Profile	SPT Test				Depth Vs N Value	Core Recovery (%)	RQD (%)	Remarks
						0.0-0.15 m	0.15-0.30 m	0.30-0.45 m	N Value				
0.0	1.5	6.0	SPT	Black colored Sandy CLAY(CL)	[Green Profile]	1	1	2	3		-	-	-
1.5	3.0		SPT			0	1	2	3				
3.0	4.5		SPT			0	1	1	2				
4.5	6.0		SPT			1	2	2	4				
6.0	7.5	10.5	SPT	Black colored Silty CLAY(CL)	[Green Profile]	0	1	1	2				
7.5	9.0		UDS			2	3	3	6				
9.0	10.5		SPT			3	3	4	7				
10.5	12.0		SPT			1	2	2	4				
12.0	13.5	3.0	SPT	Yellow and Brown colored Silty SAND(SM)	[Yellow Profile]	3	2	2	4				
13.5	15.0		UDS			1	2	3	5				
15.0	16.5		SPT			2	2	3	5				
16.5	18.0		SPT			1	2	5	7				
18.0	19.5	1.5	SPT	Yellow colored Clayey SILT(ML)	[Blue Profile]	1	4	4	8				
19.5	21.0		SPT			3	3	3	6				
21.0	22.5		SPT			0	2	3	5				
22.5	24.0		SPT			3	4	4	8				
24.0	25.5	3.0	SPT	Brown and Black colored Silty SAND mixed with Clay(SM)	[Yellow Profile]	5	8	11	19				
25.5	27.0		SPT			10	12	14	26				
27.0	28.5		SPT			13	15	18	33				
28.5	30.0		SPT			11	16	20	36				
30.0	31.5	4.5	SPT	Brown and Yellow colored Silty CLAY(CL)	[Green Profile]	12	14	17	31				
31.5	33.0		SPT			10	18	20	38				
33.0	34.5		SPT			13	15	19	34				
34.5	36.0		SPT			16	20	21	41				
36.0	37.5	4.0	SPT	Black colored Sandy CLAY(CL)	[Green Profile]	18	18	23	41				
37.5	40.0		SPT			21	23	25	48				
40.0	41.5		SPT			50/SCM			>100				



**BORE LOG AND CORE LOG SHEET**



**Geotechnical Investigation Report for Extension of Q2-Q3 Berth at Mattancherry Wharf-Kerala**

**MPAC PVT. LTD.**

**BH.NO:** 2

**DEPTH OF WATER TABLE :** 4.5M      **BORE HOLE DIAMETER:** 150mm/75mm

**LAND MARK DETAILS :** Mattancherry Wharf, Willingdon Island, Kochi Port-BH2      **DATE OF START & FINISH :** 19-02-2026 TO 01-03-2026

**BORE HOLE TERMINATION:** 41.5M      **LADITUDE & LONGITUDE :** N-1101011.00 E-638818.00

Depth (m)		Thickness of Layer (m)	Type	Description	Profile	SPT Test			N Value	Depth Vs N Value	Core Recovery (%)	RQD (%)	Remarks	
From	To					0.0 - 0.15 m	0.15 - 0.30 m	0.30 - 0.45 m						
0.0	1.5	1.5	SPT	Black colored Sandy CLAY(CL)	[Green Profile]	0	1	1	2		-	-	-	
1.5	3.0		SPT			1	1	1	2		-	-	-	
3.0	4.5		SPT			1	1	1	2		-	-	-	
4.5	6.0		SPT			1	2	1	3		-	-	-	
6.0	7.5		SPT			1	2	2	4		-	-	-	
7.5	9.0		SPT			0	2	2	4		-	-	-	
9.0	10.5		UDS			-	-	-	-		-	-	-	-
10.5	12.0	19.5	SPT	Black colored Silty CLAY(CL)		2	2	3	5		-	-	-	
12.0	13.5		SPT			2	2	4	6		-	-	-	
13.5	15.0		UDS			-	-	-	-		-	-	-	-
15.0	16.5		SPT		0	1	1	2	-	-	-			
16.5	18.0		SPT		2	3	1	4	-	-	-			
18.0	19.5		SPT		4	2	5	7	-	-	-			
19.5	21.0		SPT		5	7	7	14	-	-	-			
21.0	22.5		SPT		5	9	11	20	-	-	-			
22.5	24.0		SPT		10	11	14	25	-	-	-			
24.0	25.5	7.5	SPT	Brown and Yellow colored Silty CLAY(CL)	15	16	19	35	-	-	-			
25.5	27.0		SPT		14	19	21	40	-	-	-			
27.0	28.5		SPT		14	20	23	43	-	-	-			
28.5	30.0		SPT		10	14	20	34	-	-	-			
30.0	32.0	5.0	SPT	Brown and Grey colored Silty CLAY(CL)	11	13	20	33	-	-	-			
32.0	33.5		SPT		9	9	10	19	-	-	-			
33.5	35.0		SPT		12	14	20	34	-	-	-			
35.0	40.0	6.5	SPT	Brown and Red colored Sandy SILT mixed with Clay(ML)	15	17	21	38	-	-	-			
40.0	41.5	1.5	SPT	Yellow colored Silty SAND mixed with Clay(SM)	13	17	24	41	-	-	-			



## Annexure II

(Site Keyplan)



## Annexure III (Photographs)

# SITE PHOTOS OF GEOTECHNICAL INVESTIGATION

## BH.NO-01



### Sample photos

3.0-4.5 m



21.0-22.5 m



24.0-25.5 m



28.5-30.0 m



**10.5-12.0 m**



**16.5-18.0m**



**40.0-41.5 m**



**UDS Sample 7.0 - 9.0 m**



# SITE PHOTOS OF GEOTECHNICAL INVESTIGATION

BH.NO - 02



### Sample photos

0.0-1.5 m



4.5-6.0 m



3.0-4.5 m



10.5-12.0 m



**16.5-18.0 m**



**22.5-24.0 m**



**30.0-32.0 m**



**33.5-35.0 m**



40.0-41.5 m



Corebox

