M/s PALAVA DWELLERS PVT LTD

GEOTECHNICAL INVESTIGATION REPORT

FOR

MISCELLANEOUS BUILDINGS

AT

PALAVA 2A & 2B, DOMBIVALI (E)

MAY 2019

2017-2019-003

BY

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M/s PALAVA DWELLERS PVT LTD

MUMBAI

GEOTECHNICAL INVESTIGATION REPORT

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BY

Invest in Investigation
Ochre Drillers India Private Limited

BASEMENT, KRISHNA KUNJ,
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2017-2019-003

1.0 GENERAL

1.1 **M/s Palava Dwellers Pvt Ltd**, Mumbai have taken up construction of miscellaneous buildings at PALAVA 2A & 2B, Dombivali (E). Proposed site is located in sector 4 on MIDC Taloja road, of Palava Phase II at village Khoni, Dombivali (E). Proposed structures will be RCC framed.

1.2 Client decided to carry out geotechnical investigation work to determine foundation design parameters. **M/s Ochre Drillers India Pvt Ltd**, Thane was entrusted with work of geotechnical investigation.

1.3 Geotechnical investigation consisted of nine boreholes for proposed project. **M/s Ochre Drillers India Pvt Ltd** carried out fieldwork of nine boreholes from April 04 to May 08, 2019. Selected rock and water samples were tested in laboratory. Laboratory test results were received on May 13, 2019.

1.4 This report has been prepared by **M/s Ochre Drillers India Pvt Ltd**. Report covers data collected in fieldwork of nine investigation boreholes and analysis of laboratory test results. Report is limited to defining design parameters and specifying safe bearing capacity. It does not involve any specialist design for any subsurface component or visits by the undersigned to confirm any of the design parameters.

2.0 SCOPE OF INVESTIGATION

2.1 Scope of geotechnical investigation work for proposed project consisted of nine boreholes. Each borehole is to be drilled through overburden & minimum 8.00 m in bed rock. Estimated depth of borehole is about 10.00 m from existing ground level. Objective of investigation is to find out the subsurface stratification in project area and collect data for deciding design parameters of foundation.

2.2 To meet above objectives, following items were included in the scope of work:

I) Conduct standard penetration tests in-situ to obtain shear strength parameters of soil at interval of 1.00 to 1.50 metres & collect disturbed soil samples in SPT split spoon.

II) Collect undisturbed soil samples from cohesive soil stratum to determine the engineering properties such as shear strength and compressibility.

III) Determine ground water level in each borehole. It was also required to collect ground water sample from each borehole for chemical analysis.

IV) Collect and transport selected samples in soil & rock testing laboratory and conduct relevant tests to determine engineering properties of different subsoil strata.

V) Prepare a geotechnical investigation report based on the data collected from field and the results of the laboratory tests.

2.3 Fieldwork is summarised in the following table.

TABLE: SUMMARY OF BOREHOLES

Bore Hole No	Ground Level (m)	Rock Depth (m)	Termination Depth (m)	Ground Water Depth (m)
BH 01	110.127	0.00	10.06	2.00
BH 02	112.384	0.00	10.10	2.60
BH 03	113.334	0.30	10.00	2.10
BH 04	114.236	0.00	10.04	1.50
BH 05	115.420	1.00	10.02	1.60
BH 06	114.160	0.20	10.20	2.60
BH 07	106.987	2.00	10.22	0.00
BH 08	112.660	1.50	10.05	3.00
BH 09	113.500	1.50	10.03	3.60

3.0 METHODOLOGY

OBJECTIVE

3.1 Geotechnical investigation was planned to obtain subsoil stratification in proposed project area and collect soil, rock and ground water samples for laboratory testing to determine engineering properties such as shear strength, compressibility, along with basic soil classification of subsurface stratum.

3.2 Locations of boreholes were selected in consultation with client. Data and results obtained from this investigation will be used in design of foundation of proposed project.

FIELD INVESTIGATION

3.3 For geotechnical investigation work, standard rotary type drilling rig was used. This rig is coupled with diesel engine and has tripod and all drilling accessories. Drilling rig deployed is suitable for and has arrangement for driving as well as extracting casing, boring drilling by mud circulation method, conducting Standard Penetration Test (SPT) collection of Undisturbed Soil Sample (UDS) and Disturbed or wash Soil Sample (DS).

3.4 Drilling rig was installed at each specified borehole location. Rig was stabilised by making level ground. Initially casing of adequate diameter to suit boring of 100 mm hole was lowered and boring was commenced.

3.5 Sampling in each borehole was carried out generally as per the guidelines given in the IS code. Undisturbed soil samples were to be collected and SPTs were conducted at regular intervals. Undisturbed soil samples were not collected as cohesive stratum is stiff in consistency.

3.6 Standard Penetration Tests (SPT) were conducted in boreholes to obtain SPT 'N' values i.e. no. of blows of 63.5 kg hammer falling through 75 cm, required to penetrate 30 cm of SPT split spoon. This test was conducted as per IS-2131. SPT 'N' values are correlated with the relative density of non-cohesive soils and consistency of saturated cohesive soils. This test also collected samples in the split spoon assembly, which are treated as disturbed samples. SPTs were taken @ 1.00 m to 1.50 m interval.

3.7 SPT 'N' values are co-related with relative density of non-cohesive stratum and with consistency of cohesive stratum. Co-relations are tabulated below.

TERMS FOR NON-COHESIVE SOILS

Relative Density	Penetration Value (Blows/Ft)
Very loose	0 to 4 Blows
Loose	4 to 10 Blows
Medium	10 to 30 Blows
Dense	30 to 50 Blows
Very Dense	Above 50 Blows

TERMS FOR COHESIVE SOILS

Consistency	Penetration Value (Blows/Ft)
Very Soft	0 to 2 Blows
Soft	2 to 4 Blows
Medium Stiff	4 to 8 Blows
Stiff	8 to 16 Blows
Very Stiff	16 to 32 Blows
Hard	Above 32 Blows

3.8 When rock was encountered, size of borehole was changed to Nx (76 mm) diameter. A core barrel and Nx sized bits are used for drilling and recovering rock cores. Recovered rock cores were numbered serially and preserved in good quality sturdy wooden core boxes. Rock core recovery and Rock Quality Designation (RQD) were computed for every run length drilled. Rock samples have been selected based on the probable founding elevation of the proposed structure.

3.9 Rock classification in terms of weathering and state of fractures and strength is carried out in the following manner. Tabulations given in below explain it briefly.

SCALE OF WEATHERING GRADES OF ROCK MASS

Terms	Description	Grade	Interpretation
Fresh	No visible sign of rock material weathering; perhaps slight discoloration on major discontinuity surfaces.	**I**	**CR > 90 %**
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discoloured by weathering.	**II**	**CR between 70 % to 90 %**
Moderately Weathered	Less than half of the rock material is decomposed or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.	**III**	**CR between 51 % to 70 %**
Highly Weathered	More than half of the rock material is decomposed or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones	**IV**	**CR between 11 % to 50 %**
Completely Weathered	All rock material is decomposed and / or disintegrated to soil. The original mass structure is still largely intact.	**V**	**CR between zero to 10 %**
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.	**VI**	**CR = Zero % But N > 50**

As per IS 4464

3.10 It should be understood that all grades of weathering may not be seen in a given rock mass and that in some cases a particular grade may be present to a very small extent. Distribution of the various weathering grades of rock material in the rock mass may be

related to the porosity of the rock material and the presence of open discontinuities of all types in the rock mass.

3.11 **'Interpretation'** in above table has been done by Author of this report based on his understanding of above table & experience and is **NOT** a part of original table and observation of entire of rock mass instead of individual rock pieces.

3.12 Rock quality is further measured by frequency of natural joints in rock mass. Rock Quality Designation (RQD) is used to define state of fractures or massiveness of rock. Following table defines the quality of rock mass.

RELATION BETWEEN RQD AND IN-SITU ROCK QUALITY

ROCK QUALITY	RQD (%)
Excellent	90 to 100
Good	75 to 90
Fair	50 to 75
Poor	25 to 50
Very Poor	00 to 25

As per Annexure B, IS 13365 (Part 1): 1998

3.13 Rock is also classified by strength of intact rock cores collected during drilling. Rock compressive strength (UCS) is used to define strength of rock. Following table summarizes classification of rock based on strength.

CLASSIFICATION OF ROCK WRT COMPRESSIVE STRENGTH

ROCK STRENGTH	COMPRESSIVE STRENGTH (MPa)
Extremely weak	< 2.00
Very Weak	2.00 to 10.00
Weak	10.00 to 25.00
Average	25.00 to 50.00
Strong	50.00 to 100.00
Very Strong	100.00 to 250.00
Extremely Strong	> 250.00

As per Annexure B, IS 13365 (Part 1): 1998

3.14 Boreholes were terminated after drilling minimum 8.00 m in bed rock. Boreholes were terminated at about 10.00 m below existing ground level. On completion of boreholes, selected rock and water samples were taken to laboratory for testing.

3.15 Ground water table was observed after dewatering the borehole and waiting for time gap of 24 hours to allow for recuperation of ground water.

REQUIREMENTS FOR CONCRETE EXPOSED TO SULPHATE ATTACK

Sr. No	Class	Concentration of Sulphates Expressed as SO_3		
		Soil		Ground Water
		Total SO_3 Percent	SO_3 g/L	g/L
I	**1**	Less Than 0.20	Less Than 1.0	Less Than 0.30
II	**2**	0.20 to 0.50	1.0 to 1.90	0.30 to 1.20
III	**3**	0.50 to 1.00	1.90 to 3.10	1.20 to 2.50
IV	**4**	1.00 to 2.00	3.10 to 5.00	2.50 to 5.00
V	**5**	More Than 2.00	More Than 5.00	More Than 5.00

As per Table 4, IS 456:2000

IS CODES FOLLOWED

3.16 Field work was executed generally in accordance with IS specifications listed below:

a) IS-1892 : Code of practice for Subsurface Investigation of Foundations.
b) IS-1498 : Classification and Identification of soils for General Engineering Purposes.
c) IS-2131 : Method for Standard Penetration Test for Soils.
d) IS-2132 : Code of practice for Thin Walled Tube Sampling of Soils.
e) IS-5313 : Guide for Core Drilling Observations.

3.17 Following Laboratory testing was carried out as per relevant IS codes.

a) Grain size distribution and consistency limits on soil samples for engineering classification as per IS-1498.
b) Crushing strength of rock to decide safe bearing capacity of shallow foundation on the rock and/ or the safe friction and end bearing resistance for deep foundations such as piles, as per IS codes IS-9143 and IS-8764.
c) Chemical analysis of ground water to determine pH, $S0_3$ & Cl contents to decide any precautionary measures for protecting foundation concrete and reinforcement, as per IS-3025 (Part 24 and 32).

4.0 FINDINGS OF INVESTIGATION

4.1 Logs of nine boreholes drilled for proposed project were studied. Following subsurface profile was inferred up to final depth of boreholes.

Stratum One	:	**Overburden Soil/Filled Up Soil With Boulders**
Stratum Two		**Completely Weathered Rock**
Stratum Three	:	**Highly Weathered Basalt**
Stratum Four		**Moderately Weathered Basalt**
Stratum Five	:	**Slightly Weathered Basalt**

STRATUM ONE : OVERBURDEN SOIL / FILLED UP SOIL WITH BOULDERS

4.2 First stratum of subsurface profile is **overburden soil / filled up soil with boulders**. Overburden soil is present in BH 03, BH 05 & BH 06 and filled up soil with boulders is present in BH 07, BH 08 & BH 09. Thickness of this stratum is from 0.20 m to 2.00 m. This stratum consists of clay mixed with silt in varying percentage with gravels and small to medium sized of boulders also present in this stratum. Standard penetration test was not conducted in this stratum.

STRATUM TWO : COMPLETELY WEATHERED ROCK

4.3 Second stratum of subsurface profile is **completely weathered rock**. This stratum is present only in BH 05 & BH 08. Thickness of this stratum is 0.80 m in BH 05 and 1.00 m in BH 08. To advance through this hard stratum, drilling was carried out using Nx drilling bit & core barrel. Small rock pieces and wash samples were recovered in drill runs. Visual examination of wash & SPT samples collected during drilling revealed that it was completely weathered rock having residual rock structure, which is locally known as ‘murrum’.

STRATUM THREE : HIGHLY WEATHERED BASALT

4.4 Third stratum of subsurface profile is **highly weathered Basalt**. This stratum is present only in BH 05. Thickness of this stratum is 5.00 m. Rock core recovery values in this rock stratum are from 39 to 58 percent with one higher value of 81 percent. These values of rock core recovery show highly weathered condition of rock mass. Rock quality designation values are from 26 to 51 percent with one lower value of zero. These values indicate poor state of fractures in rock stratum. Two rock core samples collected from this stratum were tested in laboratory. Reported saturated crushing strength value of one rock core sample is 107.15 MPa. Saturated crushing strength value derived from point load strength index of

another rock core sample is 67.54 MPa. These values indicate that rock is strong to very strong in strength. Other test results are as below.

Porosity	%	04.21, 05.27
Water Absorption	%	01.53, 01.99
Dry Density	kN/m^3	27.48, 26.53
Saturated Crushing Strength	MPa	107.15
UCS from Point Load Strength Index	MPa	67.54

STRATUM FOUR : MODERATELY WEATHERED BASALT

4.5 Fourth stratum of subsurface profile is **moderately weathered Basalt**. This stratum is present in BH 01. Thickness of this stratum is 1.00 m in BH 01. Rock core recovery value in this rock stratum is 60 percent. This value of rock core recovery show moderately weathered condition of rock mass. Rock quality designation value is 56 percent. This value indicates fair state of fractures in rock stratum. No sample was selected from this stratum for laboratory testing.

STRATUM FIVE : SLIGHTLY WEATHERED BASALT

4.6 Fifth stratum of subsurface profile is **slightly weathered Basalt**. This stratum is present in all nine boreholes. This is the last stratum up to depth of investigation in all nine boreholes. Thickness of this stratum in each borehole is tabulated as below.

Borehole No	Thickness (m)	Borehole No	Thickness (m)	Borehole No	Thickness (m)
BH 01	9.06	BH 04	10.04	BH 07	8.22
BH 02	10.10	BH 05	4.02	BH 08	8.55
BH 03	9.70	BH 06	10.00	BH 09	8.53

Rock core recovery values in this rock stratum are from 67 to 99 percent. These values of rock core recovery show slightly weathered condition of rock mass. Rock quality designation values are from 47 to 99 percent. These values indicate fair to good state of fractures in rock stratum. Twenty six rock core samples selected from this stratum were tested in laboratory. Reported saturated crushing strength values of rock core samples are from 40.20 to 116.96 MPa with four lower values are from 20.92 to 26.76 MPa. These values indicate that rock is average to very strong in strength. Other test results are as below.

Porosity	%	01.63 to 09.05, 10.59 &12.15
Water Absorption	%	00.57 to 03.53, 05.68 & 04.57
Dry Density	kN/m^3	25.23 to 28.34, 21.39 & 23.16
Saturated Crushing Strength	MPa	40.20 to 116.96, 20.92 to 26.76

WATER LEVEL OBSERVATIONS

4.7 Ground water level was observed during fieldwork and after completion of all nine boreholes. At the time of investigation, water level was observed below existing ground level are tabulated below.

Borehole No	Thickness (m)	Borehole No	Thickness (m)	Borehole No	Thickness (m)
BH 01	2.00	BH 04	1.50	BH 07	0.00
BH 02	2.60	BH 05	1.60	BH 08	3.00
BH 03	2.10	BH 06	2.60	BH 09	3.60

However, for determination of more reliable ground water level, long term observations in cased holes or open stand pipe piezometers are desirable.

4.8 Water level fluctuations due to seasonal variations, amount of rainfall, runoff and other factors were not evident at the time of fieldwork. Trapped or “perched” water could occur within the fill materials and/or above low permeability soil and rock layers. Water level fluctuations and perched water may be considered while developing design and construction drawings and specifications for the project.

CHEMICAL ANALYSIS

4.9 Five water samples collected from boreholes were analysed chemically in the laboratory. Following results are reported.

‘pH’ Value	7.29, 7.60, 7.00, 7.12, 7.71	Alkaline Water
Sulphates (ppm)	172, 172, 309, 69, 172	Class II /Table IV/IS 456
Chlorides (ppm)	1171, 2084, 278, 89, 129	More than 500 ppm/Table 1/IS 456

Results of chemical analysis indicate that water is moderately aggressive to concrete and corrosive to reinforcement steel.

5.0 GEOTECHNICAL ASSESSMENT

5.1 **M/s Palava Dwellers Pvt Ltd**, Mumbai have taken up construction of miscellaneous buildings at PALAVA 2A & 2B, Dombivali (E). Proposed structures will be RCC framed.

FOUNDATION REQUIREMENTS

5.2 Foundation system designed for proposed structure shall satisfy two following independent criteria.

1. Foundation design shall have adequate factor of safety with respect to shear strength of foundation stratum.
2. Vertical deformation (settlement) caused by loading intensity on foundation stratum shall be within permissible limits of the structure. These criteria shall also ensure that magnitude of differential settlement between any two adjoining columns must remain within tolerances. So that finishing of proposed structures does not show distress.

FOUNDATION SYSTEM

5.3 Top stratum of subsurface profile is **overburden soil / filled up soil with boulders**. This stratum is present in six boreholes. Thickness of this stratum is from 0.20 m to 2.00 m. This stratum being backfilled by random dumping method, engineering properties of this stratum cannot be determined. Therefore, foundations shall not be placed in this stratum.

5.4 Second stratum of subsoil profile **completely weathered rock**. This stratum is present in BH 05 & BH 08. Therefore, foundations shall not be placed in this stratum.

5.5 This is followed by **highly weathered Basalt** which is followed by **moderately** & **slightly weathered Basalt** and improves in quality with depth. Therefore foundation shall be placed in highly weathered Basalt and slightly weathered Basalt. To evaluate safe bearing capacity of **highly weathered Basalt** & **slightly weathered Basalt**, rock mass rating value is determined. Average rock mass properties were considered to determine RMR value as per IS 13365 (part I). RMR rating values of **highly weathered Basalt** & **slightly weathered Basalt** for given conditions are 19 & 41 respectively. Using these values and referring to Table 3 of IS 12070-1987, net safe bearing capacity values work out to **398 kN/m^2** & **1332 kN/m^2**. RMR computation sheet is enclosed with this report.

5.6 Recommended minimum founding depths and net SBC value per borehole are tabulated as below. Foundations shall be placed minimum 50 cm in rock stratum.

Borehole No	Recommended Founding Stratum	Founding Depth (m)	Founding Level (m)	Net Safe Bearing Capacity kN/m^2 (T/m^2)
BH 01	Slightly Weathered Basalt	1.50	108.627	1300 (130)
BH 02	Slightly Weathered Basalt	0.50	111.884	1300 (130)
BH 03	Slightly Weathered Basalt	0.80	112.534	1300 (130)
BH 04	Slightly Weathered Basalt	0.50	113.736	1300 (130)
BH 05	Highly Weathered Basalt	1.50	113.920	390 (390)
	Slightly Weathered Basalt	6.20	109.220	1300 (130)
BH 06	Slightly Weathered Basalt	0.70	113.460	1300 (130)
BH 07	Slightly Weathered Basalt	2.50	104.487	1300 (130)
BH 08	Slightly Weathered Basalt	2.00	111.160	1300 (130)
BH 09	Slightly Weathered Basalt	2.00	111.500	1300 (130)

5.7 **Coefficient of modulus of subgrade reaction** or spring constant K is originally not a geotechnical concept. This is borrowed from Transportation engineering for using in software developed for more accurate numerical Analysis of foundation design.

5.8 In a plate load test, deformation is recorded for loads applied in increments. A graph is plotted between load applied and corresponding deformation observed. Coefficient of Modulus of Sub-grade Reaction K is defined as ratio of applied pressure and corresponding settlement at any point on the graph.

5.9 We will use “K” in our discussions below.

The basic equation is:

$$K\ (kN/m^2/m) = Pressure\ (kN/m^2) / Deflection\ (m)$$

For our case,

Safe bearing pressures are 390 & 1300 KN/m^2 derived by RMR method above.

Permissible settlements of footings on rock mass = 12 mm

Refer IS 1306:1991 Table no 1, clause 5.2.4

Therefore, $K_1 = 390\ (kN/m^2)/ 0.012\ (m)$

$K_1 = 32500\ kN/m^2/m$

And, K_2 = 1300 (kN/m^2)/ 0.012 (m)

K_2 = 108333 kN/m^2/m

5.10 In RMR method Factor of Safety is between 8 to 10.

5.11 It will be necessary to place footing of entire structure on rock of similar quality to ensure uniformity of foundation stratum and compatibility of deformation. It will be desirable that structural engineer inspects founding stratum to confirm that there are no soft pockets in the footing plan area before placing PCC.

5.12 To account for variation in founding depth thus achieved, only PCC or plum concrete of design strength recommended by structural consultant shall be used make good the difference between founding stratum and bottom of footing foundation at founding depth. **Rubble soling layer shall not be provided below footing foundation on reaching this founding stratum**.

DURABILITY

5.13 Based on the results of chemical analysis of water, it is clear that ground water is **moderately aggressive** to concrete and **corrosive** to reinforcement steel. Therefore, it is recommended to use **Pozzolana Portland Cement**. It is recommended to provide anti corrosive treatment to steel and sufficient clear cover to steel reinforcement for all underground structures.

Ochre Drillers

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Job No. : 2017
Date : 02-05-2019

Project : Miscellaneous buildings at PALAVA 2A & 2B, Dombivali (E)
Client : M/s Palava Dwellers Pvt. Ltd.

Co-Ordinate : -
R.L. : 110.127 m
Location :
Dia. of Borehole : 100 / Nx
Depth of GWT : 2.00 m

Bore Hole No. : BH 01
Depth of Bore Hole : 10.06 m
Depth of Casing : 2.00 m
Date of Commencement : 25-04-2019
Date of Completion : 27-04-2019

Scale m	Depth m	R.L. m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	15	N	CR %	RQD %	P.R. m/hr.	Remarks/ Other Tests
1	1.00	109.13		Moderately Weathered Basalt		DR1	0.00	1.00						60	56		
2				Slightly Weathered Basalt		DR2	1.00	2.00						78	65		GWT
3						DR3	2.00	3.00						81	47		
4						DR4	3.00	4.00						78	47		
5						DR5	4.00	5.00						91	91		
6						DR6	5.00	6.00						98	98		
7						DR7	6.00	7.00						97	93		
8						DR8	7.00	8.00						94	94		
9						DR9	8.00	9.00						78	62		
10	10.06	100.07		(9.1m)		DR10	9.00	10.06						90	90		
11				The Bore Hole is Terminated at 10.06 m depth													
12																	
13																	
14																	
15																	

DS: Disturbed Sample
UDS : Undisturbed Sample
SPT : Standard Penetration Test
WS : Wash Sample

CR : Core Recovery
RQD : Rock Quality Designation
PR : Rate of Penetration in Rock
VST : Vane Shear Test

K : Permeability of Soil / Rock
PT : Packer Permeability Test
DR : Drill Run
GWT : Ground Water Table

Site Engr.	Drawn By	Chkd. By	Client Rept.

Ochre Drillers India Pvt Ltd
Basement, Krishnakunj, Near Naupada Police Station, R. B.Luman Marg,
Prashant Nagar Thane (W) - 400602. Tel.022 2533 9393, 022 25371020

Ochre Drillers

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Job No. : 2017
Date : 02-05-2019

Project : Miscellaneous buildings at PALAVA 2A & 2B, Dombivali (E)
Client : M/s Palava Dwellers Pvt. Ltd.

Co-Ordinate : -
R.L. : 112.384 m
Location :
Dia. of Borehole : 100 / Nx
Depth of GWT : 2.60 m

Bore Hole No. : BH 02
Depth of Bore Hole : 10.10 m
Depth of Casing : 2.60 m
Date of Commencement : 22-04-2019
Date of Completion : 25-04-2019

Scale m	Depth m	R.L. m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	15	N	CR %	RQD %	P.R. m/hr.	Remarks/ Other Tests
1				Slightly Weathered Basalt		DR1	0.00	1.00						85	85		
2						DR2	1.00	2.00						80	66		
3						DR3	2.00	3.00						84	76		GWT
4						DR4	3.00	4.00						97	87		
5						DR5	4.00	5.00						89	89		
6						DR6	5.00	6.00						95	95		
7						DR7	6.00	7.00						94	82		
8						DR8	7.00	8.00						92	92		
9						DR9	8.00	9.00						90	90		
10	10.10	102.28		(10.1m)		DR10	9.00	10.10						94	94		
11				The Bore Hole is Terminated at 10.10 m depth													
12																	
13																	
14																	
15																	

DS: Disturbed Sample
UDS : Undisturbed Sample
SPT : Standard Penetration Test
WS : Wash Sample

CR : Core Recovery
RQD : Rock Quality Designation
PR : Rate of Penetration in Rock
VST : Vane Shear Test

K : Permeability of Soil / Rock
PT : Packer Permeability Test
DR : Drill Run
GWT : Ground Water Table

Site Engr.	Drawn By	Chkd. By	Client Rept.

Ochre Drillers India Pvt Ltd
Basement, Krishnakunj, Near Naupada Police Station, R. B.Luman Marg,
Prashant Nagar Thane (W) - 400602. Tel.022 2533 9393, 022 25371020

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(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Job No. : 2017
Date : 02-05-2019

Project : Miscellaneous buildings at PALAVA 2A & 2B, Dombivali (E)

Client : M/s Palava Dwellers Pvt. Ltd.

Co-Ordinate : -
R.L. : 113.334 m
Location :
Dia. of Borehole : 100 / Nx
Depth of GWT : 2.10 m

Bore Hole No. : BH 03
Depth of Bore Hole : 10.00 m
Depth of Casing : 2.10 m
Date of Commencement : 19-04-2019
Date of Completion : 22-04-2019

Scale m	Depth m	R.L. m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	15	N	CR %	RQD %	P.R. m/hr.	Remarks/ Other Tests
	0.30	113.03		Overburden Soil (0.30m)													
1				Slightly Weathered Basalt		DR1	0.30	1.00						94	94		
2						DR2	1.00	2.00						67	54		GWT
3						DR3	2.00	3.00						67	67		
4						DR4	3.00	4.00						89	89		
5						DR5	4.00	5.00						97	87		
6						DR6	5.00	6.00						96	91		
7						DR7	6.00	7.00						99	97		
8						DR8	7.00	8.00						93	84		
9						DR9	8.00	9.00						93	93		
10	10.00	103.33		(9.70m)		DR10	9.00	10.00						98	98		
11				The Bore Hole is Terminated at 10.00 m depth													
12																	
13																	
14																	
15																	

DS : Disturbed Sample
UDS : Undisturbed Sample
SPT : Standard Penetration Test
WS : Wash Sample

CR : Core Recovery
RQD : Rock Quality Designation
PR : Rate of Penetration in Rock
VST : Vane Shear Test

K : Permeability of Soil / Rock
PT : Packer Permeability Test
DR : Drill Run
GWT : Ground Water Table

Site Engr.	Drawn By	Chkd. By	Client Rept.

Ochre Drillers India Pvt Ltd
Basement, Krishnakunj, Near Naupada Police Station, R. B.Luman Marg,
Prashant Nagar Thane (W) - 400602. Tel.022 2533 9393, 022 25371020

Ochre Drillers

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Job No. : 2017
Date : 02-05-2019

Project : Miscellaneous buildings at PALAVA 2A & 2B, Dombivali (E)
Client : M/s Palava Dwellers Pvt. Ltd.

Co-Ordinate : -
R.L. : 114.236 m
Location :
Dia. of Borehole : 100 / Nx
Depth of GWT : 1.50 m

Bore Hole No. : BH 04
Depth of Bore Hole : 10.04 m
Depth of Casing : 1.50 m
Date of Commencement : 17-04-2019
Date of Completion : 19-04-2019

Scale m	Depth m	R.L. m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	15	N	CR %	RQD %	P.R. m/hr.	Remarks/ Other Tests
1				Slightly Weathered Basalt		DR1	0.00	1.00						91	91		
2						DR2	1.00	2.00						93	93		GWT
3						DR3	2.00	3.00						95	95		
4						DR4	3.00	4.00						93	79		
5						DR5	4.00	5.00						99	99		
6						DR6	5.00	6.00						84	84		
7						DR7	6.00	7.00						98	95		
8						DR8	7.00	8.00						98	80		
9						DR9	8.00	9.00						95	89		
10	10.04	104.20		(10.04m)		DR10	9.00	10.04						98	81		
11				The Bore Hole is Terminated at 10.04 m depth													
12																	
13																	
14																	
15																	

DS: Disturbed Sample
UDS : Undisturbed Sample
SPT : Standard Penetration Test
WS : Wash Sample

CR : Core Recovery
RQD : Rock Quality Designation
PR : Rate of Penetration in Rock
VST : Vane Shear Test

K : Permeability of Soil / Rock
PT : Packer Permeability Test
DR : Drill Run
GWT : Ground Water Table

Site Engr.	Drawn By	Chkd. By	Client Rept.

Ochre Drillers India Pvt Ltd
Basement, Krishnakunj, Near Naupada Police Station, R. B.Luman Marg,
Prashant Nagar Thane (W) - 400602. Tel.022 2533 9393, 022 25371020

Ochre Drillers

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Job No. : 2017
Date : 02-05-2019

Project : Miscellaneous buildings at PALAVA 2A & 2B, Dombivali (E)

Client : M/s Palava Dwellers Pvt. Ltd.

Co-Ordinate : -
R.L. : 115.420 m
Location :
Dia. of Borehole : 100 / Nx
Depth of GWT : 1.60 m

Bore Hole No. : BH 05
Depth of Bore Hole : 10.02 m
Depth of Casing : 1.60 m
Date of Commencement : 09-04-2019
Date of Completion : 12-04-2019

Scale m	Depth m	R.L. m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	15	N	CR %	RQD %	P.R. m/hr.	Remarks/ Other Tests
	0.20	115.22		Overburden Soil (0.20m)													
1	1.00	114.42		Completely Weathered Rock (0.80m)		DR1	0.20	1.00						Nil	Nil		Small Pieces
				Highly Weathered Basalt		DR2	1.00	2.00						46	26		GWT
2																	
						DR3	2.00	3.00						81	51		
3																	
						DR4	3.00	4.00						47	26		
4																	
						DR5	4.00	5.00						39	Nil		
5																	
						DR6	5.00	6.00						58	35		
6	6.00	109.42		(5.00m)													
				Slightly Weathered Basalt		DR7	6.00	7.00						80	80		
7																	
						DR8	7.00	8.00						80	80		
8																	
						DR9	8.00	9.00						90	75		
9																	
						DR10	9.00	10.02						94	74		
10	10.02	105.40		(4.02m)													
				The Bore Hole is Terminated at 10.02 m depth														
11																	
12																	
13																	
14																	
15																	

DS : Disturbed Sample
UDS : Undisturbed Sample
SPT : Standard Penetration Test
WS : Wash Sample

CR : Core Recovery
RQD : Rock Quality Designation
PR : Rate of Penetration in Rock
VST : Vane Shear Test

K : Permeability of Soil / Rock
PT : Packer Permeability Test
DR : Drill Run
GWT : Ground Water Table

Site Engr.	Drawn By	Chkd. By	Client Rept.

Ochre Drillers India Pvt Ltd
Basement, Krishnakunj, Near Naupada Police Station, R. B.Luman Marg,
Prashant Nagar Thane (W) - 400602. Tel.022 2533 9393, 022 25371020

Ochre Drillers

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Job No. : 2017
Date : 02-05-2019
Page No. : 1 of 1

Project : Miscellaneous buildings at PALAVA 2A & 2B, Dombivali (E)

Client : M/s Palava Dwellers Pvt. Ltd.

Co-Ordinate : -
R.L. : 114.160 m
Location :
Dia. of Borehole : 100 / Nx
Depth of GWT : 2.60

Bore Hole No. : BH 06
Depth of Bore Hole : 10.20 m
Depth of Casing : 2.60 m
Date of Commencement : 04-04-2019
Date of Completion : 08-04-2019

Scale m	Depth m	R.L. m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	15	N	CR %	RQD %	P.R. m/hr.	Remarks/ Other Tests
	0.20	113.96		Overburden Soil (-0.2m)													
1				Slightly Weathered Basalt		DR1	0.20	1.00						72	60		
2						DR2	1.00	2.00						83	83		
3						DR3	2.00	3.00						71	64		GWT
4						DR4	3.00	4.00						88	88		
5						DR5	4.00	5.00						95	95		
6						DR6	5.00	6.00						94	94		
7						DR7	6.00	7.00						93	70		
8						DR8	7.00	8.00						96	78		
9						DR9	8.00	9.00						99	99		
10	10.20	103.96		(10m)		DR10	9.00	10.20						98	98		
11				The Bore Hole is Terminated at 10.20 m depth													
12																	
13																	
14																	
15																	

DS : Disturbed Sample
UDS : Undisturbed Sample
SPT : Standard Penetration Test
WS : Wash Sample

CR : Core Recovery
RQD : Rock Quality Designation
PR : Rate of Penetration in Rock
VST : Vane Shear Test

K : Permeability of Soil / Rock
PT : Packer Permeability Test
DR : Drill Run
GWT : Ground Water Table

Site Engr.	Drawn By	Chkd. By	Client Rept.

Ochre Drillers India Pvt Ltd
Basement, Krishnakunj, Near Naupada Police Station, R. B.Luman Marg,
Prashant Nagar Thane (W) - 400602. Tel.022 2533 9393, 022 25371020

Ochre Drillers

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Job No. : 2017
Date : 02-05-2019

Project : Miscellaneous buildings at PALAVA 2A & 2B, Dombivali (E)

Client : M/s Palava Dwellers Pvt. Ltd.

Co-Ordinate : -
R.L. : 106.987 m
Location :
Dia. of Borehole : 100 / Nx
Depth of GWT : 0.00 m

Bore Hole No. : BH 07
Depth of Bore Hole : 10.22 m
Depth of Casing : 2.00 m
Date of Commencement : 28-04-2019
Date of Completion : 30-04-2019

Scale m	Depth m	R.L. m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	15	N	CR %	RQD %	P.R. m/hr.	Remarks/ Other Tests
1				Overburden Soil		DR1	0.00	1.00						11	11		Boulders
						DR2	1.00	2.00						44	31		
2	2.00	104.99		(2m)													
				Slightly Weathered Basalt		DR3	2.00	3.00						76	76		
3																	
						DR4	3.00	4.00						98	80		
4																	
						DR5	4.00	5.00						99	88		
5																	
						DR6	5.00	6.00						94	94		
6																	
						DR7	6.00	7.00						99	99		
7																	
						DR8	7.00	8.00						98	89		
8																	
						DR9	8.00	9.00						94	88		
9																	
						DR10	9.00	10.22						90	83		
10	10.22	96.77		(8.2m)													
				The Bore Hole is Terminated at 10.22 m depth														
11																	
12																	
13																	
14																	
15																	

DS : Disturbed Sample
UDS : Undisturbed Sample
SPT : Standard Penetration Test
WS : Wash Sample

CR : Core Recovery
RQD : Rock Quality Designation
PR : Rate of Penetration in Rock
VST : Vane Shear Test

K : Permeability of Soil / Rock
PT : Packer Permeability Test
DR : Drill Run
GWT : Ground Water Table

Site Engr.	Drawn By	Chkd. By	Client Rept.

Ochre Drillers India Pvt Ltd
Basement, Krishnakunj, Near Naupada Police Station, R. B.Luman Marg,
Prashant Nagar Thane (W) - 400602. Tel.022 2533 9393, 022 25371020

Ochre Drillers

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Job No. : 2017
Date : 02-05-2019

Project : Miscellaneous buildings at PALAVA 2A & 2B, Dombivali (E)
Client : M/s Palava Dwellers Pvt. Ltd.

Co-Ordinate : -
R.L. : 112.660 m
Location :
Dia. of Borehole : 100 / Nx
Depth of GWT : 3.00 m

Bore Hole No. : BH 08
Depth of Bore Hole : 10.05 m
Depth of Casing : 0.50 m
Date of Commencement : 07-05-2019
Date of Completion : 08-05-2019

Scale m	Depth m	R.L. m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	15	N	CR %	RQD %	P.R. m/hr.	Remarks/ Other Tests
	0.50	112.16		Overburden Soil **(0.5m)**													
1	1.50	111.16		Completely Weathered Rock **(1m)**		DR1	0.5	1.5						11	Nil		Small Pieces
2				Slightly Weathered Basalt		DR2	1.5	2.00						92	92		
3						DR3	2.00	3.00						99	96		GWT
4						DR4	3.00	4.00						98	92		
5						DR5	4.00	5.00						97	97		
6						DR6	5.00	6.00						99	91		
7						DR7	6.00	7.00						91	71		
8						DR8	7.00	8.00						94	89		
9						DR9	8.00	9.00						97	97		
10	10.05	102.61		**(8.6m)**		DR10	9.00	10.05						97	95		
11				The Bore Hole is Terminated at 10.05 m depth													
12																	
13																	
14																	
15																	

DS: Disturbed Sample
UDS : Undisturbed Sample
SPT : Standard Penetration Test
WS : Wash Sample

CR : Core Recovery
RQD : Rock Quality Designation
PR : Rate of Penetration in Rock
VST : Vane Shear Test

K : Permeability of Soil / Rock
PT : Packer Permeability Test
DR : Drill Run
GWT : Ground Water Table

Site Engr.	Drawn By	Chkd. By	Client Rept.

Ochre Drillers India Pvt Ltd
Basement, Krishnakunj, Near Naupada Police Station, R. B.Luman Marg,
Prashant Nagar Thane (W) - 400602. Tel.022 2533 9393, 022 25371020

Ochre Drillers

BORE LOG

(As per IS : 1892 - 1979, 4453 - 1980, & 4464 - 1967)

Job No. : 2017
Date : 02-05-2019

Project : Miscellaneous buildings at PALAVA 2A & 2B, Dombivali (E)
Client : M/s Palava Dwellers Pvt. Ltd.

Co-Ordinate : -
R.L. : 113.500 m
Location :
Dia. of Borehole : 100 / Nx
Depth of GWT : 2.60 m

Bore Hole No. : BH 09
Depth of Bore Hole : 10.03 m
Depth of Casing : 2.60 m
Date of Commencement : 04-04-2019
Date of Completion : 08-04-2019

Scale m	Depth m	R.L. m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	15	N	CR %	RQD %	P.R. m/hr.	Remarks/ Other Tests
	0.20	99.80		Overburden Soil (0.2m)													
				Slightly Weathered Basalt													
2						DR1	1.50	2.00						84	84		
3						DR2	2.00	3.00						86	86		GWT
4						DR3	3.00	4.00						94	94		
5						DR4	4.00	5.00						83	83		
6						DR5	5.00	6.00						84	76		
7						DR6	6.00	7.00						80	61		
8						DR7	7.00	8.00						90	90		
9						DR8	8.00	9.00						90	90		
10	10.03	103.47		(9.8m)		DR9	9.00	10.03						97	97		
				The Bore Hole is Terminated at 10.03 m depth													
11																	
12																	
13																	
14																	
15																	

DS: Disturbed Sample
UDS : Undisturbed Sample
SPT : Standard Penetration Test
WS : Wash Sample

CR : Core Recovery
RQD : Rock Quality Designation
PR : Rate of Penetration in Rock
VST : Vane Shear Test

K : Permeability of Soil / Rock
PT : Packer Permeability Test
DR : Drill Run
GWT : Ground Water Table

Site Engr.	Drawn By	Chkd. By	Client Rept.

Ochre Drillers India Pvt Ltd
Basement, Krishnakunj, Near Naupada Police Station, R. B.Luman Marg,
Prashant Nagar Thane (W) - 400602. Tel.022 2533 9393, 022 25371020

TEST RESULTS OF ROCK CORES

Client : **M/s Palava Dwellers Pvt Ltd**

Contractor : **M/s Ochre Drillers India Pvt Ltd, Thane**

Project : Proposed Miscellaneous Buildings at PALAVA 2A & 2B, Dombivali (E)

Sr. No.	Bore Hole No.	Core No.	Depth m	Diameter cm	Height cm	H : D (1:H/D)	Failure Load Tonnes	Uniaxial Compressive Strength MPa	Porosity %	Water Absorption %	Dry Density kN/m^3	Point Load Index MPa	Remarks
1	BH 01	5	1 - 2.00	5.40	11.40	2.11		79.23	3.18	1.16	27.54		
2	BH 01	31	4.00 - 5.00	5.3	10.8	2.04		44.21	9.05	3.53	25.64		
3	BH 01	47	8.00 - 9.00	5.3	10.8	2.04		26.76	10.59	4.57	23.16		
4	BH 02	11	1.00 - 2.00	5.5	10.4	1.89		76.01	4.45	1.64	27.16		
5	BH 02	27	5.00 - 6.00	5.5	10.7	1.95		116.96	4.34	1.55	28.08		
6	BH 02	41	8.00 - 9.00	5.6	11.1	1.98		47.81	6.26	2.36	26.56		
7	BH 03	4	0.30 - 1.00	5.6	10.5	1.88		99.06	6.26	2.24	27.95		
8	BH 03	23	4.00 - 5.00	5.5	10.90	1.98		73.99	6.72	2.41	27.87		
9	BH 03	42	8.00 - 9.00	5.5	10.60	1.93		45.60	8.49	3.16	26.83		
10	BH 04	2	0.00 - 1.00	5.6	10.70	1.91		26.69	5.17	1.95	26.56		
11	BH 04	16	4.00 - 5.00	5.5	10.70	1.95		85.13	6.18	2.29	27.03		
12	BH 04	42	9.00 - 10.04	5.50	10.40	1.89		66.00	6.40	2.44	26.24		

* indicates the sample failed along joints

** All Samples were Soaked for 24 Hours Before the Test

Job No :-	2017
Prepd By :-	Shraddha

TEST RESULTS OF ROCK CORES

Client : **M/s Palava Dwellers Pvt Ltd**

Contractor : **M/s Ochre Drillers India Pvt Ltd, Thane**

Project : Proposed Miscellaneous Buildings at PALAVA 2A & 2B, Dombivali (E)

Sr. No.	Bore Hole No.	Core No.	Depth m	Diameter cm	Height cm	H : D (1:H/D)	Failure Load Tonnes	Uniaxial Compressive Strength MPa	Porosity %	Water Absorption %	Dry Density kN/m^3	Point Load Index MPa	Remarks
13	BH 05	14	2 - 3.00	5.20	10.90	2.10		107.15	4.21	1.53	27.48		
14	BH 05	35	5.00 - 6.00					67.54	5.27	1.99	26.53	3.07	PL
15	BH 05	51	9.00 - 10.02	5.3	10.8	2.04		109.95	6.56	2.60	25.23		
16	BH 06	8	1.00 - 2.00	5.5	10.9	1.98		80.18	3.45	1.26	27.41		
17	BH 06	26	5.00 - 6.00	5.5	11.2	2.04		97.17	4.50	1.67	26.95		
18	BH 06	45	9.00 - 10.20	5.5	11.5	2.09		62.52	7.37	2.87	25.69		
19	BH 07	12	3.00 - 4.00	5.4	11	2.04		20.92	12.15	5.68	21.39		
20	BH 07	30	6.00 - 7.00	5.4	11.50	2.13		59.97	3.96	1.51	26.26		
21	BH 07	49	9.00 - 10.22	5.4	10.90	2.02		42.75	6.79	2.65	25.65		
22	BH 08	2	1.50 - 2.00	5.5	10.20	1.85		64.66	2.25	0.84	26.92		
23	BH 08	13	3.00 - 4.00	5.5	10.80	1.96		60.46	1.63	0.57	28.34		
24	BH 08	29	6.00 - 7.00	5.50	10.90	1.98		23.56	5.93	2.27	26.14		

* indicates the sample failed along joints

** All Samples were Soaked for 24 Hours Before the Test

Job No :-	2017
Prepd By :-	Shraddha

TEST RESULTS OF ROCK CORES

Client : **M/s Palava Dwellers Pvt Ltd**

Contractor : **M/s Ochre Drillers India Pvt Ltd, Thane**

Project : Proposed Miscellaneous Buildings at PALAVA 2A & 2B, Dombivali (E)

Sr. No.	Bore Hole No.	Core No.	Depth m	Diameter cm	Height cm	H : D (1:H/D)	Failure Load Tonnes	Uniaxial Compressive Strength MPa	Porosity %	Water Absorption %	Dry Density kN/m^3	Point Load Index MPa	Remarks
25	BH 08	41	9 - 10.05	5.40	11.10	2.06		40.20	4.69	1.82	25.73		
26	BH 09	5	2.00 - 3.00	5.5	11.1	2.02		63.81	2.05	0.74	27.69		
27	BH 09	23	6.00 - 7.00	5.4	10.9	2.02		54.02	5.17	1.92	26.91		
28	BH 09	36	9.00 - 10.03	5.5	10.8	1.96		94.02	2.07	0.74	27.83		

* indicates the sample failed along joints

** All Samples were Soaked for 24 Hours Before the Test

Job No :-	2017
Prepd By :-	Shraddha

Chemical Analysis of Water

Client : **M/s Palava Dwellers Pvt Ltd**

Project : Proposed Miscellaneous Buildings at PALAVA 2A & 2B, Dombivali (E)

Contractor : **M/s Ochre Drillers India Pvt Ltd, Thane**

Serial No	Bore Hole No	Depth	pH' Value	Sulphates as SO_3^-	Chlorides as Cl^-
		(m)		(ppm)	(ppm)
1	BH 02	2.60	7.29	172	1171
2	BH 05	1.60	7.60	172	2084
3	BH 07	0.00	7.00	309	278
4	BH 08	3.00	7.12	69	89
5	BH 09	3.60	7.71	172	129
				Job No :-	2017
				Prepd By :-	Shraddha

Date :	5/14/2019
Job No :	2017-2019-003
Client :	**M/s Palava Dwellers Pvt Ltd**
Project :	Miscellaneous buildings at PALAVA 2A & 2B, Dombivali (E)
Subject :	Safe Bearing Capacity by RMR Method **Slightly Weathered Basalt**

Invest in Investigation — Ochre Drillers India Private Limited

To determine net safe bearing pressure of rock stratum, strength of rock core alone is not used. Overall characteristics of rock mass which are covered by five parameters such as Rock Quality Designation value, Spacing of Discontinuty, Condition of Discontinuity and Ground Water Condition are studied and used to calculate net safe bearing pressure of rock mass instead of rock core. Average rock mass parameters as obtained from boreholes are used below.

ESTIMATION OF ROCK MASS RATING

Rock Mass Rating (RMR) of jointed rock masses has been worked out based on IS 13365 (part III)

Parameters	Unit	Classification	Lab & Field Values	Rating
Strength of Intact Rock (UCS)	MPa	Strong	75	9
Rock Quality Designation (RQD)	%	Fair	75	17
Spacing of Discontinuities	m	Moderate	0.600	15
Condition of Discontinuities		Wide Discontinuity	5	0
Ground Water Condition		Flowing	5	0
			Total Rock Mass Rating	**41**

ESTIMATION OF NET SAFE BEARING PRESSURE

Net safe bearing pressure of rock stratum is estimated for calculated rock mass rating value, by relation given in Table 3, IS 12070 : 1987 Amendment No. 1 November 2008 to Reaffirmed 2010

Description of rock with RMR Values between 40 to 60 is **Fair** and corresponding range of net safe bearing pressure is 141(to 2800 kN/m^2

By interpolation, Net safe bearing pressure = 1479.5 kN/m^2

Considering various in rock mass properties in entire footprint area,

recommended **Net Safe Bearing Pressure = 1332 kN/m^2**

SETTLEMENT CALCULATIONS

Settlement can be calculated using elastic theory by adopting appropriate values for modulus of elasticity and Poisson's ratio of the rock mass. Magnitude of settlement is calculated using following equation;

$$\delta = \frac{q_s B(1-\mu^2)}{E} C_d$$

(Reference : Duncan C Wyllie, Foundations On Rock, equation No 5.18, page No 129)

Where,

δ = Settlement of foundation

q_s = Safe bearing pressure

B = Width/diameter of foundation

μ = Poisson's ratio

E = Young's Modulus

C_d = Shape (influence) factor

For calculating Young's modulus, relation given by Serafim-Pereira (1983) is used.

$E = 10^{(RMR-10)/40}$ GPa

$E = 5956621$ kN/m^2

Poisson's ratio (μ) = 0.20 (J E Bowles, Foundation Analysis and Design, 5th edition, Table 2-7, Page No 123)

Considering square footing,

Width of Foundation (B) = 2.00 m Therefore, H/B = 2.50

Depth of Foundation (H) = 5.00 m L/B = 1.00

Shape Factor, C_d = 0.97 (Duncan C Wyllie, Foundations On Rock, Table 5.5, page No 131)

Subtituting values, δ = 0.42 mm < 12 Hence OK Permissible settlement in rock mass as per IS 13063 = 12 mm

Calculated settlement of footing foundation is within permeasible range.

Therefore, **Recommended Net Safe Bearing Capacity = 1300 kN/m^2**