SOIL

INVESTIGATION REPORT

FOR

**PROPOSED STRUCTURAL Of DESIGN FOR AUTOMATED /
MECHANIZED MULTILEVEL CAR PARKING SYSTEM
AT TEHSIL OFFICE CAMPUS, HARIDWAR,
UTTARAKHAND**

Submitted to :
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CORNER, NAVRANGPURA, AHMEDABAD-380009, GUJARAT**

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AR. DEWESH NAINWAL
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ACKNOWLEDGEMENT

We feel *profound pleasure in recording our heartfelt gratitude to The L.J. PURANI AND ASSOCIATES For providing us an opportunity to carry out these investigation for extending all out support and much needed cooperation to us while carrying out the investigations contained in the report. Without his help and assistance, it would not have been feasible for us to bring perfection in our work.*

We are also grateful to field staff for their help during the soil investigation work.

FOR
ECON Laboratory and Consultancy

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ECON Laboratory and Consultancy

MOHAN TYAGI (M-TECH)

Dr. M.Singh (Phd.IIT RKE.)

(Authorised Signatory)

(Authorised Signatory)

INTRODUCTION:

1.01 This report presents the results of the Soil Investigations carried out by ECON Laboratory and Consultancy, Vill.: Khabarwala, P.O.: Jaintanwala, Near Garhi Cantt, Dehradun, Uttarakhand-248003 for PROPOSED STRUCTURAL Of DESIGN FOR AUTOMATED / MECHANIZED MULTILEVEL CAR PARKING SYSTEM AT TEHSIL OFFICE CAMPUS, HARIDWAR, UTTARAKHAND.

1.02 The aim of these investigations is to find Safe Bearing Capacity of Soil and other parameters to enable the designer to design suitable economical foundation of proposed construction of PROPOSED STRUCTURAL Of DESIGN FOR AUTOMATED / MECHANIZED MULTILEVEL CAR PARKING SYSTEM AT TEHSIL OFFICE CAMPUS, HARIDWAR, UTTARAKHAND.

1.03 The instructions to carry out these investigations were given by *The ARCHITECTURE CONSULTANT AR. DEWESH NAINWAL DEHRADUN (U.K.) AND L.J.* PURANI AND ASSOCIATES *Er. SAKET*. The site was shown to the representative of ECON Laboratory and Consultancy.,by representative of L.J. PURANI AND ASSOCIATES 303, GALA BUSINESS CENTER-1, ST XAVIER'S CORNER, NAVRANGPURA, AHMEDABAD-380009, GUJARAT, .and the field work was done on 24-08-2022.

1.04 The scope of the work proposed was:

(i)   Carrying out Dynamic Cone penetration Tests up to 8.0m depth or refusal strata, which ever is met earlier ----- 3 locations.

(ii) Making bore-hole using 300 mm dia spiral earth auger; up to 8.0m depth from   G.L., and in this bore-hole, carrying out Standard Penetration Tests at every 1.5m interval (if fine grained soils are met),or carrying out open excavation (if gravel / boulder mixed strata is met) up to 3.0m or up to refusal strata which so ever is met earlier, representative and undisturbed soil samples were to be picked up at 1.5 m interval and also at depth where strata changed, at One location

(iii) To carry out Plate Load Tests at the proposed depth of foundation (up to 1.50m) using 30cm X 30cm plate up to loading intensity of 60 t /sqm or ultimate failure of soil, which so ever is reached earlier at 1 location.

(iv) Carrying out necessary tests in laboratory on soil samples.

(v) Submission of report in three copies giving recommendations regarding Safe   Bearing Capacity of Soil based on these tests at suitable depth/s.

2.0 FIELD WORK :

2.01 Three Dynamic Cone Penetration Tests were conducted using 65mm base dia cone as per BIS: 4968, without using bentonite slurry, marked as DCP-1 DCP-2 and DCP-3, up to refusal strata, which silt & gravels was met at about 4.00m from N.G.L..

2.02 As gravel & weathered rock pieces mixed strata was met from 0.30m depth from G.L., Bore hole could not be carried out, so open excavation was carried out at location B.H.-1 up to a possible 8.00m depth. The representative soil samples were sealed numbered and sent to our laboratory at Dehradun for analysis.

2.03 Water table was not met up to a depth of 8.0m from G.L

2.04 One Plate Load Tests were conducted at location PLT-1 at foundation level (1.50m depth from N.G.L. at site). The tests were conducted as per standard practice, using 70.0 MT capacity Hydraulic Jack with a least count of 0.20 tonnes, and the settlement was measured with the help of 3 dial gauges, having 0.01mm least count & a travel of 40mm. The loading was done on the plate up to a loading intensity on the plate of 64.0 t /sq.m. 14.72mm settlement of plate was observed at this loading intensity at location PLT-1.

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3.0 LABORATORY WORK:

Following tests were conducted on soil samples collected: -

 (i) Natural Moisture Content

(ii) Atterberg's Limits,

(iii) Grain Size Analysis.

The results have been tabulated in Fig. 5 for location B.H.-1

4.0 DISCUSSION OF TEST RESULTS:

The site is located in Haridwar .Relative test locations for different tests have been indicated in photo.

4.01 DYNAMIC CONE TESTS:

 Fig.1, Fig.2 and Fig.3 have been drawn as Dynamic Cone Penetration Resistance Curves for locations DCP-1, DCP-2 and DCP-3 respectively.1.50m depth is loose. Both show hard strata from 2.00m depth, to 4.00m sandy and silt soil followed by hard strata up to mixture of sand, silt & gravels / (GP) up to 4.00m depth

4.02 PLATE LOAD TESTS :

Load-Settlement Curve has been drawn from Plate Load Test Data, as Fig. 4 for location PLT-1 , conducted at 2.00m depth from N.G.L., the loading was done on the plate up to a loading intensity on the plate of 68.0 t /sq.m. 14.05mm settlement of plate was observed at this loading intensity at location PLT-1. Double tangents drawn on this curve indicates ultimate failure of soil a loading intensity of 36.0 t/sq.m

4.03 LABORATORY TESTS:

The top 4.00m of soil a mixture of silt & sand, followed by mixture of sand, silt & gravels / (GP) up to 4.00m depth , further followed by rock chunks or, water table was not met up to 8.00m depth, and has been expected to be very deep.

5.0 COMPUTATION OF SAFE BEARING CAPACITY OF   SOIL:

Model calculations have been done at the proposed depth of foundation of 2.00m from N.G.L. at site.

ASSUMPTIONS:

At Depth 1.50 m from G.L.:

Depth of foundation D_f = 2.00 m
Width of foundation B_f =   2.00 m
γ = 1.75 t/sqm, C =0 t/sqm, ϕ = 30, N_c =28, N_q= 20, N_γ = 19

A. From shear failure criteria qa (Nett) is given by the relation

q_a = $1/3[CN_c + 0.4\ \gamma\ B_f\ \ N_\gamma + \gamma D_f\ (N_q - 1)]$

= 1/3 [0 x 28 + 0.4x1.75 x2.00x19 + 1.75x2.00 (20-1)] = 31.03.1 t/sqm.

B. From `N' values: (Settlement Criteria)

N_c(corrected)= 14
q_a = 1.1 x N_c = 1.1 x 14 = 14.30 t /sqm .

C. From Plate Load Test : (Ultimate failure criteria) :

Fig. 2 indicates ultimate failure of soil at a loading intensity of 36.0 t/sq.m., adopting a factor of safety of 3 over this, we get Safe Bearing Capacity of soil as 36.00/3 = 12.00 t/sqm.
.

Adopt lowest of the above three, i.e. say 12.00 t/sq.m.,

Check for Settlement :
The settlement of 30 cm x 30 cm size plate S_p, for the 12mm allowable settlement of the foundation (for Isolated footings on rocky strata) of 2.0m width is as computed from relation –
$S_p = S_f (30(B_f + 30.48))^2/. (Bf (30+30.48))^2$
 For S_f = 4.0cm and B_f = 2.0 m the value of Sp works out to be
 S_p = 4.0 $(30(200 + 30.48))^2/ (200 (30+30.48))^2$ = 1.30 cm = 13.0 mm

For 14.00 t/sq.m loading intensity on plate, settlement of plate from Fig. 3 is   **2.01 mm (Safe)**

Adopt lowest value of safe Bearing Capacity of Soil as Allowable Bearing Pressure on Soil , from above, i.e. 12.00 t/ sqm.

Correction for Presence of Water Table:

Water table is too deep to have any influence over computation of Allowable Bearing Pressure on Soil, as computed in Para 5.01, but being on the slopes in hilly area, and in the absence of analysis on stability on of slopes, to be on the safer sides, adopting a correction factory of of 0.75, we get, final value of Allowable Bearing Pressure on Soil as 12.00x 0.75 = 9.00 t/sq.m.

6.00 RECOMMENDATIONS :

6.01 Fig.1, Fig.2 and Fig.3 have been drawn as Dynamic Cone Penetration Resistance Curves for locations DCP-1, DCP-2 and DCP-3, respectively. Both show good strata from 2.00m depth, followed by very hard strata up to 4.00m depth.

6.02 Load--Settlement Curves have been drawn from Plate Load Test Data, as Fig.4 for location PLT-1.

6.03 Soil properties have been mentioned in Fig 5 for bore hole B.H.-1

6.04 Water table was not met up to a depth of 8.00m from G.L. In August 2022 .

6.05 The strata being good 2.50m onwards, the foundation may be laid at 2.20m or more depths from G.L. as required, and the value recommended for Allowable Bearing Pressure on Soil (Nett.) for Isolated Footings at this depth (2.00m) or more depths is 9.00 t /sqm, and that for RAFTS is 18.00 t /sq.m..

6.06 Though utmost care was taken while carrying out these investigations, but if still some unusual variation is found after actual excavation, then please refer the matter back to us or to some expert.

6.07 This report is meant only for technical purposes, and should not be referred in legal matters.

FOR   FOR
ECON Laboratory and Consultancy   **ECON Laboratory and Consultancy**

MOHAN TYAGI (M-TECH)   **Dr. M.Singh (Phd.IIT RKE.)**

(Authorised Signatory)   (Authorised Signatory)

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SITE PHOTO

NUMBER OF BLOWS "N"

DEPTH FROM G.L. in METRES

PROPOSED STRUCTURAL of DESIGN FOR AUTOMATED / MECHANIZED MULTILEVEL CAR PARKING SYSTEM AT TEHSIL OFFICE CAMPUS, HARIDWAR, UTTARAKHAND.

DYNAMIC CONE PENETRATION RESISTANCE CURVE FOR LOCATION No. 3

FIG. No. 3

NUMBER OF BLOWS "N"
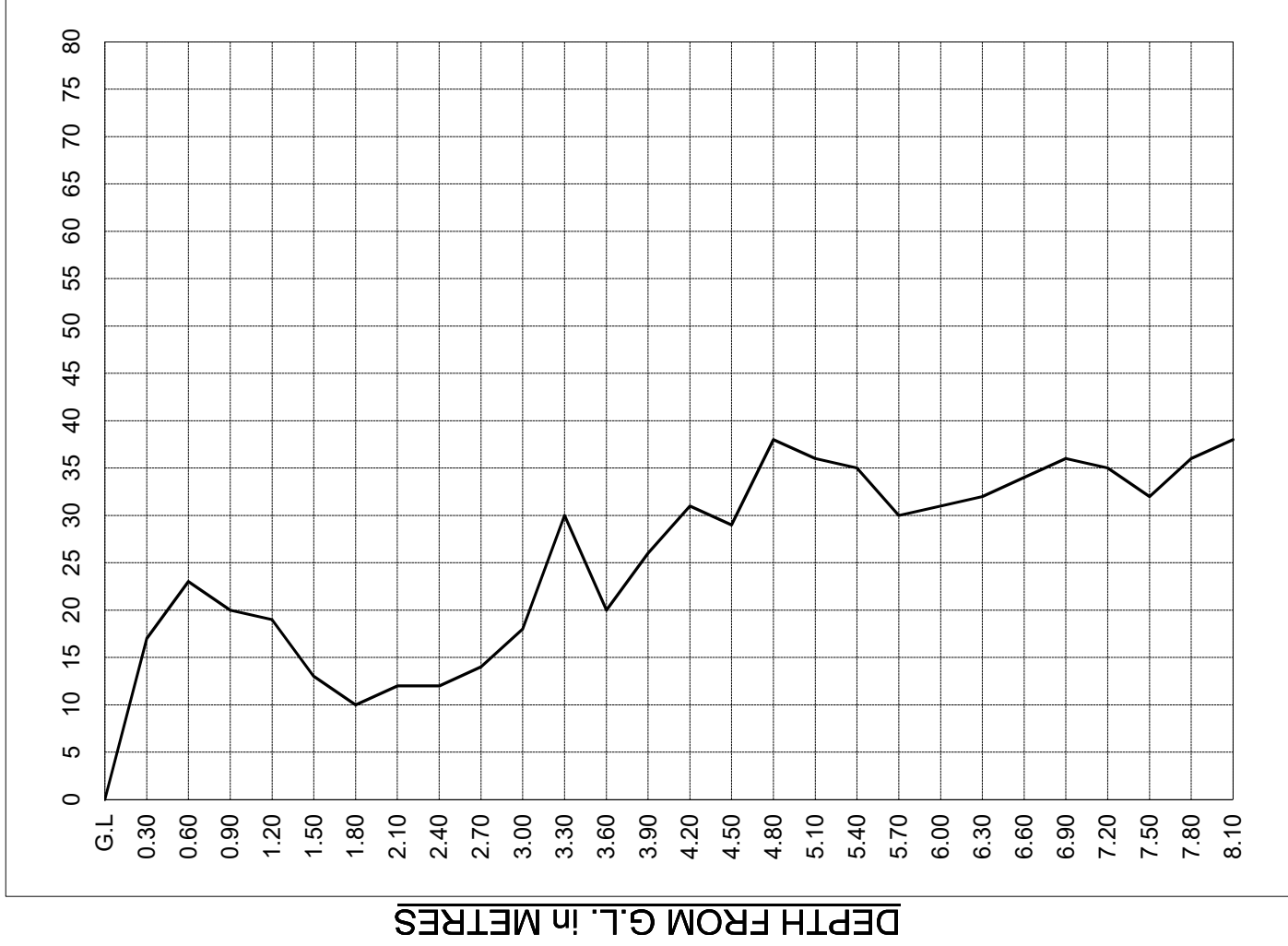
DEPTH FROM G.L. in METRES

PROPOSED STRUCTURAL of DESIGN FOR AUTOMATED / MECHANIZED MULTILEVEL CAR PARKING
SYSTEM AT TEHSIL OFFICE CAMPUS, HARIDWAR, UTTARAKHAND.

DYNAMIC CONE PENETRATION RESISTANCE CURVE FOR LOCATION No. 1.

FIG. No.1

NUMBER OF BLOWS "N"

DEPTH FROM G.L. in METRES

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DYNAMIC CONE PENETRATION RESISTANCE CURVE FOR LOCATION No. 2

FIG. No.2

NUMBER OF BLOWS "N"
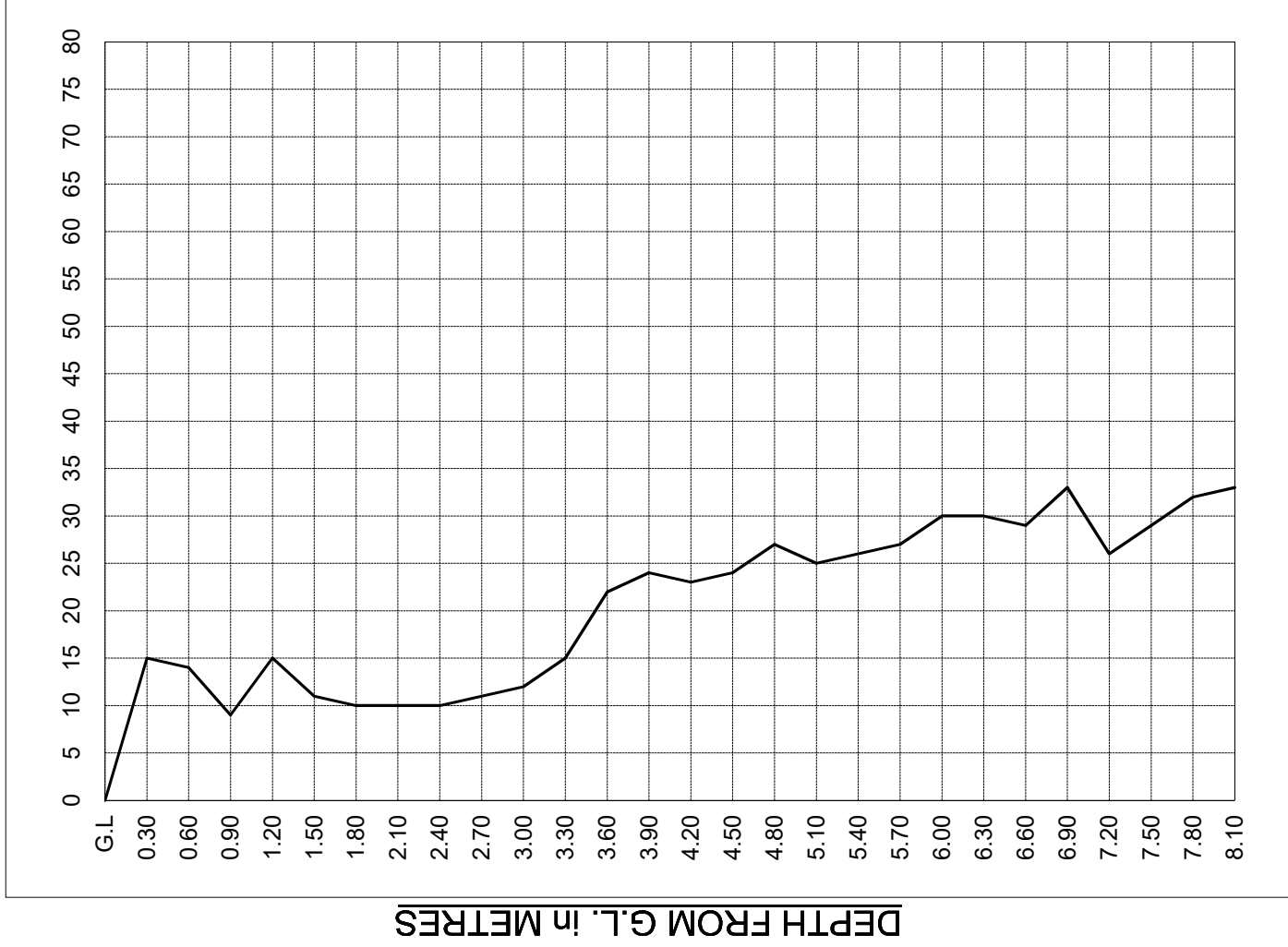
DEPTH FROM G.L. in METRES

PROPOSED STRUCTURAL of DESIGN FOR AUTOMATED / MECHANIZED MULTILEVEL CAR PARKING SYSTEM AT TEHSIL OFFICE CAMPUS, HARIDWAR, UTTARAKHAND.

DYNAMIC CONE PENETRATION RESISTANCE CURVE FOR LOCATION No. 3

FIG. No. 3

NUMBER OF BLOWS "N"

DEPTH FROM G.L. in METRES

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DYNAMIC CONE PENETRATION RESISTANCE CURVE FOR LOCATION No. 1.

FIG. No.1

NUMBER OF BLOWS "N"
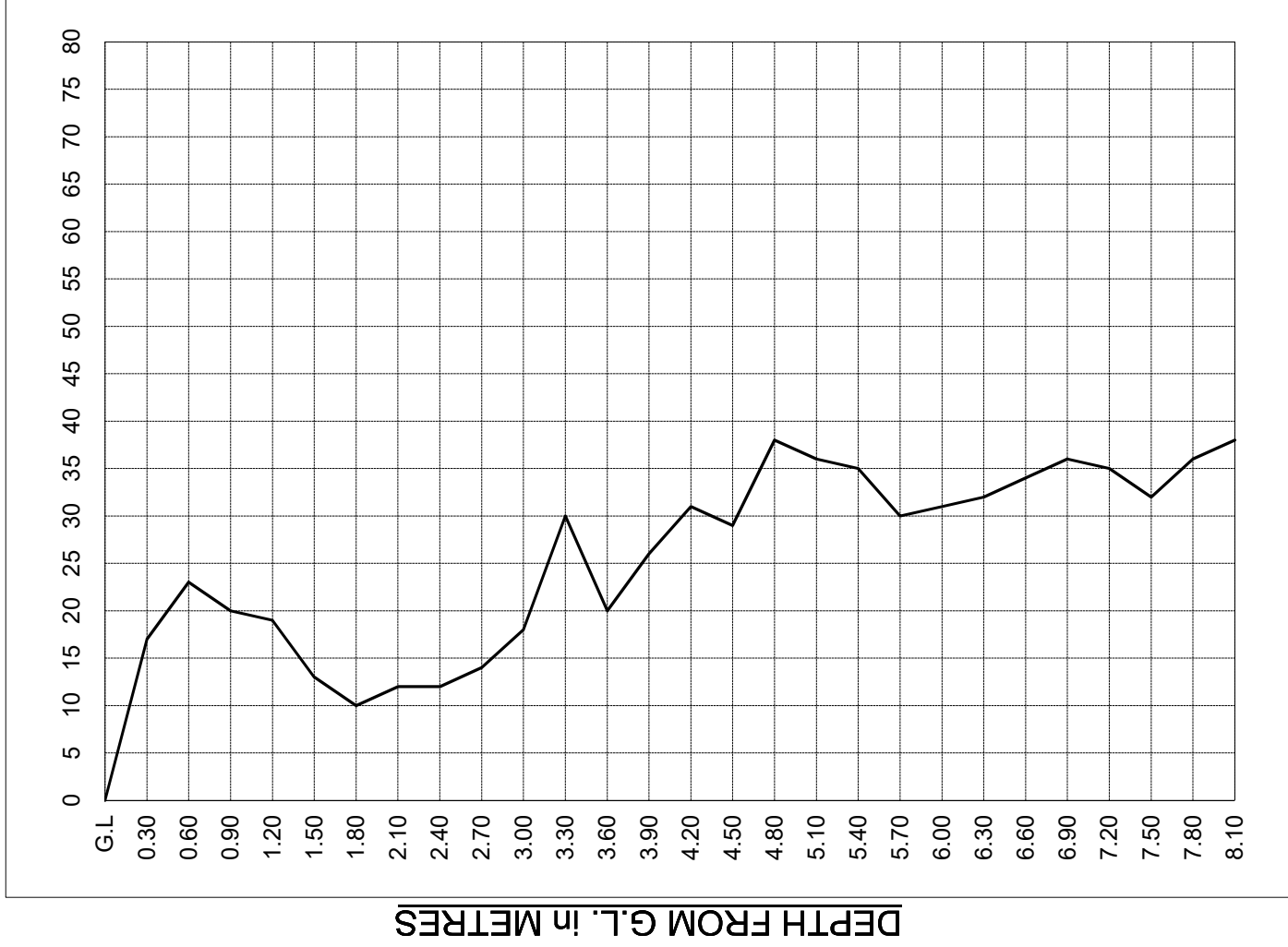
DEPTH FROM G.L. in METRES

PROPOSED STRUCTURAL of DESIGN FOR AUTOMATED / MECHANIZED MULTILEVEL CAR PARKING SYSTEM AT TEHSIL OFFICE CAMPUS, HARIDWAR, UTTARAKHAND.

DYNAMIC CONE PENETRATION RESISTANCE CURVE FOR LOCATION No. 2

FIG. No.2

NUMBER OF BLOWS "N"
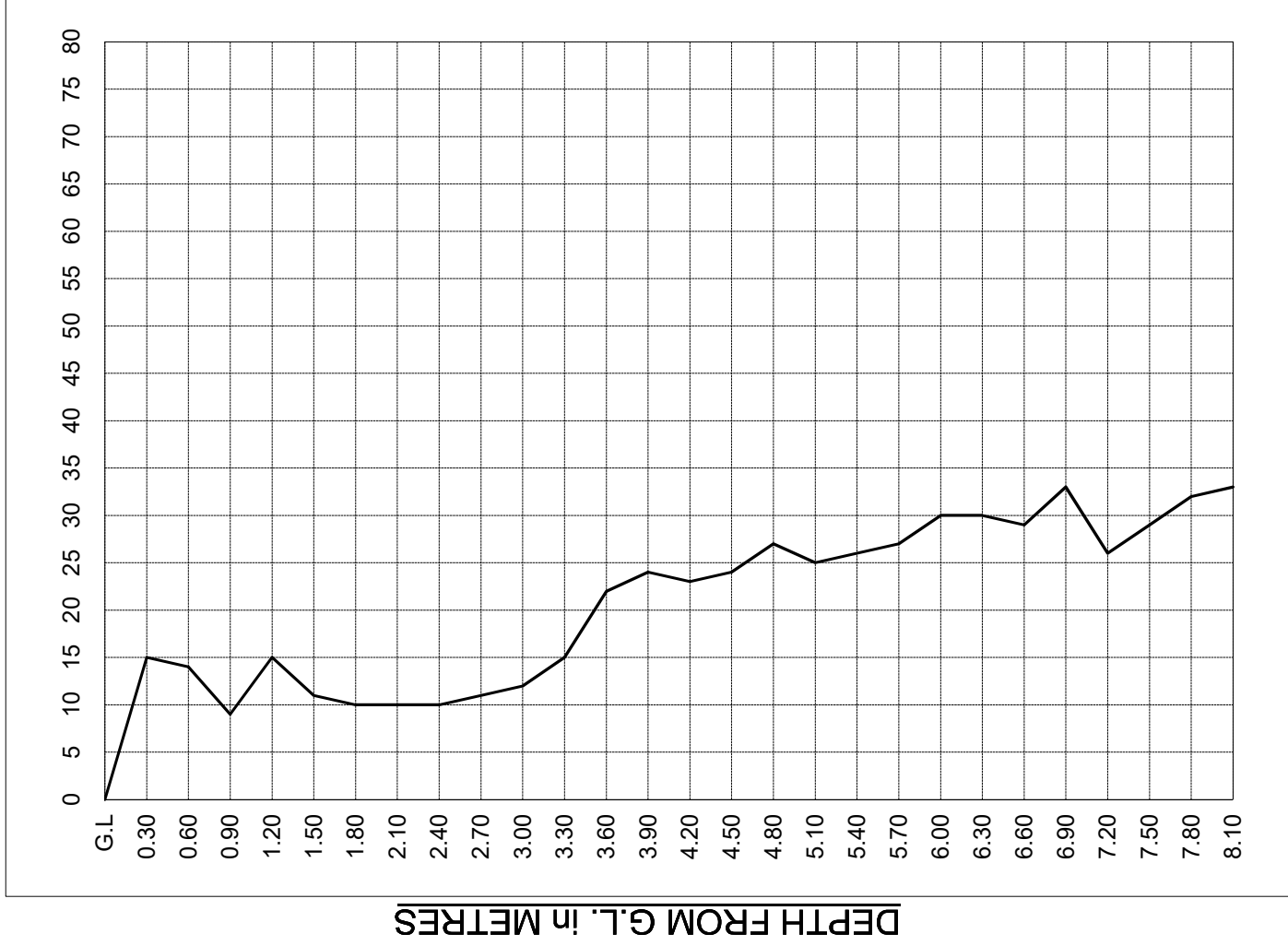
DEPTH FROM G.L. in METRES

PROPOSED STRUCTURAL of DESIGN FOR AUTOMATED / MECHANIZED MULTILEVEL CAR PARKING SYSTEM AT TEHSIL OFFICE CAMPUS, HARIDWAR, UTTARAKHAND.

DYNAMIC CONE PENETRATION RESISTANCE CURVE FOR LOCATION No. 3

FIG. No. 3

NUMBER OF BLOWS "N"

DEPTH FROM G.L. in METRES

PROPOSED STRUCTURAL of DESIGN FOR AUTOMATED / MECHANIZED MULTILEVEL CAR PARKING SYSTEM AT TEHSIL OFFICE CAMPUS, HARIDWAR, UTTARAKHAND.

DYNAMIC CONE PENETRATION RESISTANCE CURVE FOR LOCATION No. 1.

FIG. No.1

NUMBER OF BLOWS "N"
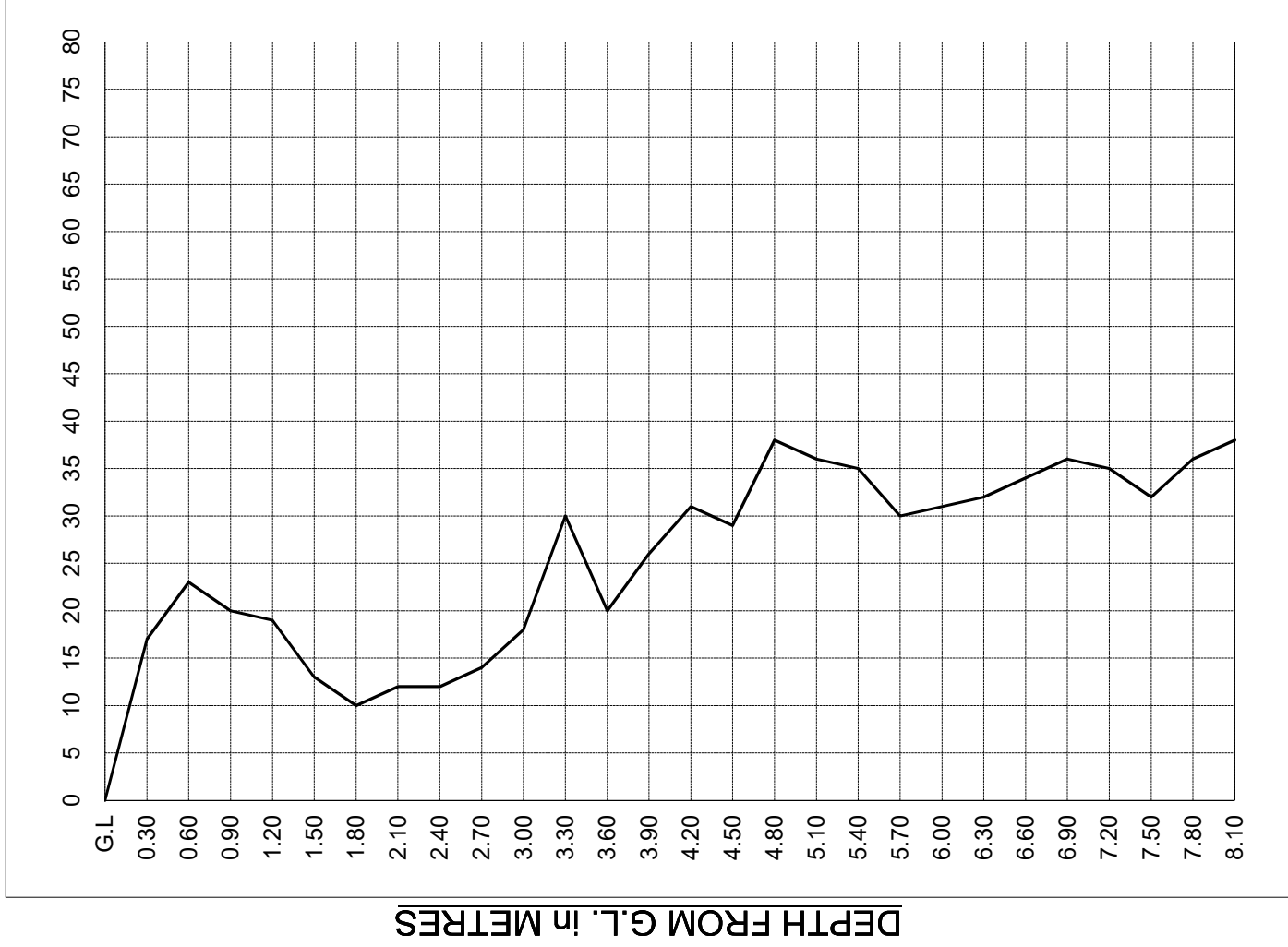

DEPTH FROM G.L. in METRES

PROPOSED STRUCTURAL of DESIGN FOR AUTOMATED / MECHANIZED MULTILEVEL CAR PARKING
SYSTEM AT TEHSIL OFFICE CAMPUS, HARIDWAR, UTTARAKHAND.

DYNAMIC CONE PENETRATION RESISTANCE CURVE FOR LOCATION No. 2
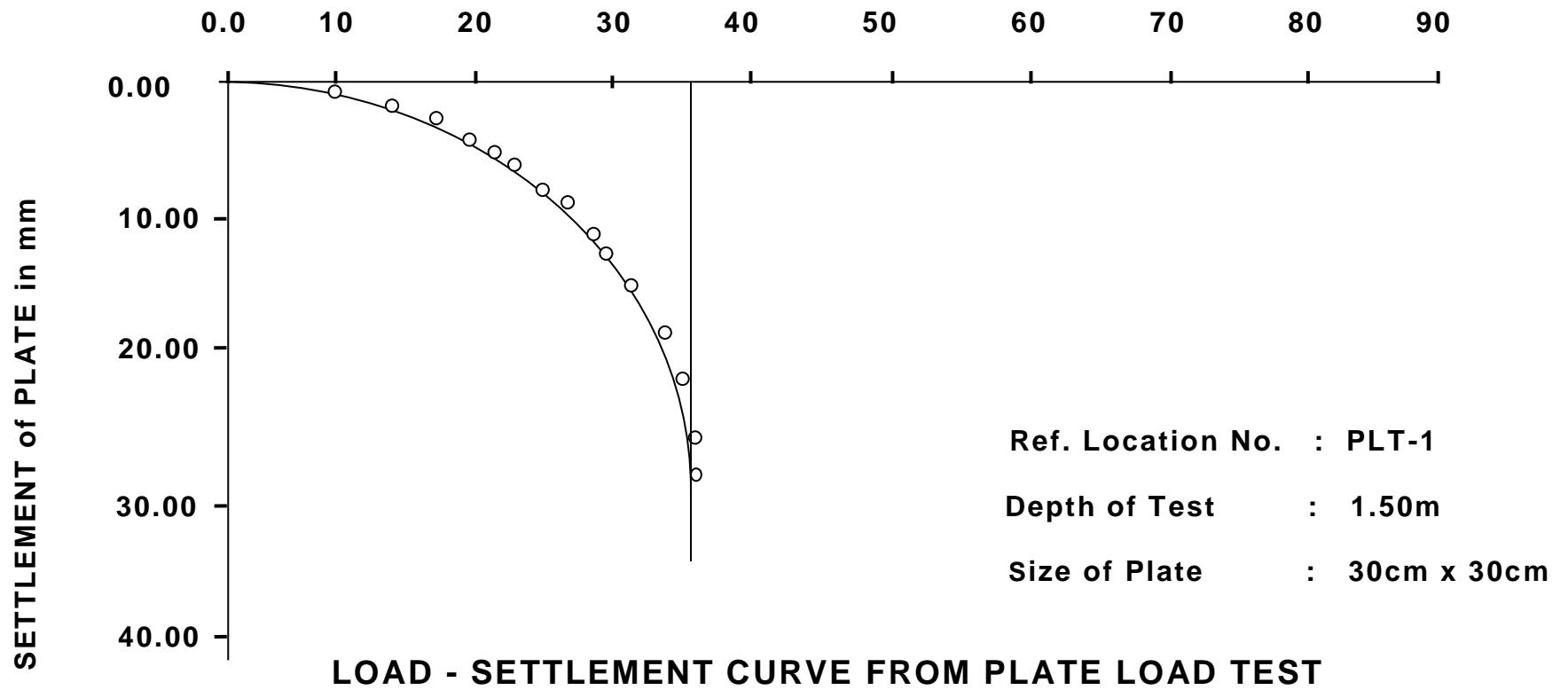
FIG. No.2

LOAD - SETTLEMENT CURVE FROM PLATE LOAD TEST

Ref. Location No. : PLT-1

Depth of Test   : 1.50m

Size of Plate   : 30cm x 30cm

PROPOSED STRUCTURAL Of DESIGN FOR AUTOMATED / MECHANIZED MULTILEVEL CAR PARKING SYSTEM AT TEHSIL OFFICE CAMPUS, HARIDWAR, UTTARAKHAND.

FIG. 4

Depth (m)	Bore Log	IS Classification	S.P.T.val No. of Blows 'N' 15cm	15cm	15cm	N"	N.M.C. %	Grain Size Analysis % Gravel	Sand	Fines	Atterberg's Limits L.L.	P.L.	P.I.	Bulk Density g/c.c 1.5	2.0	2.5	Shear Parameters C kg/sq.	φ Degrees
G.L.																		
1																		
2		ML/CL	6	6	8	8	9 %	0	68	32	-	NP	-		•		0	30
3		ML/CL	6	7	9	10	9 %	0	81	19	-	NP	-					
4		SP					10 %	0	88	12	-	NP	-					
5		SP/GP	6	8	8	11	10 %											
6		SP/GP	7	8	8	12	11 %	0	90	10	-	NP	-					
7		SP/GP									-	NP	-					
8		SP/GP	8	7	9	12	11 %	0	92	8	-	NP	-					
9		SP/GP																
10		SP/GP	7	7	8	13	13	0	93	7	-	NP	-					
11																		
12																		

Fig. 1   SOIL PROPERTIES AT B.H.- 1

PROPOSED STRUCTURAL Of DESIGN FOR AUTOMATED / MECHANIZED MULTILEVEL CAR PARKING SYSTEM AT TEHSIL OFFICE CAMPUS, HARIDWAR, UTTARAKHAND.