CHAPTER – 62

"Minor Bridge No. 341",

Location – Existing Km. - 302/14-16

62.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 5x3.05

62.2 BOREHOLE DESCRIPTIONS:

(a) Location of Structure, Boreholes with RL shown in **FIGURE-1**.

(b) Subsurface Characteristic of Soil/Rock shown in *ANNEXURE-I.*

(c) Borelogs and sub soil profile shown in *ANNEXURE-II.*

(d) Calculations of Safe Bearing Capacities in *ANNEXURE-III.*

(e) Calculations of Probable Settlement in *ANNEXURE-IV.*

(f) Depth of water Table ≥20.00m below EGL.

Subsurface profile at the site

BOREHOLE No.	Depth (m)	Type of Soil/Rock	Soil/Rock Characteristics
BH-1	0.00 to 1.50	Clayey Silt with Sand and Gravels	Loose
	1.50 to 3.00	Clayey Silt with Sand and Gravels	Medium Dense
	3.00 to 4.50	Sandy Silt with Clay	Medium Dense
	4.50 to 10.50	Silty Sand	Medium Dense
	10.50 to 12.00	Silty Sand	Dense

62.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	9.20	0.015	0.0021	NIL	0.0011	0.062
	6.00	9.00	0.010	0.0021	NIL	0.0012	0.023

62.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	11.00
	6.00	NIL

62.5 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	11.50
	3.00	19.00
	4.50	26.00
	6.00	35.00

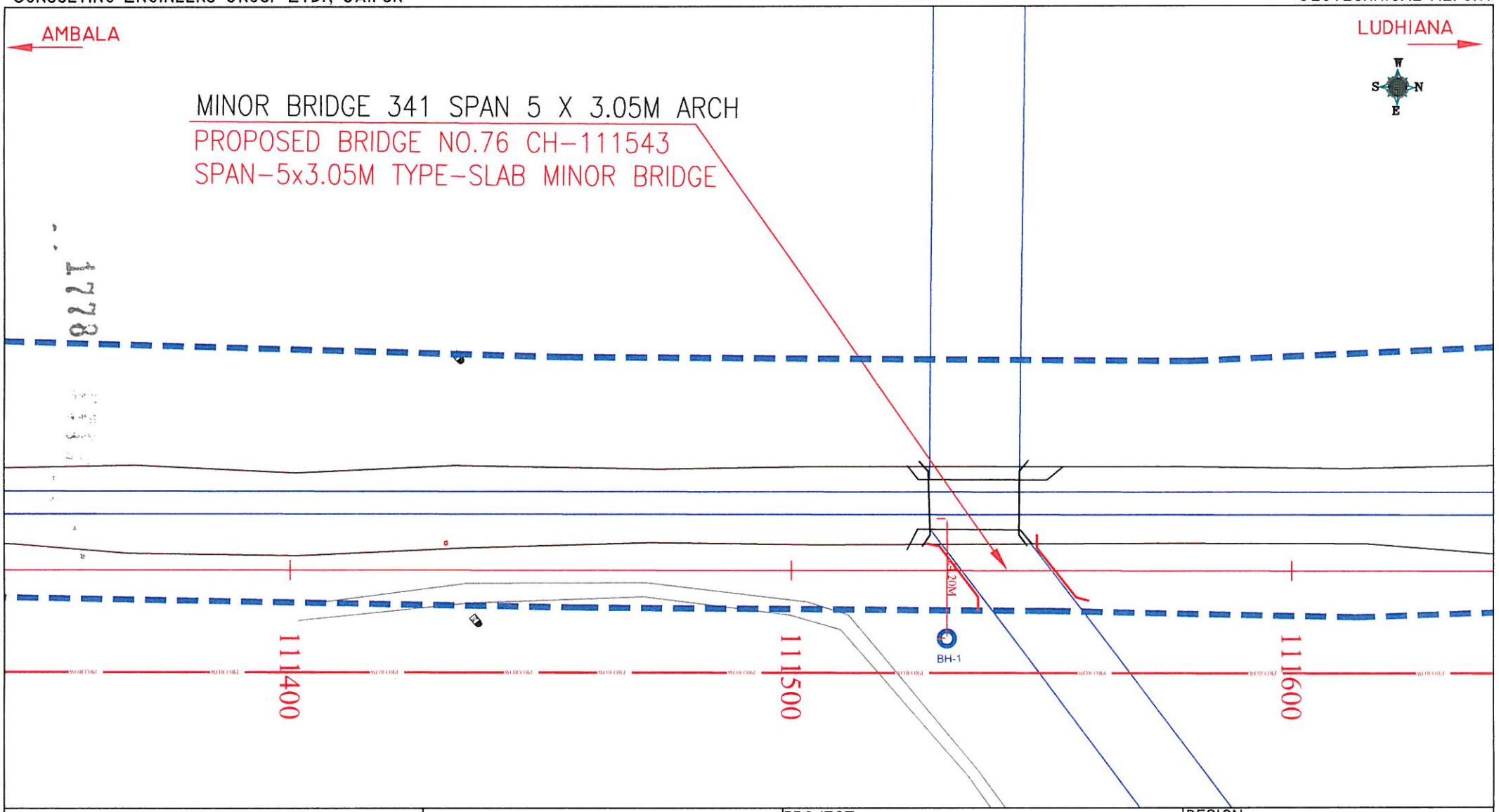
62.6 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.

62.7 RECOMMENDATIONS

(i)	*Type of foundation*	Open foundation
(ii)	*Depth of foundation below GL*	Below 3.00 m from EGL

Note- The above recommendations are based on the field and laboratory tests conducted on the soil, and our experience in this regard. If the actual subsoil conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations. However, the Depth and Type of foundation is to be decided by the structure designer depending upon the type of loading/structure and site conditions.



ALL DIMENSIONS IN METER

FIG.:-I

LOCATION PLAN OF PROPOSED MINOR BRIDGE AT CH. 302/14-16

RL OF BH-I = 262.748

PROJECT :-

LUDHIANA-AMBALA (DFCCIL)

DESIGN :-

CONSULTING ENGINEERS GROUP LTD.
E-12,Moji Colony,Malviya Nagar Jaipur-17
Tel: +91-141- 2520899, 2521899, 2520556
Fax: 2521348, E-Mail: ceg@cegindia.com

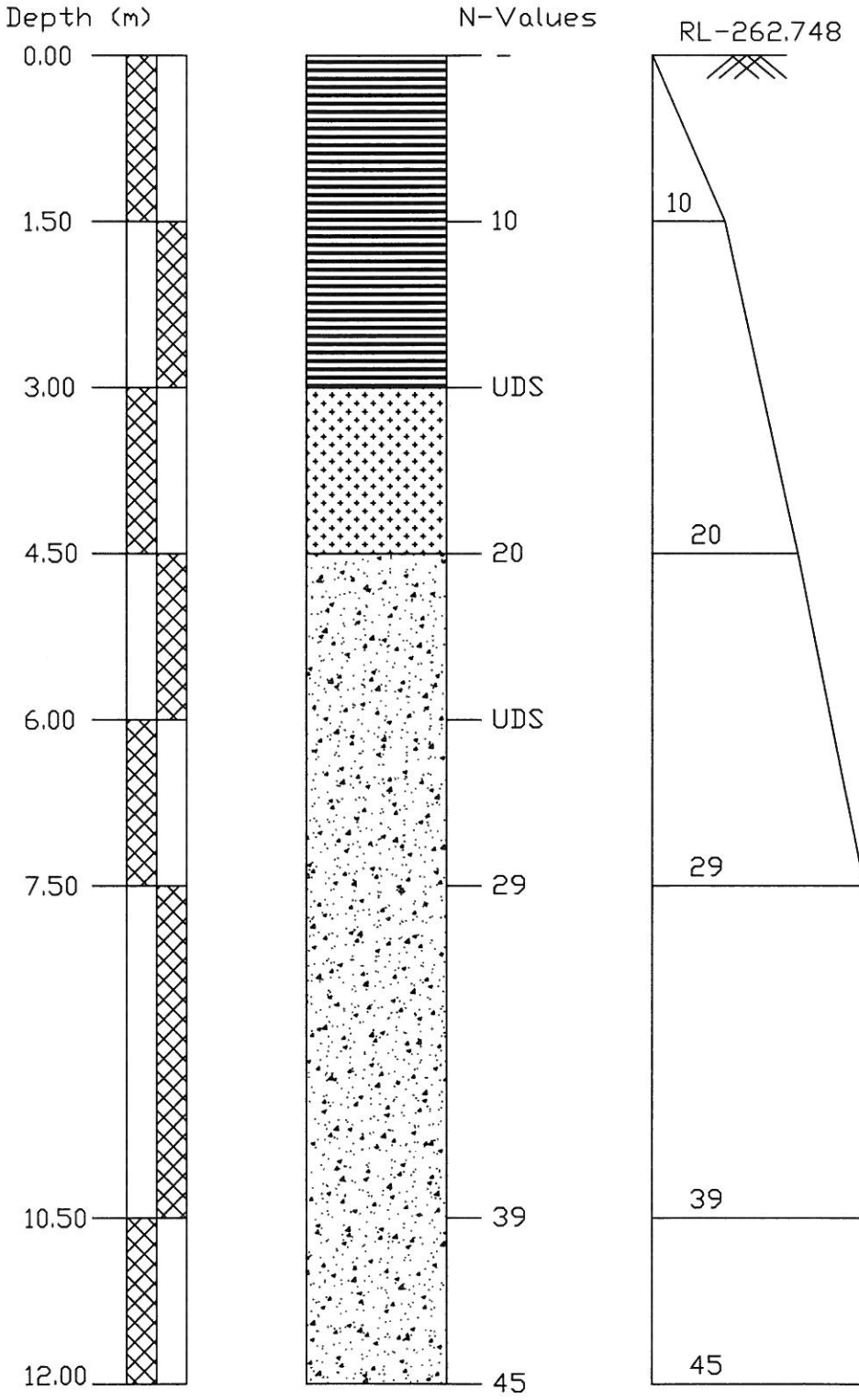
SOIL CHARACTERISTICS OF BORE HOLE AT BH-1(LHS) FOR MINOR BRIDGE No. 341 AT CHAINAGE 302/14-16

Project :	Chainage 302/14-16 Bridge No. 341			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				13.06.2009 to 13.06.2009	1	1(LHS)	below 20.00 m.	12.00mtr	262.748

Depth	Observ-	Correction	Corrected	Soil	Grain Size Distribution % wt retained							Atterberg Limits %			B.D.	M.C.	D.D.	Specific	Shear Strength	
from	ed	Factor		Description	Clay	Silt	Sand			Gravel								Gravity	c kg/cm^2	ϕ
GL (m)	N	C_n	N_n	(Soil Group)			Fine	Medium	Coarse	Fine	Coarse	L.L.	P.L.	P.I.	gm/cc	%	gm/cc			degree
0.00	-	-	-	Clayey Silt with sand andGravels	9.68	72.72	2.11	5.21	2.69	7.59	0.00	29	22	7	-	-	-	-	-	-
1.50	10	1.45	14.50	Clayey Silt with sand andGravels	17.83	63.17	3.88	4.84	3.60	6.68	0.00	30	15	15	-	-	-	-	-	-
3.00	UDS	-	-	Sandy Silt with Clay	9.33	76.01	14.09	0.27	0.30	0.00	0.00	26	19	7	1.77	8.45	1.63	2.65	0.08	22.00
4.50	20	1.08	21.60	Silty Sand	0.00	17.21	77.15	4.42	0.68	0.54	0.00	24	NIL	NP	-	-	-	-	-	-
6.00	UDS	-	-	Silty Sand	2.76	16.63	75.19	3.67	1.06	0.69	0.00	27	NIL	NP	1.81	9.59	1.65	2.64	0.00	27.50
7.50	29	0.90	26.10	Silty Sand	2.62	17.13	75.03	3.61	1.03	0.58	0.00	25	NIL	NP	-	-	-	-	-	-
10.50	39	0.79	30.81	Silty Sand	2.12	12.83	75.82	8.39	0.60	0.24	0.00	22	NIL	NP	-	-	-	-	-	-
12.00	45	0.75	33.75	Silty Sand	2.22	13.36	75.58	8.12	0.51	0.21	0.00	23	NIL	NP	-	-	-	-	-	-

CONSULTING
Engineers Group Ltd.

BORELOG OF BH–1(LHS) AT EXISTING KM–302/14–16 FOR MINOR BRIDGE NO.–341, ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	CLAYEY SILT WITH SAND & GRAVELS
	SANDY SILT WITH CLAY
	SILTY SAND

1780

CONSULTING Engineers Group Ltd.

ANNEXURE - III

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

Minor Bridge No 302/14-16 BH-1

Type of footing

1	Continuous Strip		
2	Rectangular	***Rectangular***	**2**
3	Square		
4	Circular		

Angle of internal friction (ϕ°)	22.00
Cohesion (c in t/m2)	0.80
Void ratio (e)	0.63
Direction of load with vertical ($^\circ$)	0.00
Density of surcharge (t/m^3)	1.70
Density of foundation soil (t/m^3)	1.77
Depth of water table(m)	1.50
Factor of safety	3.00

S.no.	Depth (m)	Width (m)	Length (m)
1	1.50	3.00	8.00
2	3.00	3.00	8.00

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

The ultimate net bearing capacity in case of general shear failure is given by

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1 + 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^\circ$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^\circ$

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' for local shear failure $= \tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

1701

CONSULTING Engineers Group Ltd.

ANNEXURE - III

Bearing capacity factors :

ϕ	22.00	ϕ'	15.15
N_c	17.19	N'_c	11.09
N_q	8.10	N'_q	4.01
N_γ	7.59	N'_γ	2.73

Shape factors :

S.no.	Width(m)	Length (m)	S_c	S_q	S_γ
1	3.00	8.00	1.08	1.08	0.85
2	3.00	8.00	1.08	1.08	0.85

Depth factors :

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	1.50	3.00	1.15	1.07	1.07
2	3.00	3.00	1.30	1.15	1.15

Inclination factors :

$i_c = (1-\alpha/90)^2$	$i_q = (1-\alpha/90)^2$	$i_\gamma = (1-\alpha/\phi)^2$
1.00	1.00	1.00

Water table factor :

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	1.50	3.00	0.00	0.50
2	3.00	3.00	-0.50	0.50

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	Length (m)	SBC in (t/m^2)		
				General shear	Local shear	Actual
1	1.50	3.00	8.00	15.69	6.49	12.01
2	3.00	3.00	8.00	24.57	10.25	18.84

1782

CONSULTING Engineers Group Ltd.

ANNEXURE - III

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

Minor Bridge No 302/14-16 BH-1

Type of footing

1	Continuous Strip		
2	Rectangular	***Rectangular***	**2**
3	Square		
4	Circular		

Angle of internal friction (ϕ °)	27.50
Cohesion (c in t/m2)	0.00
Void ratio (e)	0.60
Direction of load with vertical (°)	0.00
Density of surcharge (t/m^3)	1.70
Density of foundation soil (t/m^3)	1.81
Depth of water table(m)	1.50
Factor of safety	3.00

S.no.	Depth (m)	Width (m)	Length (m)
1	4.50	3.00	8.00
2	6.00	3.00	8.00

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

The ultimate net bearing capacity in case of general shear failure is given by

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1 + 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^\circ$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^\circ$

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

1783

CONSULTING Engineers Group Ltd.

ANNEXURE - III

Bearing capacity factors :

ϕ	27.50	ϕ'	19.23
N_c	25.43	N'_c	14.24
N_q	14.53	N'_q	6.02
N_γ	16.64	N'_γ	4.97

Shape factors :

S.no.	Width(m)	Length (m)	S_c	S_q	S_γ
1	3.00	8.00	1.08	1.08	0.85
2	3.00	8.00	1.08	1.08	0.85

Depth factors :

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	4.50	3.00	1.49	1.25	1.25
2	6.00	3.00	1.66	1.33	1.33

Inclination factors :

$i_c = (1-\alpha/90)^2$	$i_q = (1-\alpha/90)^2$	$i_\gamma = (1-\alpha/\phi)^2$
1.00	1.00	1.00

Water table factor :

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	4.50	3.00	-1.00	0.50
2	6.00	3.00	-1.50	0.50

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	Length (m)	SBC in (t/m^2)		
				General shear	Local shear	Actual
1	4.50	3.00	8.00	38.82	13.82	32.57
2	6.00	3.00	8.00	41.39	14.74	34.72

1784

ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1) **Ch. 302 14-16**

BH No. (A1)

Depth of foundation		=	1.5	m
Length of footing (L)		=	8.0	m
Width of footing (B)		=	3.0	m
Initial effective stress at mid of layer	Po	=	5.31	t/m^2
Concentrated load *P*		=	11.50	t/m^2
Incerase in pressure at mid of layer	ΔP	=	$P \times I_B$	
	I_B	=	0.248	
	ΔP	=	2.9	t/m^2
Compression Index	Cc	=	0.108	
Thickness of clay layer	H	=	3	m
Initial Void ratio	e_o	=	0.63	
	$\frac{Po + \Delta p}{Po}$	=	1.5371	

Settlement of clay layer $S_f = \frac{Cc}{1+ eo} H \log_{10} \frac{Po + \Delta P}{Po}$

S_f = 0.03711 m

= 37.1113 mm

Correction for Depth and Rigidity of foundation on total settlement

Depth Factor Calculation

$D/(LB)^{0.5}$ = 0.61

D = Depth of Foundation

L/B = 2.67

Depth Factor = 0.91

Rigidity Factor = $\frac{\text{Total Settlement of Rigid foundation}}{\text{Total Settlement at the centre of Flexible foundation}}$

= 0.8

Pore Pr. Correction = 0.85

Total Settlement = S_f x D.F.x R.F.

S_{f2} = 23.0 mm

Footing Depth (m)	**1.50**
SBC (t/m2)	2.30
Average N value	22
Settlement for 10 t/m2 (mm)	12.00
Total Settlement (mm)	2.76
Depth Correction	0.91
Rigidity factor	0.8
Corrected Settlement (mm)	**2.01**
Total Settlement (mm)	**25.0**

1785

CONSULTING Engineers Group Ltd.

ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1)	
Location	Minor Bridge
Chainage	302/14-16
Bore Hole No.	1

Footing Depth (m)	3.00
SBC (t/m2)	19.00
Average N value	21
Settlement for 10 t/m2 (mm)	14.40
Total Settlement (mm)	27.36
Depth Correction	0.83
Rigidity factor	0.8
Corrected Settlement (mm)	**18.2**

Footing Depth (m)	4.50
SBC (t/m2)	26.00
Average N value	24
Settlement for 10 t/m2 (mm)	12.60
Total Settlement (mm)	32.76
Depth Correction	0.74
Rigidity factor	0.8
Corrected Settlement (mm)	**19.4**

Footing Depth (m)	6.00
SBC (t/m2)	35.00
Average N value	26
Settlement for 10 t/m2 (mm)	11.40
Total Settlement (mm)	39.90
Depth Correction	0.68
Rigidity factor	0.8
Corrected Settlement (mm)	**21.7**

1786

CHAPTER – 63

"Minor Bridge No. 337",

Location – Existing Km. - 300/08-10

63.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 2x3.05

63.2 BOREHOLE DESCRIPTIONS:

(a) Location of Structure, Boreholes with RL shown in **FIGURE-1**.

(b) Subsurface Characteristic of Soil/Rock shown in *ANNEXURE-I.*

(c) Borelogs and sub soil profile shown in *ANNEXURE-II.*

(d) Calculations of Safe Bearing Capacities in *ANNEXURE-III.*

(e) Calculations of Probable Settlement in *ANNEXURE-IV.*

(f) Depth of water Table ≥20.00m below EGL.

Subsurface profile at the site

BOREHOLE No.	Depth (m)	Type of Soil/Rock	Soil/Rock Characteristics
BH-1	0.00 to 1.50	Clayey Silt with Sand	Loose
	1.50 to 3.00	Sandy Silt with Gravels	Dense
	3.00 to 4.50	Sandy Silt	Dense
	4.50 to 12.00	Silty Sand	Dense

63.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	8.70	0.002	0.0014	NIL	0.0009	0.024
	6.00	8.60	0.007	0.0014	NIL	0.0011	0.017

63.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	NIL
	6.00	NIL

63.5 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	11.00
	3.00	20.00
	4.50	31.00
	6.00	33.00

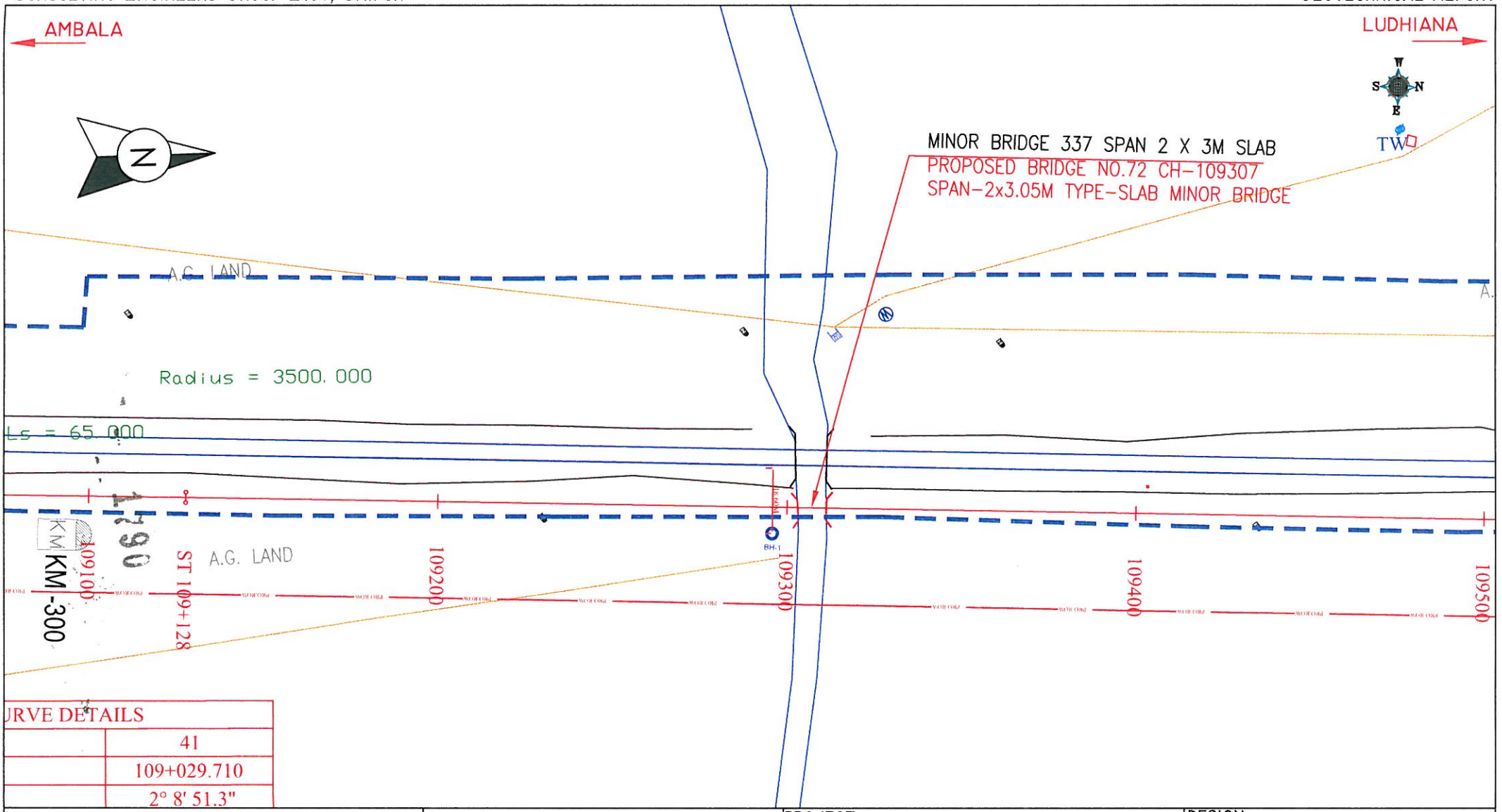
63.6 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.

63.7 RECOMMENDATIONS

(i)	*Type of foundation*	Open foundation
(ii)	*Depth of foundation below GL*	Below 3.00 m from EGL

Note- The above recommendations are based on the field and laboratory tests conducted on the soil, and our experience in this regard. If the actual subsoil conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations. However, the Depth and Type of foundation is to be decided by the structure designer depending upon the type of loading/structure and site conditions.



URVE DETAILS	
	41
	109+029.710
	2° 8' 51.3"

ALL DIMENSIONS IN METER

FIG.:-I
LOCATION PLAN OF PROPOSED MINOR BRIDGE AT CH. 300/8-10

RL OF BH-I = 263.337

PROJECT :-
LUDHIANA-AMBALA (DFCCIL)

DESIGN :-
CONSULTING ENGINEERS GROUP LTD.
E-12,Moji Colony,Malviya Nagar Jaipur-17
Tel: +91-141- 2520899, 2521899, 2520556
Fax: 2521348, E-Mail: ceg@cegindia.com

SOIL CHARACTERISTICS OF BORE HOLE AT BH-1(LHS) FOR MINOR BRIDGE No. 337 AT CHAINAGE 300/8-10

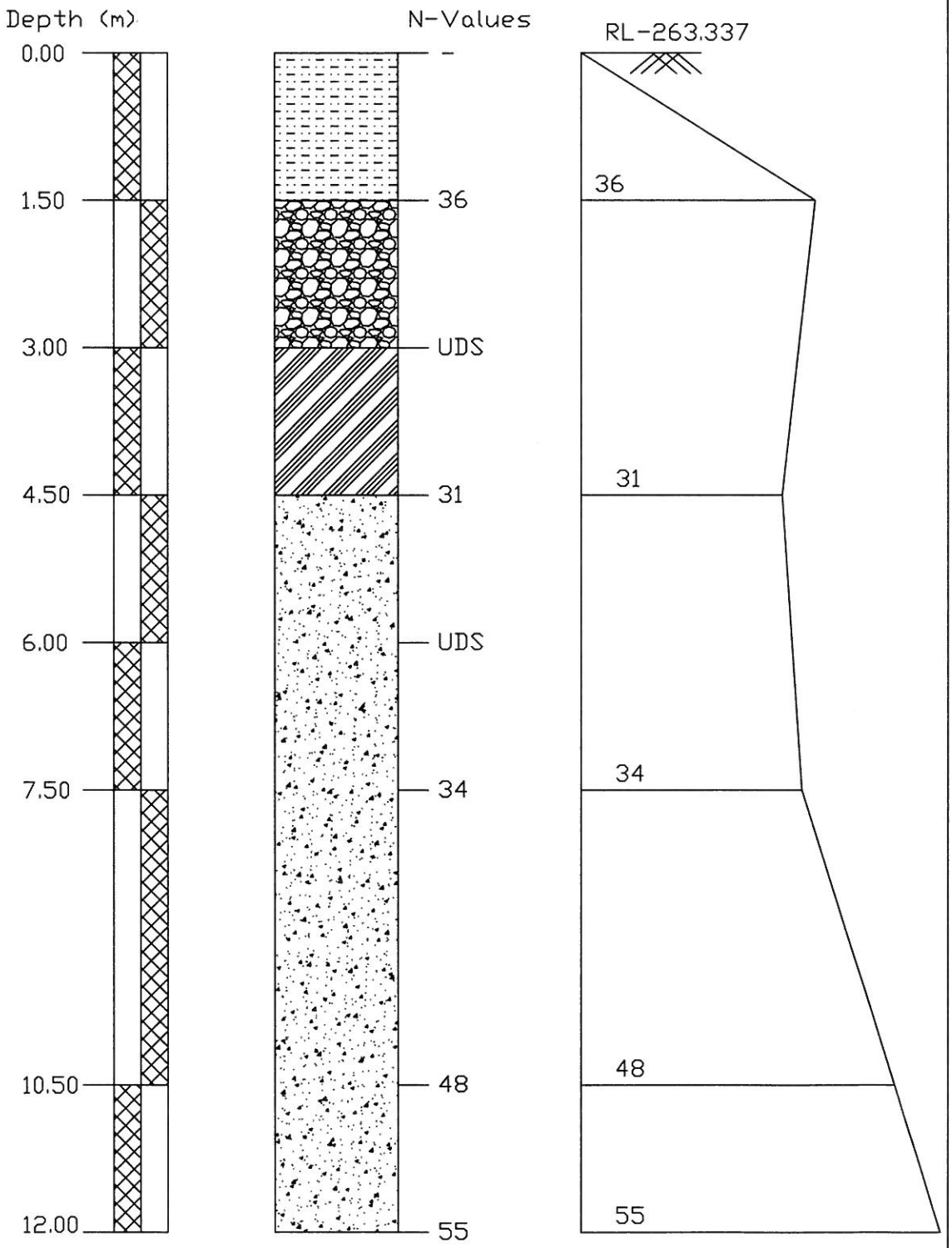
Project :	Chainage 300/8-10 Bridge No. 337			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				14.06.2009 to 15.06.2009	1	1(LHS)	below 20.00 m.	12.00mtr	263.337

Depth	Observ-	Correction	Corrected	Soil	Grain Size Distribution % wt retained							Atterberg Limits %			B.D.	M.C.	D.D.	Specific	Shear Strength	
from	ed	Factor		Description	Clay	Silt	Sand			Gravel								Gravity	c kg/cm^2	ϕ
GL (m)	N	C_n	N_n	(Soil Group)			Fine	Medium	Coarse	Fine	Coarse	L.L.	P.L.	P.I.	gm/cc	%	gm/cc			degree
0.00	-	-	-	Clayey silt with sand	10.89	51.32	20.97	3.69	5.92	7.21	0.00	30	21	9	-	-	-	-	-	-
1.50	36	1.46	52.56	Sandy Silt with Gravels	3.22	48.55	27.98	7.29	6.10	6.86	0.00	25	NIL	NP	-	-	-	-	-	-
3.00	UDS	-	-	Sandy Silt	2.00	63.88	32.58	0.47	0.37	0.70	0.00	25	NIL	NP	1.71	4.69	1.63	2.64	0.00	25.00
4.50	31	1.09	33.79	Silty Sand	2.00	5.46	90.25	2.29	0.00	0.00	0.00	22	NIL	NP	-	-	-	-	-	
6.00	UDS	-	-	Silty Sand	2.33	4.64	88.54	4.23	0.06	0.20	0.00	22	NIL	NP	1.75	6.10	1.65	2.66	0.00	27.50
7.50	34	0.91	30.94	Silty Sand	2.00	21.12	66.27	8.84	0.97	0.80	0.00	21	NIL	NP	-	-	-	-	-	-
10.50	48	0.80	38.40	Silty Sand	2.33	21.32	65.87	8.87	0.85	0.76	0.00	23	NIL	NP	-	-	-	-	-	-
12.00	55	0.76	41.80	Silty Sand	2.16	20.77	66.35	8.97	0.93	0.82	0.00	22	NIL	NP	-	-	-	-	-	-

CONSULTING
Engineers Group Ltd.

BORELOG OF BH–1(LHS) AT EXISTING KM–300/8–10 FOR MINOR BRIDGE NO.–337,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	CLAYEY SILT WITH SAND
	SANDY SILT WITH GRAVELS
	SANDY SILT
	SILTY SAND

ANNEXURE - III

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

Minor Bridge No 300/8-10 BH-1

Type of footing

1	Continuous Strip		
2	Rectangular	***Rectangular***	**2**
3	Square		
4	Circular		

Angle of internal friction (ϕ °)	25.00
Cohesion (c in t/m2)	0.00
Void ratio (e)	0.62
Direction of load with vertical (°)	0.00
Density of surcharge (t/m^3)	1.70
Density of foundation soil (t/m^3)	1.71
Depth of water table(m)	1.50
Factor of safety	3.00

S.no.	Depth (m)	Width (m)	Length (m)
1	1.50	3.00	8.00
2	3.00	3.00	8.00

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

The ultimate net bearing capacity in case of general shear failure is given by

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1 + 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10°$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10°$

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

1793

CONSULTING Engineers Group Ltd.

ANNEXURE - III

Bearing capacity factors :

ϕ	25.00
N_c	20.72
N_q	10.66
N_γ	10.88

ϕ'	17.35
N'_c	12.79
N'_q	5.10
N'_γ	3.94

Shape factors :

S.no.	Width(m)	Length (m)	S_c	S_q	S_γ
1	3.00	8.00	1.08	1.08	0.85
2	3.00	8.00	1.08	1.08	0.85

Depth factors :

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	1.50	3.00	1.16	1.08	1.08
2	3.00	3.00	1.31	1.16	1.16

Inclination factors :

$i_c = (1-\alpha/90)^2$	$i_q = (1-\alpha/90)^2$	$i_\gamma = (1-\alpha/\phi)^2$
1.00	1.00	1.00

Water table factor :

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	1.50	3.00	0.00	0.50
2	3.00	3.00	-0.50	0.50

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	Length (m)	SBC in (t/m^2)		
				General shear	Local shear	Actual
1	1.50	3.00	8.00	13.78	5.58	10.91
2	3.00	3.00	8.00	25.00	10.32	19.86

1794

CONSULTING Engineers Group Ltd.

ANNEXURE - III

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

Minor Bridge No 300/8-10 BH-1

Type of footing

1	Continuous Strip		
2	Rectangular	***Rectangular***	2
3	Square		
4	Circular		

Angle of internal friction (ϕ°)	27.50
Cohesion (c in t/m2)	0.00
Void ratio (e)	0.61
Direction of load with vertical ($^\circ$)	0.00
Density of surcharge (t/m^3)	1.70
Density of foundation soil (t/m^3)	1.75
Depth of water table(m)	1.50
Factor of safety	3.00

S.no.	Depth (m)	Width (m)	Length (m)
1	4.50	3.00	4.50
2	6.00	3.00	4.50

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

The ultimate net bearing capacity in case of general shear failure is given by

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1 + 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^\circ$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^\circ$

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

1795

CONSULTING Engineers Group Ltd.

ANNEXURE - III

Bearing capacity factors :

ϕ	27.50	ϕ'	19.23
N_c	25.43	N'_c	14.24
N_q	14.53	N'_q	6.02
N_γ	16.64	N'_γ	4.97

Shape factors :

S.no.	Width(m)	Length (m)	S_c	S_q	S_γ
1	3.00	4.50	1.13	1.13	0.73
2	3.00	4.50	1.13	1.13	0.73

Depth factors :

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	4.50	3.00	1.49	1.25	1.25
2	6.00	3.00	1.66	1.33	1.33

Inclination factors :

$i_c = (1-\alpha/90)^2$	$i_q = (1-\alpha/90)^2$	$i_\gamma = (1-\alpha/\phi)^2$
1.00	1.00	1.00

Water table factor :

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	4.50	3.00	-1.00	0.50
2	6.00	3.00	-1.50	0.50

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	Length (m)	SBC in (t/m^2)		
				General shear	Local shear	Actual
1	4.50	3.00	4.50	39.17	14.05	31.63
2	6.00	3.00	4.50	41.76	14.98	33.72

1796

CONSULTING
Engineers Group Ltd.

ANNEXURE - IV

Settlement Calculation As per IS 8009 (Part 1)	
Location	Minor Bridge
Chainage	300/8-10
Bore Hole No.	1

Footing Depth (m)	1.50
SBC (t/m2)	11.00
Average N value	32
Settlement for 10 t/m2 (mm)	8.40
Total Settlement (mm)	9.24
Depth Correction	0.91
Rigidity factor	0.8
Corrected Settlement (mm)	6.7

Footing Depth (m)	3.00
SBC (t/m2)	20.00
Average N value	35
Settlement for 10 t/m2 (mm)	7.50
Total Settlement (mm)	15.00
Depth Correction	0.83
Rigidity factor	0.8
Corrected Settlement (mm)	10.0

Footing Depth (m)	4.50
SBC (t/m2)	31.00
Average N value	33
Settlement for 10 t/m2 (mm)	8.10
Total Settlement (mm)	25.11
Depth Correction	0.74
Rigidity factor	0.8
Corrected Settlement (mm)	14.9

Footing Depth (m)	6.00
SBC (t/m2)	33.00
Average N value	34
Settlement for 10 t/m2 (mm)	7.80
Total Settlement (mm)	25.74
Depth Correction	0.68
Rigidity factor	0.8
Corrected Settlement (mm)	14.0

1797

CONSULTING
Engineers Group Ltd.

CHAPTER – 64

"Minor Bridge No. 336",

Location – Existing Km. - 299/31-33

64.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 2x3.05

64.2 BOREHOLE DESCRIPTIONS:

(a) Location of Structure, Boreholes with RL shown in **FIGURE-1**.

(b) Subsurface Characteristic of Soil/Rock shown in *ANNEXURE-I.*

(c) Borelogs and sub soil profile shown in *ANNEXURE-II.*

(d) Calculations of Safe Bearing Capacities in *ANNEXURE-III.*

(e) Calculations of Probable Settlement in *ANNEXURE-IV.*

(f) Depth of water Table ≥20.00m below EGL.

Subsurface profile at the site

BOREHOLE No.	Depth (m)	Type of Soil/Rock	Soil/Rock Characteristics
BH-1	0.00 to 1.50	Clayey Silt with Sand	Loose
	1.50 to 4.50	Clayey Silt with Sand	Medium Dense
	4.50 to 7.50	Silty Sand	Medium Dense
	7.50 to 12.00	Silty Sand	Dense

64.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	8.60	NIL	0.0018	NIL	0.0010	0.035
	9.00	8.90	0.010	0.0024	NIL	0.0013	0.028

64.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	21.00
	6.00	NIL

64.5 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	12.00
	3.00	17.00
	4.50	25.00
	6.00	27.00

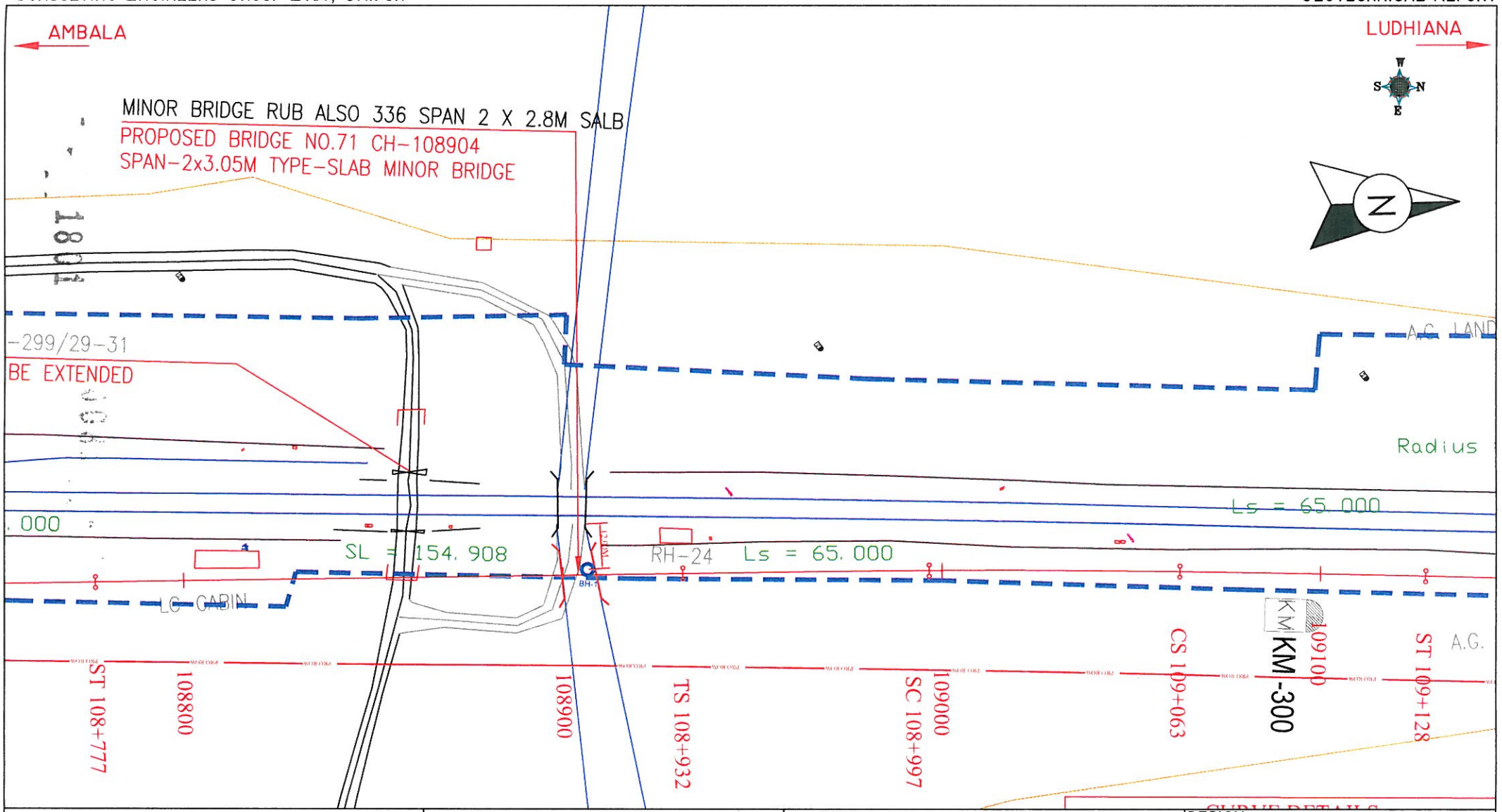
64.6 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.

64.7 RECOMMENDATIONS

(i)	*Type of foundation*	Open foundation
(ii)	*Depth of foundation below GL*	Below 3.00 m from EGL

Note- The above recommendations are based on the field and laboratory tests conducted on the soil, and our experience in this regard. If the actual subsoil conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations. However, the Depth and Type of foundation is to be decided by the structure designer depending upon the type of loading/structure and site conditions.



ALL DIMENSIONS IN METER

FIG.:-I

LOCATION PLAN OF PROPOSED MINOR BRIDGE AT CH. 299/31-33

RL OF BH-I = 263.425

PROJECT :-

LUDHIANA-AMBALA (DFCCIL)

DESIGN :-

CONSULTING ENGINEERS GROUP LTD.
E-12,Moji Colony,Malviya Nagar Jaipur-17
Tel: +91-141- 2520899, 2521899, 2520556
Fax: 2521348, E-Mail: ceg@cegindia.com

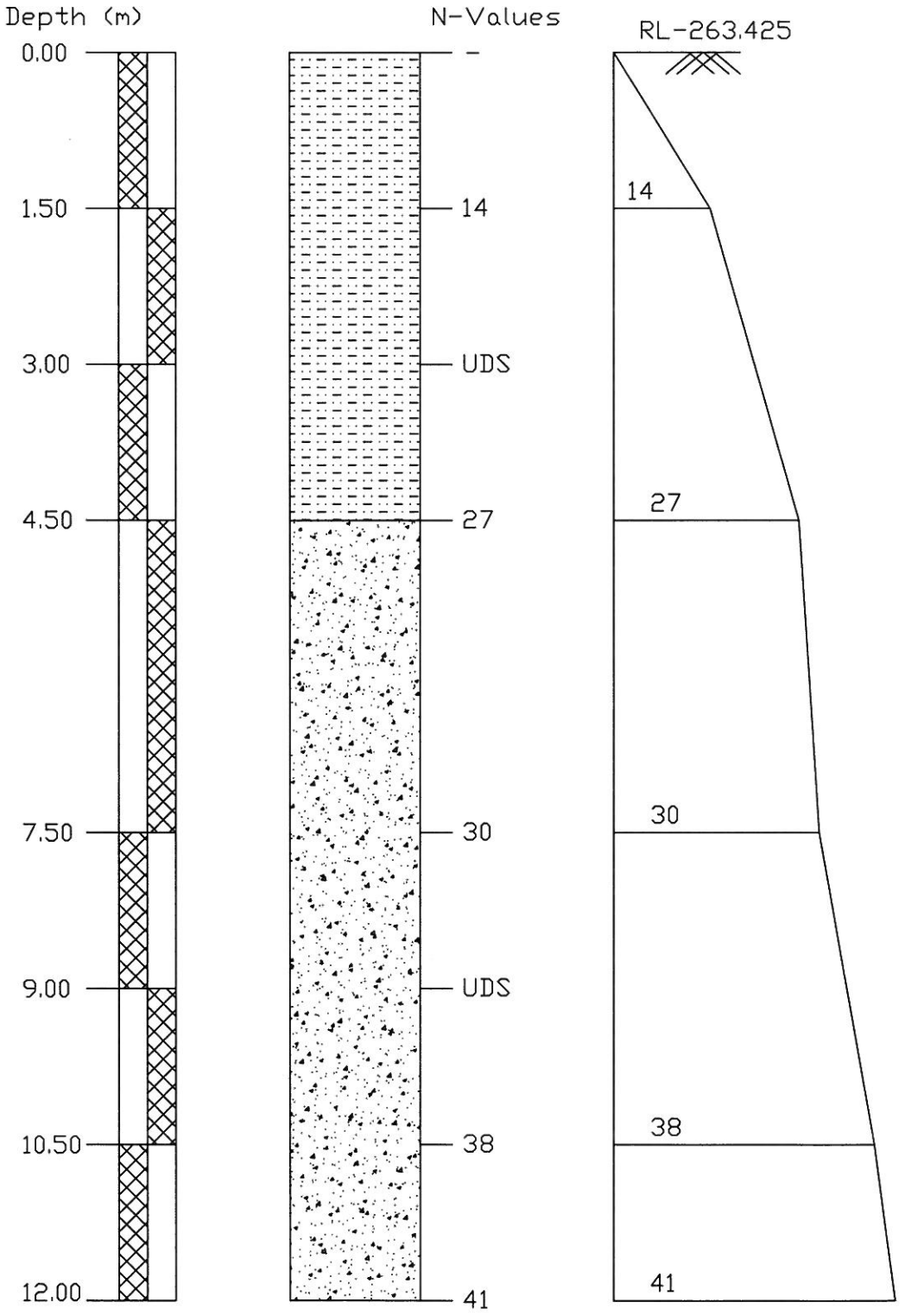
SOIL CHARACTERISTICS OF BORE HOLE AT BH-1(LHS) FOR MINOR BRIDGE No. 336 AT CHAINAGE 299/31-33

Project :	Chainage 299/33-35 Bridge No. 336			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				15.06.2009 to 15.06.2009	1	1(LHS)	below 20.00 m.	12.00mtr	263.425

Depth from GL (m)	Observ-ed N	Correction Factor C_n	Corrected N_n	Soil Description (Soil Group)	Grain Size Distribution % wt retained							Atterberg Limits %			B.D. gm/cc	M.C. %	D.D. gm/cc	Specific Gravity	Shear Strength	
					Clay	Silt	Sand			Gravel									c kg/cm^2	ϕ degree
							Fine	Medium	Coarse	Fine	Coarse	L.L.	P.L.	P.I.						
0.00	-	-	-	Clay silt with sand	14.59	71.01	9.55	2.36	1.2	1.29	0	30	18	12	-	-	-	-	-	-
1.50	14	1.44	20.16	Clay silt with sand	16.22	71.75	10.34	0.66	0.28	0.75	0.00	30	17	13	-	-	-	-		-
3.00	UDS	-	-	Clay silt with sand	18.97	75.45	2.55	1.11	1.34	0.58	0.00	37	20	17	1.79	9.20	1.64	2.64	0.18	17.00
4.50	27	1.07	28.89	Silty sand	2.00	10.08	83.52	3.71	0.15	0.54	0.00	26	NIL	NP	-	-	-	-	-	-
7.50	30	0.90	27.00	Silty sand	2.00	10.97	82.67	3.68	0.19	0.49	0.00	27	NIL	NP	-		-	-	-	
9.00	UDS	-	-	Silty Sand	3.85	5.14	85.49	5.52	0.00	0.00	0.00	29	NIL	NP	1.85	9.69	1.69	2.64	0.00	29.00
10.50	38	0.79	30.02	Silty Sand	2.29	6.53	88.36	1.93	0.33	0.56	0.00	29	NIL	NP	-	-	-	-	-	-
12.00	41	0.74	30.34	Silty Sand	2.15	7.11	88.13	1.87	0.23	0.51	0.00	28	NIL	NP	-	-	-	-	-	-

CONSULTING Engineers Group Ltd.

BORELOG OF BH–1(LHS) AT EXISTING KM–299/31–33 FOR MINOR BRIDGE NO.–336, ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	CLAYEY SILT WITH SAND
	SILTY SAND

1803

CONSULTING Engineers Group Ltd.

CHAPTER – 65

"Minor Bridge No. 335",

Location – Existing Km. - 298/33-35

65.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 2x3.05

65.2 BOREHOLE DESCRIPTIONS:

(a) Location of Structure, Boreholes with RL shown in **FIGURE-1**.

(b) Subsurface Characteristic of Soil/Rock shown in *ANNEXURE-I.*

(c) Borelogs and sub soil profile shown in *ANNEXURE-II.*

(d) Calculations of Safe Bearing Capacities in *ANNEXURE-III.*

(e) Calculations of Probable Settlement in *ANNEXURE-IV.*

(f) Depth of water Table ≥20.00m below EGL.

Subsurface profile at the site

BOREHOLE No.	Depth (m)	Type of Soil/Rock	Soil/Rock Characteristics
BH-1	0.00 to 1.50	Clayey Silt with Sand	Loose
	1.50 to 3.00	Silty Sand	Medium Dense
	3.00 to 7.50	Sandy Silt	Medium Dense
	7.50 to 12.00	Silty Sand	Dense

65.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	8.20	NIL	0.0017	NIL	0.0013	0.029
	6.00	7.90	NIL	0.0017	NIL	0.0011	0.028

65.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	NIL
	6.00	NIL

65.5 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	05.50
	3.00	10.00
	4.50	17.00
	6.00	18.00

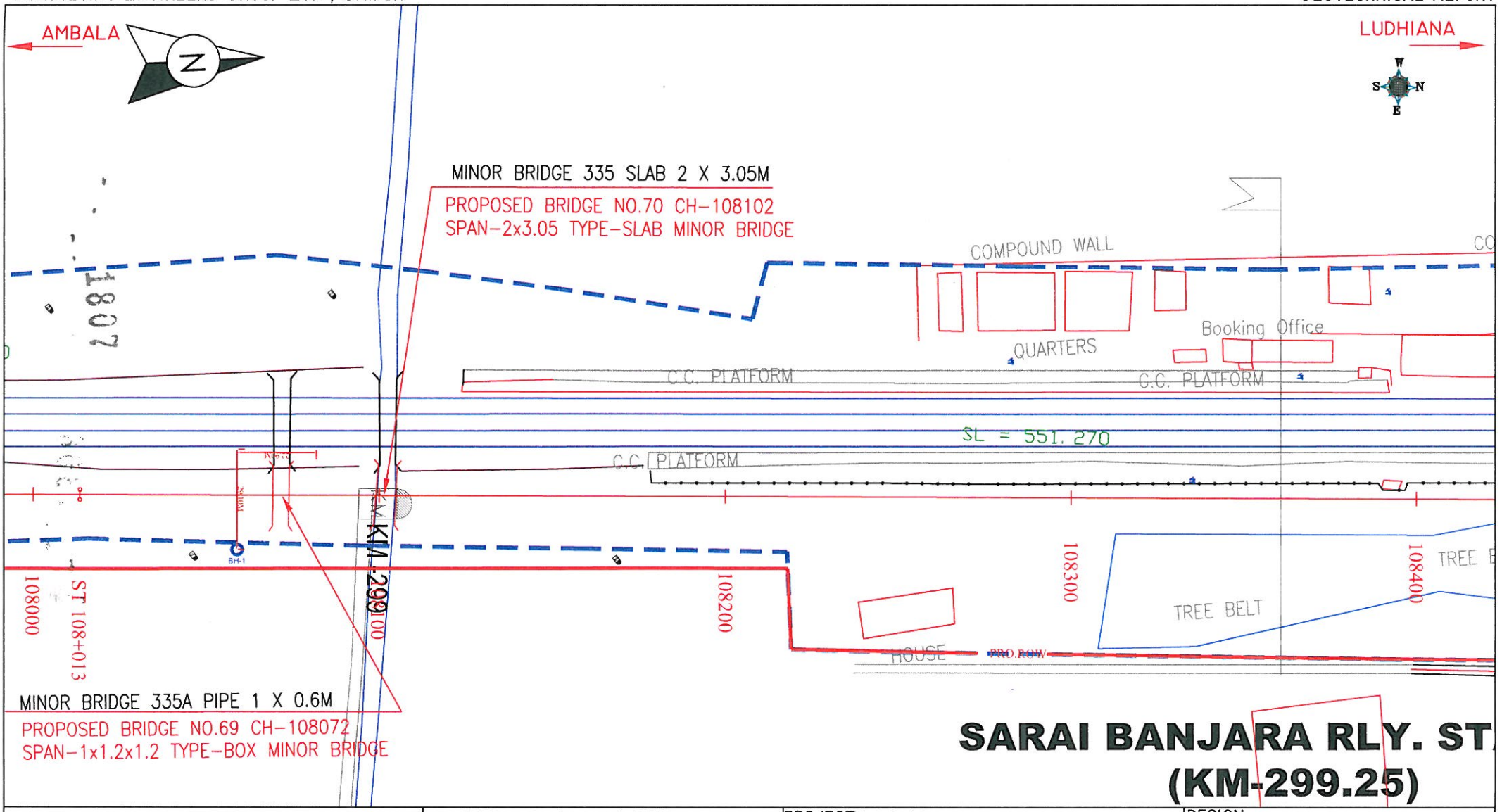
65.6 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.

65.7 RECOMMENDATIONS

(i)	*Type of foundation*	Open foundation
(ii)	*Depth of foundation below GL*	Below 4.50 m from EGL

Note- The above recommendations are based on the field and laboratory tests conducted on the soil, and our experience in this regard. If the actual subsoil conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations. However, the Depth and Type of foundation is to be decided by the structure designer depending upon the type of loading/structure and site conditions.



ALL DIMENSIONS IN METER FIG.:-I LOCATION PLAN OF PROPOSED MINOR BRIDGE AT CH. 298/33-35	RL OF BH-I = 264.197	PROJECT :- LUDHIANA-AMBALA (DFCCIL)	DESIGN :- CONSULTING ENGINEERS GROUP LTD. E-12,Moji Colony,Malviya Nagar Jaipur-17 Tel: +91-141- 2520899, 2521899, 2520556 Fax: 2521348, E-Mail: ceg@cegindia.com

SOIL CHARACTERISTICS OF BORE HOLE AT BH-1(LHS) FOR MINOR BRIDGE No. 335 AT CHAINAGE 298/33-35

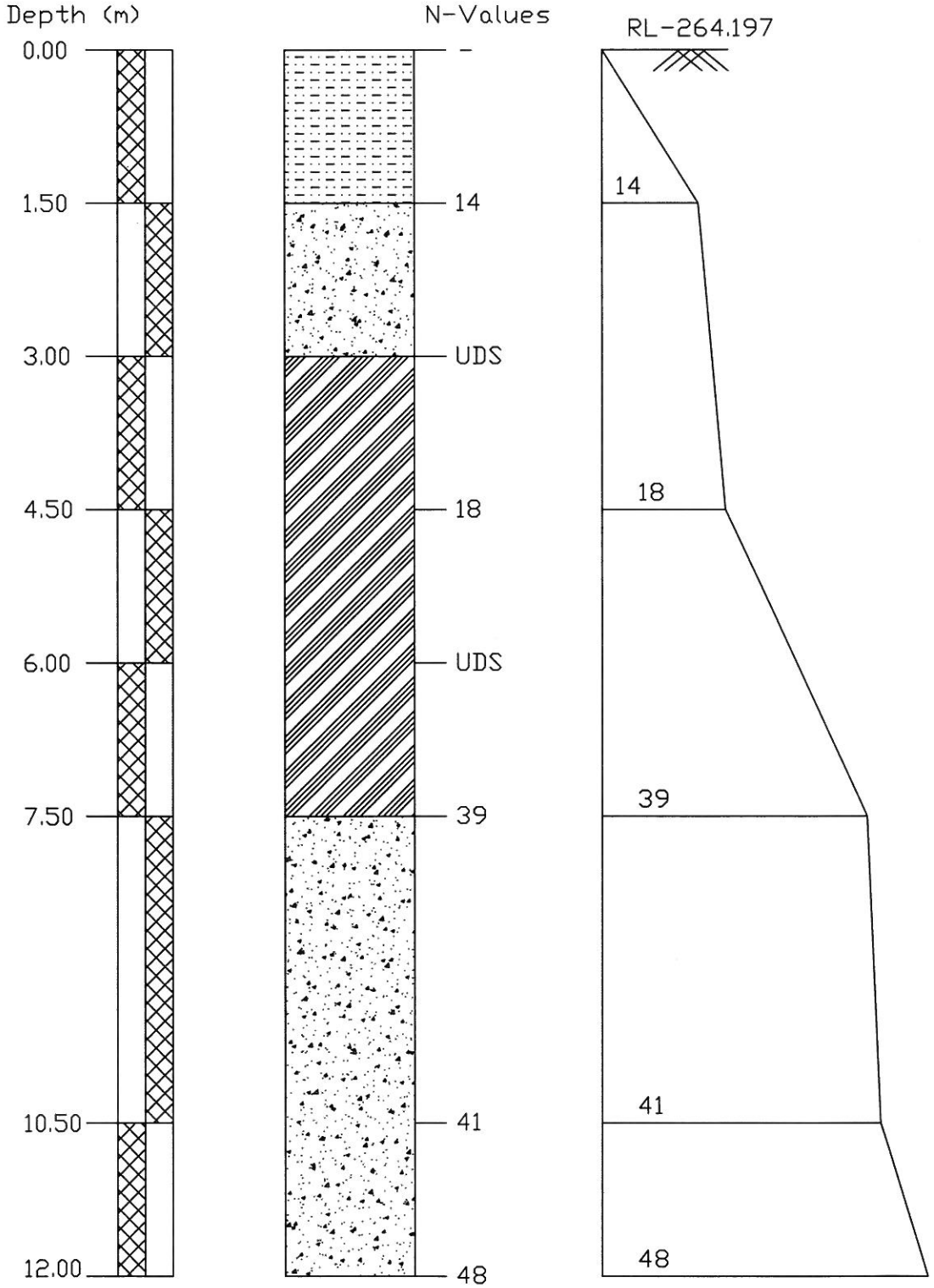
Project :	Chainage 298/33-35 Bridge No. 335			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				15.06.2009 to 15.06.2009	1	1(LHS)	below 20.00 m.	12.00mtr	264.197

Depth	Observ-	Correction	Corrected	Soil	Grain Size Distribution % wt retained							Atterberg Limits %			B.D.	M.C.	D.D.	Specific	Shear Strength	
from	ed	Factor		Description	Clay	Silt	Sand			Gravel								Gravity	c kg/cm^2	ϕ
GL (m)	N	C_n	N_n	(Soil Group)			Fine	Medium	Coarse	Fine	Coarse	L.L.	P.L.	P.I.	gm/cc	%	gm/cc			degree
0.00	-	-	-	Clayey silt with Sand	12.1	50.56	35.69	1.26	0.39	0.00	0.00	31	21	10	-	-	-	-	-	-
1.50	14	1.53	21.42	Silty Sand	2.15	45.98	51.66	0.21	0.00	0.00	0.00	23	NIL	NP	-	-	-	-	-	-
3.00	UDS	-	-	Sandy Silt	2.39	44.02	52.38	1.11	0.10	0.00	0.00	27	NIL	NP	1.57	4.59	1.50	2.61	0.00	25.00
4.50	18	1.12	20.16	Sandy Silt	1.86	76.06	21.69	0.39	0.00	0.00	0.00	21	NIL	NP	-	-	-	-	-	-
6.00	UDS	-	-	Sandy Silt	2.22	75.06	22.58	0.14	0.00	0.00	0.00	25	NIL	NP	1.68	7.15	1.57	2.64	0.00	26.00
7.50	39	0.94	36.66	Silty Sand	2.29	8.33	81.10	6.35	1.15	0.78	0.00	27	NIL	NP	-	-	-	-	-	-
10.50	41	0.82	33.62	Silty Sand	2.51	7.77	81.05	6.55	1.25	0.87	0.00	26	NIL	NP	-	-	-	-	-	-
12.00	48	0.78	37.44	Silty Sand	2.61	7.01	81.25	7.05	1.19	0.89	0.00	25	NIL	NP	-	-	-	-	-	-

CONSULTING Engineers Group Ltd.

BORELOG OF BH–1(LHS) AT EXISTING KM–298/33–35 FOR MINOR BRIDGE NO.–335,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	CLAYEY SILT WITH SAND
	SILTY SAND
	SANDY SILT

1809

CONSULTING Engineers Group Ltd.

CHAPTER – 66

"Minor Bridge No. 334",

Location – Existing Km. - 297/22-24

66.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 4x3.05

66.2 BOREHOLE DESCRIPTIONS:

(a) Location of Structure, Boreholes with RL shown in **FIGURE-1**.

(b) Subsurface Characteristic of Soil/Rock shown in *ANNEXURE-I.*

(c) Borelogs and sub soil profile shown in *ANNEXURE-II.*

(d) Calculations of Safe Bearing Capacities in *ANNEXURE-III.*

(e) Calculations of Probable Settlement in *ANNEXURE-IV.*

(f) Depth of water Table ≥20.00m below EGL.

Subsurface profile at the site

BOREHOLE No.	Depth (m)	Type of Soil/Rock	Soil/Rock Characteristics
BH-1	0.00 to 1.50	Clayey Silt with Sand	Loose
	1.50 to 6.00	Clayey Silt with Sand	Medium Dense
	6.00 to 12.00	Silty Sand	Medium Dense

66.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	7.80	NIL	0.0021	NIL	0.0012	0.024
	6.00	8.30	0.002	0.0014	NIL	0.0009	0.026

66.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	12.00
	6.00	18.00

66.5 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	07.00
	3.00	10.00
	4.50	11.00
	6.00	13.00

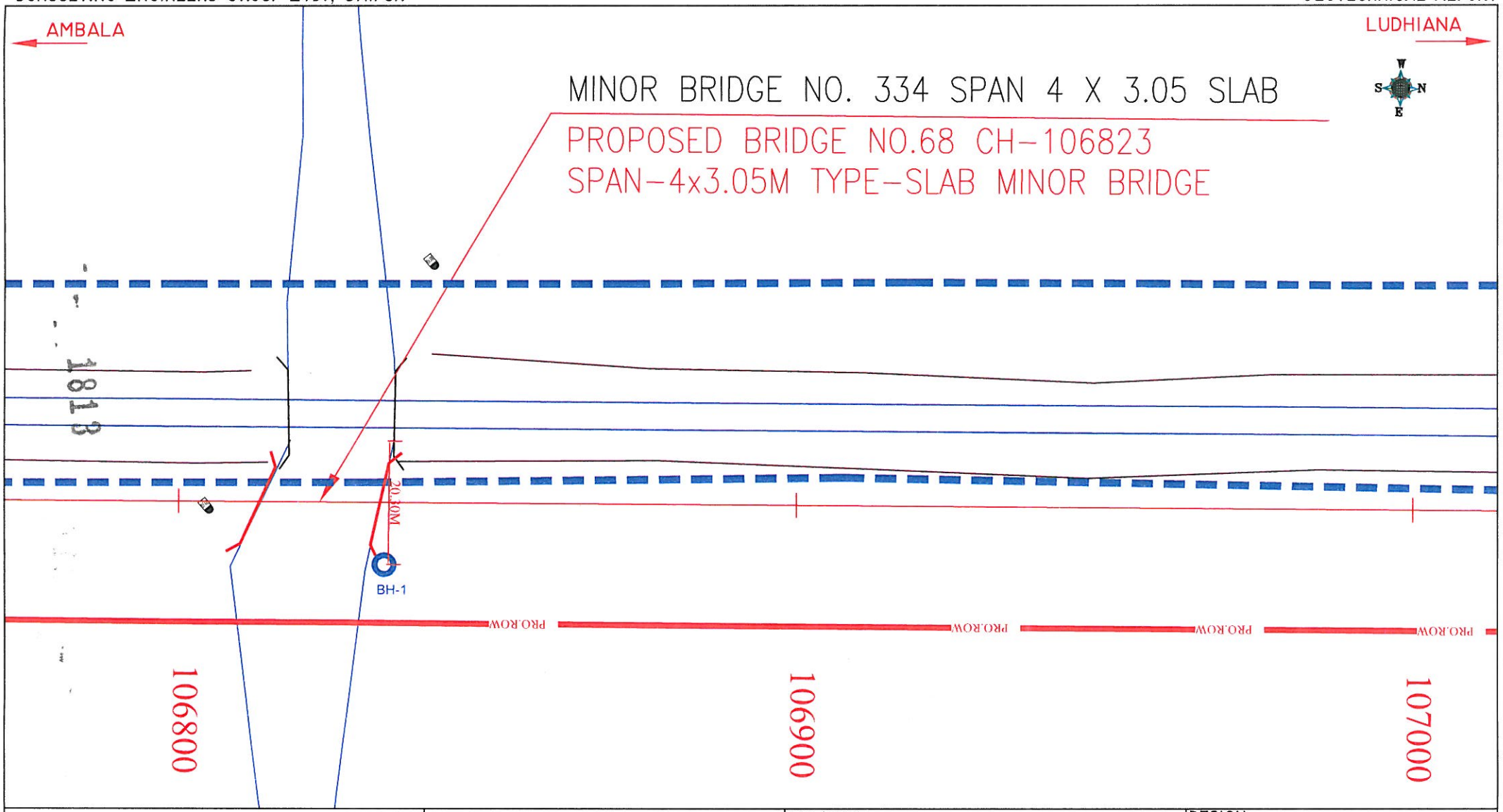
66.6 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.

66.7 RECOMMENDATIONS

(i)	*Type of foundation*	Open foundation
(ii)	*Depth of foundation below GL*	Below 6.00 m from EGL

Note- The above recommendations are based on the field and laboratory tests conducted on the soil, and our experience in this regard. If the actual subsoil conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations. However, the Depth and Type of foundation is to be decided by the structure designer depending upon the type of loading/structure and site conditions.



ALL DIMENSIONS IN METER FIG.:-I LOCATION PLAN OF PROPOSED MINOR BRIDGE AT CH. 297/22-24	RL OF BH-I = 264.315	PROJECT :- LUDHIANA-AMBALA (DFCCIL)	DESIGN :- CONSULTING ENGINEERS GROUP LTD. E-12,Moji Colony,Malviya Nagar Jaipur-17 Tel: +91-141- 2520899, 2521899, 2520556 Fax: 2521348, E-Mail: ceg@cegindia.com

SOIL CHARACTERISTICS OF BORE HOLE AT BH-1(LHS) FOR MINOR BRIDGE No. 334 AT CHAINAGE 297/22-24

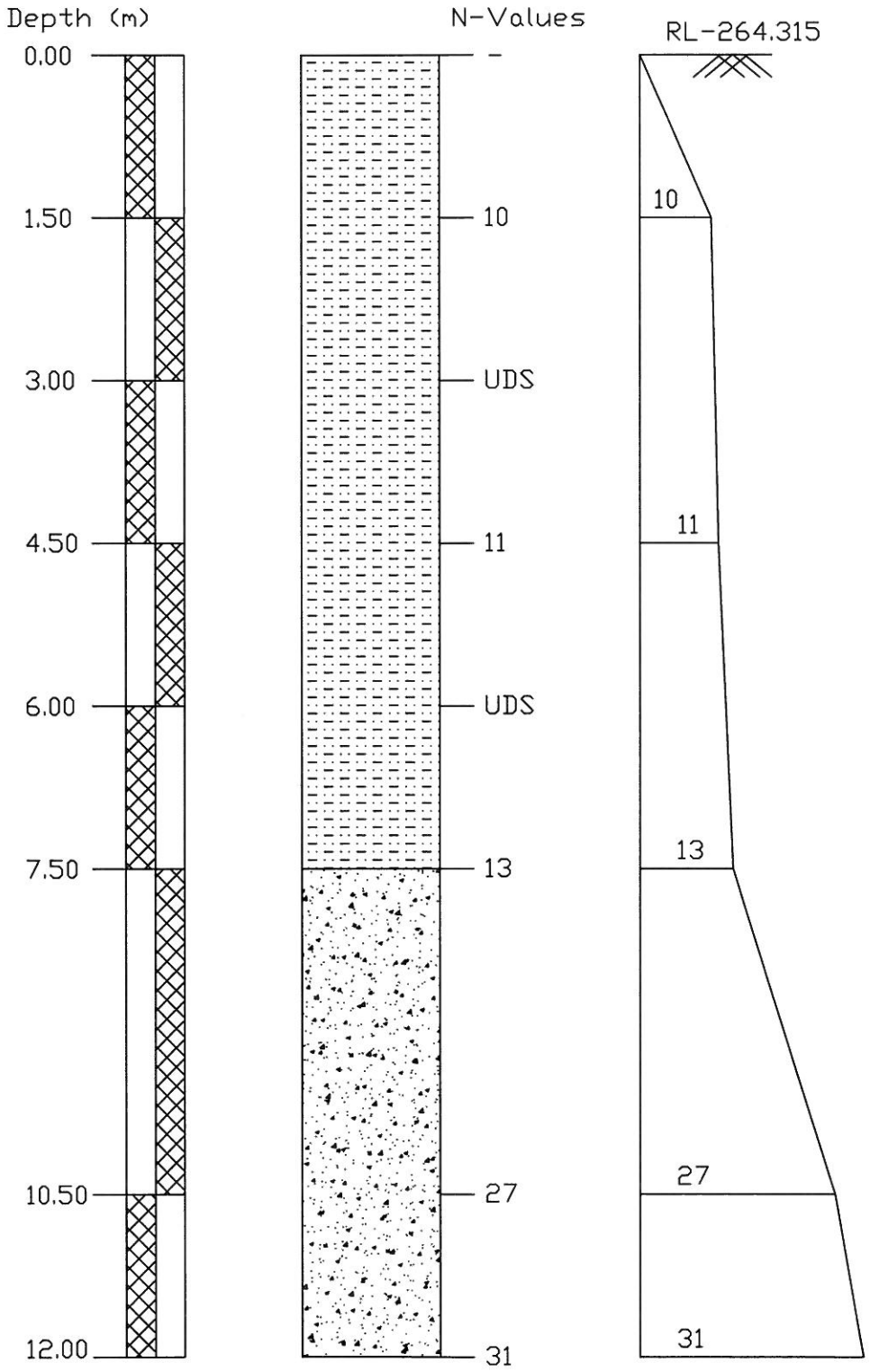
Project :	Chainage 297/22-24 Bridge No. 334			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				15.06.2009 to 15.06.2009	1	1(LHS)	below 20.00 m.	12.00mtr	264.315

Depth	Observ-	Correction	Corrected	Soil	Grain Size Distribution % wt retained							Atterberg Limits %			B.D.	M.C.	D.D.	Specific	Shear Strength	
from	ed	Factor		Description	Clay	Silt	Sand			Gravel								Gravity	c kg/cm^2	ϕ
GL (m)	N	C_n	N_n	(Soil Group)			Fine	Medium	Coarse	Fine	Coarse	L.L.	P.L.	P.I.	gm/cc	%	gm/cc			degree
0.00	-	-	-	Clayey silt with sand	12.89	64.99	15.29	2.36	4.15	0.32	0	29	19	10	-	-	-	-	-	-
1.50	10	1.44	14.40	Clayey silt with sand	15.12	65.83	10.65	6.25	2.15	0.00	0.00	32	20	12	-	-	-	-	-	-
3.00	UDS	-	-	Clayey silt with sand	11.87	76.66	7.52	2.15	0.58	1.22	0.00	29	20	9	1.78	16.08	1.53	2.66	0.10	21.0
4.50	11	1.08	11.88	Clayey silt with sand	13.96	77.05	6.26	2.14	0.59	0.00	0.00	31	20	11	-	-	-	-	-	-
6.00	UDS	-	-	Clayey silt with sand	18.21	73.49	2.34	3.18	0.00	2.78	0.00	36	21	15	1.82	21.83	1.49	2.66	0.17	17.00
7.50	13	0.90	11.70	Silty Sand	2.14	13.80	74.25	6.54	2.58	0.69	0.00	21	NIL	NP	-	-	-	-	-	-
10.50	27	0.79	21.33	Silty Sand	2.65	17.29	70.25	6.58	2.55	0.68	0.00	22	NIL	NP	-	-	-	-	-	-
12.00	31	0.74	22.94	Silty Sand	2.66	28.55	62.25	3.59	1.69	1.26	0.00	25	NIL	NP	-	-	-	-	-	-

CONSULTING
Engineers Group Ltd.

BORELOG OF BH–1(LHS) AT EXISTING KM–297/22–24 FOR MINOR BRIDGE NO.–334,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	CLAYEY SILT WITH SAND
	SILTY SAND

1815

CONSULTING Engineers Group Ltd.

CHAPTER – 67

"Minor Bridge No. 333",

Location – Existing Km. - 295/14-16

67.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 2x3.05

67.2 BOREHOLE DESCRIPTIONS:

(a) Location of Structure, Boreholes with RL shown in **FIGURE-1**.

(b) Subsurface Characteristic of Soil/Rock shown in *ANNEXURE-I.*

(c) Borelogs and sub soil profile shown in *ANNEXURE-II.*

(d) Calculations of Safe Bearing Capacities in *ANNEXURE-III.*

(e) Calculations of Probable Settlement in *ANNEXURE-IV.*

(f) Depth of water Table ≥20.00m below EGL.

Subsurface profile at the site

BOREHOLE No.	Depth (m)	Type of Soil/Rock	Soil/Rock Characteristics
BH-1	0.00 to 4.50	Clayey Silt with Sand	Loose
	4.50 to 7.50	Clayey Silt with Sand	Medium Dense
	7.50 to 12.00	Silty Sand	Medium Dense

67.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	7.70	0.002	0.0018	NIL	0.0009	0.0032
	6.00	8.10	NIL	0.0021	NIL	0.0010	0.0029

67.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	18.00
	6.00	17.00

67.5 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	06.00
	3.00	10.00
	4.50	16.00
	6.00	17.00

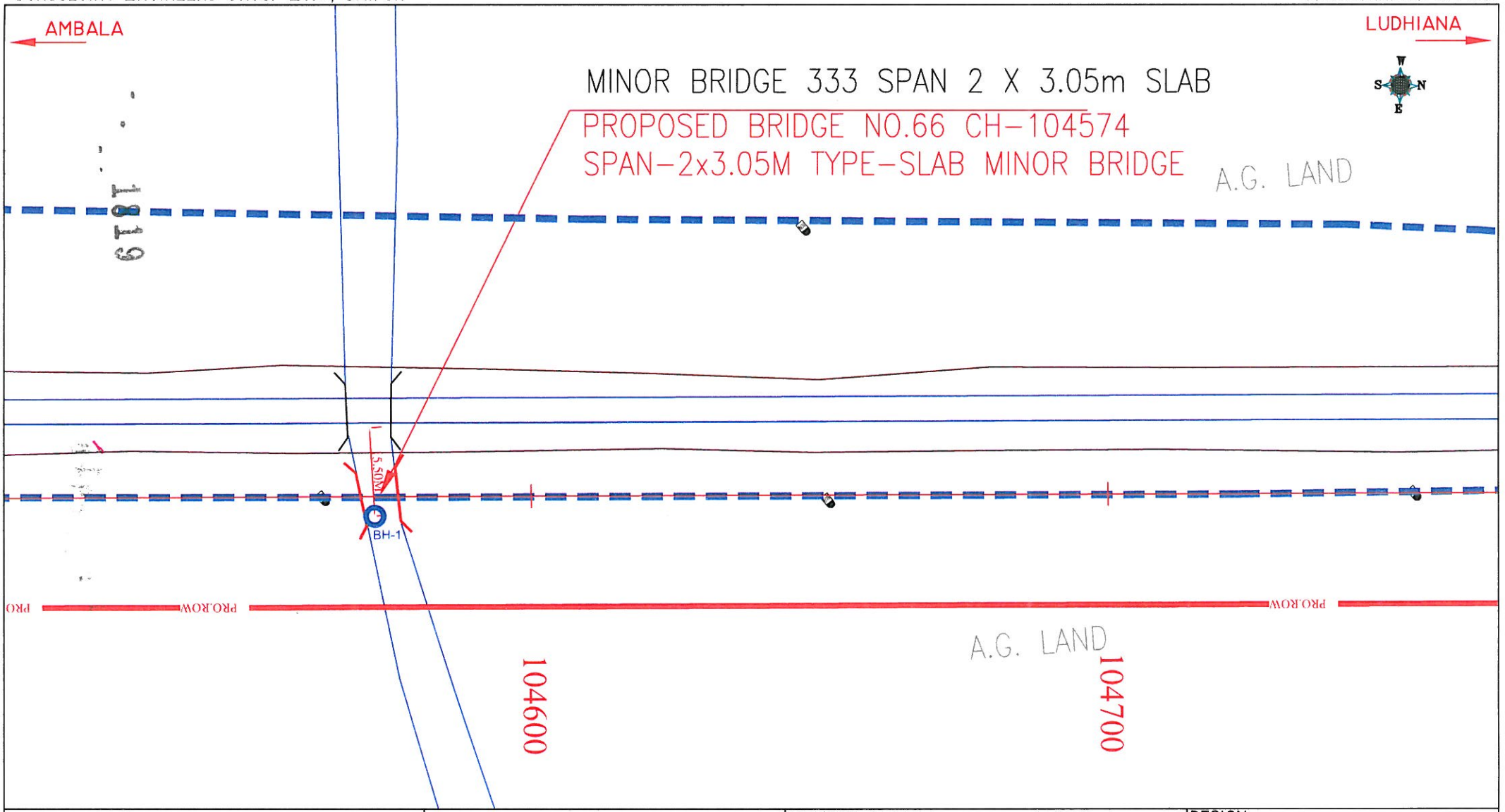
67.6 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.

67.7 RECOMMENDATIONS

(i)	*Type of foundation*	Open foundation
(ii)	*Depth of foundation below GL*	Below 4.50 m from EGL

Note- The above recommendations are based on the field and laboratory tests conducted on the soil, and our experience in this regard. If the actual subsoil conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations. However, the Depth and Type of foundation is to be decided by the structure designer depending upon the type of loading/structure and site conditions.



ALL DIMENSIONS IN METER FIG.:-I LOCATION PLAN OF PROPOSED MINOR BRIDGE AT CH. 295/14-16	RL OF BH-I = 264.916	PROJECT :- LUDHIANA-AMBALA (DFCCIL)	DESIGN :- CONSULTING ENGINEERS GROUP LTD. E-12,Moji Colony,Malviya Nagar Jaipur-17 Tel: +91-141- 2520899, 2521899, 2520556 Fax: 2521348, E-Mail: ceg@cegindia.com

SOIL CHARACTERISTICS OF BORE HOLE AT BH-1 FOR MINOR BRIDGE No. 333 AT CHAINAGE 295/14-16

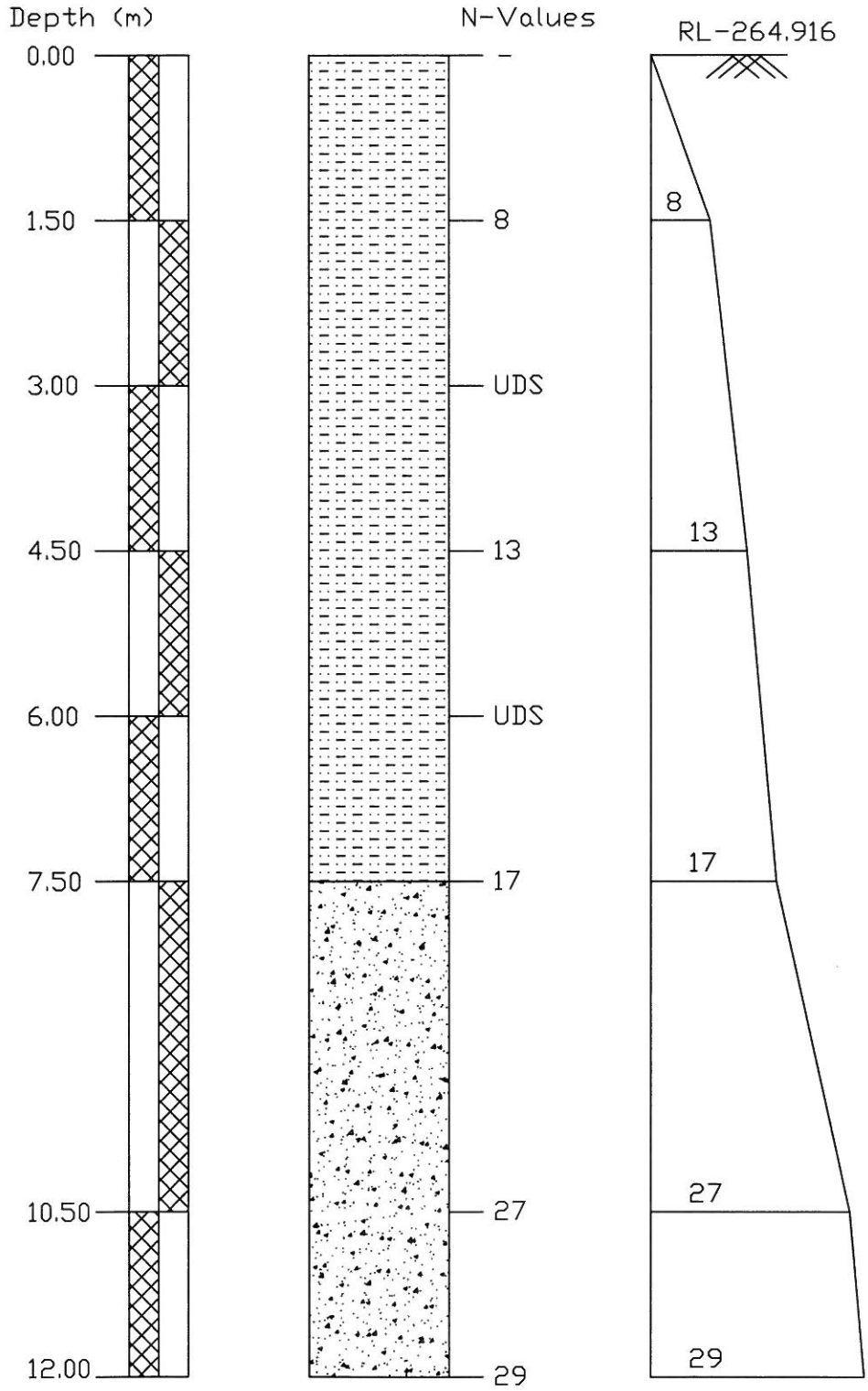
Project :	Chainage 295/14-16 Bridge No. 333			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				16.06.2009 to 16.06.2009	1	1	below 20.00 m.	12.00mtr	264.916

Depth	Observ-	Correction	Corrected	Soil	Grain Size Distribution % wt retained							Atterberg Limits %			B.D.	M.C.	D.D.	Specific	Shear Strength	
from	ed	Factor		Description	Clay	Silt	Sand			Gravel								Gravity	c kg/cm^2	ϕ
GL (m)	N	C_n	N_n	(Soil Group)			Fine	Medium	Coarse	Fine	Coarse	L.L.	P.L.	P.I.	gm/cc	%	gm/cc			degree
0.00	-	-	-	Clayey silt with sand	12.95	14.89	60.35	10.26	0.33	1.22	0.00	31	21	10	-	-	-	-	-	-
1.50	8	1.51	12.08	Clayey silt with sand	15.12	25.71	45.25	12.36	1.20	0.36	0.00	34	22	12	-	-	-	-		-
3.00	UDS	-	-	Clayey silt with sand	18.11	57.60	20.35	1.20	2.38	0.36	0.00	38	23	15	1.62	8.21	1.50	2.64	0.20	17.0
4.50	13	1.11	14.43	Clayey silt with sand	13.26	58.66	23.28	1.25	2.35	1.20	0.00	31	20	11	-	-	-	-	-	-
6.00	UDS	-	-	Clayey silt with sand	16.28	63.07	14.29	3.28	2.22	0.86	0.00	34	21	13	1.77	12.94	1.57	2.65	0.18	19.0
7.50	17	0.92	15.64	Silty Sand	2.41	43.79	38.29	12.30	3.21	0.00	0.00	21	NIL	NP	-	-	-	-	-	-
10.50	27	0.81	21.87	Silty Sand	2.39	37.90	48.29	10.22	1.20	0.00	0.00	23	NIL	NP	-	-	-	-	-	-
12.00	29	0.76	22.04	Silty Sand	2.41	28.80	60.31	5.26	3.22	0.00	0.00	23	NIL	NP	-	-	-	-	-	-

CONSULTING
Engineers Group Ltd.

BORELOG OF BH–1(LHS) AT EXISTING KM–295/14–16 FOR MINOR BRIDGE NO.–333,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	CLAYEY SILT WITH SAND
	SILTY SAND

1821

CONSULTING Engineers Group Ltd.

CHAPTER – 68

"Minor Bridge No. 330",

Location – Existing Km. - 294/03-05

68.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 3x3.05

68.2 BOREHOLE DESCRIPTIONS:

(a) Location of Structure, Boreholes with RL shown in **FIGURE-1**.

(b) Subsurface Characteristic of Soil/Rock shown in *ANNEXURE-I*.

(c) Borelogs and sub soil profile shown in *ANNEXURE-II*.

(d) Calculations of Safe Bearing Capacities in *ANNEXURE-III*.

(e) Calculations of Probable Settlement in *ANNEXURE-IV*.

(f) Depth of water Table ≥20.00m below EGL.

Subsurface profile at the site

BOREHOLE No.	Depth (m)	Type of Soil/Rock	Soil/Rock Characteristics
BH-1	0.00 to 1.50	Clayey Silt with Sand	Loose
	1.50 to 3.00	Clayey Silt with Sand	Medium Dense
	3.00 to 6.00	Sandy Silt	Medium Dense
	6.00 to 10.50	Clayey Silt with Sand	Medium Dense
	10.50 to 12.00	Silty Sand	Medium Dense

68.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	6.00	8.60	0.005	0.0017	NIL	0.0013	0.027

68.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	6.00	20.00
	10.50	NIL

68.5 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	07.00
	3.00	09.00
	4.50	09.50
	6.00	10.50

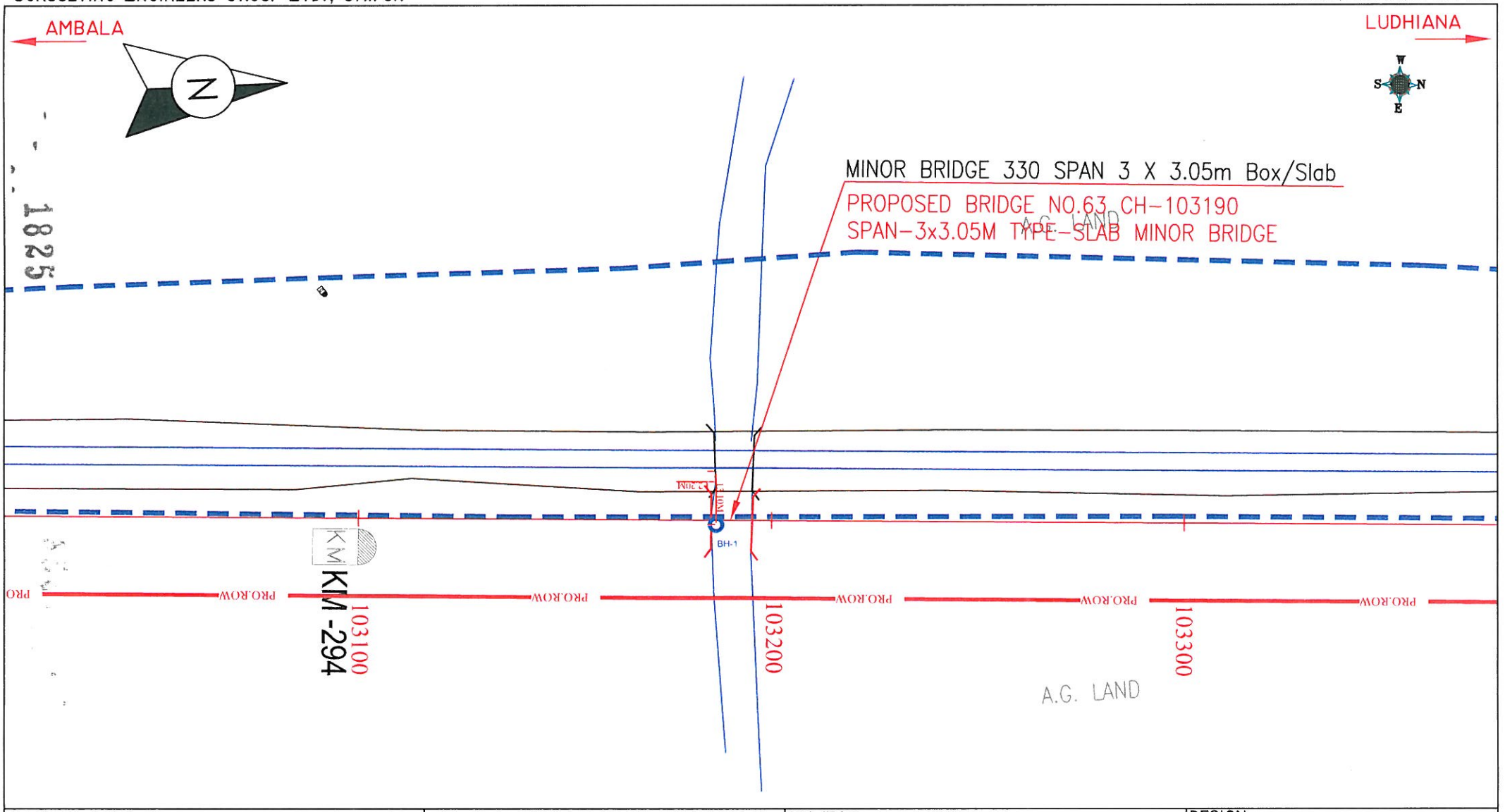
68.6 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.

68.7 RECOMMENDATIONS

(i)	*Type of foundation*	Open foundation
(ii)	*Depth of foundation below GL*	Below 6.00 m from EGL

Note- The above recommendations are based on the field and laboratory tests conducted on the soil, and our experience in this regard. If the actual subsoil conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations. However, the Depth and Type of foundation is to be decided by the structure designer depending upon the type of loading/structure and site conditions.



ALL DIMENSIONS IN METER

FIG.:-I

LOCATION PLAN OF PROPOSED MINOR BRIDGE AT CH. 294/3-5

RL OF BH I = 264.495

PROJECT :-

LUDHIANA-AMBALA (DFCCIL)

DESIGN :-

CONSULTING ENGINEERS GROUP LTD.
E-12,Moji Colony,Malviya Nagar Jaipur-17
Tel: +91-141- 2520899, 2521899, 2520556
Fax: 2521348, E-Mail: ceg@cegindia.com

SOIL CHARACTERISTICS OF BORE HOLE AT BH-1 FOR MINOR BRIDGE No. 330 AT CHAINAGE 294/3-5

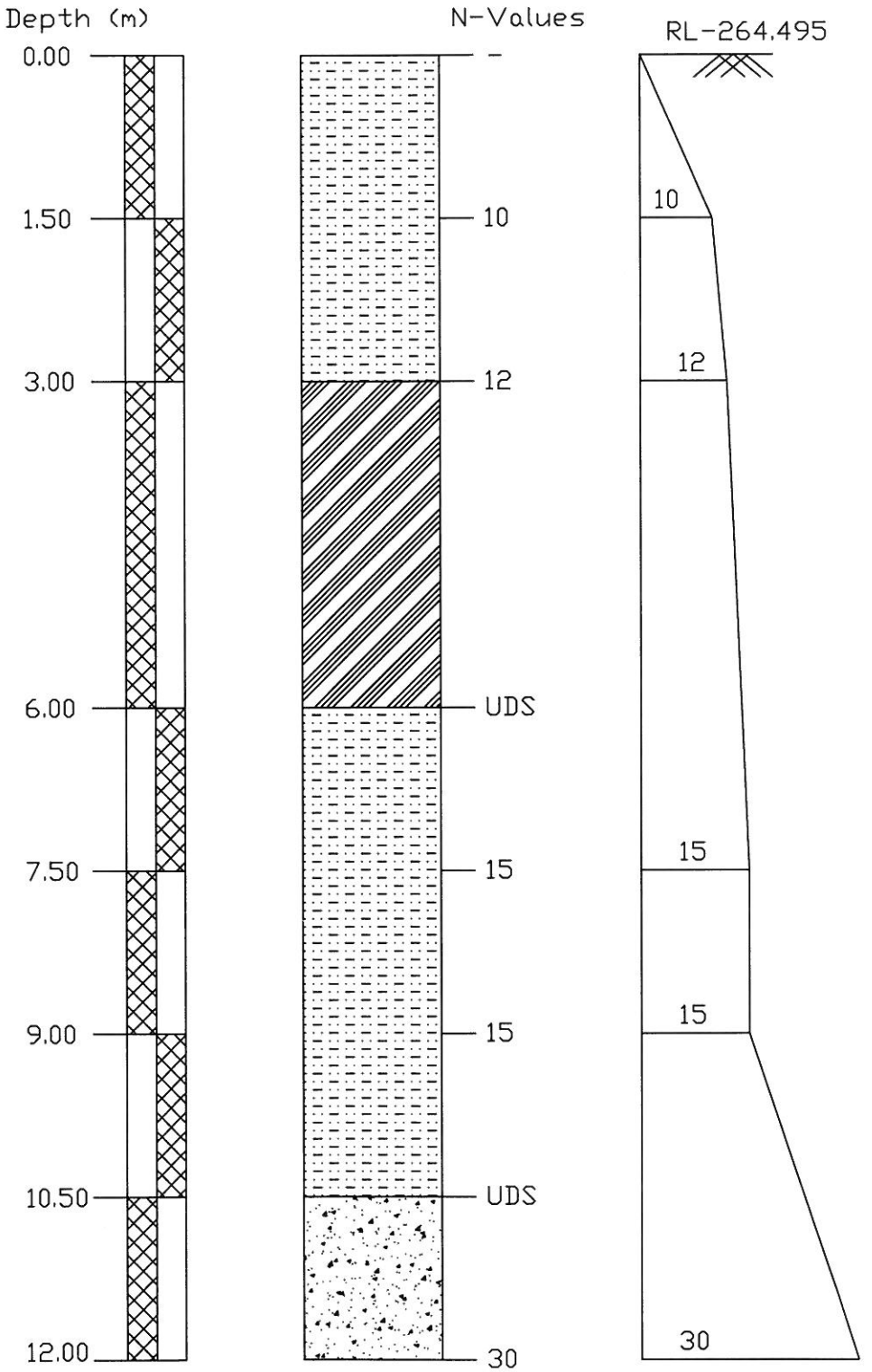
Project :	Chainage 294/3-5 Bridge No. 330			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				17.06.2009 to 17.06.2009	1	1	below 20.00 m.	12.00mtr	264.495

Depth from GL (m)	Observ-ed N	Correction Factor C_n	Corrected N_n	Soil Description (Soil Group)	Grain Size Distribution % wt retained							Atterberg Limits %			B.D. gm/cc	M.C. %	D.D. gm/cc	Specific Gravity	Shear Strength	
					Clay	Silt	Sand			Gravel									c kg/cm^2	ϕ degree
							Fine	Medium	Coarse	Fine	Coarse	L.L.	P.L.	P.I.						
0.00	-	-	-	Clayey silt with sand	17.12	69.23	8.26	2.18	1.1	2.11	0	31	17	14	-	-	-	-	-	-
1.50	10	1.52	15.20	Clayey silt with sand	19.89	72.06	5.94	0.60	0.41	1.10	0.00	36	18	18	-	-	-	-	-	-
3.00	12	1.25	15.00	Sandy Silt	2.35	89.72	5.81	0.57	0.43	1.12	0.00	23	NIL	NP	-	-	-	-	-	-
6.00	UDS	-	-	Clayey silt with sand	21.59	50.66	26.87	0.81	0.07	0.00	0.00	36	18	18	1.61	9.52	1.47	2.64	0.22	15.00
7.50	15	0.94	14.10	Clayey silt with sand	14.68	60.80	20.36	2.59	1.57	0.00	0.00	28	16	12	-		-	-	-	-
9.00	15	0.88	13.20	Clayey silt with sand	12.33	76.43	9.03	2.08	0.13	0.00	0.00	25	15	10	-	-	-	-	-	-
10.50	UDS	-	-	Silty Sand	2.69	29.43	62.33	4.26	1.29	0.00	0.00	23	NIL	NP	1.74	10.32	1.58	2.66	0.00	26.00
12.00	30	0.77	23.10	Silty Sand	2.70	9.45	82.03	5.50	0.32	0.00	0.00	26	NIL	NP	-	-	-	-	-	-

CONSULTING
Engineers Group Ltd.

BORELOG OF BH–1(LHS) AT EXISTING KM–294/3–5 FOR MINOR BRIDGE NO.–330,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	CLAYEY SILT WITH SAND
	SANDY SILT
	SILTY SAND

1827

CONSULTING Engineers Group Ltd.

CHAPTER – 69

"Minor Bridge No. 329",

Location – Existing Km. - 293/14-16

69.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 4x3.05

69.2 BOREHOLE DESCRIPTIONS:

(a) Location of Structure, Boreholes with RL shown in **FIGURE-1**.

(b) Subsurface Characteristic of Soil/Rock shown in *ANNEXURE-I*.

(c) Borelogs and sub soil profile shown in *ANNEXURE-II*.

(d) Calculations of Safe Bearing Capacities in *ANNEXURE-III*.

(e) Calculations of Probable Settlement in *ANNEXURE-IV*.

(f) Depth of water Table ≥20.00m below EGL.

Subsurface profile at the site

BOREHOLE No.	Depth (m)	Type of Soil/Rock	Soil/Rock Characteristics
BH-1	0.00 to 6.00	Clayey Silt with Sand	Loose
	6.00 to 12.00	Sandy Silt	Medium Dense

69.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	8.10	NIL	0.0021	NIL	0.0012	0.026
	7.50	8.60	NIL	0.0028	NIL	0.0010	0.039

69.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	18.00
	7.50	NIL

69.5 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	06.50
	3.00	09.00
	4.50	10.00
	6.00	17.00

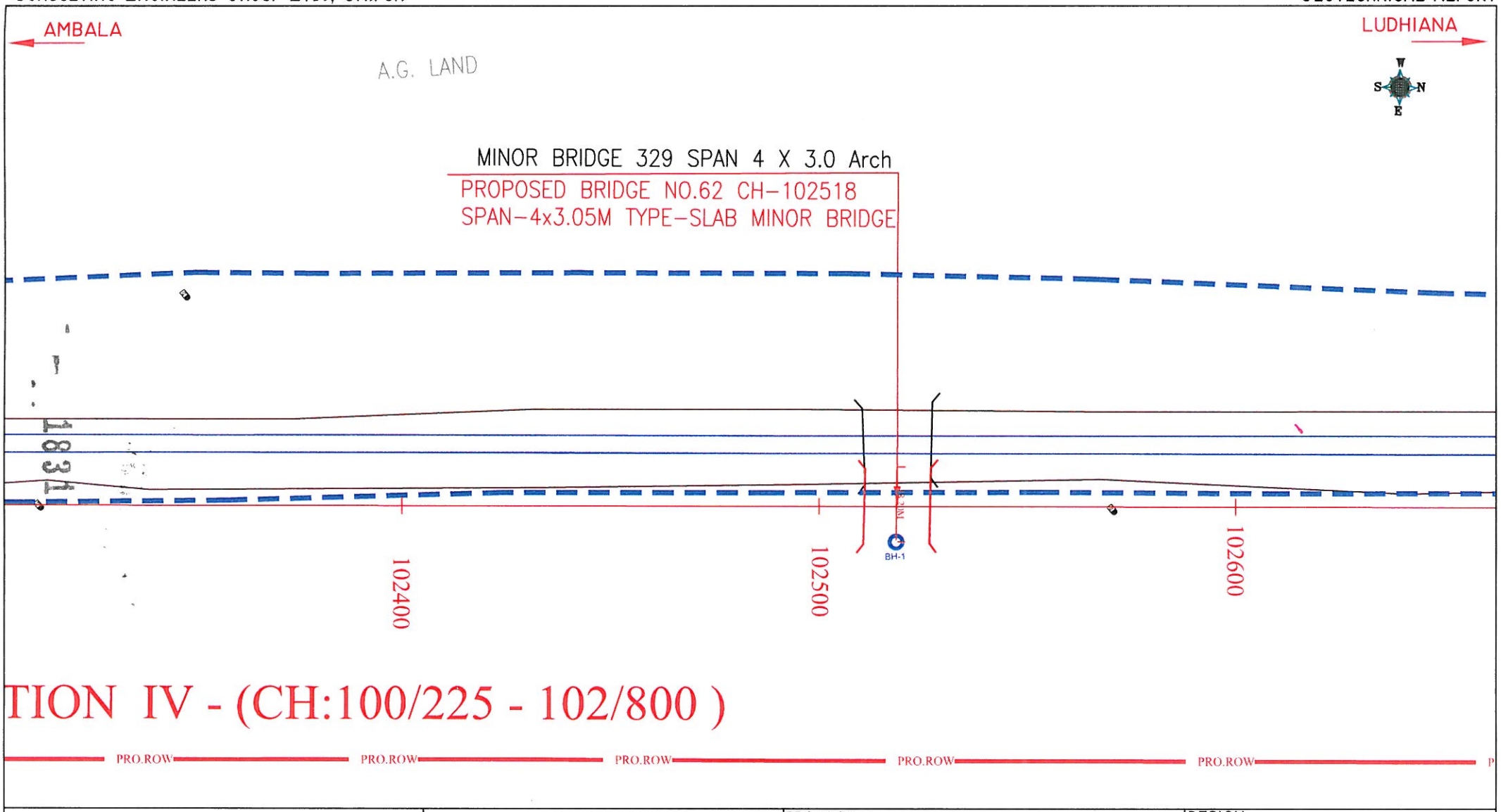
69.6 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.

69.7 RECOMMENDATIONS

(i)	*Type of foundation*	Open foundation
(ii)	*Depth of foundation below GL*	Below 6.00 m from EGL

Note- The above recommendations are based on the field and laboratory tests conducted on the soil, and our experience in this regard. If the actual subsoil conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations. However, the Depth and Type of foundation is to be decided by the structure designer depending upon the type of loading/structure and site conditions.



ALL DIMENSIONS IN METER FIG.:-I LOCATION PLAN OF PROPOSED MINOR BRIDGE AT CH. 293/14-16	RL OF BH I = 264.358	PROJECT :- LUDHIANA-AMBALA (DFCCIL)	DESIGN :- CONSULTING ENGINEERS GROUP LTD. E-12,Moji Colony,Malviya Nagar Jaipur-17 Tel: +91-141- 2520899, 2521899, 2520556 Fax: 2521348, E-Mail: ceg@cegindia.com

SOIL CHARACTERISTICS OF BORE HOLE AT BH-1 FOR MINOR BRIDGE No. 329 AT CHAINAGE 293/14-16

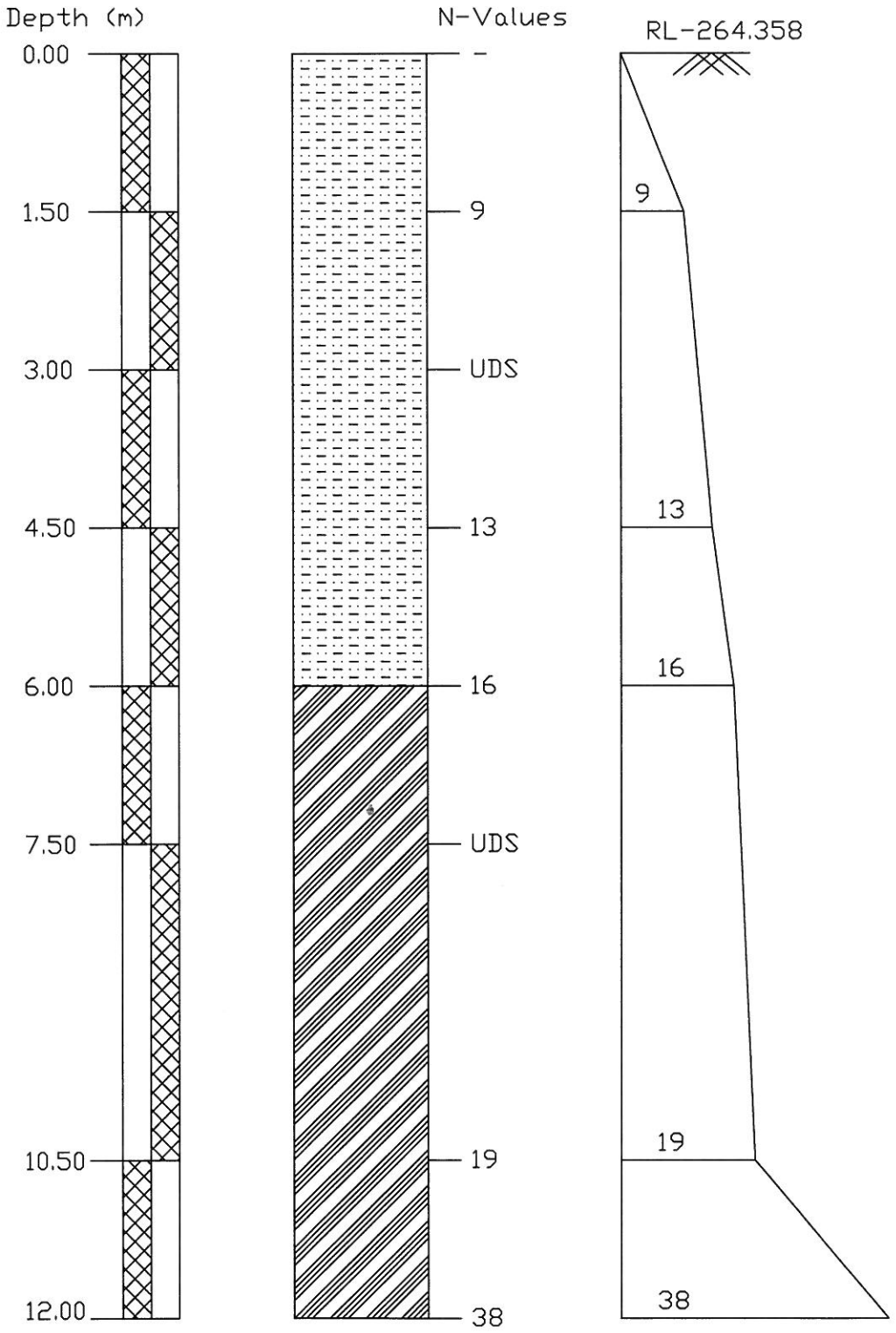
Project :	Chainage 293/14-16 Bridge No. 329			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				17.06.2009 to 17.06.2009	1	1	below 20.00 m.	12.00mtr	264.358

Depth from GL (m)	Observ-ed N	Correction Factor C_n	Corrected N_n	Soil Description (Soil Group)	Grain Size Distribution % wt retained							Atterberg Limits %			B.D. gm/cc	M.C. %	D.D. gm/cc	Specific Gravity	Shear Strength	
					Clay	Silt	Sand			Gravel									c kg/cm^2	ϕ degree
							Fine	Medium	Coarse	Fine	Coarse	L.L.	P.L.	P.I.						
0.00	-	-	-	Clayey silt with sand	16.99	53.33	20.33	4.54	2.23	2.58	0	32	17	15	-	-	-	-	-	-
1.50	9	1.51	13.59	Clayey silt with sand	20.33	58.62	15.26	3.25	1.26	1.28	0.00	35	17	18	-	-	-	-	-	-
3.00	UDS	-	-	Clayey silt with sand	16.85	63.33	15.28	3.25	1.29	0.00	0.00	32	18	14	1.64	9.33	1.50	2.64	0.16	18.00
4.50	13	1.10	14.30	Clayey silt with sand	17.85	56.69	20.35	2.26	1.25	1.60	0.00	36	21	15	-	-	-	-	-	-
6.00	16	1.01	16.16	Sandy Silt	3.22	70.01	23.25	3.24	0.28	0.00	0.00	26	NIL	NP	-		-	-	-	-
7.50	UDS	-	-	Sandy Silt	2.15	78.71	16.35	0.59	1.26	0.94	0.00	22	NIL	NP	1.67	4.97	1.59	2.65	0.00	25.00
10.50	19	0.82	15.58	Sandy Silt	2.19	74.77	21.36	1.29	0.39	0.00	0.00	24	NIL	NP	-	-	-	-	-	-
12.00	38	0.77	29.26	Sandy Silt	2.68	66.76	25.36	4.26	0.94	0.00	0.00	25	NIL	NP	-	-	-	-	-	-

CONSULTING
Engineers Group Ltd.

BORELOG OF BH–1(LHS) AT EXISTING KM–293/14–16 FOR MINOR BRIDGE NO.–329,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	CLAYEY SILT WITH SAND
	SANDY SILT

1833

CONSULTING Engineers Group Ltd.

CHAPTER – 70

"Minor Bridge No. 328",

Location – Existing Km. - 291/32-34

70.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 2x9.15

70.2 BOREHOLE DESCRIPTIONS:

(a) Location of Structure, Boreholes with RL shown in **FIGURE-1**.

(b) Subsurface Characteristic of Soil/Rock shown in *ANNEXURE-I.*

(c) Borelogs and sub soil profile shown in *ANNEXURE-II.*

(d) Calculations of Safe Bearing Capacities in *ANNEXURE-III.*

(e) Calculations of Probable Settlement in *ANNEXURE-IV.*

(f) Depth of water Table ≥20.00m below EGL.

Subsurface profile at the site

BOREHOLE No.	Depth (m)	Type of Soil/Rock	Soil/Rock Characteristics
BH-1	0.00 to 4.50	Clayey Silt with Sand	Loose
	4.50 to 10.50	Clayey Silt with Sand	Medium Dense
	10.50 to 12.00	Silty Sand	Medium Dense

70.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	8.40	NIL	0.0018	NIL	0.0010	0.039
	6.00	8.50	0.002	0.0018	NIL	0.0010	0.041

70.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	20.00
	6.00	18.00

70.5 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	06.00
	3.00	09.00
	4.50	12.00
	6.00	13.00

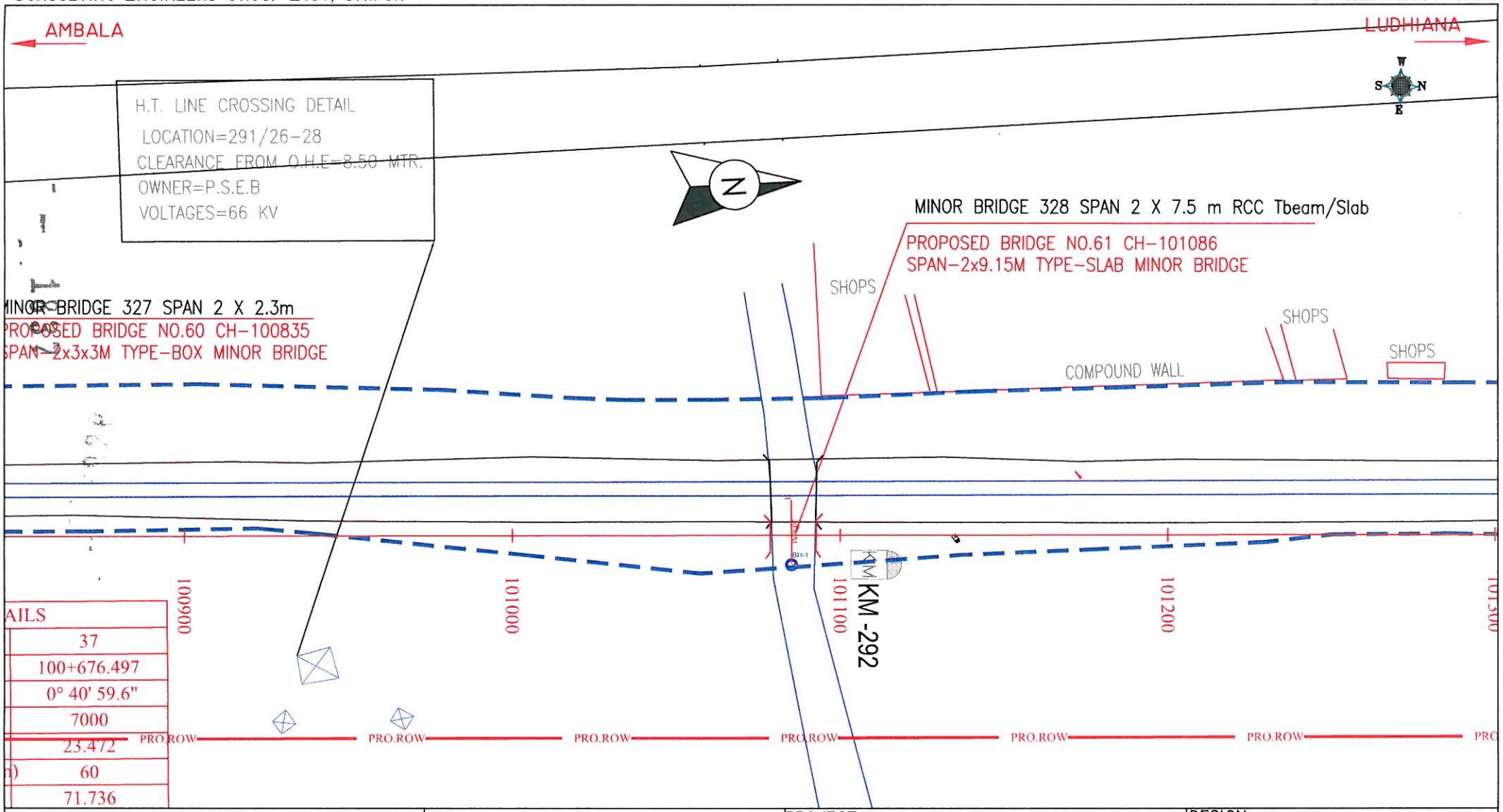
70.6 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.

70.7 RECOMMENDATIONS

(i)	*Type of foundation*	Open foundation
(ii)	*Depth of foundation below GL*	Below 6.00 m from EGL

Note- The above recommendations are based on the field and laboratory tests conducted on the soil, and our experience in this regard. If the actual subsoil conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations. However, the Depth and Type of foundation is to be decided by the structure designer depending upon the type of loading/structure and site conditions.



ALL DIMENSIONS IN METER

FIG.:-I
LOCATION PLAN OF PROPOSED MINOR BRIDGE AT CH. 291/32-34

RL OF BH I = 265.345

PROJECT :-
LUDHIANA-AMBALA (DFCCIL)

DESIGN :-
CONSULTING
ENGINEERS GROUP LTD.
E-12,Moji Colony,Malviya Nagar Jaipur-17
Tel: +91-141- 2520899, 2521899, 2520556
Fax: 2521348, E-Mail: ceg@cegindia.com

SOIL CHARACTERISTICS OF BORE HOLE AT BH-1 FOR MINOR BRIDGE No. 328 AT CHAINAGE 291/32-34

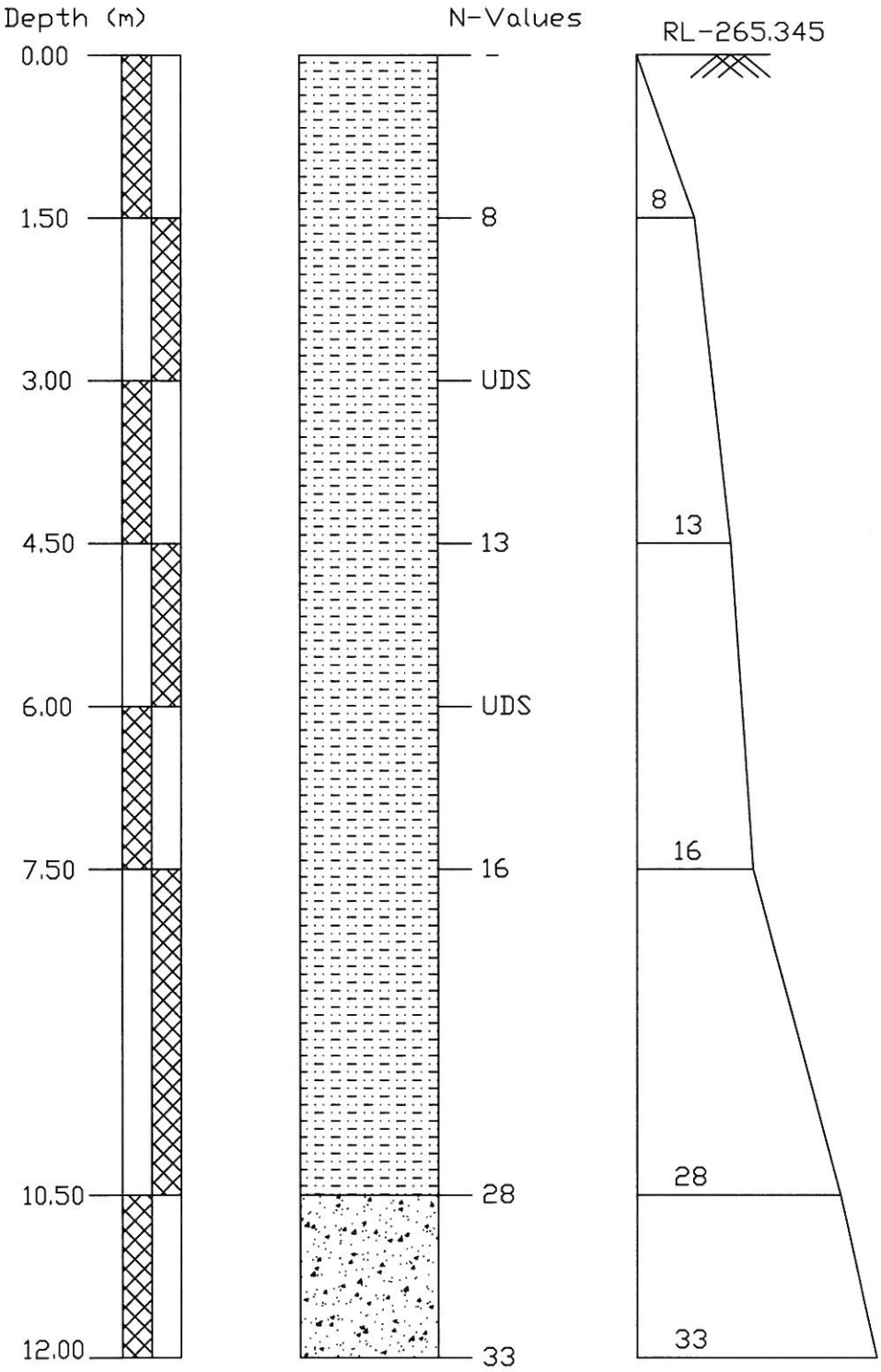
Project :	Chainage 291/32-34 Bridge No. 328			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				17.06.2009 to 17.06.2009	1	1	below 20.00 m.	12.00mtr	265.345

Depth	Observ-	Correction	Corrected	Soil	Grain Size Distribution % wt retained							Atterberg Limits %			B.D.	M.C.	D.D.	Specific	Shear Strength	
from	ed	Factor		Description	Clay	Silt	Sand			Gravel								Gravity	c kg/cm^2	ϕ
GL (m)	N	C_n	N_n	(Soil Group)			Fine	Medium	Coarse	Fine	Coarse	L.L.	P.L.	P.I.	gm/cc	%	gm/cc			degree
0.00	-	-	-	Clayey silt with sand	20.39	59.46	15.26	2.65	1.29	0.95	0.00	39	21	18	-	-	-	-	-	-
1.50	8	1.51	12.08	Clayey silt with sand	23.59	68.26	8.09	0.06	0.00	0.00	0.00	42	22	20	-	-	-	-		-
3.00	UDS	-	-	Clayey silt with sand	17.98	51.69	19.57	1.22	1.83	7.71	0.00	38	22	16	1.64	11.13	1.48	2.61	0.2	16
4.50	13	1.10	14.30	Clayey silt with sand	22.86	73.19	2.27	0.72	0.27	0.69	0.00	41	21	20	-	-	-	-		-
6.00	UDS	-	-	Clayey silt with sand	18.12	75.25	3.30	1.80	1.53	0.00	0.00	32	17	15	1.72	12.86	1.52	2.60	0.18	17
7.50	16	0.93	14.88	Clayey silt with sand	19.67	70.82	6.92	0.86	0.58	1.15	0.00	37	20	17	-	-	-	-	-	-
10.50	28	0.81	22.68	Silty Sand	2.15	6.26	90.35	1.24	0.00	0.00	0.00	26	NIL	NP	-	-	-	-	-	-
12.00	33	0.77	25.41	Silty Sand	2.23	7.47	89.13	1.17	0.00	0.00	0.00	25	NIL	NP	-	-	-	-	-	-

CONSULTING
Engineers Group Ltd.

BORELOG OF BH–1(LHS) AT EXISTING KM–291/32–34 FOR MINOR BRIDGE NO.–328,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	CLAYEY SILT WITH SAND
	SILTY SAND

CONSULTING Engineers Group Ltd.

CHAPTER – 71

"Minor Bridge No. 326",

Location – Existing Km. - 291/15-17

71.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 1x3x3

71.2 BOREHOLE DESCRIPTIONS:

(a) Location of Structure, Boreholes with RL shown in **FIGURE-1**.

(b) Subsurface Characteristic of Soil/Rock shown in *ANNEXURE-I.*

(c) Borelogs and sub soil profile shown in *ANNEXURE-II.*

(d) Calculations of Safe Bearing Capacities in *ANNEXURE-III.*

(e) Calculations of Probable Settlement in *ANNEXURE-IV.*

(f) Depth of water Table ≥20.00m below EGL.

Subsurface profile at the site

BOREHOLE No.	Depth (m)	Type of Soil/Rock	Soil/Rock Characteristics
BH-1	0.00 to 4.50	Clayey Silt with Sand	Loose
	4.50 to 1.50	Clayey Silt with Sand	Medium Dense
	10.50 to 12.00	Silty Sand	Dense

71.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	8.70	0.010	0.0028	NIL	0.0013	0.055
	6.00	8.60	0.005	0.0025	NIL	0.0010	0.047

71.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	25.00
	6.00	19.00

71.5 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	09.50
	3.00	14.00
	4.50	24.00
	6.00	25.00

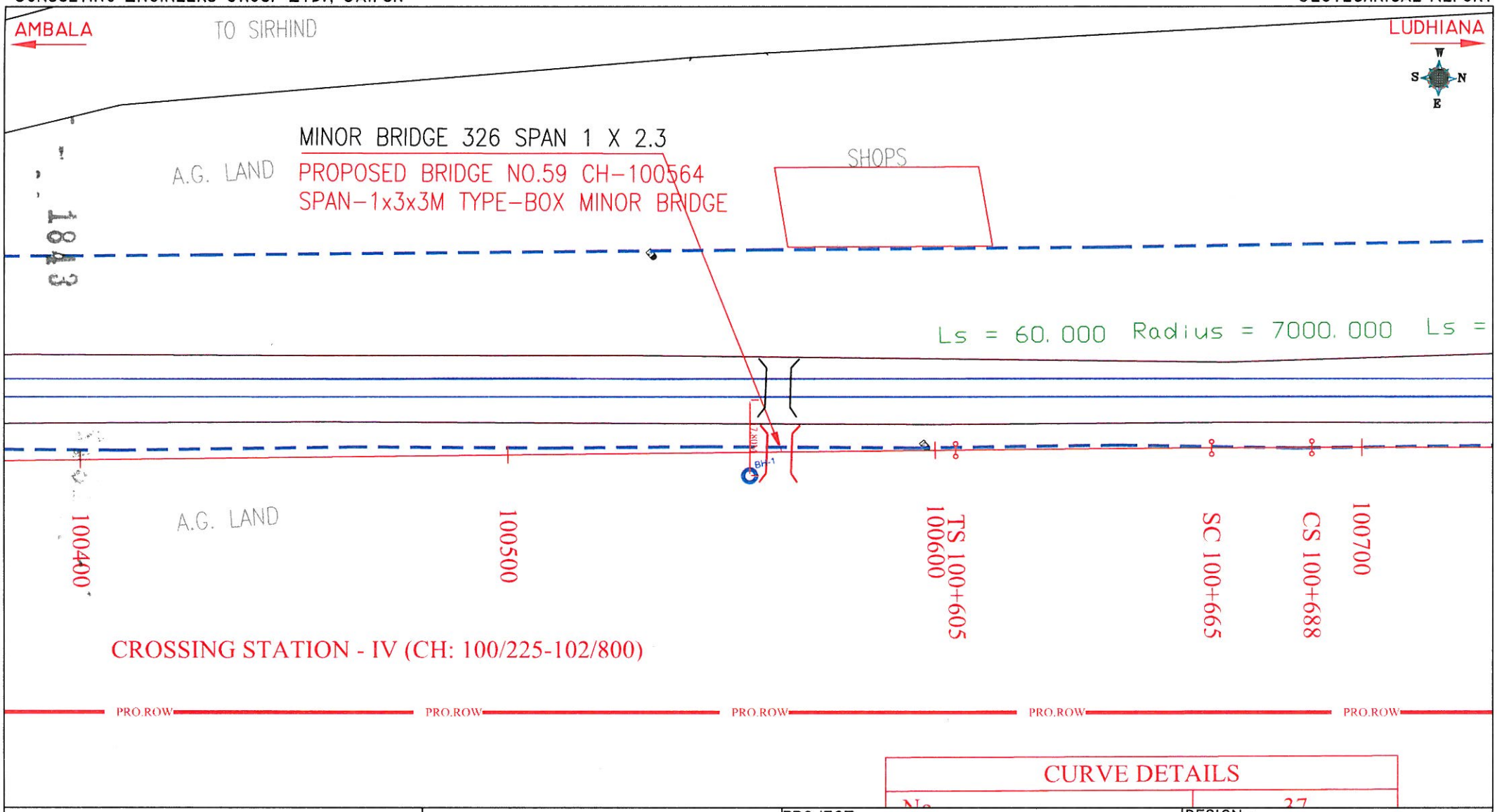
71.6 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.

71.7 RECOMMENDATIONS

(i)	*Type of foundation*	Open foundation
(ii)	*Depth of foundation below GL*	Below 4.50 m from EGL

Note- The above recommendations are based on the field and laboratory tests conducted on the soil, and our experience in this regard. If the actual subsoil conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations. However, the Depth and Type of foundation is to be decided by the structure designer depending upon the type of loading/structure and site conditions.



ALL DIMENSIONS IN METER FIG.:-I LOCATION PLAN OF PROPOSED MINOR BRIDGE CH-291/15-17	RL OF BH-I = 265.576	PROJECT :- LUDHIANA-AMBALA (DFCCIL)	DESIGN :- CONSULTING ENGINEERS GROUP LTD. E-12,Moji Colony,Malviya Nagar Jaipur-17 Tel: +91-141- 2520899, 2521899, 2520556 Fax: 2521348, E-Mail: ceg@cegindia.com

SOIL CHARACTERISTICS OF BORE HOLE AT BH-1(LHS) FOR MINOR BRIDGE No. 326 AT CHAINAGE 291/15-17

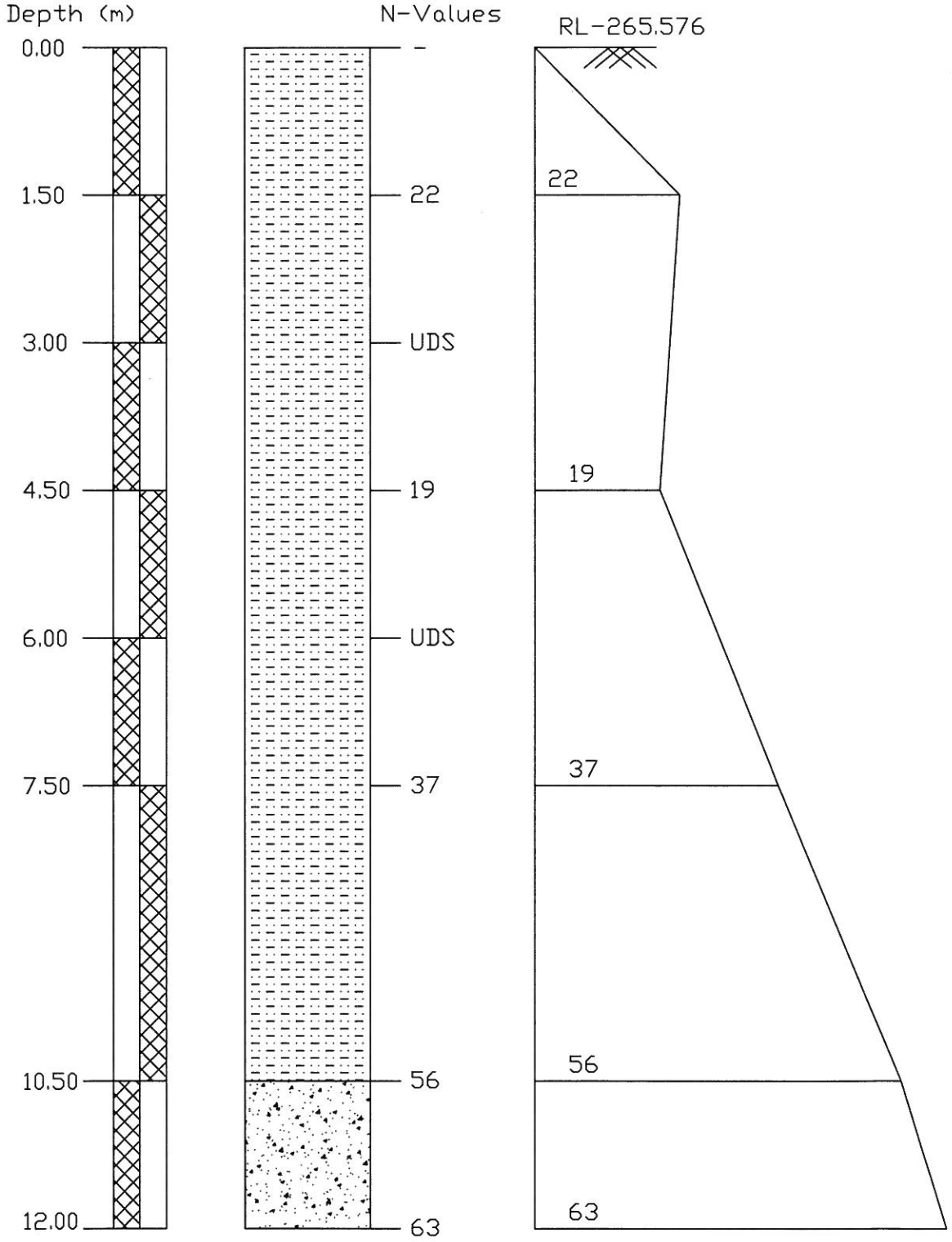
Project :	Chainage 291/15-17 Bridge No. 326			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation
				17.06.2009 to 17.06.2009	1	1 (LHS)	below 20.00 m.	12.00mtr	

Depth	Observ-	Correction	Corrected	Soil	Grain Size Distribution % wt retained							Atterberg Limits %			B.D.	M.C.	D.D.	Specific	Shear Strength	
from	ed	Factor		Description	Clay	Silt	Sand			Gravel								Gravity	c kg/cm^2	ϕ
GL (m)	N	C_n	N_n	(Soil Group)			Fine	Medium	Coarse	Fine	Coarse	L.L.	P.L.	P.I.	gm/cc	%	gm/cc			degree
0.00	-	-	-	Clayey silt with sand	18.86	69.52	9.56	1.38	0.68	0.00	0.00	37	21	16	-	-	-	-	-	-
1.50	22	1.45	31.90	Clayey silt with sand	22.10	71.81	5.37	0.52	0.20	0.00	0.00	40	21	19	-	-	-	-		-
3.00	UDS	-	-	Clayey silt with sand	23.12	66.53	10.04	0.31	0.00	0.00	0.00	39	19	20	1.73	5.69	1.64	2.65	0.25	14.0
4.50	19	1.09	20.71	Clayey silt with sand	12.97	80.11	2.96	1.53	1.28	1.15	0.00	32	21	11	-	-	-	-	-	-
6.00	UDS	-	-	Clayey silt with sand	17.83	74.14	4.71	1.32	2.00	0.00	0.00	33	18	15	1.80	7.95	1.67	2.62	0.20	18.0
7.50	37	0.91	33.67	Clayey silt with sand	18.96	75.60	3.13	2.13	0.18	0.00	0.00	40	24	16	-	-	-	-	-	-
10.50	56	0.79	44.24	Silty Sand	2.19	7.28	87.04	3.21	0.28	0.00	0.00	21	NIL	NP	-	-	-	-	-	-
12.00	63	0.75	47.25	Silty Sand	2.28	11.31	81.29	3.15	0.64	1.33	0.00	22	NIL	NP	-	-	-	-	-	-

CONSULTING Engineers Group Ltd.

BORELOG OF BH–1(LHS) AT EXISTING KM–291/15–17 FOR MINOR BRIDGE NO.–326,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	CLAYEY SILT WITH SAND
	SILTY SAND

CONSULTING Engineers Group Ltd.

CHAPTER – 72

"Minor Bridge No. 325A",

Location – Existing Km. - 291/04-08

72.1 LOCATION OF STRUCTURE:

Proposed Minor Bridge of Span 1x1.2x1.2

72.2 BOREHOLE DESCRIPTIONS:

(a) Location of Structure, Boreholes with RL shown in **FIGURE-1**.

(b) Subsurface Characteristic of Soil/Rock shown in *ANNEXURE-I.*

(c) Borelogs and sub soil profile shown in *ANNEXURE-II.*

(d) Calculations of Safe Bearing Capacities in *ANNEXURE-III.*

(e) Calculations of Probable Settlement in *ANNEXURE-IV.*

(f) Depth of water Table ≥20.00m below EGL.

Subsurface profile at the site

BOREHOLE No.	Depth (m)	Type of Soil/Rock	Soil/Rock Characteristics
BH-1	0.00 to 1.50	Clayey Silt with Sand	Loose
	1.50 to 4.50	Clayey Silt with Sand	Medium Dense
	4.50 to 7.50	Clayey Silt with Sand	Dense
	7.50 to 10.50	Clayey Silt with Sand	Very Dense
	10.50 to 12.00	Silty Sand	Very Dense

72.3 CHEMICAL ANALYSIS OF SOIL:

BOREHOLE		CHEMICAL PROPERTIES					
No.	Depth (m)	pH	Carbonate	Chlorides %	Sulphate %	Nitrate %	Salinity %
BH-1	3.00	8.00	NIL	0.0028	NIL	0.0013	0.055
	6.00	8.60	0.005	0.0021	NIL	0.0012	0.061

72.4 DIFFERENTIAL FREE SWELL INDEX (DFS)

Bore Hole No.	Depth (m)	DFS Index in %
BH-1	3.00	30.00
	6.00	19.00

72.5 NET ALLOWABLE BEARING PRESSURE

Borehole No.	Depth from EGL (m)	Net Allowable Bearing Pressure (t/m^2)
BH-1	1.50	11.00
	3.00	17.00
	4.50	21.00
	6.00	23.00

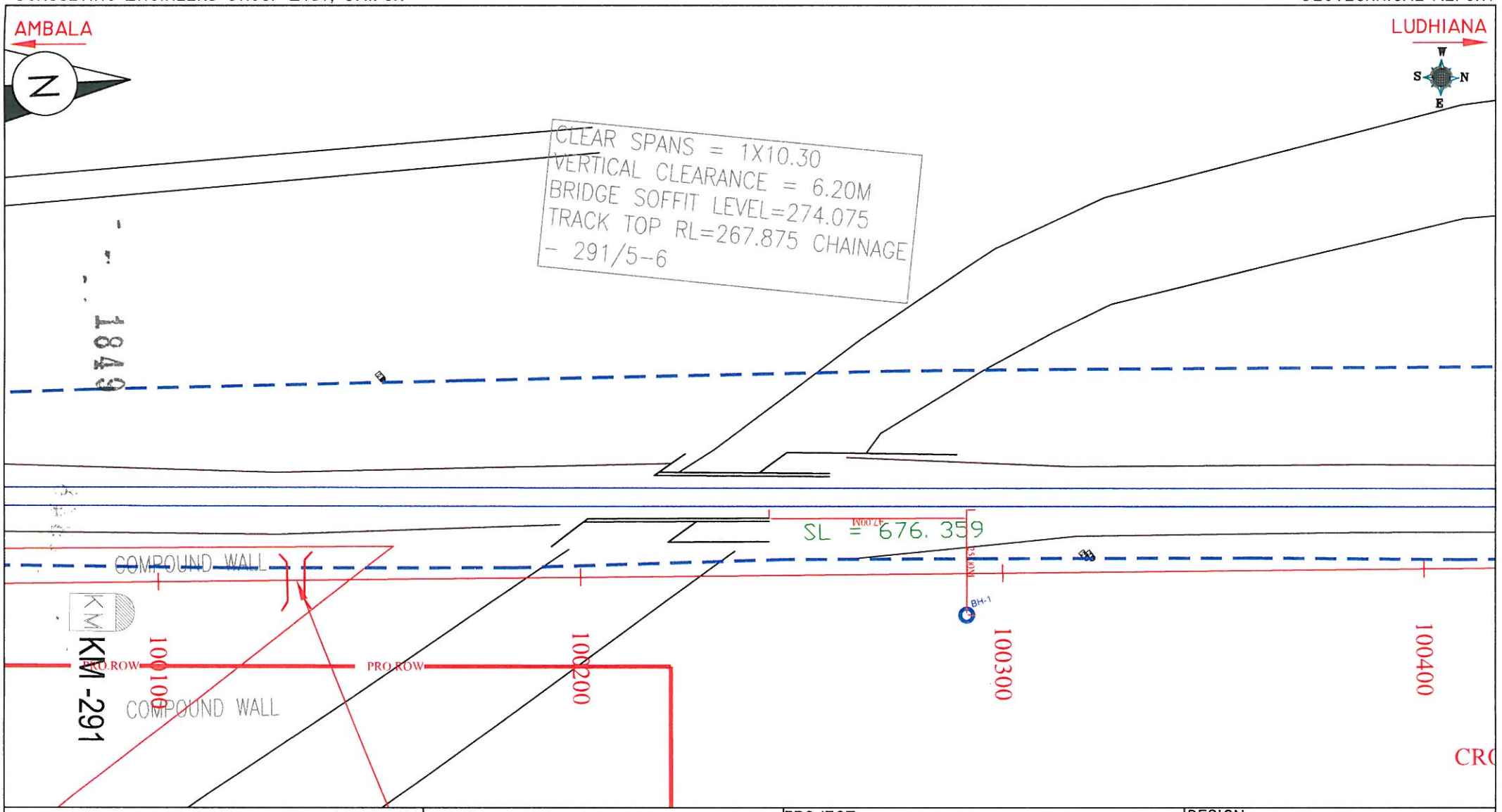
72.6 CONCLUSIONS

- Subsurface Profiles indicates suitable Soil formation for foundations.

72.7 RECOMMENDATIONS

(i)	*Type of foundation*	Open foundation
(ii)	*Depth of foundation below GL*	Below 3.00 m from EGL

Note- The above recommendations are based on the field and laboratory tests conducted on the soil, and our experience in this regard. If the actual subsoil conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations. However, the Depth and Type of foundation is to be decided by the structure designer depending upon the type of loading/structure and site conditions.



ALL DIMENSIONS IN METER FIG.:-I LOCATION PLAN OF PROPOSED MINOR BRIDGE CH-291/4-8	RL OF BH-I = 265.768	PROJECT :- LUDHIANA-AMBALA (DFCCIL)	DESIGN :- CONSULTING ENGINEERS GROUP LTD. E-12,Moji Colony,Malviya Nagar Jaipur-17 Tel: +91-141- 2520899, 2521899, 2520556 Fax: 2521348, E-Mail: ceg@cegindia.com

SOIL CHARACTERISTICS OF BORE HOLE AT BH-1(LHS) FOR MINOR BRIDGE No. 325A AT CHAINAGE 291/4-8

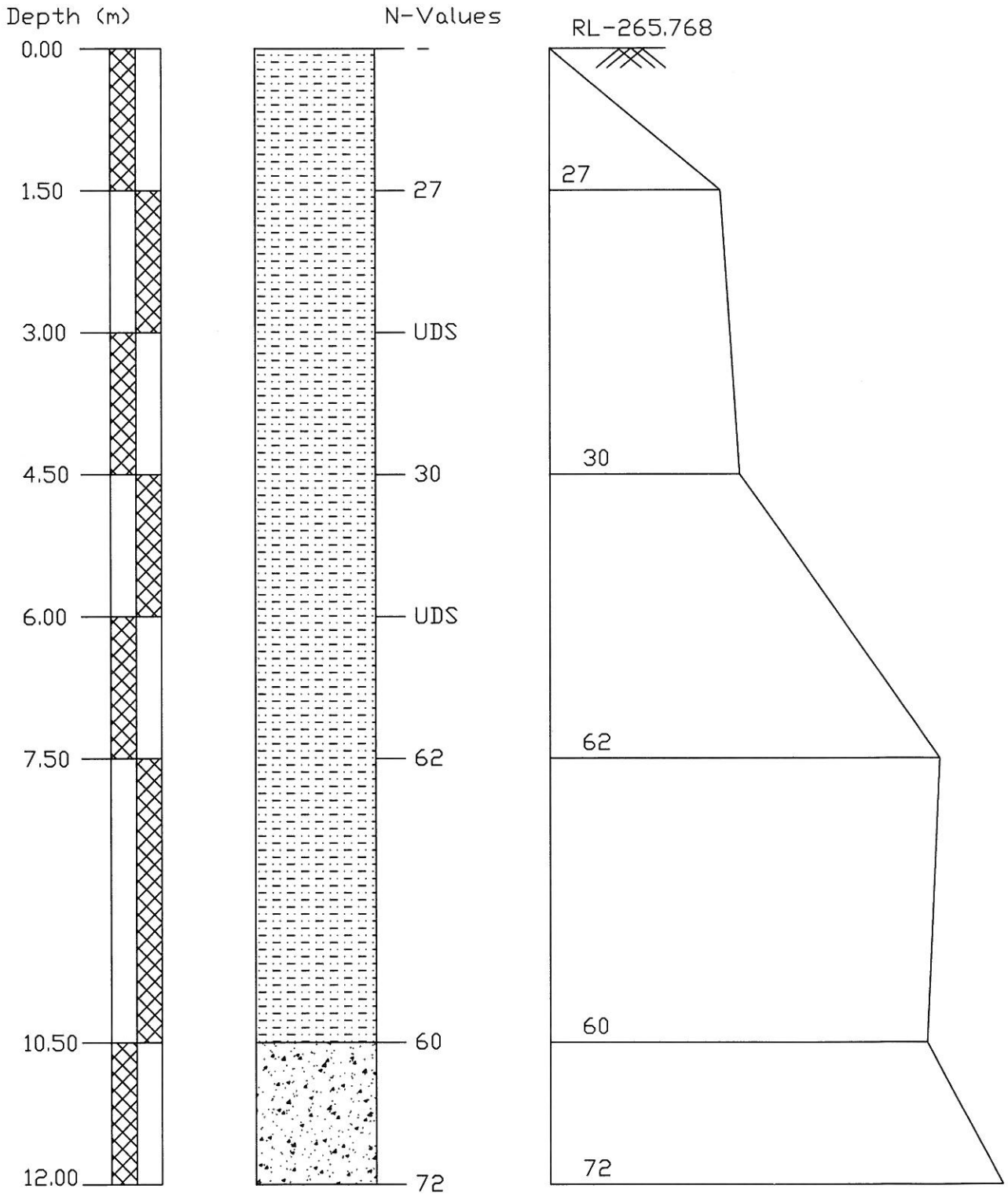
Project :	Chainage 291/4-8 Bridge No. 325A			Date of Testing	Location at	B.H. No.	Depth of Water Table	Termination Depth	Surface Elevation	Ref. Code
				17.06.2009 to 17.06.2009	1	1 (LHS)	below 20.00 m.	12.00mtr	265.768	

Depth	Observ-	Correction	Corrected	Soil	Grain Size Distribution % wt retained							Atterberg Limits %			B.D.	M.C.	D.D.	Specific	Shear Strength	
from	ed	Factor		Description	Clay	Silt	Sand			Gravel								Gravity	c kg/cm^2	ϕ
GL (m)	N	C_n	N_n	(Soil Group)			Fine	Medium	Coarse	Fine	Coarse	L.L.	P.L.	P.I.	gm/cc	%	gm/cc			degree
0.00	-	-	-	Clayey silt with sand	23.68	66.34	3.59	2.49	1.23	2.67	0.00	42	22	20	-	-	-	-	-	-
1.50	27	1.44	38.88	Clayey silt with sand	25.22	66.96	2.50	2.87	0.45	2.00	0.00	42	19	23	-	-	-	-	-	-
3.00	UDS	-	-	Clayey silt with sand	26.12	67.37	5.04	0.28	0.49	0.70	0.00	43	20	23	1.82	7.95	1.69	2.67	0.3	13.0
4.50	30	1.07	32.10	Clayey silt with sand	12.22	42.00	44.61	0.65	0.17	0.35	0.00	24	15	9	-	-	-	-	-	-
6.00	UDS	-	-	Clayey silt with sand	16.68	66.17	11.92	0.75	1.99	2.49	0.00	31	17	14	1.94	10.35	1.76	2.66	0.15	18.0
7.50	62	0.89	55.18	Clayey silt with sand	17.21	73.04	7.96	0.34	0.69	0.76	0.00	30	16	14	-	-	-	-	-	-
10.50	60	0.77	46.20	Silty Sand	2.14	5.04	91.10	1.57	0.15	0.00	0.00	23	NIL	NP	-	-	-	-	-	-
12.00	72	0.73	52.56	Silty Sand	2.33	6.51	87.26	3.25	0.65	0.00	0.00	22	NIL	NP	-	-	-	-	-	-

CONSULTING
Engineers Group Ltd.

BORELOG OF BH–1(LHS) AT EXISTING KM–291/4–8 FOR MINOR BRIDGE NO.–325 A,

ON KESARI TO SANEHWAL, LUDHIANA



LEGEND

SYMBOL	DESCRIPTION
	CLAYEY SILT WITH SAND
	SILTY SAND

CONSULTING Engineers Group Ltd.

CHAPTER – 73

"Minor Bridge No. 325B",

Location – Existing Km. - 289/08-10